Școala Națională de Studii Politice și Administrative
Facultatea de Administrație Publică
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SMART CITIES
ORAȘUL INTELIGENT

Sustainability and Innovation

PROCEEDINGS OF THE SMART CITIES
INTERNATIONAL CONFERENCE (SCIC)
11th Edition, 2023

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Orașul Inteligent

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Coordonator:

Conf. univ. dr. **Cătălin VRABIE**

PRO UNIVERSITARIA 2024
BUCUREȘTI

Editat de **Pro Universitaria SRL**, editură cu prestigiu recunoscut.
Editura **Pro Universitaria** este acreditată CNCS în domeniul Științelor Umaniste și CNATDCU (lista A2-Panel 4) în domeniul Științelor Sociale.

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ISBN 978-606-26-1935-0

Smart Cities (Print) ISSN 2501-1677 ISSN-L 2501-1677
Smart Cities (Online) ISSN 2972-1032 ISSN-L 2501-1677

Redactor:	Elena Onea
Tehnoredactor:	Victor-Ovidiu Căpriceru
Copertă:	Aurelian Leahu

Smart-EDU Hub
Faculty of Public Administration, SNSPA
Expozitiei blvd. no. 30A, 6th floor,
Bucharest,
Postal code: 012104, Romania
Tel. 0372-177182
e-mail: catalin.vrabie@snspa.ro
www.administratiepublica.eu

Redacție:
tel.: 0732.320.664
e-mail: editura@prouniversitaria.ro
Editura Pro Universitaria
www.prouniversitaria.ro

Librăria UJmag:
tel.: 0733.673.555; 021.312.22.21
e-mail: comenzi@ujmag.ro
Ujmag.ro
www.ujmag.ro

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Promisiunile Inteligenței Artificiale (AI) Administrației Publice și Orașelor Inteligente

Cătălin VRABIE
Școala Națională de Studii Politice și Administrative, București, Romania
catalin.vrabie@snspa.ro

Abstract
Tehnologiile de vârf precum Realitatea Virtuală (VR), Realitatea Augmentată (AR) și Inteligența Artificială (AI) sunt din ce în ce mai prezente în viața noastră, iar utilizarea lor în contextul guvernării electronice este un subiect de interes major pentru cercetători și decidenți politici deopotrivă. În ultimii ani, am asistat la o creștere exponențială a numărului de aplicații AI utilizate în guvernare, de la sisteme de votare electronice (offline sau online – adesea susținute de tehnologii blockchain) și platforme pentru administrarea serviciilor publice, până la programe de monitorizare a comportamentului cetățenilor și sisteme de identificare facială. Integrarea acestora în guvernarea electronică poate aduce numeroase beneficii, printre care: sporirea eficienței și transparenței în procesele administrative, îmbunătățirea calității serviciilor publice și creșterea accesului la informații publice. Cu toate acestea, există și preocupări legate de riscurile pentru viața privată a cetățenilor și potențialul impact negativ asupra drepturilor și libertăților individuale. Articolul "Promisiunile Inteligenței Artificiale (AI) Administrației Publice și Orașelor Inteligente" introduce o paradigmă disciplinară inovativă, centrată pe noțiunea de "smart governance" sau "guvernare inteligentă". Acest concept se distinge semnificativ de "guvernarea electronică" (frecvent denumită "e-government" sau "e-administrație"), punând accentul pe integrarea inteligenței artificiale în mecanismele de guvernare, și nu doar pe utilizarea tehnologiilor electronice pentru comunicare și arhivare. Pentru a fundamenta această abordare, articolul sintetizează selectiv cercetările relevante existente privind impactul inteligenței artificiale asupra proceselor guvernamentale și a relației cu cetățenii. De asemenea, ea explorează posibile strategii pentru minimizarea riscurilor asociate și pentru asigurarea unui echilibru între utilizarea inteligenței artificiale și protecția drepturilor cetățenești, încadrând aceste strategii în contextul politicilor publice destinate reglementării digitalizării și inteligenței artificiale.

Keywords: artificial intelligence, smart cities, digitalisation, technology, information.

1. Introducere
În ultimii ani, digitalizarea instituțiilor publice din România a devenit o prioritate strategică în cadrul procesului de modernizare a statului. Acest fenomen reprezintă o consecință a avansului tehnologic rapid și a dezvoltării noilor tehnologii, cum ar fi Inteligența Artificială (AI), care pot aduce numeroase beneficii procesului de guvernare.

Într-o lume tot mai interconectată, instituțiile publice se confruntă cu provocări complexe precum eficientizarea serviciilor, creșterea transparenței, luarea deciziilor bazate pe date și îmbunătățirea comunicării cu cetățenii. Digitalizarea instituțiilor publice și adoptarea tehnologiilor emergente oferă oportunități semnificative pentru abordarea acestor provocări.

Inteligența Artificială reprezintă un domeniu al informaticii care se ocupă cu crearea de sisteme și tehnologii care pot simula și reproduce funcțiile umane inteligente. În contextul instituțiilor publice din România, utilizarea Inteligenței Artificiale poate aduce multiple avantaje și îmbunătățiri în procesul de guvernare. În continuare sunt prezentate câteva motive care justifică utilizarea Inteligenței Artificiale în procesele de guvernare:

- Eficiență sporită. Tehnologiile AI precum automatizarea proceselor și roboții software, pot realiza sarcini repetitive și muncă manuală, permițând instituțiilor publice să se concentreze pe activități cu valoare adăugată mai mare.

- Luarea deciziilor bazate pe date. Inteligența Artificială poate ajuta la analizarea și interpretarea cantităților masive de date (Big Data) pe care instituțiile publice le dețin. Astfel, se pot lua decizii informate și se pot identifica tendințe și modele care pot sprijini procesul decizional.
- Servicii mai bune pentru cetățeni. Utilizarea AI în instituțiile publice poate duce la îmbunătățirea calității serviciilor oferite cetățenilor, prin personalizarea și adaptarea acestora la nevoile individuale. Chatbots înzestrați cu inteligență artificială pot oferi asistență și răspunsuri rapide la întrebările cetățenilor.
- Transparență și responsabilitate. Utilizarea tehnologiilor AI conduce la creșterea transparenței în procesul de guvernare deoarece oferă un cadru obiectiv și imparțial pentru luarea deciziilor. Algoritmii pot fi ajustați pentru a se asigura faptul că sunt respectate principii precum nediscriminarea și tratamentul corect al cetățenilor.
- Prevenirea fraudei și detectarea comportamentelor suspecte. Inteligența Artificială poate fi folosită pentru a identifica modele și a semnala anomalii în datele instituțiilor publice, contribuind la prevenirea fraudelor și la detectarea comportamentelor suspecte în timp real.

În contextul accelerat al digitalizării instituțiilor publice din România și al avansării tehnologice, inclusiv a inteligenței artificiale, guvernarea se confruntă cu oportunități semnificative pentru îmbunătățirea eficienței, transparenței și calității serviciilor oferite cetățenilor [1]. Este important să se facă distincția între "digitizare" și "digitalizare" pentru a se înțelege complexitatea transformării tehnologice în sfera publică. Dacă digitizarea se referă la conversia datelor și proceselor într-un format digital, digitalizarea va merge mai departe, având rolul de a transforma procesele și de a crea noi modele, adesea facilitată chiar de etapele de digitizare. Astfel, digitalizarea, mai ales în domeniul guvernării electronice și a orașelor inteligente, nu își propune doar să convertească sistemele existente într-un format digital, ci și să capitalizeze pe tehnologie pentru a revitaliza serviciile publice, a crește transparența și a stimula inovarea [2].

Afirmarea că sistemele informatice sunt "unelte" reprezintă cu o subestimare gravă a complexității și a potențialului lor. Asemenea unei analogii care compară un computer cu un simplu calculator, această simplificare nu captează întreaga gamă de funcționalități și capabilități ale tehnologiei moderne. Deși sistemele informatice pot funcționa ca unelte pentru diverse sarcini, inclusiv calcule, aceasta reprezintă doar o fracțiune mică a capacităților lor globale. Limitarea percepției lor la rolul de "unelte" este comparabilă cu utilizarea unui automobil exclusiv pentru ascultarea știrilor la radio, o utilizare care ignoră întreaga paletă de funcționalități și avantaje pe care le poate oferi tehnologia în contextul actual.

Rolul sistemelor informatice s-a extins semnificativ, depășind cu mult funcția de "unelte". Astăzi, un computer poate servi nu doar ca asistent, dar și ca manager în anumite contexte. În calitate de asistent, tehnologia poate gestiona agende, sorta și filtra e-mailuri, sau chiar asista în diagnosticarea medicală sau în procesul de educație prin algoritmi Deep Learning (DL) avansați. Sistemele de recunoaștere a limbajului uman permit asistenților virtuali să răspundă la întrebări și să efectueze sarcini, facilitând astfel viața utilizatorilor.

Mai mult decât atât, sistemele informatice pot acționa și ca manageri, coordonând și optimizând o serie de procese complexe. Un exemplu notabil este sistemul de semaforizare inteligentă care gestionează fluxul de trafic urban. Aceste sisteme nu doar că "administrează" mișcările vehiculelor (și deci a șoferilor) și pietonilor, dar le optimizează și pentru a reduce ambuteiajele și a îmbunătăți siguranța rutieră. În acest sens, computerul devine un manager eficient al resurselor și spațiului urban, demonstrând astfel o versatilitate și o complexitate care depășesc cu mult termenul redus de "unealtă".

Transformarea digitală și adoptarea Inteligenței Artificiale în instituțiile publice din România reprezintă o oportunitate strategică în modernizarea și eficientizarea proceselor de guvernare.

2. Fundamentare teoretică

2.1. Prezentarea domeniului

Investigarea literaturii de specialitate (dedicate administrației publice, impactului tehnologiei asupra eficientizării serviciilor publice și a creșterii legitimității proceselor de guvernare) a reprezentat un prim pas, esențial în elaborarea prezentului articol. Acest proces a implicat identificarea și analiza cercetărilor internaționale relevante domeniului științelor administrative și subdomeniului guvernării digitale/inteligente. Prin consultarea articolelor științifice, cărților, rapoartelor și documentelor de politici publice, s-a format o bază teoretică necesară analizei subiectului propus. Accesarea bazelor de date academice relevante domeniului științelor administrative și a platformelor online au ajutat la identificarea surselor relevante și actualizate în domeniul cercetat.

Domeniul de cercetare a Inteligenței Artificiale în contextul guvernării este un subiect vast și în continuă expansiune, care explorează utilizarea tehnologiilor AI pentru îmbunătățirea eficienței, transparenței și calității serviciilor publice. Acest domeniu multidisciplinar combină cunoștințe din informatică, știința datelor, etică, științe politice și administrative pentru a aborda provocările și oportunitățile asociate cu integrarea Inteligenței Artificiale în guvernare.

Cercetarea în domeniul Inteligenței Artificiale în guvernare se concentrează pe dezvoltarea și aplicarea algoritmilor și tehnologiilor Machine Learning (ML), Natural Language Processing (NLP), computer vision, roboți software și alte tehnici avansate pentru a sprijini procesele de guvernare și administrare publică. Această cercetare are drept scop îmbunătățirea luării deciziilor, eficientizarea serviciilor publice și creșterea participării și implicării cetățenilor în procesul de guvernare.

Câteva direcții de cercetare importante în domeniul Inteligenței Artificiale în contextul guvernării includ:

- Automatizarea proceselor administrative. Utilizarea algoritmilor și roboților software pentru a automatiza și eficientiza procesele administrative și birocratice în instituțiile publice. Acest lucru poate include procesarea automată a documentelor, gestionarea bazelor de date, monitorizarea și raportarea datelor etc.
- Asistența virtuală și chatbots. Dezvoltarea de asistenți virtuali și chatbots bazați pe Inteligența Artificială pentru a răspunde întrebărilor cetățenilor, a oferi informații

și asistență personalizată în timp real. Aceste tehnologii pot fi utilizate pentru a facilita accesul la serviciile publice și a crește interacțiunea cu cetățenii.

- Analiza și luarea deciziilor bazate pe date. Utilizarea Inteligenței Artificiale pentru a analiza și interpreta volume mari de date în scopul identificării modelelor, tendințelor și informațiilor relevante. Aceasta poate sprijini procesul decizional în guvernare, asigurând o bază mai solidă pentru luarea deciziilor informate.
- Transparență și responsabilitate. Integrarea Inteligenței Artificiale în procesul de guvernare poate contribui la creșterea transparenței prin furnizarea de informații clare și accesibile cetățenilor. De asemenea, poate asigura responsabilitatea prin monitorizarea și auditarea deciziilor algoritmice pentru a preveni discriminarea sau tratamentul inechitabil al cetățenilor.
- Participarea și implicarea cetățenilor. Utilizarea tehnologiilor de Inteligență Artificială pentru a stimula participarea cetățenilor în procesul de guvernare și luarea deciziilor. Aceasta poate implica dezvoltarea de platforme de participare online, co-crearea de politici publice și implicarea cetățenilor în monitorizarea serviciilor publice.

Acestea sunt doar câteva aspecte ale cercetării în domeniul Inteligenței Artificiale în guvernare. Cercetătorii explorează continuu noi aplicații, tehnici și abordări pentru a îmbunătăți procesele de guvernare și a aduce beneficii semnificative pentru cetățeni și instituțiile publice.

În ultimele decenii, transformarea digitală a instituțiilor publice și utilizarea Inteligenței Artificiale au devenit teme centrale în domeniul guvernării. Această evoluție a fost susținută de cercetări și studii care evidențiază beneficiile și provocările asociate utilizării AI în guvernare. Astfel, unul dintre specialiștii de top ai guvernării electronice – Frank Bannister, profesor la Trinity College din Dublin și fost președinte al panelului de lucru tematic “e-Government” din cadrul “European Group for Public Administration (EGPA)”, argumentează încă din 2010 în lucrarea sa “Deep E-Government: Beneath the Carapace”, că integrarea digitală este esențială pentru o societate guvernată eficient [3]. De asemenea, Darrell West – director a “Governance Studies program” din cadrul Brookings Institution, subliniază în studiul său din 2005, “Digital Government: Technology and Public Sector Performance”, că tehnologiile digitale pot îmbunătăți performanța sectorului public și pot aduce beneficii semnificative cetățenilor [4].

Utilizarea AI în guvernare a captat interesul cercetătorilor din întreaga lume, astfel, companii precum Intel, explorează în cercetările lor viitorul guvernării bazate pe AI și evidențiază oportunitățile și provocările asociate cu această evoluție [5]. Zuiderwijk et al. efectuează o analiză a literaturii de specialitate asupra utilizării AI în guvernare și servicii publice, identificând în rândul titlurilor studiate multiple aplicații și beneficii în acest cadru [6].

AI are potențialul de a transforma modul în care instituțiile publice furnizează servicii cetățenilor. Arthur Mickoleit, Analyst Director la Gartner (2023) examinează în lucrarea sa “Top Technology Trends in Government”, utilizarea AI, cu precădere Machine Learning (ML), în guvernare, evidențiind beneficiile aduse în eficiența serviciilor și în luarea deciziilor [7]. De asemenea, Irina Moroianu Zlătescu, Carnegie Council alături de alți

cercetători și instituții de top din sfera științelor juridice analizează provocările etice și perspectivele utilizării AI în sectorul public, subliniind importanța unui cadru etic și legal robust [8, 9, 10, 11, 12, 13] în timp ce Vătămănescu și Brătianu alături de alți cercetători români, le analizează pe cele derivate din conceptul de sustenabilitate [14, 15].

În timp ce AI aduce o serie de avantaje, există și provocări semnificative în implementarea și utilizarea acesteia în guvernare. Un raport al World Bank evidențiază faptul că progresele în guvernare digitală nu sunt lipsite de provocări [16]. Göran Smith și Johan Sandberg au analizat, încă din 2018, în lucrarea lor "Barriers to innovating with open government data: Exploring experiences across service phases and user types" [17], obstacolele și provocările guvernării prin date deschise, evidențiind importanța abordării corecte a acestor aspecte. Bârgăoanu, în volumul "#FAKENEWS. Noua cursă a înarmării", ca și în alte articole științifice [18, 19, 20] precum și Buturoiu & Corbu în articolul "Exposure to Hate Speech in the Digital Age" [21] ne fac atenți asupra pericolelor știrilor false și instigării la ură folosind platformele social-media – pericole asupra cărora numai înzestrați cu instrumente AI putem lupta [22, 23].

În continuarea celor de mai sus, vizând tensiunile generate de AI, autorii Madan și Ashok [24] introduc modelul TOE (Technology-Organisational-Environmental) ale cărui variabile contextuale și capacitatea de absorbție sunt considerate ca factori ce influențează adoptarea AI în administrația publică.

Literatura din domeniul managementului public sugerează că aplicațiile de inteligență artificială și knowledge management pot aborda aceste provocări și pot contribui la generarea și menținerea unei bune guvernări [25, 26, 27, 28]. Mai mult, AI poate spori transparența și responsabilitatea, precum și crește participarea și implicarea cetățenilor [29, 30]. Ibtissem et al. a utilizat metode statistice avansate pentru a investiga provocările cu care se confruntă economiile emergente în abordarea problemelor de guvernanță precară în serviciile publice [31]. Astfel, AI are potențialul de a transforma managementul public și guvernarea, ajutând autoritățile publice să răspundă mai bine așteptărilor cetățenilor și să îmbunătățească încrederea în serviciile guvernamentale. De asemenea, Straub et al. [32] apreciază verosimilitatea impactului progreselor AI în îmbunătățirea activității guvernamentale.

Analiza studiilor prezentate în *Sustainability* (2020-2023), *Government Information Quarterly* (2020-2023) și *International Journal of Web Services Research* (2020-2023), se poate concluziona că mare parte din accent se pune pe e-guvernare în general și mai puțin pe utilizarea tehnologiilor de vârf (AI, ML, NLP, RPA/IPA) pentru îmbunătățirea proceselor de guvernare. Cu toate astea trendul ascendent al cercetărilor din domeniu arată importanța implementării inteligenței artificiale în procesele administrației publice. Studiile realizate și publicate în jurnalele științifice menționate demonstrează aplicabilitatea AI în guvernare și impactul ei asupra eficienței și luării deciziilor. În același timp, provocările etice și legale asociate cu utilizarea AI în guvernare sunt și ele identificate și abordate.

"European Union AI Act" – primul cadru legal al folosirii AI [33], abordările EU "High-Level Expert Group" [34] precum și "OECD Framework for the Classification of

AI Systems" [35] sunt documente ce au ca scop reglementarea adoptării și utilizării tehnologiilor de inteligență artificială la nivel global și european. Acestea reflectă o preocupare crescândă pentru stabilirea unor norme și standarde care să ghideze dezvoltarea responsabilă și etică a noilor tehnologii dorindu-se diminuarea și temperarea tensiunilor generate de AI.

Această fundamentare teoretică oferă o bază solidă pentru înțelegerea și analizarea rolului și impactului AI în guvernare și are puterea de a stimula cercetările viitoare în acest domeniu în continuă dezvoltare.

2.2. Concepte teoretice și modele existente

Îmbinând noțiunea de guvernare digitală cu utilizarea AI și procesul de digitalizare, acest capitol explorează conceptele teoretice și modelele existente în domeniul guvernării asistate de inteligența artificială și digitalizare în general. Se va evidenția importanța acestora în procesele de guvernare și se vor examina exemple concrete care demonstrează aplicabilitatea lor.

Guvernarea digitală. Guvernarea digitală reprezintă un concept central în era tehnologiei digitale. Ea se concentrează pe utilizarea tehnologiilor informaționale și de comunicare pentru a transforma procesele de guvernare și a îmbunătăți relația dintre instituțiile publice și cetățeni. Acest concept evidențiază importanța utilizării tehnologiilor digitale pentru creșterea eficienței, transparenței și participării cetățenilor în procesele de guvernare [36, 37].

Digitalizarea instituțiilor publice. Procesul de digitalizare a instituțiilor publice reprezintă o componentă esențială în modernizarea serviciilor publice. Aceasta implică transformarea documentelor și a proceselor fizice în formate electronice, facilitând astfel accesul rapid și eficient la informații și servicii. Digitalizarea permite, de asemenea, automatizarea unor sarcini și procese reducându-se, pe de o parte, birocrația și pe de altă parte procesul poate conduce la o creștere a eficienței în furnizarea serviciilor publice [38].

Smart governance. Utilizarea Inteligenței Artificiale în guvernare reprezintă o evoluție semnificativă în procesele de luare a deciziilor și furnizare a serviciilor publice. AI poate sprijini instituțiile publice în identificarea și analiza modelelor complexe de date, oferind astfel baza pentru luarea deciziilor informate. De asemenea, AI poate automatiza sarcinile administrative și poate îmbunătăți interacțiunea cu cetățenii prin asistență virtuală și chatbots [39, 40, 41].

E-guvernare (ca model). Conceptul de e-guvernare se referă la utilizarea tehnologiei informației și comunicațiilor pentru a facilita și îmbunătăți interacțiunea dintre cetățeni și instituțiile publice. Prin intermediul portalurilor online, platformelor de participare și serviciilor electronice, cetățenii pot accesa rapid informații și pot interacționa cu autoritățile publice. Aceste modele de e-guvernare permit o administrare mai eficientă și o comunicare mai transparentă între cetățeni și guvern [42, 43, 44, 45, 46].

Smart City și Smart Governance. Conceptul de Smart City sau oraș inteligent implică utilizarea tehnologiilor digitale și AI în gestionarea și furnizarea serviciilor la nivel urban. Prin intermediul sistemelor de gestionare a traficului, monitorizării mediului și serviciilor

publice inteligente, administrațiile pot îmbunătăți calitatea vieții cetățenilor și eficiența administrării urbane. Aceste modele de guvernare inteligentă (smart governance) au ca scop crearea unor orașe sustenabile și eficiente din punct de vedere al resurselor [47, 36, 48, 49, 50, 51].

Asistență virtuală. Asistența virtuală și chatbots bazați pe AI sunt exemple concrete de utilizare a tehnologiei pentru a oferi asistență și informații cetățenilor. Aceste instrumente pot răspunde întrebărilor, oferi ghidare și sprijin în diverse domenii, precum serviciile publice, asistența juridică sau informațiile administrative. Utilizarea asistenței virtuale și a chatbots-ilor în procesul de guvernare poate reduce timpul folosit și efortul depus pentru a obține informațiile necesare și îmbunătăți interacțiunea cu cetățenii [41, 52, 53].

Conceptele teoretice și modelele existente în guvernarea asistată de Inteligența Artificială și digitalizare în general demonstrează importanța și potențialul transformator al acestor tehnologii în procesele de guvernare. Guvernarea digitală, Inteligența Artificială, digitalizarea instituțiilor publice și modelele de e-guvernare, guvernare inteligentă și utilizarea asistenței virtuale și chatbots de către administrația publică reprezintă direcții importante pentru creșterea eficienței, transparenței și participării cetățenilor în procesele de guvernare.

Deși există deja modele și exemple de succes ale digitalizării și implementării AI în guvernare, este important să se continue cercetările și dezvoltarea de aplicații în acest domeniu. Este necesară o abordare atentă și responsabilă în ceea ce privește aspectele etice, protecția datelor și securitatea informațiilor în contextul utilizării AI în guvernare.

Pe măsură ce tehnologiile continuă să avanseze și se dezvoltă noi paradigme ale guvernării digitale, este esențial ca autoritățile publice să fie deschise și flexibile în adoptarea și adaptarea acestor inovații. Cooperarea și colaborarea între sectorul public, mediul academic și sectorul privat sunt esențiale pentru a asigura dezvoltarea și implementarea responsabilă a soluțiilor de digitalizare bazate pe AI în guvernare.

Conceptele teoretice și modelele existente în domeniul guvernării asistate de Inteligența Artificială și digitalizare în general oferă perspective promițătoare pentru îmbunătățirea proceselor de guvernare și serviciilor publice. Utilizarea eficientă a AI și digitalizării poate duce la o guvernare mai eficientă, transparentă și orientată către cetățeni. Cu toate acestea, este necesară o abordare echilibrată și responsabilă, luând în considerare aspectele etice, juridice și sociale pentru a asigura o transformare pozitivă și sustenabilă a guvernării.

3. Rezultatele procesului de analiză și dimensiunea lor în contextul temei abordate

Pentru a înțelege complexitatea transformărilor digitale și folosirea tehnologiilor de vârf, așa cum este Inteligența Artificială, trebuie avut în vedere traseul parcurs de conceptul studiat de-a lungul dezvoltării sale. În acest sens trebuie evidențiat faptul că inteligența nu se rezumă doar la capacitatea noastră, sau mai nou, la cea a computerelor pe care le utilizăm, ci că ea există mai întâi sub forma inteligenței colective, care reprezintă în esență manifestarea inteligenței în grupuri de indivizi [54, 40, 55].

Pornind de la definiția inteligenței[1] [56] și încercând să o definim mai departe pe cea colectivă putem spune despre aceasta din urmă că este caracteristică grupurilor de indivizi care acționează colectiv într-o manieră inteligentă. Se poate astfel trage concluzia că această formă de inteligența există de foarte mult timp: armate, instituții publice sau private, guverne, familii etc., toate acestea fiind exemple de grupuri de oameni care lucrează împreună în moduri care, cel puțin uneori (!), par inteligente [54].

În ultimii ani totuși, s-au putut observa câteva tipuri foarte noi de inteligență colectivă. Apariția acestora a fost potențată, evident, de capacitățile hardware și software tot mai versatile a computerelor. Google de exemplu, este un serviciu folosit de milioane de oameni din întreaga lume care au creat pagini web și, cu ajutorul link-urilor le-au "legat" pe acestea între ele. Aceste pagini conțin informații, iar Google, prin tehnologiile de care dispune, le colectează pe toate astfel încât, atunci când utilizatorul introduce un cuvânt sau o expresie în bara de căutare, răspunsurile pe care le returnează (lăsând la o parte viteza cu care o face) sunt adesea deosebit de inteligente. Wikipedia, de asemenea; mii de oameni din întreaga lume au creat în mod colectiv un produs deosebit de valoros – atât prin volum cât și prin calitate, fără un control centralizat și, în cele mai multe cazuri, într-o manieră voluntară.

Anii/deceniile care urmează vor etala multe alte exemple ale acestor tipuri de inteligență colectivă. Dacă am dori să prezicem ce se va întâmpla, și mai ales dacă dorim să profităm de avantajele tehnologiei, trebuie înțelese aceste posibilități mult mai profund decât până acum. Cercetătorul Andy Clark spune în volumul său "Natural-Born Cyborgs: Minds, Technologies, and the Future of Human Intelligence" [39] că omul a devenit de ceva vreme "cyborg, dar nu în sensul superficial [n.a. prezentat de literatura SF] în care corpul biologic se îmbină cu elemente de tehnologie [n.a. deși această ipoteză începe să fie și ea din ce în ce mai des testată [57]], ci într-un sens mult mai profund, și anume acela de a fi în simbioza om-tehnologie în care sistemele de gândire și raționament sunt răspândite atât în creierul biologic cât și în circuitele non-biologice".

Așa cum a fost menționat, demersul acestui studiu, are ca scop principal răspunsul la întrebarea: "Cum pot fi conectați oamenii cu tehnologia astfel încât, în mod colectiv, acțiunile acestor entități de lucru să fie mai inteligente decât ale oricărei persoane, grup de persoane, computer sau rețele de computere întreprinse vreodată?". Nu este deloc o întrebare ușoară și, în urma analizelor făcute, s-a observat că există cel puțin două răspunsuri. Unul ar fi dat de conectarea oamenilor între ei în moduri noi, bazate evident pe tehnologie, astfel încât aceștia să poată acționa mai inteligent ca grup. Mai există însă un mod, care se poziționează central în acest articol, și anume conectarea oamenilor la sisteme înzestrate cu tehnologii de vârf.

Pentru a alinia tehnologia cu nevoile umane și organizaționale, este important să fie adoptate următoarele strategii și tactici:

- Strategii și politici clare. Instituțiile trebuie să dezvolte strategii și politici clare care să orienteze utilizarea tehnologiei (cu precădere AI) în conformitate cu

[1] Capacitatea de a înțelege ușor și bine, de a sesiza ceea ce este esențial, de a rezolva situații sau probleme noi pe baza experienței acumulate anterior.

obiectivele și valorile instituției. Acestea ar trebui să includă orientări cu privire la etica și transparența folosirii lor, precum și la responsabilitatea organizației/instituției pentru consecințele utilizării tehnologiei [38, 58, 13].

- Implicarea oamenilor. Este important ca oamenii să se implice în procesul de creare și implementare a tehnologiilor de vârf, deoarece aceștia pot oferi o perspectivă importantă asupra nevoilor individuale și instituționale. Implicarea acestora ar putea fi făcută în etapele de planificare, dezvoltare și evaluare a tehnologiilor AI [59, 60].
- Îmbunătățirea accesibilității. Tehnologiile ar trebui să fie concepute și dezvoltate pentru a fi accesibile și ușor de folosit de către toți utilizatorii, inclusiv cei cu nevoi speciale. Acest lucru ar putea implica dezvoltarea de interfețe de utilizator prietenoase și soluții personalizate pentru a răspunde nevoilor individuale [61].
- Obiective și evaluări robuste. Obiectivele, alături de evaluările făcute în vederea atingerii acestora, trebuie să fie riguroase și să ia în considerare nevoile și perspectivele umane și instituționale. Trebuie să fie dezvoltate și evaluate folosind open data și să includă mecanisme de feedback pentru a se asigura că tehnologia răspunde în continuare nevoilor instituției și mediului căreia i se adresează [62, 63].
- Stimulente financiare. Statul trebuie să ofere stimulente financiare pentru dezvoltarea și implementarea tehnologiilor de vârf care să răspundă nevoilor umane și instituționale. Aceste stimulente ar putea include subvenții pentru cercetare și dezvoltare, pentru implementare și reduceri fiscale pentru organizațiile și instituțiile care utilizează asemenea tehnologii în mod responsabil și eficient [64, 65].

În general, este importantă recunoașterea faptului că tehnologiile de vârf trebuie să fie dezvoltate și utilizate în mod responsabil luându-se în considerare nevoile și perspectivele umane și instituționale. Prin adoptarea acestor măsuri și oferirea de stimulente, instituțiile publice se pot asigura că tehnologiile folosite sunt și vor fi aliniate cu obiectivele și valorile lor răspunzând nevoilor mediului căruia li se adresează.

3.1. Concepte teoretice și modele existente

Termenul "Inteligență Artificială" este deosebit de greu de definit. Uneori este folosit pentru a explica lucruri greu de realizat de computere, cum ar fi participarea la un dialog verbal – desi, de curând, inițiativa celor de la OpenAI de a crea aplicația ChatGPT s-a bucurat de un imens succes [66], succes ce poate conduce la opinia că o astfel de sarcină ar fi trivială (nimic mai greșit!!), spre deosebire de lucruri pe care deja știm că acestea le fac excelând, precum calculul tabelar. În ultimul timp, din pricina "modei AI", firmele care activează în domeniul IT își promovează cele mai noi produse folosindu-se de acest termen pentru a evidenția aproape orice pot face computerele, inclusiv operarea bazelor de date tradiționale.

Conceptul, deși des întâlnit în mass-media și discuții colocviale – lăsând astfel impresia că este bine înțeles, nu-și găsește ușor o definiție corectă, indiscutabilă. Există însă multe definiții concurente ce vizează, printre altele, aptitudinea pentru logică și înțelegere, abilitatea de a planifica, dezvoltarea afectului și a conștiinței, creativitatea, rezolvarea problemelor și, poate mai presus ca toate celelalte, capacitatea de a învăța.

Howard Gardner, psiholog și profesor la Universitatea Harvard, care și-a dedicat cariera profesională investigării modurilor în care indivizii abordează și rezolvă diverse probleme cu care se confruntă, a definit inteligența umană ca fiind abilitatea de a rezolva probleme apărute în unul sau mai multe cadre culturale date [67]. Într-un contrast absolut, cuvântul "artificial" este destul de clar, el însemnând ceva ce nu apare ca fiind un fenomen natural – așa cum este totuși inteligența (neluând în calcul și posibilitatea cultivării ei), ceea ce trimite cu gândul la un oximoron .

Informal însă, așa cum a fost menționat anterior, cei mai mulți dintre utilizatorii tehnologiilor computaționale, folosesc termenul de "inteligență artificială" făcând referire, în general, la acele activități care sunt dificil de executat de către computere (precum înțelegerea limbajului vorbit sau găsirea drumului optim într-o hartă dinamică) prin contrast cu cele la care știu că acestea excelează (precum calcule de înaltă precizie sau contabilitate).

Trebuie totodată făcută distincția între ceea ce se numește "Narrow AI"[2] și "General AI"[3]. Primul concept se bazează pe sisteme de calcul construite pentru a rezolva sarcini specifice – care au la bază reguli clare și un cadru delimitat (cum ar fi un sistem capabil să joace șah sau Go) [63, 68, 69]. Termenul "General AI" se referă însă la sisteme care au abilitatea de a rezolva singure probleme de natură diferită [70, 71, 72] așa cum, de altfel, o fac și oamenii. Până în acest moment toate aplicațiile din domeniul inteligenței artificiale, chiar și cele mai avansate dintre acestea, precum recunoașterea imaginilor, procesarea limbajului uman sau cele folosite de vehiculele autonome, sunt din zona de "Narrow AI". Cu toate că subiectul "General AI" și cercetarea din acest domeniu este de foarte mare interes științific, se pare că mai sunt încă mulți ani, dacă nu decenii, până la implementarea cu succes a unor astfel de aplicații.

Pentru mulți cercetători, gândirea modernă despre sistemele inteligente a început când Alan Turing a scris în 1950 celebrul său articol intitulat "Computing Machinery and Intelligence" [73]. De atunci, calculatoarele s-au îmbunătățit atât de mult încât astăzi apar dificultăți în a identifica evenimente ori acțiuni în care omul se poate angaja și care să nu fie asistate de acestea. Concepte precum Machine Learning (ML), Natural Language Processing (NLP) și Robotică nu mai reprezintă limitele lumii științifice. Netflix știe ce filme și seriale vor utilizatorii să urmărească, Amazon știe când și unde își fac clienții cumpărăturile, iar Google știe ce caută internauții. Cele mai influente corporații globale, precum Amazon, Apple, Meta/Facebook și Alphabet (compania-mamă a Google), recurg la utilizarea inteligenței artificiale în marea majoritate a operațiunilor lor. De fapt, majoritatea se bazează pe AI ca pe un instrument pivotant în procesul lor de transformare [74]. Altele, cele a căror activitate nu este direct legată de tehnologie, folosesc deja pe scară largă inteligența artificială pentru a-și îmbunătăți ciclurile de producție sau pentru a câștiga mai multă eficiență în procesele de management [75, 76].

[2] Notat de regula cu acronimul "AI".
[3] Regăsit sub acronimul "AIG" – Artificial General Intelligence.

Recent, organizații din sectorul public au început să folosească aplicații de Robotic Process Automation pentru a gestiona sarcinile repetitive și a reduce erorile umane [77]; analiza video[4] este utilizată tot mai mult pentru a supraveghea traficul și a identifica comportamente greșite [78]; senzorii și dispozitivele IoT sunt plasați peste tot în orașe pentru a colecta date [47]. În spatele acestor operațiuni stau întotdeauna aplicații de inteligență artificială.

Cererea de servicii publice crește continuu, iar orașele se confruntă cu o tot mai gravă lipsă de forță de muncă [79]; organizațiile publice se luptă să răspundă prompt și eficient așteptărilor tot mai mari ale cetățenilor; avansul în tehnologia mobilă a deschis ușa serviciilor la cerere prin diferite aplicații și platforme, precum și un nou tip de livrare prin interacțiuni la distanță, accesibile oriunde și oricând [80, 81]. Astfel de servicii sunt utile deoarece reduc costurile și evită cheltuielile inutile.

Cu toate că cercetarea în domeniu are o tradiție destul de îndelungată, dezvoltarea rapidă a instrumentelor și tehnologiilor AI (aplicabile organizațiilor din sectorul public, orașelor și guvernelor în ansamblu), a fost posibilă prin combinarea perfectă a (1) îmbunătățirii puterii de procesare a computerelor cu (2) apariția bazelor mari de date (big data) și, nu în ultimul rând, cu (3) un efort intelectual deosebit venit din partea cercetătorilor din domeniu. Din mixarea acestor ingrediente a rezultat o schimbare semnificativă în ceea ce privește acceptarea tehnologiei AI și influența acesteia asupra societății.

Tehnologiile bazate pe date și calcule au crescut într-un ritm exponențial – legea lui Moore [82], care explică dezvoltarea exponențială a performanței computerelor, este probabil cea mai citată din domeniu. În mod similar, aplicațiile orientate către consumatori au cunoscut o creștere rapidă prin furnizarea de servicii la costuri reduse. Digitalizarea datelor publice ar putea duce la un model de dezvoltare asemănător în instituțiile publice și orașe, pe măsură ce procesarea acestor date devine mai puțin costisitoare. În continuarea acestor idei, Bill Gates[5] a postulat următoare lege – cunoscută astăzi ca "Legea Gates": "oamenii tind să exagereze dezvoltarea tehnologiei pe termen scurt în timp ce o subestimează pe termen lung" [83].

3.1. Concepte teoretice și modele existente

3.3.1. Instrumente regăsite în sfera digitalizării

Digitalizarea implică mai întâi conversia informațiilor din format fizic în format digital (digitizare) și apoi utilizarea tehnologiilor digitale pentru a simplifica și îmbunătăți procesele [84, 85]. Ea include:

- Transformarea Digitală. Reimaginarea proceselor și serviciilor prin utilizarea tehnologiei digitale [15].
- Cloud Computing. Stocarea și procesarea datelor pe servere la distanță, accesibile prin internet [86].
- Big Data. Colectarea, stocarea și analiza unor volume mari de date pentru a obține informații utile [87].

[4] Termen regăsit în literatura tehnică de specialitate sub denumirea "computer vision".
[5] Este vorba despre fondatorul companiei Microsoft.

- Internet of Things (IoT). Conectarea dispozitivelor fizice la internet pentru colectarea și schimbul de date [88, 89].
- Securitate Cibernetică. Protejarea sistemelor, rețelelor și aplicațiilor software de atacuri digitale.

3.3.2. Instrumente regăsite în sfera inteligenței artificiale

Pentru o mai bună înțelegere a realizărilor științifice semnificative și de actualitate din domeniu, în continuare sunt redate cu titlu explicativ instrumentele folosite de inteligența artificială.

- Machine Learning (ML). Acest domeniu are în vedere modele de învățare automată pentru a prezice, modela sau înțelege date. Unele dintre cele mai importante tehnici de ML sunt: Unsupervised learning – când mașinile[6] învață singure având acces la date, Supervised learning – când oamenii, folosind exemple, furnizează răspunsuri corecte mașinilor astfel încât acestea să poată învăța mai rapid și Reinforcement Learning – atunci când mașinile efectuează sarcini care schimbă structura naturii / realității și primesc recompense (ori sunt penalizate) după ce rezultatul este măsurat. Tehnologiile ML combinate, ce folosesc rețele neuronale (denumite astfel după modelul celor aflate în creierul uman) sunt numite tehnologii Deep Learning și reprezintă, în acest moment, apogeul realizărilor din domeniul tehnologiilor computaționale.
- Natural Language Processing (NLP). Acest domeniu, devenit astăzi foarte cunoscut grație inițiativei companiei OpenAI de a dezvolta ChatGPT, se concentrează pe înțelegerea și generarea limbajelor naturale astfel încât fluența și flexibilitatea rezultatelor să se apropie de un dialog între oameni reușind astfel să treacă celebru test Turing [90].
- Robotica și Robotic/Intelligent Process Automation (RPA/IPA). Această tehnologie este utilizată pentru automatizarea sarcinilor repetitive atât în fluxul documentelor precum și a altor operațiuni care sunt efectuate ca activități suport în instituții.

Inteligența artificială este componentă a digitalizării fiind astfel profund interconectată cu aceasta și având menirea de a amplifica și facilita progresul în domeniu. Împreună, acestea sunt forțe motrice ale inovației și transformării în societatea modernă, raporturile dintre ele putând fi regăsite astfel (Figura 1):

Complementaritate: AI este adesea utilizată pentru a analiza și interpreta datele generate și colectate prin procesele de digitalizare. De exemplu, algoritmii de ML pot identifica pattern-uri și insight-uri din seturi mari de date (Big Data) colectate prin digitalizare [91, 92].

Inovație: Digitalizarea facilitează dezvoltarea și implementarea soluțiilor de AI, oferind infrastructura necesară (cum ar fi cloud computing și IoT) pentru a rula aplicații complexe de AI [93, 94].

[6] Termen folosit aici pentru a sublinia ideea de manipulare și procesare mecanică a informațiilor spre deosebire de abilitatea omului de a face același lucru grație intuiției și creativității cu care a fost înzestrat de natură.

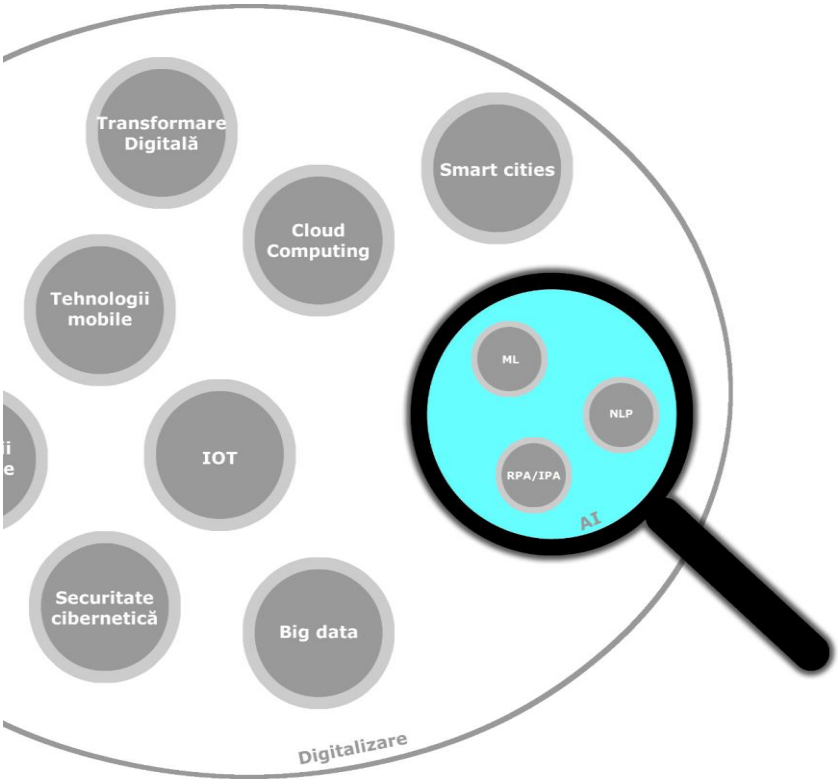

Fig. 1. Sferele noțiunilor de AI și digitalizare
Sursa: autorul

Transformare: AI și digitalizarea lucrează împreună pentru a transforma industrii întregi, de la sănătate și educație până la transport și administrație publică, prin automatizare, eficiență crescută și noi modele de afaceri [95].

Interdependență: Progresele într-un domeniu pot stimula inovații în celălalt. De exemplu, dezvoltările în NLP pot îmbunătăți interfețele utilizator în aplicațiile digitalizate, făcând tehnologia mai accesibilă și mai ușor de utilizat.

3.3.3. Posibile implementări ale Inteligenței Artificiale în instituții publice și orașe inteligente

Petiționarea

Strâns legat de libertatea de exprimare precum și de conceptul de responsabilitate politică, dreptul de a petiționa se află la baza democrațiilor locale [96, 97]. În timp ce municipalitățile își propun să devină mai participative și deschise cetățenilor, acestea creează facilități pentru a interacționa prin Internet.

Petiționarea electronică, de exemplu, este una dintre acele instrumente ușor de utilizat, folosite în prezent în întreaga lume, atât în administrațiile locale, cât și în cele centrale. Este adevărat că, în prezent, multe organizații publice folosesc rețelele sociale pentru a interacționa cu comunitățile lor și multe plângeri, comentarii sau sugestii sunt adresate de

cetățeni prin intermediul Twitter, Facebook și alte asemenea platforme. Inteligența artificială poate ajuta și în aceste cazuri, oferind răspunsuri scurte sau alertând autoritatea să răspundă. Cu toate acestea, în majoritatea cazurilor, comunicarea pe rețelele sociale nu are consecințe legale în multe instanțe administrative (de exemplu, dacă un cetățean ridică o plângere, aceasta nu este considerată oficială, așa cum se întâmplă în cazul petițiilor). Din acest motiv petiționarea este o problemă posibil a fi rezolvată de inteligența artificială [98, 99, 100].

Cetățenii se așteaptă ca autoritățile publice să fie prompte, axate pe excelență și eficiente. În timp ce nivelul de încredere în administrații continuă să scadă în întreaga lume [101], se cere o infrastructură mai bună, servicii mai calitative și un leadership adaptabil. Odată cu creșterea nevoilor, bugetele publice se confruntă cu constrângeri serioase, efect care, coroborat cu lipsa personalului sau slaba lui calificare, duce la întârzieri lungi în prezentarea de soluții eficiente. Și aceasta este o problemă posibil a fi rezolvată de aplicații AI care vor conduce la o creștere a calității actului de guvernare. În cazul specific al petițiilor online, AI poate oferi ajutor în trierea lor, poate da răspunsuri automate la anumite întrebări și decide care petiții necesită o analiză mai detaliată a unui departament specializat. De asemenea, poate ajuta în luarea deciziilor prin furnizarea, la cerere, a unor dovezi pentru un răspuns mai cuprinzător, în conformitate cu reglementările naționale sau internaționale existente [52, 102, 103].

AI poate filtra petițiile pentru a verifica eligibilitatea acestora (e.g., dacă au fost formulate adecvat și adresate autorității potrivite), pentru a compara subiecte și pentru a măsura eficiența organizațională (e.g., timpul petrecut pentru a răspunde la diferite întrebări și resursele alocate). În efectuarea acestor sarcini, aplicațiile înzestrate cu inteligență artificială economisesc timp, energie și resurse. În plus, ele pot utiliza funcții de comparare pentru a facilita navigarea printre reglementările ce ar putea fi importante pentru furnizarea unui răspuns oficial corect și complet [53, 104] limitând astfel redundanța și pierderea timpului.

Aplicațiile AI pot identifica urgențele în textele petițiilor (prin sentiment analysis – vom reveni la acest tip de aplicații) și, în consecință, declanșa reacții mai rapide din partea administrațiilor crescând astfel nivelul de încredere în autoritățile publice [105, 41].

În susținerea acestor idei, autorul prezentului articol a redactat și publicat studiul “E-Government 3.0: An AI Model to Use for Enhanced Local Democracies" [41] care demonstrează aplicabilitatea tehnologiilor ML și NLP în petiționarea electronică.

Tehnologii AI în Serviciul Public de Sănătate

Tehnologiile AI au început să joace un rol semnificativ în transformarea serviciilor publice, inclusiv în domeniul sănătății. Aplicabilitatea acestora în serviciul public de sănătate, de la diagnosticare și tratament până la gestionarea resurselor și optimizarea fluxurilor de lucru este deja bine cunoscută fiind o zona de intensă cercetare științifică [106, 107]. Într-o eră în care sistemele de sănătate sunt supuse presiunilor crescânde, fie din cauza pandemiilor, fie a îmbătrânirii populației, AI oferă oportunități inovatoare pentru îmbunătățirea eficienței și eficacității. În continuare vor fi etalate câteva cazuri concrete de utilizare precum și impactul acestora în societate. Scopul este de a furniza o perspectivă cuprinzătoare asupra modului în care AI poate servi ca un instrument valoros pentru inovație și îmbunătățirea calității serviciilor de sănătate publică.

Algoritmii AI sunt deja folosiți în spitale pentru sarcini specializate, cum ar fi identificarea problemelor cardiace prin intermediul electrocardiogramelor, a retinopatiei diabetice prin examinarea oculară și chiar a cancerului pulmonar și mamar [108].

Google evaluează un sistem AI conceput pentru a răspunde întrebărilor medicale prin intermediul unui chatbot numit Med-PaLM 2 [109], și despre care speră să fie mai eficient în conversații medicale decât algoritmii cu aplicabilitate generală (așa cum sunt cei folosiți de ChatGPT), având în vedere că acesta a fost antrenat cu întrebări și răspunsuri din medicină.

Med-PaLM 2 poate fi utilizat pentru a oferi răspunsuri la întrebări medicale și pentru a îndeplini o varietate de sarcini, cum ar fi sumarizarea documentelor sau organizarea datelor medicale de volum mare. Studiile întreprinse de companie arată că medicii care au examinat răspunsurile date de Med-PaLM 2 la peste 1,000 de întrebări medicale puse de pacienți au confirmat acuratețea acestora în 8 din cele 9 categorii de evaluare.

Pe lângă Google, Microsoft intenționează de asemenea să dezvolte un asistent virtual care să răspundă la întrebările medicale ale pacienților din întreaga lume [110], în special în zonele cu acces restricționat la serviciile medicale. Iată deci că parteneriatele public-private între companiile de IT și sistemul medical pot ajuta cetățenii oferindu-le suportul informațional potrivit mult mai prompt decât se obține în acest moment.

Merită menționat aici efortul celor de la DeepMind a căror aplicație AlphaFold[7] (2020) a făcut istorie câștigând prestigioasa competiție “Critical Assessment of protein Structure Prediction (CASP)" [111]. Prin utilizarea algoritmilor Deep Learning, aplicația amintită a reușit să rezolve una dintre cele mai mari provocări științifice ale secolului: predicția structurii proteinei[8] într-o manieră atât de precisă încât rivalizează cu metode experimentale ca razele X și criomicroscopia electronică. Această realizare nu doar accelerează înțelegerea funcției proteinei în biologie, dar deschide și noi căi pentru dezvoltarea de medicamente și terapii personalizate. Într-un context în care cercetarea medicală a fost adesea limitată de lipsa de informații structurale despre moleculele biologice-cheie, AlphaFold oferă oportunitatea de a accelera progresele în domenii variate, de la oncologie la boli infecțioase.

Reînnoirea Documentelor de Identitate

Contrastul între eficiența serviciilor online private și dificultățile întâlnite în obținerea sau reînnoirea actelor de identitate în România evidențiază un decalaj semnificativ în adaptarea la tehnologia digitală a organizațiilor publice în fața celor private. În timp ce achiziționarea de bilete la spectacole, programarea la medic sau cumpărarea de produse online pot fi realizate în câteva minute, simpla obținere a unui act care atestă identitatea poate dura zile

[7] Un sistem AI dezvoltat de DeepMind – o subsidiară a Alphabet.

[8] Numărul total de forme unice de proteine – cunoscut sub numele de "proteomul uman", este estimat la sute de mii sau chiar milioane (cărora li se adaugă și proteine de la alte specii însumând peste 200 de milioane de structuri proteice). Pentru descifrarea unei singure structuri era, până de curând, nevoie de cercetări de nivel doctoral. Dacă asociem fiecărei astfel de inițiative o perioadă de cinci ani, ajungem la concluzia că AlphaFold, grație inteligenței artificiale, a economisit un număr uriaș de ani de cercetare în domeniu. Luând în considerare că această realizare impresionantă a inteligenței artificiale a fost atinsă în mai puțin de un an, putem aprecia cu adevărat magnitudinea lucrării și impactul profund pe care îl are AI în societatea modernă.

întregi și implică deseori interacțiuni directe, ineficiente și consumatoare de timp cu funcționarii publici.

Această ineficiență este adesea cauzată de lipsa unor soluții electronice sau de redundanțe. În acest context, inteligența artificială și aplicațiile RPA/IPA ar putea juca un rol cheie în optimizarea acestor procese. Prin analizarea documentelor, verificarea și certificarea informațiilor personale, aprobarea sau redirecționarea cererilor pentru reînnoirea actelor de identitate, AI ar putea reduce timpul necesar și complexitatea proceselor.

De exemplu, AI poate fi folosită pentru a automatiza procesul de reînnoire a permiselor de conducere, a pașapoartelor și a cărților de identitate, eliminând astfel necesitatea interacțiunii față în față cu un funcționar public. Prin digitalizarea și automatizarea acestor servicii, nu numai că ar fi redus timpul necesar eliberării, dar s-ar îmbunătăți și experiența cetățenilor, care ar putea realiza aceste sarcini din confortul propriei lor case, la fel ca în cazul cumpărăturilor online sau programării unei vizite la medic.

Adaptarea la tehnologia digitală în domeniul serviciilor publice, în special în ceea ce privește obținerea și reînnoirea actelor de identitate, ar putea oferi beneficii semnificative atât pentru cetățeni, cât și pentru funcționarii publici, și ar reprezenta un pas important către modernizarea și eficientizarea administrației publice din România [112].

Reînnoirea Permiselor de Parcare

Aplicarea tehnologiilor RPA/IPA și în zonele rezidențiale poate duce la optimizarea semnificativă a unei game largi de procese, inclusiv reînnoirea permiselor de parcare. Astăzi, deși există soluții digitale pentru aceste procese, acestea nu sunt de obicei automate, ceea ce rezultă într-o multitudine de sarcini repetitive și predispuse la erori, gestionate de personalul de back-office.

Tehnologia RPA poate fi utilizată pentru a automatiza aceste sarcini, îmbunătățind eficiența și reducând probabilitatea de eroare. Un sistem RPA poate prelua sarcina de a verifica și compara documentele recent primite cu înregistrările anterioare stocate în bazele de date locale, inclusiv detalii precum adresa, numărul de înmatriculare, tipul și marca mașinii. În cazul în care sistemul detectează modificări, poate să actualizeze automat informațiile corespunzătoare ori să redirecționeze solicitarea către un operator uman pentru cercetări suplimentare dacă situația o cere.

Aceste tipuri de aplicații RPA/IPA sunt deja utilizate cu succes în sectorul privat în diverse domenii. De exemplu, în contabilitate, RPA este folosit pentru a automatiza introducerea datelor pentru plata facturilor [77]. În sectorul asigurărilor, roboții software înzestrați cu inteligență artificială pot gestiona procesul de plată a despăgubirilor, uneori fără nicio interacțiune umană cu clientul [113].

Achiziții Publice

Implementarea sistemelor RPA/IPA în sistemele electronice de achiziții publice poate aduce beneficii semnificative. Înlocuind procesele manuale și repetabile cu un sistem automat, funcționarii publici ar putea doar să completeze un formular cu detalii despre

produsele sau serviciile de care au nevoie și să permită sistemului să gestioneze restul operațiunilor, inclusiv respectarea termenelor limită și a reglementărilor în vigoare.

Această automatizare poate avea ca rezultat un surplus de timp pentru personal, permițându-le să se concentreze mai mult pe sarcini esențiale, cum ar fi menținerea relațiilor cu furnizorii și planificarea intervențiilor de mentenanță. De asemenea, poate duce la reducerea erorilor și la îmbunătățirea eficienței operaționale.

Într-un document recent publicat de UiPath, lider mondial în tehnologia RPA, sunt descrise două arii principale de aplicare a RPA: (1) ajutorarea mediului de afaceri să se recupereze după crize și (2) modernizarea și eficientizarea administrațiilor publice [76].

O implementare de succes a tehnologiei RPA/IPA a fost realizată de General Services Administration (GSA) din Statele Unite. Utilizând soluția de Document Understanding, GSA a reușit să automatizeze procesul de verificare a miilor de documente, comparându-le cu legislația în vigoare și contractele semnate, în doar câteva minute. Aceste sarcini ar fi necesitat un număr mare de zile dacă ar fi fost să fie efectuate manual de către angajații instituției.

Folosirea Metaversului ca Mediu Virtual de Interacțiune

Într-o conferință de marcă desfășurată recent în septembrie 2023, sub umbrela Meta/Facebook și intitulată sugestiv “Meta Connect. Expanding reality, today and tomorrow" [114], Mark Zuckerberg a dezvăluit o serie de produse inovatoare care promit să schimbe fundamental modul în care interacționăm în mediul digital. Aceste produse au capacitatea de a transporta utilizatorii în Metavers, un concept tehnologic fascinant care deschide noi orizonturi în interacțiunile umane online și estimat să atingă o valoare impresionantă de 1 trilion de dolari în următorii trei ani [115]. Oricât de revoluționară sau chiar incredibilă ar părea această idee, World Economic Forum a publicat în iulie 2023 în cadrul “Defining and Building the Metaverse Initiative" [116] raportul “Social Implications of the Metaverse”, care își propune să adune principalii actori interesați din mediul universitar, societatea civilă, guvern și mediul de afaceri pentru a promova un consens și a crea un metavers economic viabil, interoperabil, sigur, echitabil și inclusiv. Inițiativa este împărțită în două fluxuri de lucru: guvernare și crearea de valoare economică și socială. [115].

Metavers-ul oferă utilizatorilor posibilitatea de a comunica, colabora și chiar de a trăi experiențe virtuale prin intermediul avatarurilor sau identităților digitale. Această paradigmă revoluționară poate revoluționa guvernanța și administrația publică, permițând cetățenilor și funcționarilor publici să se întâlnească și să colaboreze într-un spațiu virtual, reflectând în mod fidel interacțiunile din lumea reală, dar într-un cadru digital. Această inovație ar putea avea implicații semnificative în ceea ce privește eliminarea suspiciunilor de corupție, îmbunătățirea transparenței și gestionarea urbană mai eficientă. Prin crearea unui mediu virtual pentru dialog și cooperare, administrația publică poate avansa în direcția unor comunități mai sigure, mai conectate și mai sustenabile, în care siguranța publică și dezvoltarea urbană pot fi gestionate într-un mod mai inteligent și mai adaptat nevoilor cetățenilor.

Public Sentiment Analysis
Roboții software pot juca un rol esențial în colectarea și analiza datelor referitoare la percepția publicului asupra diferitelor acțiuni administrative.

Platformele de social media sunt o resursă valoroasă de informații, având în vedere că un număr semnificativ de persoane le utilizează pentru a-și exprima opiniile și a oferi feedback cu privire la diferite aspecte ale vieții, inclusiv serviciile oferite de administrația publică. Roboții software, prin utilizarea tehnologiilor NLP și sentiment analysis, pot extrage și analiza aceste comentarii și evaluări, oferind astfel o imagine de ansamblu asupra percepției publice.

Această analiză poate fi extrem de utilă pentru administrațiile publice, deoarece le permite să identifice zonele care necesită îmbunătățiri și să își adapteze strategiile în consecință. De exemplu, dacă roboții software identifică o percepție negativă predominantă cu privire la un anumit serviciu public, administrația poate lua măsuri pentru a îmbunătăți acel serviciu, lucru ce ar putea duce la o mai bună satisfacție a cetățenilor și, prin urmare, la o eficiență mai mare a administrației.

Rezultatele obținute de roboții software pot fi, de asemenea, de un real folos pentru cercetători, politicieni sau alți oficiali, ajutându-i să înțeleagă mai bine starea de spirit a cetățenilor și să ia decizii mai bine informate. Astfel, utilizarea tehnologiei RPA în colectarea și analiza datelor de pe platformele social media reprezintă o oportunitate valoroasă pentru îmbunătățirea eficienței în administrația publică [83, 117, 118, 119].

Generarea de Rapoarte
Reducerea birocrației a constituit unul dintre pilonii centrali ai reformelor în administrația publică de-a lungul ultimelor decenii, la nivel global. Un factor crucial în această direcție a fost exploatarea potențialului tehnologiei Inteligenței Artificiale, care a adus soluții revoluționare în generarea de rapoarte privind bugetele, cheltuielile, operațiunile, solicitările cetățenilor, granturile și multe alte sarcini specifice sectorului public. Utilizarea AI în acest sens nu doar că poate simplifica procesele administrative, dar poate impune un nivel mai mare de responsabilitate a instituțiilor publice.

Pe parcursul ultimului deceniu, companiile din sfera digitală au lucrat intens la dezvoltarea tehnologiilor AI bazate pe NLP. Una dintre acestea este Automated Storytelling, care transformă datele brute în povestiri articulate, facilitând astfel înțelegerea și interpretarea informațiilor.

Un alt exemplu remarcabil în acest sens este reprezentat de compania Narrative Science, care, după cum a afirmat co-fondatorul său, Kris Hammond, se folosește de această tehnologie “pentru a umaniza datele”, creând un pod de comunicare între cifre și cunoaștere [120].

Datele necesare pentru elaborarea acestor rapoarte provin, de obicei, din sistemele moștenite ale organizațiilor, adică de la acele sisteme informaționale vechi pe care instituțiile le folosesc de ani de zile. Aici intervine utilitatea roboților de tip RPA/IPA

echipați cu funcții de Recunoaștere Optică a Caracterelor (OCR). Acești roboți software sunt capabili să citească și să interpreteze textul din imagini și documente, să extragă datele relevante și să le transforme apoi în rapoarte comprehensive. Acest lucru permite o mai bună gestionare și monitorizare a informațiilor, oferind în același timp o bază solidă pentru luarea deciziilor [79]. Un astfel de proces ar reprezenta de asemenea un pas crucial în direcția digitalizării și eficientizării administrației publice, dar și înspre asigurarea unei mai mari responsabilități administrative.

Îmbunătățirea Performanței Sportive prin Inteligență Artificială

În ultimele decenii, tehnologia a schimbat modul în care sportul este practicat și analizat. Inteligența artificială în special, a fost un instrument valoros pentru a rafina antrenamentele, a îmbunătăți performanța și a reduce riscul de accidentare într-o varietate de sporturi deschizând astfel noi oportunități pentru îmbunătățirea performanței atleților și a echipelor sportive. Prin urmare putem spune cu convingere că sportul se poate bucura și el de avansul tehnologiilor inteligente prin furnizarea de analize avansate, modelare de date, predicții și suport pentru decizii [121].

Competițiile sportive la care participă atât cluburile sportive private cât și cele finanțate de la bugetul de stat demonstrează ineficiența metodelor folosite de cele din urmă [122, 123] motiv pentru care ar trebui ca și acestea să urmărească trendul trasat de tehnologie.

AI poate juca un rol crucial în personalizarea antrenamentelor pentru atleți. Sistemele de inteligență artificială pot procesa și analiza mari volume de date pentru a identifica tendințele și modelele în performanța unui sportiv, permițând antrenorilor să ajusteze regimurile de antrenament în mod corespunzător. De exemplu, algoritmi ML pot analiza videoclipuri cu mișcările unui atlet, identificând astfel aspecte care necesită îmbunătățiri.

AI poate ajuta, de asemenea, la analiza performanțelor în timp real sau a performanțelor anterioare pentru a ghida strategia echipei. În fotbal, de exemplu, algoritmi de AI pot fi folosiți pentru a urmări mișcările jucătorilor pe teren, analizând în același timp strategiile echipelor adversare [123]. Acest lucru poate duce la dezvoltarea de tactici mai eficiente și la obținerea unui avantaj competitiv.

Un alt domeniu în care AI și-a găsit aplicație este în monitorizarea sănătății și prevenirea accidentărilor. Sistemele inteligente pot prevedea riscul de accidentare prin analizarea datelor de la senzorii purtați de atleți. Acestea pot identifica semne de oboseală sau stres excesiv, permițând antrenorilor să modifice programul de antrenament și să prevină posibilele accidentări.

Inteligența artificială deține o capacitate extraordinară de a revoluționa lumea sportului, iar echipele sportive finanțate din fonduri publice nu ar trebui să ignore acest fapt. Motivul este simplu: AI poate furniza resursele necesare pentru a îmbunătăți performanțele sportive, optimiza strategiile de echipă și monitoriza sănătatea atleților. Pe măsură ce cercetarea și dezvoltarea în domeniul AI avansează, viitorul va aduce și mai multe oportunități pentru a îmbunătăți performanța în sport prin utilizarea acestor tehnologii.

Care sunt efectele pentru formularea politicilor în domeniul sportului, în ce mod schimbă percepția cetățenilor cu privire la susținerea serviciilor de sport pentru toată lumea ori a celui de performanță – acestea sunt posibile întrebări de context pentru o analiză aprofundată a rolului statului în promovarea acestui tip de servicii publice.

Utilizarea Inteligenței Artificiale în Educație

Transformarea digitală a afectat semnificativ multe aspecte ale societății, iar educația nu face excepție. Sistemul educațional se poate bucura de aceasta prin îmbunătățirea implicării studenților și susținând dezvoltarea materialelor de învățare interactive. Recent, în anul 2021, Facultatea de Administrație Publică a SNSPA a pus în aplicare proiectul e-QUAL EDU. Această inițiativă a vizat adoptarea metodelor sofisticate de e-learning, care se bazează pe tehnologiile de inteligență artificială și strategiile de gameification, cu scopul de a stimula participarea activă a studenților și de a consolida cunoștințele acestora [124].

Concluziile proiectului sunt următoarele (reproducere din concluziile articolului "Education 3.0 – AI and gamification tools for increasing student engagement and knowledge retention" [125]: principalul beneficiu al utilizării AI în educație este capacitatea de a personaliza procesul de învățare pentru fiecare student. Sistemele de AI pot analiza performanța unui student, identificând punctele forte și zonele de îmbunătățire, și pot personaliza materialul de învățare în funcție de nevoile individuale ale acestuia. Aceasta îmbunătățește experiența de învățare a studenților, îi face să se simtă mai implicați și contribuie la creșterea eficienței educaționale.

Inteligența artificială ajută, de asemenea, la crearea de materiale de învățare interactive, cum ar fi tutoriale video, jocuri educaționale și simulări virtuale. Acestea oferă studenților oportunitatea de a explora și de a învăța într-un mediu stimulant și interactiv, ceea ce îmbunătățește implicarea și înțelegerea. Profesorii pot folosi instrumente AI pentru a crea aceste materiale într-un mod mai eficient și eficace, permițându-le să își dedice mai mult timp sarcinilor de predare și mentorat.

Sistemele AI pot oferi, de asemenea, asistență în timp real și feedback instantaneu, ceea ce este esențial pentru o învățare eficientă. Asistenți virtuali sau chatbots (așa cum, prin APIs[9], poate fi implementată tehnologia ChatGPT) pot răspunde la întrebările studenților, oferindu-le sprijin instantaneu și facilitând învățarea independentă. În plus, AI poate oferi feedback automatizat privind performanța studenților, ajutându-i să înțeleagă mai bine unde au nevoie de îmbunătățiri. Profesorii vor beneficia și ei de AI grație template-urilor sugerate de aceasta, template-uri care vor avea în vedere un design adecvat fiecărei discipline sau categorii de discipline abordate.

Rezultatele pozitive ale proiectului și ale tehnologiilor aplicate în cadrul acestuia au fost confirmate în iunie 2023, când a avut loc evenimentul Hackathon numit "Smart2Education". În cadrul acestui eveniment, opt echipe formate din câte trei studenți, îndrumate de un profesor din Facultatea de Administrație Publică, au creat materiale de

[9] Application Programming Interfaces (APIs) sunt seturi de reguli și protocoale care permit comunicarea între două sau mai multe aplicații software.

curs similare. Succesul acestui eveniment este demonstrat de implicarea activă a celor 24 de studenți și a profesorilor care au participat din afara echipei de proiect inițial [126].

În plus, în domeniul dezvoltării carierei, implementarea unui sistem de consiliere bazat pe inteligență artificială, capabil să distingă hobby-urile, interesele, talentele înnăscute și mecanismele de adaptare ale fiecărui elev sau student poate fi de mare folos atât individului cât și societății în ansamblu. Utilizând aceste date, sistemul ar putea facilita explorarea unor trasee de carieră personalizate, bazându-se inițial pe experiențele profesionale ale unor profesioniști umani pentru ca apoi, cu lecțiile învățate, sistemul să poate întreprinde, independent de aceștia, activități de consiliere în carieră. Un astfel de sistem de consultanță profesională cu inteligență artificială ar putea ghida elevii de liceu spre diferite domenii pentru a profita în mod optim de aceste oportunități profesionale, maximizându-și astfel potențialul de carieră.

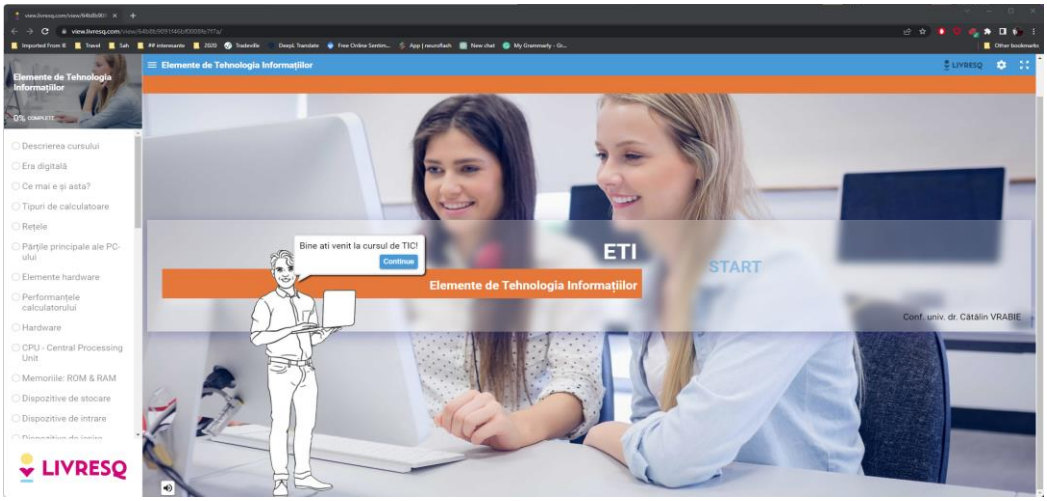

Fig. 2. Pagina de start a cursului “Elemente de Tehnologia Informațiilor" [127] realizat prin proiectul e-QUAL EDU (poate fi văzut asistentul virtual ce urmează în curând să fie îmbogățit cu capabilitățile LLMs10)

Inteligența artificială are un potențial semnificativ de a transforma educația, îmbunătățind implicarea studenților și facilitând dezvoltarea de materiale de învățare interactive. În documentul “Artificial Intelligence and Education. A critical view through the lens of human rights, democracy and the rule of law” emis de Consiliul Europei în luna noiembrie, 2022, sunt trasate trei direcții spre care educația trebuie să se îndrepte: (1) “learner-supporting AI”, (2) “teacher-supporting AI” și (3) “institution-supporting AI" [128].

Recepție

Roboții hardware, precum Pepper – de al cărui test de prezență a beneficiat și Facultatea de Administrație Publică din SNSPA în cadrul primei ediții a Hackathon-ului “Smart2Education” din iunie 2023 (Figura 3) dar și în cadrul Conferinței Internaționale

[10] Large Language Models – tehnologii AI care permit funcționarea aplicațiilor precum GhatGPT.

Smart Cities (SCIC) din decembrie 2023, sau Relay, au un potențial enorm de a fi implementați în instituțiile publice, atât la nivel local, cât și central. Aceștia pot fi folosiți în primării, birouri ale Avocatului Poporului sau alte entități similare pentru a ghida cetățenii spre ghișeul adecvat sau pentru a rezolva prompt anumite solicitări.

Roboți de acest tip și-au găsit deja aplicabilitate în industria hotelieră sau în instituții culturale precum teatre și muzee. Aceste locații necesită adesea personal dedicat direcționării și asistării clienților sau vizitatorilor, o sarcină pe care roboții o pot prelua cu succes.

În momentul de față, numeroase organizații publice utilizează mașini automate fixe pentru emiterea bonurilor de ordine [80, 81]. Cu toate acestea, tehnologia avansează rapid și următorul pas ar putea fi reprezentat de introducerea așa-numiților "ofițeri" de primire roboți. Aceștia pot fi programați pentru a recunoaște cetățenii prin identificare facială și a răspunde la întrebări, îndrumând cetățeanul către cel mai apropiat ghișeu liber sau furnizând informații care ar putea contribui la rezolvarea problemei acestuia [129].

Fig. 3. Pepper (central) salutând participanții[11] (studenți și cadre didactice) la Hackathon-ul "Smart2Education"

În plus, în timp ce interacționează cu cetățeanul, roboții ar putea efectua, în paralel, sarcini de back-office, pregătind informațiile de care funcționarul desemnat să se ocupe de caz va avea nevoie. Astfel, nu doar că se va facilita interacțiunea dintre cetățean și angajații instituției, dar se va oferi și un mediu mai prietenos și eficient pentru dialog. Implementarea acestei tehnologii va marca un pas important în îmbunătățirea serviciilor oferite de instituțiile publice și în creșterea satisfacției cetățenilor.

Managementul Traficului

Mobilitatea este un aspect foarte important în orice oraș din întreaga lume. Cu tendința crescândă de urbanizare, cetățenii tind să-și organizeze agendele pentru a evita congestiile de trafic, transportatorii își îmbie clienții cu reduceri pentru a stimula utilizarea serviciilor de transport în afara orelor de vârf, organizațiile publice își ajustează orarele de funcționare

[11] În această fotografie, robotul Pepper știa că urmează să fie fotografiat și, după cum poate observa, s-a așezat într-o postură care să-l evidențieze.

pentru a satisface cerințele comunităților lor, iar producătorii de automobile, precum și alți furnizori de servicii caută soluții pentru a face "așteptarea în trafic" mai plăcută pentru șoferi [130, 131]. Aplicațiile de inteligență artificială pot fi de mare ajutor; pot colecta date de la șoferi și pot prezice comportamentele acestora, ajustând astfel fluxul de autovehicule și îmbunătățind mobilitatea generală a tuturor.

Aplicații precum Waze și Google Maps fac deja acest lucru și astfel am putea spune că augmentarea acestora este redundantă. Doar că acestea singure, așa cum sunt astăzi, prevăd doar condițiile de trafic pe o perioadă scurtă (sau foarte scurtă) de timp [132, 96]. Aplicații AI dedicate anumitor zone metropolitane ar putea rula pe platforma Google Maps și colectând date de trafic specifice respectivei localități pentru a obține informații despre condițiile de navigare în toate anotimpurile, pot prezice comportamentele șoferilor în diferite contexte, cum ar fi: vremea (e.g., cum va afecta un ploaie ușoară sau o zăpadă grea traficul), anumite momente din zi (e.g., ora de vârf etc.), sărbătorile (zile lucrătoare versus weekend), calendarul școlar (știindu-se că, spre exemplu, deschiderea școlilor îi determină de obicei pe părinți să folosească mașinile personale mai mult decât în restul zilelor) și, în consecință, să ofere participanților la trafic rute mai eficiente [78].

Aceste aplicații pot comunica cu șoferii prin tehnici NLP și, generând text în baza datelor culese din trafic, îl pot apoi citi [98] pentru a le furniza mai multe informații cu privire la ruta pe care aceștia trebuie să o parcurgă. Senzorii de trafic (camere) pot monitoriza activitatea de pe șosele trimițând datele spre servere și ajustând astfel intrările de pe dispozitivele mobile ale șoferilor ceea ce ar duce la o îmbunătățire a capacităților sistemului – în plus, în situația în care vehiculele de utilitate publică / poliție / pompieri / ambulanțe sunt forțate să intervină, vor folosi în principal această rețea de senzori / camere pentru a preveni cazuri precum cel înregistrat în Berlin, unde un "jurnalist a folosit 99 de telefoane pentru a păcăli Google Maps să emită alerte de blocaj de trafic" [133].

Următorul pas va fi de a sincroniza datele cu sistemul de semaforizare și, bazat pe dispozitivele IoT, aplicațiile AI vor putea controla schimbarea culorii semafoarelor optimizând traficul auto. Sistemul ar trebui să poată anticipa coliziunile datorate traficului / vremii sau altor variabile și astfel să le evite prin redirecționarea șoferilor prin aplicațiile lor mobile sau prin semnalele de la semafor. În unele cazuri, datele trebuie prezentate în rapoarte narative [79]: organizațiile publice, împreună cu părțile implicate, ar trebui să poată efectua aceste operații prin tehnici NLP [134]. Acest lucru poate fi important pentru mass-media, inițiative juridice sau explicații venite din partea autorităților (de exemplu în cazul unei defecțiuni a sistemului). Aceste aspecte secundare ale implementării AI într-un sistem de gestionare a traficului ar trebui, de asemenea, luate în considerare.

Managementul Parcărilor

Implementarea de aplicații pentru cartografierea locurilor de parcare, bazate pe tehnici de Machine Learning care lucrează cu date colectate într-o perioadă mai lungă de timp, poate juca un rol major în gestionarea eficientă a locurilor de parcare [135, 136, 89] – considerate aici resurse. Un astfel de sistem nu doar că ar putea indica șoferilor locurile de parcare disponibile în proximitatea zonei solicitate, dar ar putea și rezerva aceste locuri în numele lor într-o aplicație dedicată acestui lucru.

Pornind de la datele colectate în trecut, sistemul ar putea prezice disponibilitatea fiecărui loc de parcare și furniza aceste informații în timp real șoferilor. În acest fel, aceștia ar putea economisi timp valoros și reduce consumul de combustibil, ceea ce duce la o scădere a nivelului de stres și al poluării.

Principalul beneficiar al acestui sistem va fi cetățeanul, dar beneficiile nu se opresc aici. Instituțiile publice și comunitățile în general vor avea și ele de câștigat prin utilizarea acestei tehnologii. Îmbunătățirea eficienței gestionării locurilor de parcare poate conduce la îmbunătățirea calității vieții pentru toți locuitorii.

În plus, decongestionarea traficului poate reduce presiunea asupra forțelor de ordine, care altfel ar fi trebuit să se ocupe de gestionarea problemelor legate de parcarea neregulamentară sau a aglomerației din trafic. Această măsură ar putea, de asemenea, conduce la o scădere a numărului de incidente rutiere, datorită reducerii aglomerației pe șosele și facilitării procesului de căutare a locurilor de parcare.

Gestionarea Deșeurilor Municipale

Inteligența artificială are potențialul de a revoluționa și serviciile de gestionare a deșeurilor municipale, cu ajutorul tehnologiilor avansate, precum senzorii IoT și algoritmii de reinforcement learning.

În primul rând, coșurile de gunoi pot fi echipate cu senzori inteligenți care monitorizează în mod constant nivelul de umplere al acestora. Acești senzori pot trimite un semnal către compania de colectare a deșeurilor atunci când coșul este plin în proporție de 80%, permițând astfel planificarea colectării înainte de atingerea capacității maxime [137, 138, 139]. Acest lucru poate preveni nu numai supraîncărcarea coșurilor de gunoi, ci și disconfortul rezultat din mirosurile neplăcute sau posibilele probleme de igienă.

În al doilea rând, utilizarea algoritmilor ML poate optimiza traseele vehiculelor de colectare a deșeurilor rezolvând în timp real o dificilă problemă matematică – Traveling Salesman Problem (TSM) [140]. Acești algoritmi pot analiza diverse variabile, cum ar fi locația coșurilor de gunoi, traficul rutier, timpul necesar pentru colectarea deșeurilor de la fiecare coș, și pot concepe cea mai eficientă rută pentru fiecare vehicul de colectare. Aceasta nu numai că ar reduce timpul și costurile de colectare, dar ar putea conduce și la o reducere a emisiilor de carbon, contribuind la obiectivele de sustenabilitate ale orașelor.

Într-o notă adițională, inteligența artificială poate fi utilizată și în sortarea deșeurilor. Algoritmi avansați de recunoaștere a imaginilor pot fi utilizați pentru a identifica și a sorta diferitele tipuri de deșeuri, îmbunătățind eficiența sistemelor de reciclare [141, 88, 142].

Toate aceste inițiative pot fi realizate prin colaborarea dintre autoritățile locale, companiile de gestionare a deșeurilor și dezvoltatorii de tehnologie AI, contribuind astfel la crearea de orașe mai curate și mai inteligente.

Vehicule Autonome

Introducerea vehiculelor autonome de nivel 4 [143] în transportul public are potențialul de a revoluționa modul în care călătorim, îmbunătățind siguranța și eficiența, și contribuind la

dezvoltarea orașelor inteligente. Cu toate acestea, implementarea acestei tehnologii trebuie realizată cu grijă pentru a asigura siguranța călătorilor și a celorlalți participanți la trafic. Olli, spre exemplu, este un vehicul autonom folosit pentru transportul școlar, care utilizează tehnologii de navigație robotică pentru a opera pe rute dedicate [144]. Acesta nu numai că oferă o călătorie sigură pentru copii (deocamdată doar în campusurile instituțiilor), dar și reduce necesitatea șoferilor umani și poate funcționa în mod eficient pe orare fixe.

Un alt exemplu de vehicul autonom de nivel 4 ar putea fi NAVYA Autonom Shuttle, un microbuz electric fără șofer care poate transporta până la 15 pasageri și care a fost deja implementat în câteva orașe din întreaga lume [145]. Acest microbuz funcționează pe rute dedicate și poate fi folosit pentru transportul urban sau pentru navetă în campusurile universitare și parcurile industriale.

Localitatea Milton Keynes din Marea Britanie a anunțat într-o postare oficială recentă (septembrie 2023) pe portalul MKCitizen [146] că, până în octombrie 2024, transportul public se va efectua doar cu ajutorul autobuzelor autonome. Denumit StreetCAV, proiectul face parte dintr-un program mai larg al guvernului britanic, care a alocat 18,5 milioane de lire sterline pentru îmbunătățirea sistemului public de transport urban al țării.

Orașul californian San Francisco, folosește deja de mai mult timp serviciile de transport marfă și taximetrie fără șofer oferite de Cruise – parte a General Motors și Waymo – o subsidiară a Alphabet Inc [147, 148]. Dacă până de curând (august 2023) acestea aveau voie să opereze doar noaptea, Comisia pentru utilități publice din California a permis ambilor operatori să efectueze curse fără șofer 24 de ore din 24, 7 zile din 7 [149], decizie lăudată de companii și considerată o importantă realizare în demersurile implementării serviciilor de transport public fără șofer în Statele Unite și probabil în întreaga lume.

Cu toate acestea, pentru a avea succes, introducerea vehiculelor autonome necesită nu numai dezvoltarea tehnologiei și reglementări adecvate ci și o infrastructură rutieră dezvoltată alături de acceptarea publicului. Totodată, este esențială colaborarea cu autoritățile de reglementare și cu alte părți interesate pentru a aborda problemele legate de siguranță, responsabilitate, confidențialitate și securitate, elemente ce vor modela viitorul transportului autonom și rolul acestuia în ecosistemele orașelor inteligente.

3.4. Considerente de natură etică la implementarea sistemelor AI

Alături de aplicațiile AI care vizează impactul social, trebuie avute în vedere și considerente de etică, educație AI și, nu în ultimul rând, despre consecințele asupra pieței muncii – impact ce ar putea fi analizat în continuarea exemplelor de mai jos.

Google. Vestitul motor de căutare nu doar a înlocuit bibliotecarii (aceștia fiind cei care au îndeplinit o funcție oarecum similară în trecut), dar a permis crearea de conținut într-o manieră mult mai facilă, permițând totodată o cercetarea mult mai laborioasă în uriașa bibliotecă de cunoștințe disponibile online. Deși Google poate fi acuzat de dispariția bibliotecarilor, de fapt el trebuie lăudat deoarece, grație lui, au fost create mult mai multe noi locuri de muncă ce vizează atât căutarea de informații relevante cât și crearea de conținut nou și publicitatea necesară promovării acestuia către utilizatori (e.g., YouTube).

Wikipedia. Aici tot oamenii sunt cei care creează și editează conținutul. Mașinile însă, precum roboții software ai Wikipedia, sunt mai bune decât oamenii la a scana rapid elemente precum cuvinte obscene și plagiatul de pe alte site-uri web. Prin urmare, combinația, sau poate mai bine spus, simbioza dintre oameni și roboți, funcționează mai bine decât oricare dintre aceste două categorii lăsate să lucreze individual. Wikipedia însă nu a înlocuit doar enciclopediile tipărite ci a extins considerabil sfera de aplicare și actualitatea informațiilor înscrise într-o enciclopedie, multiplicând totodată ocaziile în care acestea sunt folosite.

Sistemele înzestrate cu AI nu sunt ușor de proiectat sau de operat. Pentru a funcționa corespunzător, sunt necesare echipe de ingineri și personal dedicat. Operațiunile de mentenanță trebuie efectuate regulat atât la un capăt al fluxului – având grijă de dispozitivele IoT, senzori și camerele de luat vederi, cât și la celălalt, cel dedicat procesării datelor – la servere.

Cel mai probabil, organizațiile publice și orașele vor trebui să externalizeze o parte din procese către companii specializate, cu experiență în domeniul tehnologiei [150]. Cu toate acestea, personalul propriu trebuie, de asemenea, să fie instruit [151]. O categorie dedicată de angajați ar trebui să supravegheze sistemul pentru a-l învăța mai bine – de exemplu, în ceea ce privește gestionarea traficului, atunci când se observă o congestie generată de o coliziune sau când pe hartă apar informații despre o intervenție sau un șantier, aceștia trebuie să permită aplicației să "învețe" pentru a putea redirecționa traficul prin simpla ajustare a parametrilor.

Similar, în ceea ce privește gestionarea parcărilor, atunci când observă că anumite zone de parcare (de exemplu, în zonele rezidențiale) devin libere după ce localnicii pleacă la serviciu în timpul dimineții, pot "învăța" sistemul despre acest fenomen. Aportul lor, referitor la toate situațiile în care supervised learning funcționează, este deosebit de important pentru a menține sistemul în funcțiune, îmbunătățindu-l în permanență.

În plus, externalizarea înseamnă colaborarea între mai mulți actori implicați. Companiile IT se vor ocupa de nevoile și actualizările software, iar cele de transport și servicii pentru mentenanța hardware-ului. Cel mai probabil, va fi necesară o actualizare a legislației actuale privind traficul, prin urmare, instituțiile publice trebuie să participe și ele atât la nivel administrativ cât și legislativ.

3.5. Aspecte critice în implementarea sistemelor de inteligență artificială în guvernare

AI provoacă tot ce este convențional, pentru a pune sub semnul întrebării abordarea clasică și își propune a clădi una ajustată evoluției extraordinare a tehnologiei. În esență acest lucru poate fi privit ca o limitare dar, viteza și forța cu care mașinile își fac loc în viața noastră este cu mult mai mare decât capacitatea fiecărui utilizator de a se adapta. Ca societate însă acest aspect este mai ușor de asimilat – inteligența colectivă fiind mai mare decât suma inteligențelor individuale. În continuare sunt prezentate câteva aspecte critice ale implementărilor sistemelor digitale – cu precădere a tehnologiilor bazate pe inteligență artificială, în procesele de guvernare așa cum sunt ele prezentate de Comisia Europeană [152], OECD [153], World Economic Forum [154] și United Nations [155].

- Provocări etice și juridice. Utilizarea inteligenței artificiale ridică întrebări privind confidențialitatea datelor, discriminarea algoritmică, responsabilitatea în luarea deciziilor automate și drepturile cetățenilor. Este necesară o abordare etică și o reglementare adecvată pentru a gestiona aceste provocări și pentru a asigura utilizarea responsabilă a inteligenței artificiale.
- Dependența de tehnologie. O implementare extensivă a soluțiilor bazate pe inteligența artificială poate duce la o dependență crescută de tehnologie. Întreruperi tehnice sau eșecuri pot afecta funcționarea adecvată a serviciilor publice și pot avea un impact negativ asupra cetățenilor. Este important să se dezvolte planuri de rezervă pentru a minimiza riscurile asociate cu dependența de tehnologie.
- Disparități digitale și accesibilitate. Implementarea soluțiilor digitale poate amplifica diviziunile existente între cei care au acces la tehnologie și resurse digitale și cei care nu au. Este important să se asigure că soluțiile bazate pe inteligența artificială sunt accesibile și echitabile pentru toți cetățenii și să se dezvolte inițiative pentru reducerea decalajelor digitale.
- Schimbarea culturală și rezistența la schimbare. Implementarea soluțiilor bazate pe inteligența artificială implică adesea o schimbare culturală și o adaptare la noi tehnologii și moduri de lucru. Rezistența la schimbare și lipsa de încredere în tehnologie pot fi obstacole în procesul de implementare. Este importantă conștientizarea, comunicarea și implicarea tuturor părților interesate pentru a depăși aceste provocări.

Implementarea soluțiilor bazate pe inteligența artificială în mediul public nu este lipsită de provocări. Prin urmare, este esențială abordarea acestora cu atenție și responsabilitate. Sugestiile și limitările menționate mai sus pot ghida procesul de digitalizare și implementare a soluțiilor bazate pe inteligența artificială în instituțiile publice, asigurând beneficii semnificative și maximizând impactul pozitiv asupra guvernării și serviciilor publice.

3.6. Impactul în aria guvernării

Consecințele aplicării tehnologiilor AI și a altor tehnologii emergente în guvernare sunt diverse și ample. Acestea se extind de la creșterea eficienței administrative și îmbunătățirea interacțiunii cu cetățenii, până la modificarea fundamentală a proceselor de guvernare și provocările etice și sociale asociate.

Implicarea tehnologiilor AI și emergente în guvernare poate avea un impact extins, îmbunătățind eficiența administrativă și interacțiunea cu cetățenii, modificând fundamental procesele de guvernare și ridicând provocări etice și sociale. Rolul AI în creșterea transparenței poate duce la o guvernare mai responsabilă, în timp ce interfețele om-mașină pot face serviciile publice mai accesibile. Integrarea AI și IoT în gestionarea orașelor inteligente poate îmbunătăți eficiența și calitatea vieții, în timp ce modelarea proceselor de decizie bazate pe date poate optimiza deciziile administrative. AI ca instrument transformator poate eficientiza operațiile de guvernare, iar analiza impactului AI asupra funcționarilor publici este esențială pentru înțelegerea efectelor automatizării. Tehnologiile de vârf pot îmbunătăți serviciile publice, în timp ce alinierea acestora la nevoile umane și

organizaționale va asigura o implementare adecvată și etică. Simplificarea experienței cetățenilor cu administrația prin tehnologie poate face guvernarea mai accesibilă și mai responsabilă.
Cercetarea pe aceste teme va avea un impact semnificativ asupra modului în care guvernarea este realizată și experimentată, cu oportunități pentru a îmbunătăți eficiența, accesibilitatea și transparența, în timp ce se adresează provocărilor importante legate de etică, adaptare socială și aspecte legate de forța de muncă.

Totuși, nu trebuie uitat conceptul de "Chasm", dezvoltat de Geoffrey Moore în volumul "Crossing the Chasm" [156]. Acesta se referă la etapa critică în cadrul ciclului de adopție a tehnologiilor, când un produs sau o tehnologie trec de la a fi adoptate de "inovatori" și "adoptanții timpurii" la o adopție mai largă în rândul "majorității timpurii" (Figura 4). Aceasta este adesea cea mai dificilă etapă de adopție – în care societatea încearcă să pășească, deoarece necesită ca produsul sau tehnologia să fie adaptate pentru a satisface nevoile unui public mult mai larg și mai divers.

În stadiul de "inovatori" și "utilizatorii timpurii", putem vedea experimente cu AI în anumite domenii ale guvernării, cum ar fi analiza datelor pentru formularea politicilor sau automatizarea anumitor procese administrative. Cu toate acestea, pentru a trece "prăpastia" și a ajunge la "majoritatea timpurie", adică la implementarea pe scară largă a AI în guvernare, sunt necesare mai multe condiții: trebuie demonstrată eficiența și siguranța AI, trebuie actualizate reglementările pentru a permite utilizarea AI, iar publicul trebuie să aibă încredere în tehnologie. Aceasta este adesea cea mai dificilă parte a procesului de adoptare deoarece implică rezolvarea unor probleme complexe de etică, reglementare și acceptare publică.

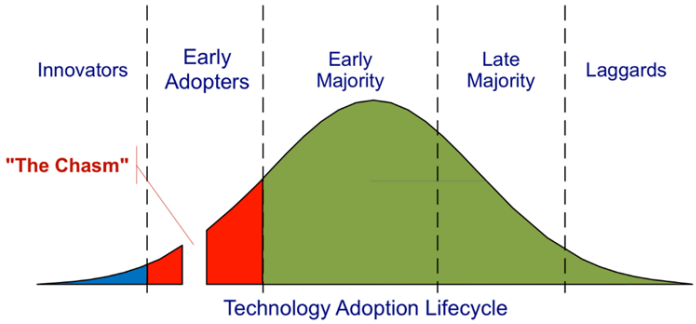

Fig. 4. Cele cinci grupuri de utilizatori ai tehnologiei conform "Crossing the Chasm" [156]

Încorporând conceptul de "Crossing the Chasm", autorul vizează nu numai evaluarea posibilităților și aplicabilității Inteligenței Artificiale și altor tehnologii emergente în Științele Administrative, ci și formularea de strategii care facilitează tranziția de la faza "inovatorilor" și "adoptanților timpurii" la "majoritatea timpurie". Această etapă este esențială în procesul de adoptare a tehnologiilor capabile să transforme guvernarea electronică într-o guvernare inteligentă.

În fazele incipiente, pot exista inițiative izolate sau pilot care aplică AI pentru sporirea transparenței, eficienței și participării cetățenești. Cu toate acestea, provocările se multiplică atunci când se încearcă scalarea acestor inițiative pentru a satisface nevoile unui

public mult mai larg și mai divers. De asemenea, trecerea peste "prăpastie" implică abordarea unor probleme etice stringente, actualizarea cadrului regulator și construirea încrederii publice în tehnologie.

Un accent deosebit va fi pus pe identificarea și rezolvarea barierelor care pot împiedica adopția pe scară largă, precum lipsa de încredere, reglementările neclare sau nefavorabile și lacunele în infrastructura tehnologică – acestea fiind considerate ca fiind elementele ce au cel mai mare potențial de frânare.

3. Discuții și concluzii

Când vine vorba de tehnologii noi, entuziasmul și îngrijorarea merg mână-n mână. Chiar și așa, ambele abordări vor continua să aibă valoare științifică și comercială. Fiecare idee face parte din "povestea AI" dar nu reprezintă întreaga "poveste". Marvin Minsky – un pionier al acestor tehnologii, a spus un lucru important în cărțile sale: "Avem nevoie de tot. Avem nevoie de toate tipurile de reprezentare, toate metodele și formele de învățare, toate lucrând împreună" [157].

În anul 1997, supercomputerul IBM denumit Deep Blue a reușit să depășească performanțele lui Garry Kasparov, campionul mondial de șah al vremii, printr-un algoritm expert ce era capabil să evalueze aproximativ 200 de milioane de mutări pe secundă [158]. Cu toate că sistemul beneficia de o capacitate computațională remarcabilă, întrecerea a fost percepută ca fiind extrem de competitivă, și a stârnit numeroase controverse în comunitatea șahistă globală. Este demn de notat faptul că Deep Blue a triumfat cu o marjă îngustă de 3½ – 2½, în contextul în care Kasparov îl învinsese pe Deep Blue cu un an înainte, cu scorul de 4-2.

În contrast, după două decenii, în anul 2016, sistemul de inteligență artificială AlphaGo a celor de la DeepMind a reușit să îl învingă pe Lee Sedol, campionul mondial la jocul de Go, cu un scor decisiv de 4-1 [159]. Acest rezultat a fost obținut prin implementarea unei combinații sofisticate de tehnici de inteligență artificială. Evenimentul a fost interpretat în cadrul științific și public ca un reper semnificativ pentru avansul în domeniul inteligenței artificiale, confirmând că tehnologia a atins un prag la care poate depăși capacitatea umană în anumite domenii complexe, o opinie susținută chiar și de Lee Sedol.

Analizând perspectivele viitoare, apare următoarea întrebare: cât de aproape ne aflăm de atingerea unei Inteligențe Artificiale Generale (General AI)? Prognoza însă prezintă complexități semnificative. Avansul în știință este asemănător cu navigarea într-un teritoriu necunoscut, unde obstacolele imediate sunt adesea singurele vizibile. Avansarea trebuie să fie incrementală, fiecare etapă dezvăluind noi provocări și obstacole pe care tehnologia și cercetarea va trebui să le abordeze pentru a progresa spre ținta finală.

Numeroși experți din domeniu au încercat să abordeze chestiunea complexă a cât de aproape ne aflăm de realizarea unei Inteligențe Artificiale Generale. Unul dintre acești specialiști, profesorul Patrick Winston de la Massachusetts Institute of Technology (MIT), a sumarizat această incertitudine cu o remarcă simplă și directă: "I can't answer this question" [160]. Aceasta subliniază incertitudinea care caracterizează predicțiile în cercetarea științifică.

În contextul cercetării, spre deosebire de inginerie sau alte domenii aplicative, este dificil să se creeze un plan de avansare predefinit. Yann LeCun[12], un alt expert proeminent în domeniul inteligenței artificiale, a oferit o metaforă elucidantă în acest sens: "A cerceta în știință este similar cu a dărâma ziduri, nu știi ce se află după următorul, poate fi ceva revoluționar sau încă un zid, și încă unul și tot așa" [22].

Prin urmare, predicțiile în ceea ce privește evoluția spre Inteligența Artificială Generală sunt pur speculative și însoțite de variabile necunoscute, care pot fi elucidate doar prin avansări incrementale și descoperiri ulterioare în domeniul cercetării.

În evoluția cercetării științifice, în special într-un domeniu emergent și atât de dinamic precum inteligența artificială, descoperirile pot varia semnificativ în ceea ce privește momentul apariției lor. Aceasta necesită o combinație de intuiție, creativitate și inspirație pentru a completa rigorile metodologice. Desigur, poate fi intuitiv să proiectăm traiectorii tehnologice viitoare, dar cronologia exactă a acestor avansări rămâne dificil de anticipat.

În acest context, dezvoltarea conceptului de guvernanță inteligentă devine o necesitate incontestabilă. Dezvoltarea rapidă a inteligenței artificiale oferă guvernanței un set complex de instrumente pentru optimizarea proceselor și pentru luarea de decizii mai eficiente. La bază, guvernanța inteligentă se referă la folosirea tehnologiilor avansate pentru a facilita și îmbunătăți procesul de guvernare. Într-o astfel de paradigmă, tehnologia ajută la analiza datelor în timp real, la automatizarea proceselor și la îmbunătățirea livrării serviciilor publice. Fără a trece prea abrupt la aplicațiile practice, este esențial să spunem că tehnologiile de vârf, dintre care cea mai vizibilă astăzi este Inteligența Artificială, îmbogățește și amplifică potențialul guvernării.

În plan practic, aplicațiile AI în procesul de guvernare sunt variate și promițătoare. Un exemplu remarcabil se regăsește în domeniul sănătății, unde sistemele de sănătate utilizează algoritmi de AI pentru a detecta anumite afecțiuni medicale în stadii incipiente. Rolul acesteia se extinde și la administrațiile locale. În orașele inteligente, AI poate ajuta la gestionarea eficientă a resurselor, de la controlul traficului până la managementul deșeurilor. Platformele de e-guvernare pot integra AI pentru a filtra și sintetiza feedback-ul cetățenesc, oferind astfel un răspuns mai prompt și adaptat la nevoile populației.

În pofida tuturor beneficiilor, există și provocări notabile în adopția AI pentru guvernarea inteligentă. Acestea includ probleme etice legate de confidențialitate și securitate, precum și riscul amplificării inegalităților sociale. De aceea, este imperativ ca subiectele de cercetare să fie abordate cu prudență pentru a asigura o implementare etică și eficientă a AI în procesele de guvernare.

În mod cert guvernarea inteligentă asistată de AI oferă un potențial uriaș pentru optimizarea serviciilor publice și pentru consolidarea relației dintre stat și cetățean. Este un domeniu în continuă evoluție, cu oportunități și capcane, care necesită un efort concertat din partea cercetătorilor din mediul academic, a guvernului și a societății în ansamblu pentru a naviga cu succes în complexitatea acestei noi ere.

[12] Yann LeCun deține, în momentul redactării acestui articol, funcția de vicepreședinte și Chief AI Scientist la Meta/Facebook fiind totodată și profesor la New York University (NYU).

Acknowledgement:

Este important de menționat că segmente ale acestui articol sunt preluate din Teza de Abilitare a autorului intitulată "The Promise of Artificial Intelligence to Smart Cities and Public Administration". Această publicație încrucișată își propune să diseminеze rezultatele cercetării către un public academic mai larg și să contribuie la evoluția discursului despre rolul e-guvernării în societatea actuală.

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The role of uses and gratification theory and technology acceptance model in the adoption and usage of wearable technology

Dan Florin STĂNESCU,
National University of Political Studies and Public Administration, Bucharest, Romania
dan.stanescur@comunicare.ro

Marius Constantin ROMAȘCANU,
National University of Political Studies and Public Administration, Bucharest, Romania
marius.romascanu@comunicare.ro

Abstract
The growth of wearable products has had a multifaced impact on society, touching various aspects of our lives, from health and technology to fashion and privacy. Devices such as smartwatches, display glasses, wristbands, and headbands have been rapidly propagated to mainstream usage, due to their capability for both leisure or fitness and medical data tracking. **t**he study utilized the Technology Acceptance Model to investigate the motivations (gratifications) driving students to embrace wearable technologies and their subsequent utilization of these technologies. The research employed a cross-sectional design, gathering data from a convenience sample of 261 participants (48 males and 213 females), whose ages ranged from 18 to 29 years (M=21.73, SD=3.70). Data collection involved administering two structured questionnaires: the Technology Acceptance Model and the Gratifications of Wearables Technology. The study's findings indicate significant correlations between several factors. Specifically, both Perceived Ease of Use (r=.279, p<.01) and Perceived Usefulness (r=.386, p<.01) are positively associated with Actual System Use. Additionally, Perceived Ease of Use displays a positive correlation with the Accessibility scale of Gratifications of Wearables Technology (r=.380, p<.01), while Perceived Usefulness exhibits positive correlations with all scales of Gratifications of Wearables Technology, including Health (r=.427, p<.01), Accessibility (r=.522, p<.01), and Status (r=.262, p<.01). The outlook for the wearable industry suggests that significant transformations are on the horizon in the coming years, with wearables becoming increasingly prevalent in mainstream usage. This study not only delves into the practical implications but also outlines potential avenues for future research in this field.

Keywords: TAM, explorative study, motivation, ease of use, usefulness.

1. Introduction
Over the past few years, the wearable products industry has experienced exponential growth. Devices like smartwatches, display glasses, wristbands, headbands, and even brain machines have swiftly integrated into mainstream use, driven by their versatility in both leisure and fitness, as well as their capacity for medical data tracking [1, 2]. Wearable technology has permeated various sectors, starting from the medical, healthcare, and fitness, to the fashion industries [3, 4, 5].

As mentioned by Celik and colleagues [6] wearable technology encompasses a diverse range of devices. Given their broad categorization, it is crucial to establish a clear definition of wearable technology for the scope of this study. In this research, wearable technology is defined as any device worn by the user that incorporates data collection capabilities or motion sensors. These devices may be worn on the wrist, ear, and feet, or even embedded in shoes, clothing, or body (insertions and smart tattoos).

Sharma and Biros [7] characterized wearables as “a subset of IoT that encompasses 'things' capable of being integrated into clothing or worn as accessories on the body”.

Furthermore, in the conceptualization of Seneviratne and colleagues [8], “wearables can continuously sense, collect, and upload physiological data, offering opportunities to enhance the quality of life beyond what can be easily achieved with smartphones alone.

Additionally, wearables enable users to conveniently and naturally perform various micro-tasks, such as checking incoming text messages and accessing urgent information, in contrast to smartphones often carried in pockets or bags”.

According to other authors, such as Wright and Keith [9], wearable technology and devices are electronics seamlessly integrated into clothing and accessories that can be comfortably worn on the body. These devices furnish users (and other stakeholders) with information about their habits, activity levels, and various physiological data [10].

1.1. Technology Acceptance Model

The literature extensively discusses the interaction between humans and technology, with one of the widely recognized models being the Technology Acceptance Model (TAM) developed by Davis in 1986 [11, 12]. The Technology Acceptance Model (TAM) originated from the Theory of Reasoned Action (TRA) [13], a social psychological theory aimed at understanding the motivations underlying various behaviors. TAM was developed specifically to assess the attributes of “computer-based information systems” and investigate how these attributes influence their adoption [14].

TAM stands out as the most widely accepted theory for elucidating an individual's acceptance of information systems [15]. Scholars emphasize that TAM's widespread acceptance is rooted in its robust theoretical foundation and practical effectiveness [16].

Illustrated in Figure 1, this model posits that an individual's acceptance of technology is influenced by two key variables: perceived usefulness and perceived ease of use [17].

Davis [18] proposes that the combined influence of Perceived Ease of Use and Perceived Usefulness directly shapes an individual's attitudes toward utilizing a specific technology.

During the last decade, the TAM model and its revised forms have gained considerable prominence, particularly due to its transferability to various contexts and samples, its potential to explain variance in the intention to use or the use of technology, and its simplicity of specification within structural equation modeling frameworks [19, 20].

Shroff, Deneen, and Ng [21] described that by manipulating these two variables, technology systems developers can have better control over users' beliefs about a specific system and so can better predict their behavioral intention and actual usage of the system.

Bogozzi [22] has stated that the TAM is too simple and leaves out important variables.

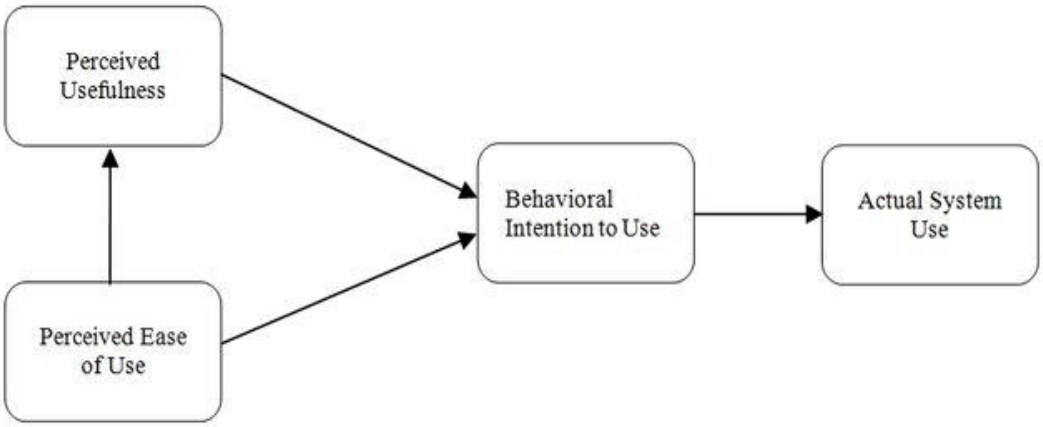

Fig. 1. The earliest technology acceptance model
Source: Davis, 1989

Thus, Mugo and colleagues [23] stated that both perceived ease of use and perceived usefulness are influenced by two categories of variables: internal and external variables.

Internal variables consist of factors such as the attitude of the user, their pedagogical beliefs, and level of competency, whereas external variables include those external barriers faced by users during utilization.

With few exceptions such as Venkatesh [24], technology acceptance models make use of predictors that are exclusively cognitive, relating the adoption and actual behavior of new technology to attitudes, beliefs, and perceptions [25, 26].

Considering that a significant number of individuals acquire wearable devices due to their popularity, yet many stop using them shortly after obtaining the device underscores the importance of this study, which concentrates on gratifications and actual usage.

1.2. Uses and Gratification Theory

In the realm of communication research, the Uses and Gratifications theory is frequently employed to identify the motives driving the utilization of a specific medium [27].

According to Katz and colleagues [28], the Uses and Gratifications theory explores both social and psychological needs that drive the use of media, focusing on the anticipated gratifications that users expect to derive from using that particular media.

Gratifications can be categorized as either instrumental or ritualized [29]. Instrumental use emphasizes utility gratifications, driven by the intention to achieve a specific end-goal. [30, 31]. In contrast, ritualized use places greater emphasis on the process rather than the end-goal. Individuals engaging in ritualized use of media seek gratifications such as relaxation and entertainment [32, 33]. Ritualized gratifications are often associated with process gratifications, while instrumental gratifications are more likely linked to content gratifications [34].

Furthermore, the Uses and Gratifications theory posits that individuals are proactive and will choose the most suitable media outlet to best satisfy their gratifications [35]. Instead of passively consuming media, they actively seek out specific media with deliberate intentions.

Several studies have identified that individuals tend to prioritize perceived ease of use and perceived usefulness differently, depending on the specific gratifications they seek from that particular technology. In a study conducted by Park [36] on the adoption of computer-based voice over Internet Protocol (VoIP) phone services, it was found that individuals utilizing VoIP services for entertainment and communication placed less emphasis on perceived usefulness compared to those employing it for other purposes.

Moreover, previous studies [37] have observed that individuals pursuing varied gratifications from a technology tend to hold distinct perceptions regarding both ease of use and usefulness. In their study from 2013, Joo and Sang [38]observed that individuals seeking instrumental gratifications for smartphone use demonstrated higher perceptions of usefulness compared to ease of use. This suggests that when individuals use a smartphone for instrumental purposes, they tend to perceive the device as more useful than easy to use.

Conversely, those seeking ritualized use for smartphones tended to have higher perceptions of ease of use than perceived usefulness.

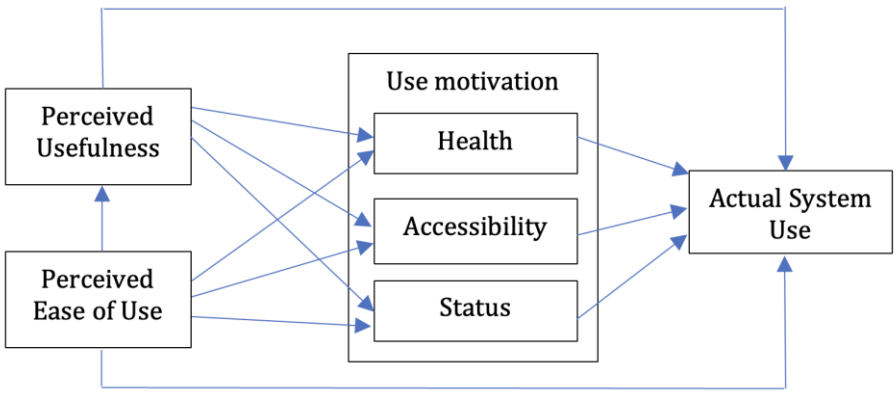

Fig. 2. Conceptual framework

This study aims to adopt the Technology Acceptance Model and Use and Gratification Theory as the theoretical framework for investigating the user motivation and adoption of wearable technology among students. Following the initial model, we put forth the following research questions (Figure 2):

- RQ1: What relations can be observed between perceived usefulness and user motivation/gratification in the adoption of wearable technology?
- RQ2: What relations can be observed between perceived ease of use and user motivation/gratification in the adoption of wearable technology?

- RQ3: What relations can be observed between user motivation/gratification in the adoption of wearable technology and actual system usage?
- RQ4: What relations can be observed between actual system usage and perceived usefulness?
- RQ5: What relations can be observed between actual system usage and perceived ease of use?

2. Methods

The sample comprised 261 students, with 48 males and 213 females. Participants' ages ranged from 18 to 29 years (M=21.73, SD=3.70). We employed a purposive convenience sampling technique for data collection, using a self-reported method. Before completion, participants received a brief explanation of the study's purpose, and informed consent was obtained. Assurance of data confidentiality for research purposes was provided.

Participants were invited to complete a set of questionnaires, including the Gratifications of Wearables Technology [39]and the Technology Acceptance Model [40].

The Gratifications of Wearables Technology [41] questionnaire consists of 60 items structured across three dimensions: health, accessibility, and status. Each item used a 5-point Likert Scale, with responses ranging from 1 (strongly disagree) to 5 (strongly agree).

The composite score demonstrated excellent internal consistency with a coefficient of α=.96, and subscales showed strong alpha scores: health α=.96, accessibility α=.87, and status α=.93.

The Technology Acceptance Model [42]comprises 12 items, covering two dimensions: perceived usefulness and perceived ease of use. Responses were provided on a seven-point Likert scale, ranging from 1 (Extremely unlikely) to 7 (Extremely likely). The internal consistency coefficients (Cronbach's Alpha) for these scales were α=0.79 for perceived ease of use and α=0.75 for perceived usefulness.

3. Results

Table 1 displays the means, standard deviations, and bivariate correlations for all variables under investigation. To address our initial research question (RQ1: What relations can be observed between perceived usefulness (PUSE) and user motivation/gratification in the adoption of wearable technology?), we computed the correlations between PUSE, Health, Accessibility, and Status. The results, as presented in Table 1, reveal a positive correlation between PUSE and all motivation/gratification scales (Health r=.427, p<0.01; Accessibility r=.522, p<0.01; Status r=.262, p<0.01). This implies that individuals seeking wearable technology for practical, action-oriented purposes, such as staying informed, connected, or monitoring health and sleep patterns, perceive greater usefulness. These findings align with Joo and Sang's [43] investigation of smartphone use, suggesting that this correlation can be extended to almost all wearable technologies.

Table 1. Descriptive statistics and inter-correlations of the study variables

	Mean	SD	1	2	3	4	5
1. PEU	3.83	.80	-				
2. PUSE	3.53	.84	.502**	-			
3. Health	2.86	1.07	.119	.427**	-		
4. Accessibility	3.81	.78	.380**	.522**	.303**	-	
5. Status	2.66	.92	-.077	.262**	.540**	.471**	-
6. ASU	2.16	1.28	.279**	.386**	.205**	.199**	.261

Source: Author own work

To answer the second research question (RQ2: What relations can be observed between perceived ease of use (PEU) and user motivation/gratification in the adoption of wearable technology?) the correlations between PEU and Health, Accessibility, and Status were computed. The data analysis reveals a positive correlation between PEU and Accessibility ($r=.380$, $p<0.01$), while no significant correlation was found between PEU and Health or Status ($p>0.05$). These findings suggest that individuals may embrace wearable technologies for health or status reasons irrespective of the ease with which they can operate them.

In addressing the third research question (RQ3: What relations can be observed between user motivation/gratification in the adoption of wearable technology and actual system usage (ASU)?), the results indicate positive correlations between Health ($r=.205$, $p<0.01$), Accessibility ($r=.199$, $p<0.01$), and actual system use. The Status subscale of motivation/gratification does not exhibit a significant correlation with actual system use ($p>0.05$). This is noteworthy given the advertising campaigns positioning these devices as highly anticipated innovations and novel status symbols of the future.

Starting from the TAM theory which posits that perceived usefulness and perceived ease of use are two cognitive belief dimensions that shape users' attitudes, which in turn determines intention to use and actual use, we have calculated the correlation between actual system usage and perceived usefulness and perceived ease of use, thus answering to the last two research questions (RQ4: What relations can be observed between actual system usage and perceived usefulness?; RQ5: What relations can be observed between actual system usage and perceived ease of use?). Therefore, Perceived Ease of Use, the degree to which a person believes that using technology will be free from effort [44] ($r=.279$, $p<.01$), and Perceived Usefulness, the extent to which a consumer believes that using wearable technology increases personal efficiency ($r=.386$, $p<.01$) are positively associated with Actual System Use. Expanding upon the established TAM model, the current results validate that attitudes toward using the technology, leading to adoption intention, are indeed influenced by perceived usefulness and perceived ease of use.

4. Conclusions

The fulfillment of gratifications through wearable technology influenced perceptions of ease of use, usefulness, and attitudes toward usage. Individuals who sought wearable technology for practical purposes, such as gathering information about their health and sleeping patterns, held higher perceptions of usefulness. Similarly, those who sought wearable technology for ritualized use perceived their devices to be easier to use.

The current findings align with prior research that emphasized positive correlations among perceived ease of use (PEU), perceived usefulness (PU), attitude, motivation for use, and actual system usage [45, 46]. Various studies have also revealed that individuals seeking different gratifications from a technology tend to perceive differences in ease of use and usefulness [47, 48].

Furthermore, in this research context, both perceived ease of use and perceived usefulness emerged as noteworthy and positive predictors of individuals' attitudes toward adopting wearable technology. A notable meta-analysis by King and He [49] further corroborated the significance of perceived benefits in technology acceptance. As technology progresses, the imperative for innovations to maintain simplicity in usage and navigation becomes increasingly crucial.

Despite the valuable insights provided by this study, it is not without limitations. One primary weakness lies in the use of a cross-sectional design, which precludes the assessment of cause-and-effect relationships. Additionally, the reliance on self-reported questionnaires, a common limitation in many studies, tends to focus on investigating and reporting attitudes rather than behaviors. The small sample size poses another limitation, making it challenging to generalize the results, especially considering that a majority of respondents were young (18-29 years old). Moreover, it's conceivable that individuals who opted to participate may have possessed a specific interest in the topic, introducing a slight potential for voluntary response bias [50]. Given that younger individuals predominantly use wearable devices, future studies should consider including older consumers who may be less familiar with such technologies.

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Modele de design organizațional în sectorul aviatic European și efectele acestora asupra condițiilor de muncă ale angajaților

Cristina LEOVARIDIS,
SNSPA, București, România
cristina.leovaridis@comunicare.ro

Florin-Domnel GRAFU,
ROMATSA, București, România
florin.grafu@romatsa.ro

Abstract
Lucrarea își propune identificarea principalelor efecte ale introducerii de noi modele de design organizațional în sectorul aviatic european, asupra pe de o parte, a performanței angajaților (personal tehnic – ingineri, tehnicieni, cât și cel operațional – controlori de trafic aerian), dar și, pe de altă parte, asupra condițiilor lor de muncă și satisfacției muncii acestora. După o prezentare generală a contextului actual al pieței forței de muncă în post-pandemie la nivel international și în țara noastră, pe baza unei analize secundare de date statistice, lucrarea continuă cu schițarea unei imagini statistice sintetice asupra forței de muncă din sectorul aviatic la nivel european și în România, pentru ca apoi să continue cu o detaliere a principalelor cinci modele diferite de aranjamente organizaționale și, implicit de mecanisme ce fac posibile livrarea de servicii de transport aerian la nivel european, în scopul creării "Cerului Unic European", cu accent pe efectele acestora asupra: design-ului organizațional, rolurilor și responsabilităților posturilor, competențelor și instruirii personalului, culturii organizaționale și condițiilor de muncă, pe baza analizei unor documente interne europene din domeniu, elaborate de instituții oficiale din sectorul aviatic din UE.

Cuvinte cheie: Cer Unic European, sector aviatic, restructurări organizaționale, centre virtuale.

1. Introducere
Dezvoltarea tehnologiei și digitalizarea infrastructurii aviatice generează nevoia de schimbare, inclusiv la nivel organizațional. Mai mult, scăderea numărului angajaților în sectorul aviatic din anumite țări europene, din cauza scăderii atractivității acestui tip de profesie, asociată deseori cu supraîncărcarea, stresul și riscul, a creat nevoia ca responsabilitățile acestor angajați să fie preluate de omologi de pe posturi similare din țările vecine. Inițial, pentru crearea unui "Cer unic european", au fost create la nivel european consorții / alianțe formate din minim două țări vecine, ceea ce a dus la implementarea unor noi modele de design organizațional în organizațiile responsabile de traficul aerian din acele țări. În prezent, se testează aceste modele între anumite țări, pentru a identifica acea variantă de model organizațional optim, care apoi să fie implementată și în celelalte state europene. Lucrarea va cuprinde o analiză a unor documente europene elaborate de instituții oficiale din sectorul aviatic din UE, ce fac referire la efectele aplicării acestor modele de design organizațional pe baza cărora s-au constituit consorțiile/ alianțele ce premerg formarea "Cerului unic european".

2. Contextul actual al pieței forței de muncă în post-pandemie. Așteptări ale angajaților – analiză secundară de date statistice
Sondajul la nivel global realizat de Ernst&Young, *Work Reimagined*, desfășurat în intervalul iunie-august 2023, care a primit răspunsuri de la peste 17.050 de angajați și 1.575 de

angajatori din 25 de sectoare economice, din peste 20 de arii geografice (incluzând Europa, America, Asia, Africa), arată că: angajații și angajatorii au perspective diferite asupra a ceea ce înseamnă "noul normal" al muncii de după pandemie. 34% dintre angajați afirmă că sunt dispuși să-și schimbe locul de muncă în următorul an, angajatorii fiind mai predispuși decât angajații să creadă că provocările economice vor reduce probabil plecările angajaților; salariile rămân principala preocupare a angajaților, aceștia concentrându-se pe programe complete de recompense. Angajatorii și angajații cred că balanța puterii s-a mutat ușor înapoi către angajatori, deoarece după pandemie devenise evident în favoarea angajaților. Practicarea unei culture organizaționale bazate pe încredere și a unui model de leadership centrat pe oameni duc la rezultate organizaționale semnificativ mai bune, inclusiv la percepții asupra culturii organizaționale și productivității companiei, mai bune. Dezvoltarea competențelor și formarea sunt priorități de top pentru angajatorii care doresc să-și perfecționeze forța de muncă și pentru angajații care doresc să rămână competitivi pe piața muncii. Atât angajații, cât și angajatorii manifestă entuziasm față de folosirea inteligenței artificale la locul de muncă: 33% dintre ei așteaptă de la AI beneficii pentru productivitate și noi moduri de lucru, iar 44% – impact asupra muncii flexibile. Printre angajații înalt calificați a căror activitate se bazează în mod tradițional pe utilizarea analizei / expertizei în domeniu într-un cadru profesional de birou, mai mult de o treime preferă să lucreze complet la distanță, cu o preferință mai puternică în rândul femeilor decât al bărbaților; spre deosebire de angajatori, dintre care doar o cincime sunt de acord cu munca doar de la distanță, majoritatea dorind ca angajații să lucreze cel puțin două sau trei zile pe săptămână de la birou. Imobilul de birouri de o calitate superioară nu este suficient pentru a atrage angajații înapoi la birou, dar organizațiile cu condiții fizice de muncă de calitate superioară au mai multe șanse să raporteze o productivitate a muncii și o cultură organizațională mai bune, precum și o probabilitate scăzută ca angajații să vrea să migreze [1].

După ce imediat după pandemie, în 2021- începutul lui 2022, tendința la nivel mondial a angajaților (ma ales a celor din generațiile Z și Millenials) era să renunțe la locul de muncă (*The Great Resignation*) [2], urmată la mijlocul anului 2022 de o nouă tendință în comportamentul angajaților, *The Quiet Quitting* (o continuare a The Great Resignation, mai precis atitudinea angajaților de a-și îndeplini la minimum îndatoririle profesionale, de a nu mai fi disponibili să facă ore suplimentare neplătite sau să-și asume în mod voluntar sarcini solicitante, propunându-și să facă doar strictul necesar la locul de muncă, și nimic altceva în plus, în vederea prioritizării vieții personale și timpului din afara serviciului; fenomenul având ca forme scăderea productivității, neparticiparea la întâlniri și evitarea contribuirii la proiectele de echipă, a sosi târziu și a pleca devreme de la locul de muncă [3], în 2023 se adaugă o tendință nouă, *Career Cushioning*, mai precis o "poliță de asigurare" pentru angajații care se simt temători că situația socio-economică ar putea duce la concedieri în organizația din care fac parte, este o soluție pentru volatilitatea profesională care îi ajută să fie pregătiți pentru ce este mai rău, asigurând un "plan B" prin perfecționare, recalificare, căutare de alt post sau chiar trecere la organizații mai stabile din punct de vedere financiar [4]. Înseamnă a căuta potențiale posturi chiar și atunci când nu vrei să-ți dai demisia, astfel încât dacă se întâmplă să fii dat afară, să ai o variantă de rezervă sau măcar opțiuni potențiale. Această reacție de apărare în fața incertitudinii îi face pe angajați să prospecteze piața de potențiale job-uri sau să-și analizeze mai bine abilitățile și să le dezvolte pe cele care le lipsesc [5].

Astfel, studiul "Ce își doresc românii de la locul de muncă", realizat în aprilie – mai 2023 de agenția MSL The Practice și eJobs, pe un eşantion format din 3.272 de persoane cu vârsta de peste 18 ani, active pe piaţa muncii, a arătat că 8 din 10 angajați (79%) intenționează să își schimbe locul de muncă în următorul an. Intenţia de a schimba locul de muncă este mai ridicată (peste 75%) în rândul angajaţilor din domeniile auto, HoReCa, Oil&Gas sau Retail, cea mai scăzută rată de fluctuaţie fiind în IT&C şi Media&Advertising. În medie, un angajat și-a schimbat locul de muncă în urmă cu 2,5 ani, iar un manager în urmă cu 3 ani. Topul primelor trei motive de alegere a unui angajator sunt: salariul și beneficiile oferite (pentru 85% din angajați), echilibrul dintre viața profesională și cea personală (pentru 6 din 10 angajați), atmosfera de lucru (pentru peste 50% din angajați, mai importantă decât siguranța jobului, posibilitatea de perfecționare sau planul de carieră) [6].

Preferința pentru programul flexibil, în scopul echilibrării raportului dintre muncă și viața personală este confirmată și de un alt studiu românesc, realizat de iSense Solutions în 2022-2023 pe populație urbană activă de 18-65 ani. Conform acestuia, dintre două locuri de muncă ce oferă același salariu, Gen Z l-ar alege pe cel care oferă creșteri salariale planificate (50% dintre respondenții din Gen Z), program flexibil/ posibilitatea de a lucra și de-acasă (46%), bonusuri de performanță (41%), posibilitatea de promovare rapidă (38%), zile de concediu suplimentare (37%). Gen Y l-ar alege pe cel care oferă: creșteri salariale planificate (52% dintre respondenții din Gen Y), bonusuri de performanță (49%), program flexibil/ posibilitatea de a lucra și de-acasă (40%), tichete de masă (35%), zile de concediu suplimentare (33%). Gen X l-ar alege pe cel care oferă: creșteri salariale planificate (52% dintre respondenții din Gen X), bonusuri de performanță (49%), tichete de masă (40%), program flexibil/ posibilitatea de a lucra și de-acasă (35%), vouchere cadou (33%) [7].

În România anului trecut, tendința globala numită *The Quiet Quitting* a părut să fie de o intensitate mai redusă: conform studiului Gallup *State of the Global Workplace 2022,* gradul de *engagement* (nivelul de implicare și entuziasm la locul de muncă) al angajaților din țara noastră a fost anul trecut de 33%, ceea ce ne plasa pe primul loc în Europa la acest indicator; pe ultimul loc se află Italia, unde doar 4% dintre angajați erau implicați în mod real la locul de muncă pe care îl au. Totuși, 31% dintre angajații români se simțeau zilnic îngrijorați la locul de muncă (cel mai puțin îngrijorați fiind elvețienii – 21%), în timp ce 35% au declarat că se simt stresați (cel mai puțin stresați erau danezii – 21%). 12% dintre angajații români resimțeau anul trecut pe parcursul unei zile de muncă stări de furie (cel mai puțin furioși la locul de muncă erau filandezii- 5%), iar 17% sentimente de tristețe (cel mai puțin triști la serviciu fiind angajații din Kosovo – 6%) [8]. Oarecum paradoxal, angajații români încă se implică mult la locul de muncă, în ciuda faptului că resimt stres sau tristețe din cauza acestuia. Este încă o reminiscență a trecutului: ni s-a tot indus ideea că trebuie să muncim din greu și "să dăm bine" la locul de muncă, chiar și în ciuda lipsei unei remunerări pe măsura efortului depus și a recunoașterii ori a timpului liber, concepție transmisă și generațiilor mai tinere [3].

În acest an, la nivel internațional, studiul *Global Workforce Hopes and Fears Survey 2023* realizat de PwC pe 54.000 angajați din 46 țări (din care peste 500 în România) arată că 1 din 4 angajați (26%) la nivel mondial sunt în căutarea unui job nou, ca urmare a creșterii

costului vieții, față de 19% anul trecut. Angajații care au probabilitatea cea mai mare de a-și schimba angajatorul în următoarele 12 luni sunt în principal: cei care se simt supraîncărcați (44%), cei cărora le e greu să își plătească facturile în fiecare lună (38%), și Gen Z (35%). Doar 38% din forța de muncă la nivel global consideră că le-au mai rămas bani la sfârșitul lunii, în scădere față de 2021 (47%). 14% din totalul angajaților fac eforturi mari pentru a-și plăti facturile lunare, iar 42% spun că după plata acestora le mai rămâne foarte puțin sau nimic (în creștere de la 37% in 2022). 1 din 5 angajați (21%) mai au un job pe lângă cel de bază, cu 69% dintre aceștia procedând astfel deoarece au nevoie de venituri suplimentare. Ponderea angajaților cu mai multe job-uri este mai mare printre cei din Gen Z (30%) și minoritățile etnice (28%) [9].

La nivel național, rezultatele aceluiași studiu, *PwC's Workforce Hopes and Fears Romania Survey 2023*, arată că unii angajați trăiesc o stare de nelinişte: pentru 18% este probabil să-și schimbe locul de muncă în următoarele 12 luni (față de 16% anul trecut). Ponderea este mai mare pentru Gen Z (18-26 years), cu 28% dintre ei planificându-și să-și schimbe job-urile. Și când se pune problema solicitării unei creșteri de salariu, Gen Z este în top, cu 51%. Cauza este aceeași ca la nivel mondial – creșterea dificultăților financiare: 13% din angajați depun eforturi mari pentru a plăti facturile în fiecare lună (similar cu procentul global de 14%). Însă doar 10% au un job în plus, mai puțin decât 21% la nivel global. Principalul motiv pentru care își caută un alt loc de muncă este acela de a câștiga mai mulți bani (67%), urmat la mare distanță de celelalte [10].

3. O imagine sintetică asupra forței de muncă în sectorul aviatic european

În 2019, înainte de pandemie, 408 000 persoane cu vârsta cuprinsă între 20-64 de ani lucrau în sectorul transportului aerian în UE, reprezentând o creștere de 11% față de 2018. Acești angajați au reprezentat 0,2% din totalul forței de muncă din UE. Dintre statele membre ale UE, Luxemburg a înregistrat cea mai mare pondere a persoanelor angajate în sectorul transportului aerian (1,0% din totalul angajării), urmat de Malta (0,5%), Irlanda, Țările de Jos și Portugalia (toate 0,4%). În funcție de gen, peste jumătate din angajații din transportul aerian erau bărbați (56%): cea mai mare pondere a bărbaților a fost înregistrată în Suedia (77%), urmată de Danemarca (74%) și Malta (73%). Prin contrast, Finlanda a fost singurul stat membru al UE în care femeile erau predominante în sectorul transportului aerian (57% dintre angajații din transportul aerian erau femei). [11]

Pandemia a afectat profund sectorul aviatic, printr-o scădere semnificativă a numărului de pasageri. Autoritățile din întreaga lume au reacționat la răspândirea bolii Covid-19 prin închiderea granițelor pentru cetățenii străini, ceea ce a dus la reducerea numărului de călătorii aeriene. În consecință, companiile aeriene și cele asociate și-au redus numărul de angajați. În primul trimestru al anului 2022, erau angajate 325.600 de persoane în sectorul transportului aerian în UE. Acesta este cel mai mic număr înregistrat în ultimii 14 ani. Numărul total actual al angajaților din sectorul transportului aerian din cele 27 de state membre UE în primele trei luni ale anului 2022 prezintă o scădere semnificativă, de la aproximativ 410.000 angajați înainte de pandemie, mai precis din primul trimestru din 2019 [12].

Angajații tineri au fost cei mai afectați în această perioadă: scăderea mare a numărului de angajați din sector are loc pe seama scăderii numărului lucrătorilor cu vârste între 15 și 39

de ani (de la 204.400 în T1 2008, la 121.400 în T1 2022; o scădere de 83.000 persoane). În același interval, s-a înregistrat o creștere, deși mai ușoară, a angajaților între 40 și 64 de ani (de la 170.500 la 204.200; o creștere de 33.700 persoane). Situația este asemănătoare, dacă vom compara primul trimestru din 2019 (de dinainte de pandemie) cu primul trimestru din 2022: deși a existat o scădere semnificativă a angajaților cu între 15 și 39 de ani (de la 184.900 la 121.400; o scădere de 63.500 persoane), a existat o scădere mult mai mică a angajaților cu vârste între 40 și 64 de ani (de la 225.500 la 204.200; o scădere de 21.300 persoane). Din punct de vedere al ponderii pe genuri, ponderea bărbaților în transportul aerian a fost stabilă în timp: bărbații reprezentau 58% din forța de muncă în sectorul aviatic european, în primul trimestru al anului 2022, pondere înregistrată și în primul trimestru al anului 2008. Deși în timpul pandemiei, în perioada cuprinsă între primul trimestru al anului 2019 și primul trimestru al anului 2022, a scăzut atât numărul angajaților bărbați, cât și al angajatelor, bărbații au fost ceva mai afectați, ei reprezentând 60% din totalul angajaților cu care a scăzut forța de muncă din sector (-33.800 pentru femei față de -50.900 pentru bărbați) [13].

Ponderea totală a femeilor angajate în sectorul aviație a crescut la 42% în 2022, ajungând la niveluri superioare la o pondere de 28%, cee ace reprezintă o creștere de aproape 15% față de 2021. Cea mai vizibilă schimbare este pe posturile tehnice, unde 18% din locurile de muncă sunt ocupate de femei, comparative cu 12% în 2021. Procentul a femeilor de pe puntea de zbor este acum de 5%, ceea ce reprezintă o creștere cu 23% creștere față de anul trecut [14].

Numărul pasagerilor a scăzut cu 60% în 2020 față de anul precedent și, deși sectorul aviatic a început să se redreseze în 2021, totuși numărul de pasageri a rămas mai mic cu 40% față de anul 2019. S-a estimat că acest fapt a dus la o pierdere de venituri pentru companiile aeriene de aproximativ 372 de miliarde de dolari (363 de miliarde de euro) și 324 de miliarde de dolari (316 de miliarde de euro) în 2020 și, respectiv, 2021. Guvernele naționale din UE au fost forțate să intervină și să salveze multe companii aeriene în dificultate, inclusiv transportatori de prestigiu precum Lufthansa din Germania și Air France din Franța. Cu toate acestea, în acest 2022, companiile aeriene au fost deseori acuzate că nu și-au completat personalul înainte de sezonul aglomerat de vară, lipsa forței de muncă fiind cauza a zeci de mii de anulări de zboruri și întârzieri mari [12].

Din punct de vedere al condițiilor de muncă, utilizarea altor metode de reducere a costurilor cu forța de muncă, cum ar fi externalizarea, utilizarea contractelor de muncă part-time și utilizarea lucrătorilor cu contract de muncă pe perioadă determinată rămâne o caracteristică cheie a organizațiilor din sectorul aerian: unele companii aeriene, chiar consacrate, folosesc lucrători temporari din afara UE (din Asia) pentru echipajul de cabină și, de asemenea, externalizează în totalitate unele rute către o firmă care are sediul afara UE, ceea ce aduce ca beneficii o forță de muncă mult mai ieftină. Lucrătorii temporari pot fi angajați de firmă de recrutare externă și furnizați companiei aeriene sau pot fi lucrători pe cont propriu și angajați de această firmă pentru a furniza servicii companiei aeriene. În plus, ponderea angajaților ce fac parte din sindicate din sectorul transportului aerian s-a redus, în special la companiile aeriene, unde transportatorii low cost și alți nou intrați pe piață au o reprezentare sindicală mult mai scăzută decât transportatorii de rețea, care raportează

niveluri ridicate de sindicalizare, în special în rândul personalului de zbor și al echipajului de cabină. Se poate observa și o scădere evidentă a proporției de tineri angajați în vârstă de 15-29 de ani, ceea ce indică o stagnare sau o reducere a oportunităților de angajare în sectorul transportului aerian pentru acest grup; această grupă de vârstă este și cel mai afectată de schimbările pe piața muncii și condițiile de muncă, deoarece cei care intră pe piața de muncă pentru prima dată este cel mai probabil să fie angajați în cadrul unor aranjamente de angajare mai noi observate în sector [15].

Conform unei cercetări calitative și cantitative despre formele atipice de angajare în sectorul aviatic european, bazată pe chestionare aplicate asupra 6633 de angajați din echipaje de zbor și de cabină din diferite companii aeriene europene, dintre care majoritatea piloți, unii dintre aceștia sunt nemulțumiți de lipsa siguranței locului de muncă, a unui "home base" pentru familie (care să reprezinte locul unde se odihnesc și fac pauze), salarii mici, amenințări subtile din partea managementului că vor fi dați afară dacă se îmbolnăvesc și își iau conediu medical, mai ales în companiile low cost, demotivare, oboseală, oportunități reduse de training-uri etc. Până la liberalizarea aviației civile europene, existau doar companii aeriene naționale cu angajați doar din țara în care compania națională respectivă își avea sediul, țară care reprezenta "home base"-ul fiecărui angajat; în prezent, după liberalizarea aviației civile europene, și apariția noilor modele de business, precum companii aeriene low cost și companii aeriene de rețea, lucrurile s-au schimbat în mod radical pentru condițiile de muncă ale angajaților (de exemplu, pot exista pentru un angajat, mai multe "home base"-uri, dintre care unele în afara UE). Piloții ma tineri, cu mai puțină experiență, au o probabilitate mai mare de a fi angajați de companii aeriene low cost, pe când companiile de rețea preferă piloții cu experiență. Totuși, per ansamblu grup intervievat, 60% din intervievați spun că sunt mulțumiți de condițiile lor de muncă și de training-urile primite (70%), 82% cred că există competiție între piloți pe piața muncii din Europa din cauza diferențelor între condițiile de muncă oferite de diferite companii aeriene, 50% se simt sprijiniți de compania aeriană la care lucrează, la 58% le face plăcere să lucreze pentru compania la care sunt angajați în prezent [16].

În România, cele mai recente date cu privire la personalul operational din sectorul aviatic, pe categorii de personal, sunt sintetizate în tabelul de mai jos [17].

Tabel 1. Categorii de personal aeronautic în România – număr de licențe în 2022

Categorie personal aeronautic	Număr de licențe
Piloți avion și elicopter	2337
Ingineri recepție și control (IRC)	2
Mecanici naviganți (Mec nav)	37
Membri ai echipajului de cabină (CC)	562
Personal ATSEP (Air Traffic Safety Electronics Personnel)	462
Controlori de trafic aerian și meteo (CTA+MET+CITA)	1018
Personal tehnic	373
Total	4791

Sursa: Autoritatea Aeronautică Civilă Română (2022). Raport de activitate 2022. Consiliul de Administrație și Regia Autonomă Autoritatea Aeronautică Civilă Română, București, p. 16

4. Efecte ale "Cerului Unic European" asupra design-ului organizațional și condițiilor de muncă

Reprezentând un sector important din punct de vedere strategic care aduce o contribuție extrem de importantă la economia generală și la ocuparea forței de muncă a UE, aviația susține aproape 5 milioane de locuri de muncă și contribuie cu 300 de miliarde euro, sau 2,1% la PIB-ul european. În ciuda crizei economice actuale, transportul aerian global pe termen lung este de așteptat să crească cu aproximativ 5% anual până în 2030. Pe măsură ce traficul crește, se amplifică și preocupările legate de siguranță. Politica aviatică comună a UE urmărește să facă din Europa cel mai sigur spațiu aerian din lume. Inițiativa lansată în 2004, numită Single European Sky – SES (Cerul unic european) are ca scop decongestionarea abundentă a spațiului aerian care provoacă întârzieri îndelungate la multe zboruri europene, precum și a presiunii asupra capacității aeroporturilor din cauza creșterii traficului. Un al doilea pachet de măsuri, cunoscut sub numele de SES II, a urmat în 2009 și a pus un accent mai mare pe mediu (scăderea poluării) și pe eficiența costurilor. Tehnologia necesară viitorului "cer unic" este furnizată prin programul de cercetare în managementul traficului aerian SESAR, care are ca scop modernizarea infrastructurii și creșterea capacității de trafic aerian, încât SES să poată deveni realitate [18].

Detaliem mai jos cinci modele diferite de aranjamente organizaționale și, implicit de mecanisme ce fac posibile livrarea de servicii de transport aerian la nivel european, dar mai ales efectele acestora asupra: design-ului organizațional, rolurilor și responsabilităților posturilor; competențelor și instruirii personalului; culturii organizaționale și condițiilor de muncă.

În cadrul *Modelului de Alianță*, nu are loc nicio schimbare la nivel de organizație în țările participante la alianță, dar are loc o armonizare prin utilizarea aceluiași tip de echipamente pentru realizarea funcției de management al traficului aerian. În *Modelul bazat pe Separare*, în fiecare țară va avea loc o împărțire a activităților pe două niveluri: furnizori de date și furnizori de servicii de trafic; deși vor exista puține schimbări în serviciul de trafic aerian prestat, totuși practicile de lucru ale controlorilor de trafic aerian (proceduri, diviziunea sarcinilor) pot evolua pe măsură ce sistemele se armonizează și se introduce suport tehnic de la distanță. În *Modelul Specializat*, are loc o structurare mai profundă: fiecare serviciu necesar controlorilor de trafic este oferit de către o entitate organizațională separată; modelul de livrare specializată implică inclusiv furnizori de servicii specializați în furnizarea de date, de exemplu furnizarea de date de supraveghere într-o regiune (servicii de radar). În *Modelul pe trei niveluri*, pe lângă modificările observate în modelul de separare, vor fi introduse noi diviziuni organizaționale în nivelurile de producție și prelucrare a datelor. Se presupune că se va aplica concurență efectivă pentru furnizarea de servicii de date ATM, precum și pentru furnizarea de servicii CNS, AIS și MET (către ADSP). Se presupune că sunt create entități separate, iar acestea funcționează în condiții echitabile, asigurând date accesibile unei piețe ADS și permițând noilor intrați pe piață să concureze pentru a furniza servicii performante. Se presupune că personalul va fi angajat de către entitățile separate. *Modelul la nivelul întregii uniuni* reproduce *Modelul pe trei niveluri*, dar recunoaște că nu toate funcțiile incluse în *ATM Data Services* pot fi furnizate cel mai bine printr-un model de piață. Poate fi nevoie, pe măsură ce sistemul tehnic evoluează, ca anumite funcții să fie asigurate printr-un monopol natural din motive de

siguranță, securitate sau economice. Se presupune că aceste funcții ar fi furnizate ca un serviciu public sub controlul unei agenții sau instituții a Uniunii Europene. Structura organizatorică a unei astfel de entități ar urma probabil precedentele existente, cum ar fi Managerul de rețea (NM), Baza de date AIS europeană (EAD) sau altele. Controlul, guvernarea și bugetarea s-ar baza pe legislația UE sau, eventual, pe acorduri multilaterale la nivel de stat [19].

Din punct de vedere al designului organizațional, rolurilor și responsabilităților aferente posturilor, *Modelul Alianței* de furnizare ADS include cea mai mică schimbare în designul organizațional și rolurile și responsabilitățile ulterioare, în special acolo unde există Alianțe deja formate, care cooperează în dezvoltarea și achizițiile de sisteme tehnice comune. Deoarece ANSP-urile mențin controlul asupra întregului lanț valoric și se asociază pentru a partaja funcțiile, pot exista modificări limitate în rolurile și responsabilitățile interne de gestionare și supraveghere a funcțiilor partajate. Pot fi necesare competențe superioare pentru a înțelege specificațiile în evoluție ale sistemelor tehnice și funcționale, dar aceste competențe pot fi împărtășite între mai multe ANSP, mai degrabă decât să fie concentrate într-un singur departament organizațional. Interfețele dintre ANSP-uri ar trebui, de asemenea, gestionate. Aplicarea scenariilor de implementare în Modelul Alianței este limitată la nevoile operaționale.

În *Modelul bazat pe Separare,* echipele tehnice angajate în prezent de ANSP ar fi probabil împărțite, majoritatea rolurilor tehnice experimentate în prelucrarea datelor și monitorizarea și controlul sistemului relevante, devenind parte a ADSP. O echipă tehnică mai mică ar trebui să rămână la ATSP pentru a asigura întreținerea continuă, împreună cu gestionarea interfețelor și legătura cu echipele operaționale. Echipele responsabile pentru furnizarea datelor (AIS, CNS, MET) pot rămâne în structura ANSP actuală sau se pot muta la o nouă entitate, în funcție de opțiunile locale. Echipele tehnice mutate la ADSP-uri ar trebui să se adapteze unei noi organizații, cu o nouă structură de management. Acolo unde aceasta devine o nouă entitate, conducerea, cultura, procesele și stimulentele s-ar putea adapta. Cu toate acestea, proprietatea ar putea rămâne în continuare la ANSP-urilor existente și, prin urmare, cultura și procesele de sus în jos ar putea rămâne similare cu cele de astăzi. Deoarece un ADSP ar putea deservi mai multe ATSP, personalul tehnic trebuie să fie capabil să gestioneze mai multe interfețe diferite, chiar dacă procesarea de bază a datelor ATM este comună diferitelor ATSP: aceasta ar crea oportunitatea de a exista echipe mai mici cu o expertiză mai restrânsă, dar mai profundă. Crearea de echipe specializate ar putea crea oportunitatea unor niveluri de servicii îmbunătățite și un potențial de creștere a inovației. ATSEP implicat în instalarea, operarea și întreținerea sistemului CNS/ATM ar trebui să aibă o înțelegere comună a ceea ce se așteaptă de la aceștia în termenii de performanță oriunde ar putea funcționa, pentru a sprijini un sistem interoperabil la nivel global și pentru a obține o capacitate optimă în limitele de siguranță acceptabile. În timp ce realitatea este că mulți ATSEPi sunt specializați (în ceea ce privește fluxurile de competențe și sistemele tehnice), evoluția rolului și capacitatea de a contribui eficient la performanța generală a siguranței sugerează că această înțelegere comună va fi utilă într-un viitor sistem interconectat. Un model mai puțin integrat pe verticală va aduce noi provocări pentru a obține o înțelegere comună a sistemului în viitor, necesitând noi mijloace de monitorizare, comunicare și reacție la probleme pe măsură ce apar. Dacă ADSP va fi

separat de ATSP se vor putea implementa scenarii mai complexe – de exemplu, centre virtuale care oferă capacitate la cerere într-o manieră tactică – importanța operațiunilor ADSP poate crește (de exemplu, siguranță, securitate, reziliență).

Potențiala redistribuire a sarcinilor și a volumului de muncă ar trebui monitorizate cu atenție pentru a preveni oboseala sau suprasolicitarea angajaților. În plus, modificarea domeniului de activitate al unui individ ar putea reduce satisfacția la locul de muncă pentru unii angajați, deși nu există niciun motiv fundamental pentru care un nou domeniu ar trebui să fie în mod inerent demotivant. Deoarece echipele de inginerie ar furniza acum servicii ATSP-urilor situate în diferite țări, procedurile ar trebui să fie optimizate. Este posibil să fie necesară introducerea unor practici optimizate de management al schimbărilor. De asemenea, pot exista modificări ale limbilor folosite de personalul tehnic, limbile locale nemaifiind o soluție viabilă.

Dacă rolurile se mută de la ATSP la ADSP, poate fi nevoie ca personalul să schimbe locul de muncă, în funcție de circumstanțele și deciziile locale specifice. Mobilitatea forței de muncă și concurența pot duce totuși la schimbări la nivel local în întreaga UE. Având în vedere o perioadă estimată de zece ani de schimbare a noilor ADSP, este puțin probabil ca forța de muncă să fie extrasă din industrii noi sau din rândurile absolvenților, având în vedere competențele și experiența necesare. În schimb, vor exista unele transferuri de roluri de la ANSP-urile existente, cu o oarecare evoluție naturală prin mișcările de personal și pensionări. Având în vedere că transferul de roluri formează baza multor ADSP-uri noi, este, de asemenea, mai posibil ca termenii și condițiile anumitor roluri să fie menținute pe termen aproape mediu.

Echipele care ar rămâne la ATSP pot vedea o schimbare în responsabilitățile muncii lor, care ar putea fi concentrate pe integrare și întreținere, precum și pe monitorizarea și supravegherea sistemului. Poate include competența în validarea și afișarea rezultatelor unui serviciu de date ATM pe poziția de lucru a operatorului, în funcție de armonizarea și natura productivă a serviciului de date ATM final. Va fi nevoie de un management atent al rolurilor, responsabilităților și satisfacției în muncă.

Deoarece modelul separat introduce eficiență în furnizarea de servicii de date ATM, cu potențial un singur FDP bazat pe cloud partajat între mai multe ATSP-uri (cu redundanță corespunzătoare), poate fi mai puțină forță de muncă generală necesară în industrie ca urmare a acestei opțiuni. Acest lucru ar trebui să fie cântărit în raport cu cerința ca noul ADSP să fie un ANSP certificat, separat de ATSP, cu structuri de conducere și administrative corespunzătoare [19].

În cazul *Modelului Specializat,* pe măsură ce o arhitectură mai mare orientată spre servicii pătrunde în sistem, iar ADSP-urile specializate și alți furnizori de servicii (de exemplu, CNS) evoluează, vor fi observate modificări suplimentare în personalul necesar. Amploarea acestora va depinde de luarea deciziilor la nivel local, deoarece modelul specializat prevede încă unele ADSP-uri complet integrate, care pot reproduce designul organizațional existent cu o separare limitată de ATSP-urile pe care le deservesc. Acolo unde noii veniți pot intra pe piața de furnizare a serviciilor de date ATM, pot exista noi

companii comerciale care doresc să inoveze și să implementeze modelele existente. În cadrul serviciilor pe care le oferă, aceștia vor solicita în continuare competențele, rolurile și responsabilitățile din prezent. Aceștia pot decide să investească în noi tehnici de gestionare a datelor cu scopul de a-și îmbunătăți serviciile și de a obține un avantaj competitiv. S-ar putea face comparații cu companii IT de nișă, care oferă competențe și servicii dependente de inteligența artificială, învățarea automată, progresele blockchain și altele similare. Forța de muncă de specialitate este integrată cu competențe tradiționale, companiile cu sediul în UE și căutând să ofere afacerilor clienților lor performanțe mai mari. Asocierea acestui lucru cu preocupările sporite acordate siguranței și securității din partea ANS va reprezenta o provocare pentru aceste companii.

În *Modelul pe trei niveluri*, pe lângă schimbările în practicile de lucru observate în cadrul *Modelelor Separat* sau *Specializat*, echipele tehnice pot fi distribuite într-un număr mai mare de companii/entități organizaționale, ceea ce ar însemna probabil că fiecare unitate organizațională va avea un domeniu de activitate mai restrâns și o competență mai specializată, personalul tehnic angajat având o expertiză profundă cu privire la sistemul specific sau fluxul de date. În acest model ar exista un număr crescut de ADSP-uri specializate și companii de producție de date, fiecăruia corespunzându-i o rază geografică mai mare: aceasta ar însemna că personalul ar putea fi obligat să-și mute baza de operare, să schimbe limba în care lucrează sau să fie supus unei schimbări organizaționale mai mari. Pe măsură ce numărul de interfețe din acest model ar crește, ar fi necesar personal suplimentar pentru a gestiona colaborarea cu alte companii și entități. Cultura entităților se poate muta de la o organizație de stat la o companie axată pe performanță pentru a obține cota de piață. Poate exista concurență pentru ATSEP sau alt personal specializat pe piață, ceea ce poate duce la creșterea salariilor, condițiilor și îmbunătățirea condițiilor de muncă. Nivelul de armonizare și, eventual, standardizare, a procedurilor și practicilor specifice de management pentru gestionarea datelor esențiale pentru siguranță va crește în acest model. Procesele optimizate de management al schimbărilor trebuie aplicate în mod consecvent. Gestionarea incidentelor ar trebui, de asemenea, armonizată acolo unde este posibil. Piața muncii în acest model se poate schimba radical, în special dacă toate serviciile sunt furnizate pe o bază transfrontalieră, cu specializarea ADSP-urilor în întreaga UE.

Trebuie avut grijă ca industria să nu fie stimulată în mod nejustificat să reducă costurile sau rezistența personalului, luarea deciziilor la nivel organizațional local trebuind să reflecte performanța și strategia generală pentru ANS/ATM, mai degrabă decât doar profitul. De asemenea, rolul ATSEP în lanțul de siguranță ar putea necesita o analiză suplimentară, recunoscând că asigurarea locală ar trebui consolidată în cadrul ADSP-urilor și al furnizorilor de servicii de date, în locul supravegherii depline din partea ATSP.

Introducerea unor scenarii mai avansate pentru serviciile de date ATM, de exemplu capacitatea completă la cerere în cadrul ATSP-urilor care achiziționează servicii de la serviciile de date ATM standardizate, poate duce, de asemenea, la o variabilitate mai mare (pe termen mediu) a volumului de servicii achiziționate de la fiecare furnizor de servicii. Forțele concurențiale pot duce la creșterea anumitor furnizori și la scăderea altora, piața muncii evoluând în continuare [19].

În *Modelul la nivelul întregii Uniuni,* odată cu adăugarea unui furnizor de servicii de monopol pentru o anumită funcție, organizat și furnizat la nivelul Uniunii, ar fi nevoie de proiectare organizațională și de resurse. Acest lucru ar putea distorsiona o piață pentru serviciile de date ATM, dacă nu este clar delimitată la elementele de serviciu necesare. Este de așteptat să fie furnizat ca un serviciu public, guvernat de o agenție sau instituție a UE. Este posibil ca, în ciuda înființării unei entități publice la nivel de Uniune, să mai existe ADSP-uri sau ATSP-uri care să decidă să utilizeze un serviciu de substituție dacă este disponibil, în special dacă funcția poate fi asigurată în condiții de siguranță și economice de mai multe entități. În funcție de domeniul de aplicare al funcției/funcțiilor la nivelul Uniunii, piața personalului competent ar putea fi afectată, în special în cazul în care, de exemplu, în organismul public erau implementate roluri cu condiții sociale atractive. Având în vedere centralizarea expertizei, există și pericolul ca sfera inițială a organizației să se schimbe pentru a cuprinde mai multe funcții generale. Experiența în prelucrarea datelor ar ajunge să fie centralizată, cu un potențial mai mare pentru furnizarea de servicii ineficientă și nerezistentă. Piața muncii de la stat la stat ar fi afectată [19].

Din punct de vedere al competențelor și instruirii personalului ATM/ANS, în *Modelul Alianței*, existând ANSP-uri integrate pe verticală și personal care rămâne cu ANSP-ul lor, acest model nu ar trebui să necesite nicio modificare a competențelor și a schemelor de formare existente în afara celor necesare ca parte a evoluției funcțiilor ATM Data Services (adică evoluțiile conținute în *Master Planul ATM*).

În *Modelul bazat pe Separare*, cerințele privind competențele și cerințele de formare care trebuie furnizate pentru ATSEP sunt stabilite în regulamentul privind cerințele comune. Acestea se aplică oricărui ANSP certificat relevant și depind de domeniul de aplicare al furnizării serviciilor sale. Acestea sunt supravegheate de autoritatea competentă desemnată de statul membru. În viitor, personalul tehnic ar putea fi angajat de ADSP. ADSP ar fi un ANSP certificat. Prin urmare, este posibil să asistăm la o schimbare a cadrului pentru ANSP-urile existente și acesta să poată fi aplicat noilor ADSP, personalul care lucrează la operarea sau întreținerea serviciilor de date ATM trebuind să fie competent în conformitate cu cerințele Part-PERS (- ca ATSEP). ATSEP își poate exercita competența în furnizarea de servicii de date ATM în mai multe state. Punerea în aplicare a cadrelor de competență și formare a personalului este lăsată la latitudinea statelor membre și, într-adevăr, a furnizorului de servicii însuși. Nu există o acreditare la nivelul Uniunii. Cerințele comune pentru ATM/ANS precizează că furnizorii de servicii trebuie să se asigure că ATSEP cunoaște limba (limbile) necesară(e) pentru a-și îndeplini atribuțiile. Pe măsură ce munca transfrontalieră și proprietatea ADSP dincolo de granițele statului devin tot mai răspândite, prevăzute de scenariile de implementare a ADSP, acest lucru este probabil să necesite competențe lingvistice comune mai mult decât este cazul în prezent într-un ANSP integrat vertical. Acest lucru poate fi echilibrat de necesitatea de a păstra ATSEP cu experiență în industrie, care pot avea un anumit set de abilități lingvistice.

Este posibil să fie nevoie să fie luate în considerare cerințele și practicile locale, pe lângă un set de cerințe minime care să permită persoanelor competente să furnizeze servicii peste granițe. De exemplu, descentralizarea abordării bazate pe servicii poate necesita noi tehnici de monitorizare, supraveghere și comunicații de date, împreună cu o mai bună înțelegere a

lanțului de date de la capăt la capăt. Acest lanț de date ar putea fi supravegheat prin intermediul conștientizării situației comune la nivelul întregului sistem, permițând tuturor părților să mențină monitorizarea și conștientizarea impactului asupra întregului lanț de servicii ATM. Aceasta se adaugă evoluțiilor existente, necesare indiferent de apariția ADSP-urilor, concentrate pe securitatea cibernetică și pe vulnerabilitățile sistemelor funcționale. Grupul european pentru dimensiunea umană a publicat, de asemenea, un proiect în care menționează că competențele suplimentare pentru personalul tehnic (ATSEP) ar putea include: competențe de afaceri, inclusiv interoperabilitate, înțelegere operațională, factori umani (de exemplu, gestionarea stresului în timpul incidentelor); procese (de exemplu, cele mai bune practici IT și inginerie); și competențe și atitudini comportamentale, inclusiv managementul resurselor echipei și cooperarea organizațională. Instruirea personalului tehnic ar urma să fie efectuată de către ADSP, fie direct, fie prin intermediul părților contractate. Pentru acest model, aceeași entitate ADSP poate fi responsabilă pentru serviciile de producere a datelor (CNS), inclusiv întreținerea/întreținerea echipamentului. Dacă integrarea orizontală este utilizată în organizație, poate fi necesară o pregătire suplimentară pentru a gestiona diferite niveluri/configurații de infrastructură dintr-o singură echipă (de exemplu, radare în mai multe țări) [19].

Modelul Specializat include mai multe servicii unice furnizate de entități specifice, ceea ce duce la o specializare din ce în ce mai mare a cerințelor de competență și formare – de exemplu, competența de integrare a supravegherii într-o singură organizație, integrarea datelor de zbor într-o organizație. Acest lucru poate genera o mai mare specializare a competențelor, încurajând inovația și calitatea serviciilor. Un aspect cheie este necesitatea de a asigura înțelegerea întregului sistem, în special în aspectele operaționale ale serviciului de date ATM. De exemplu, persoana care operează software-ul de integrare a supravegherii poate avea nevoie să cunoască comportamentul datelor primite, precum și impactul oricăror modificări ale datelor livrate către un alt ADSP.

Într-un *Model pe trei niveluri*, impactul asupra managementului competențelor va fi similar cu cel observat în Modelul Separat. Diferența cheie va fi numărul de entități separate care vor necesita supraveghere și nevoia mai presantă de soluții la nivelul Uniunii care să permită libera circulație a forței de muncă. În plus, va exista un număr mai mare de entități transfrontaliere. Configurația de supraveghere poate fi diferită, o responsabilitate mai mare revenind reglementărilor la nivelul Uniunii și nu autorităților naționale de reglementare. Acest model este mai probabil să producă o piață competitivă. Ca atare, ADSP-urile ar trebui să fie mai flexibile în reinstruirea personalului pentru a furniza servicii noilor ANSP.

În *Modelul la nivelul întregii Uniuni*, adăugarea unei entități de monopol administrată public pentru o anumită funcție sau element de serviciu al ATM Data Services va concentra în mod necesar competența în acel organism. Prin urmare, se va asigura formarea în domeniile relevante pentru organizațiile de interfață, astfel încât competența să nu se piardă. Un exemplu actual ar putea fi prelucrarea de big data a traiectoriilor efectuată de Managerul de Rețea (NM). Deși datele sunt disponibile altor ANSP, există o preocupare generală că o înțelegere profundă a datelor, combinată cu capacitatea de a inova și de a dezvolta servicii cu valoare adăugată, este concentrată în organismul la nivelul întregii

Uniune, datorită avantajului natural al acestora în colectarea, stocarea și procesarea planurilor de zbor (și a traiectoriilor) pentru întreaga UE [19].

Din punct de vedere al culturii organizaționale și condițiilor de muncă, în *Modelul Alianței*, cu ANSP-urile existente menținându-și integrarea verticală, nu se crede că ar exista o schimbare în culturi sau condiții de muncă pentru personalul implicat în ATM Data Services.

În *Modelul Separat*, în ceea ce privește echipele tehnice (operarea și întreținerea sistemelor tehnice care stau la baza ATM Data Services), echipele actuale ar putea fi împărțite în două companii și potențial împărțite în mai multe țări, ceea ce poate crea probleme de comunicare. Vor fi necesare eforturi pentru a crea bune practici de lucru în cadrul companiilor. Aranjamente contractuale vor fi din nou necesare pentru a stabili procese, așteptări clare și pentru a asigura fluxurile de raportare și informații ca în prezent.

Pentru ca înființarea ADSP-urilor să aibă succes, trebuie susținută încrederea umană în furnizarea de servicii, de exemplu ATCO care au încredere în ADS. Într-un scenariu în care încrederea scade (de exemplu, din cauza unei întreruperi a serviciului sau a unor erori persistente), este probabil să fie mult mai dificil de restabilit încrederea în serviciu, fără a avea vizibilitate asupra pașilor corectivi întreprinși de conducerea ADSP. Fără încredere în întregul sistem, ATCO pot simți că nu sunt în măsură să ofere un serviciu sigur, ceea ce duce la întreruperi serioase ale furnizării serviciilor, deoarece sunt adăugate *tampoane* pentru a asigura siguranța. Dacă structura de proprietate este divizată, ATSP poate să nu aibă o perspectivă atât de mare asupra deciziilor manageriale, a proceselor de control și a contractelor care sunt puse în aplicare în ADSP. Acest lucru ar putea duce la mai puțină vizibilitate și control asupra calității serviciului și a capacității de a asigura continuitatea serviciului. Împărțirea responsabilităților organizaționale poate duce la modificări ale implementării îmbunătățirilor sistemelor operaționale.

În ciuda punctelor de mai sus, impactul asupra culturii organizaționale în acest model este de așteptat să fie minim, deoarece structurile de proprietate similare cu cele ale ANSP înființate inițial vor fi menținute. Aranjamentele de stabilire a costurilor vor urma probabil "prețul corect", mai degrabă decât o "piață competitivă", permițând în continuare culturii să rămână în status quo. Ca atare, impactul asupra personalului ar trebui să fie minim, cu ajustări minore de management și organizație [19].

În *Modelul Specializat,* cu o specializare sporită și, mai mulți actori, interfețele suplimentare între organizații vor trebui gestionate separat. Ar fi necesar un efort suplimentar pentru a asigura menținerea încrederii în sistem, cu definirea clară a proceselor sistemului și a condițiilor limită pentru toate părțile interesate. Ar fi probabil necesare prevederi contractuale suplimentare pentru a proteja ATSP de defecțiuni ale sistemului și probleme de furnizare a datelor. Schimbările organizaționale ar fi mai semnificative, iar procesul vertical defalcat într-un număr mai mare de entități. Ca atare, vizibilitatea proceselor *end-to-end* și a deciziilor manageriale la nivelul entităților ar fi redusă. În plus, este probabil să existe un impact mai mare asupra culturii organizaționale, deoarece este de așteptat să se creeze o piață competitivă între ADSP-uri.

Modelul pe 3 niveluri implică o piață nesigură pentru ADS și alte servicii care contribuie, cum ar fi CNS. Acest lucru ar putea pune presiune asupra reducerilor de costuri și ar necesita o optimizare a modalităților de lucru în cadrul furnizorilor de servicii. Pot fi observate efecte asupra asupra orelor de lucru, în limitele practicilor sigure și ale legislației privind condițiile de muncă.
În mod pozitiv, un mediu orientat spre profit poate recompensa performanța personalului mai pe deplin, conducând la o motivație mai mare și o inovație sporită.

În *Modelul la nivelul întregii Uniuni*, adăugarea unei entități publice care furnizează servicii la nivelul întregului sindicat nu ar trebui să aibă un impact nejustificat asupra culturii și condițiilor de muncă. Există riscuri ca un mare furnizor de servicii publice să denatureze piața, dacă este capabil să ofere condiții de muncă mai atractive decât orice alt furnizor. Cu toate acestea, acestea sunt depășite prin monitorizarea eficientă a reglementării economice și evaluarea comparativă a costurilor permise. Cultura entității la nivelul întregii Uniuni va depinde de guvernanța și structura exactă a acesteia [19].

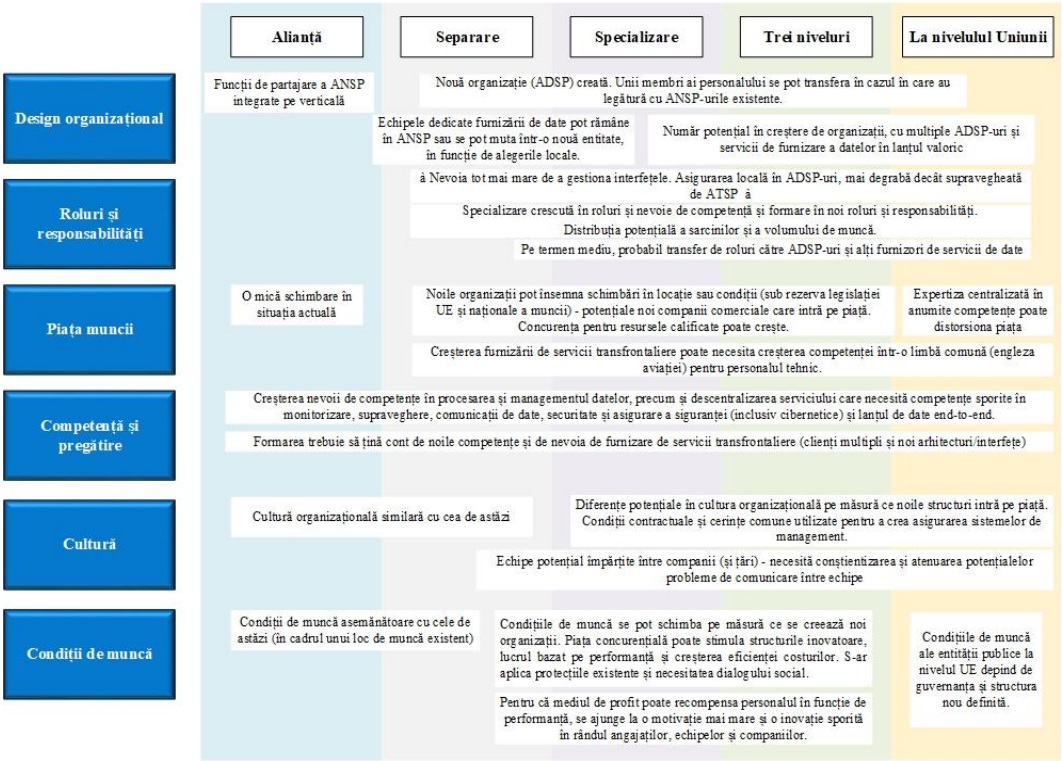

Fig. 1 Efecte ale celor 5 modele de structure organizaționale, pe diferite dimensiuni
Sursa: European Commission (2020). Legal, economic, and regulatory aspects of ATM data services provision and capacity on demand as part of the future European air space architecture. Final report, p. 334

Ultimele evoluții din Europa în sprijinul modernizării ATM au condus la elaborarea a altor documente europene importante, interne sectorului, precum *Studiul de arhitectură a spațiului aerian* (AAS) [20] și *Master Planul european pentru ATM* al cărui subtitlu este "Digitalizarea infrastructurii aviatice a Europei" [21]. Unul dintre elementele comune cheie ale acestor documente strategice este implementarea independenței locației, automatizarea și digitalizarea ATM-ului, în special prin Centrele Virtuale (VC).

Acestea din urmă sunt detaliate într-un alt document european, intern sectorului aviatic. Conform acestuia, traficul aerian a crescut în ultimii ani, ajungând la peste 11,1 milioane de zboruri în zona europeană în 2019 (adică cu 16,3 % mai multe zboruri decât în anul 2009). Deși aviația a fost puternic afectată de pandemie, și chiar dacă în 2022 traficul a ajuns aproape de nivelurile din 2019, mai lent decât s-a așteptat, cu toate acestea, traficul va ajunge în cele din urmă peste nivelurile pre-pandemie, ceea ce necesită pregătirea personalului pentru a gestiona niveluri ridicate de trafic, evitând nivelurile ridicate de întârziere din 2018 și 2019. Conform statisticilor Eurocontrol și Serviciului de prognoze (STATFOR), cel mai probabil se va ajunge la aproximativ 16 milioane de zboruri în 2050, care corespunde cu 5 milioane de zboruri mai mult față de 2019. Cu acest trafic aerian în continuă creștere, susținerea creșterii durabilă a capacității a devenit una dintre principalele provocări pentru sectorul ATM; există probleme de congestie în multe zone din rețeaua europeană de ATM, "lider" în 2018-2019 la cele mai mari întârzieri din ultimul deceniu. În prezent, arhitectura ATM din Europa este rezultat al istoricului operațional și tehnic, gestionat la nivel naţional şi conducând la un sistem general fragmentat. Această arhitectură actuală limitează atât pe ansamblu capacitatea maximă, precum și scalabilitatea pentru a satisface schimbările și fluctuațiile cererii. Acest lucru are ca rezultat un dezechilibru: un stoc de rezervă în unele zone ale Europei și supraîncărcarea în alte zone în acelasi timp [22].

Și *Studiul de arhitectură a spațiului aerian* (AAS) reconfirmă că fără o accelerare a modernizării ATM și modificări complementare, situația întârzierilor din traficul aerian va continua să se deterioreze la un nivel fără precedent. Estimarea creșterii până în 2035 cu 50% a numărului de zboruri anuale creează o provocare majoră pentru industria ATM-urilor, care va trebui să se adapteze și să gestioneze traficul în creștere în siguranță, eficient și la un cost acceptabil din punct de vedere economic. Nivelurile estimate de întârzieri până în 2035 (8,5 minute per zbor în medie comparative cu 0.9 minute în 2017) sunt fără precedent și mai mari decât cele mai mari întârzieri înregistrate vreodată în Europa (5,4 minute în 1999, în timpul crizei din Kosovo). În ciuda problemei de capacitate, este important de menționat că nivelurile de performanță pentru siguranță – care este activitatea de bază a ATM – au fost și sunt remarcabile. Implementarea integral a strategiei propuse ar reduce întârzierile în conformitate cu obiectivul SES (0,5 minute întârziere medie pe rută de zbor), menținând nivelul ridicat de siguranță și eficiență actual pentru cele 16 milioane de zboruri preconizate (+50% față de 2017) [20].

Conceptul de Centru Virtual adaugă de fapt un nou tip de entitate numit ATM Data Service provider (ADSP), care este gândit să ofere servicii de date independente de locație.

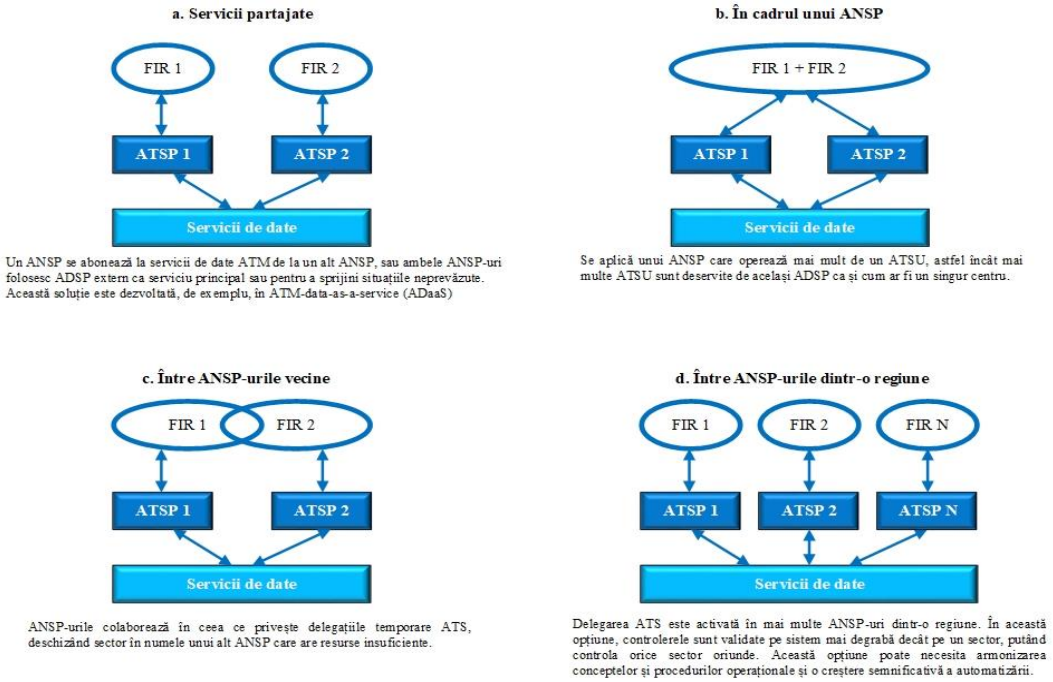

Fig. 2. Opțiuni de implementare a unui Centru Virtual în funcție de nivelul de colaborare dintre statele europene

Sursa: Eurocontrol (2023). Performance Insight. Reorganising ATS with Virtual Centres. January, p. 2.

Folosind conceptul de Centru Virtual, un ANSP se va putea armoniza și moderniza de la tehnologia de la sol până la procedurile operaționale și proiectarea spațiului aerian pe cer.

Fig. 3. Reorganizarea ATS prin Centre Virtuale

Sursa: Eurocontrol (2023). Performance Insight. Reorganising ATS with Virtual Centres, p. 0

Centrul virtual aduce o serie de beneficii: permite ANSP să reacționeze mult mai rapid la creșterea sau scăderea cererii de trafic aerian prin adaptarea capacității de a absorbi trafic, astfel face ATM-ul mai eficient, mai rezistent, scalabil și mai puțin costisitor; contribuie la limitarea impactului aviației asupra mediului, permițând optimizarea traiectoriilor de zbor, ceea ce reduce emisiile de CO2; întărește capacitatea de adaptare printr-o mai mare rezistență operațională și securitate cibernetică; armonizarea și modernizarea tehnologică favorizează îmbunătățirea continuă a siguranței operațiunilor de trafic aerian; mai multă automatizare permite gestionarea unui trafic mai mare, cu aceeași forță de muncă precum în prezent [22].

Master Planul european pentru ATM este principalul instrument de planificare pentru stabilirea priorităților ATM și pentru a garanta că obiectivul țintă SESAR devine realitate. Master Planul este o foaie de parcurs în evoluție și rezultatul unei colaborări puternice între toate părțile interesate de ATM. Ca pilon tehnologic al inițiativei SES, SESAR contribuie la atingerea obiectivelor la nivel înalt SES și sprijină SESale Single European Sky. Pentru prima dată, Raportul cartografiază evoluția implementării Master Planului pe cele patru faze progresive ale Viziunii SESAR, așa cum a fost definită în ediția 2020 a Master Planului, pentru livrarea unui cer european digital: faza A – Remedierea deficiențelor critice cunoscute de performanță a rețelei; faza B – Servicii eficiente și livrarea infrastructurii; faza C – Defragmentarea *cerurilor europene* prin virtualizare; faza D – *Digital European Sky* [21].

5. Concluzii și discuții

Analiza a cinci tipuri de modele de aranjamente organizaționale, propuse la nivel european pentru digitalizarea activității în sectorul aviatic și eficientizarea traficului aerian, pe care am realizat-o în acest articol, arată că există posibilitatea, din punct de vedere tehnic, dar și organizațional, a creării Cerului Unic European.

Gradul ridicat de dezvoltare a tehnologiei actuale poate ajuta domeniul aviatic, prin interconectarea mai facilă a sistemelor de date. Armonizarea serviciilor de trafic aerian și definirea de noi soluții la nivel de design organizațional va conduce pe viitor la costuri mai scăzute ale serviciilor de transport aerian, la scăderea emisiilor de CO2 și la reducerea întârzierii zborurilor. Mai mult, Centrele Virtuale, ca un nou tip de entitate gândită să ofere servicii de date independente de locație, favorizează, pe baza modernizării tehnologice, atât îmbunătățirea continuă a siguranței operațiunilor de trafic aerian, cât și gestionarea unui trafic aerian mai mare.

Din punct de vedere social însă, în contextul general al unei piețe a forței de muncă în care tendința actuală din 2023 la nivel internațional, cât și național, este aceea ca și persoanele active care au un loc de muncă să "se pună la adăpost" de incertitudinile economice și creșterea costului vieții, fiind în căutarea constantă a unui alt loc de muncă (ca *back-up* în fața unei eventuale concedieri), în particular, în sectorul aviatic, numărul persoanelor angajate a înregistrat un minim față de ultimii 14 ani, cei mai afectați fiind tinerii (cu o scădere evidentă a proporției de tineri angajați în vârstă de 15-29 de ani, din cauza reducerii oportunităților de angajare în sectorul transportului aerian pentru acest grup), iar o pondere care nu e deloc de neglijat de angajați din sector sunt nemulțumiți de actualele condiții de

muncă. În tot acest tablou, constatăm o preocupare încă insuficientă, în documentele recente europene din domeniu analizate, față de consecințele pe care le pot avea, la nivelul calității vieții de muncă a angajaților, reorganizările departamentelor operaționale din sectorul aerian, ca umare a creșterii gradului de digitalizare.

Considerăm a fi necesară realizarea unor cercetări sociologice calitative, în profunzime, pe bază de ghid de interviu, cu manageri, cât și cu angajați fără funcții de conducere din departamentele care vor fi afectate de restructurările implicate de modelele de design organizațional descrise în lucrare, din sectorul aviatic din fiecare stat al Uniunii, pentru a afla percepțiile acestora cu privire la consecințele pe care fiecare din modele le poate avea asupra condițiilor lor de muncă, încât factorii de decizie să poată preveni și minimiza din timp potențialele efecte sociale negative asupra calității vieții angajaților; o abordare detaliată din punct de vedere social a restructurărilor organizaționale propuse trebuie să completeze și chiar să fie prioritare abordărilor economice, tehnice și legislative existente.

ANEXĂ

Acronime:
ADS – ATM Data Services (Servicii de date pentru ATM)
ADSP – ATM Data Service Provider (Furnizor de servicii de date pentru ATM)
AIS – Aeronautical Information Service (Servicii de informare aeronautică)
ANS – Air Navigation Services (Servicii de navigație aeriană)
ANSP – Air Navigation Service Provider (Furnizaor de servicii pentru navigația aeriana)
ATCO – Air Traffic Controller (Controlor de trafic aerian)
ATM – Air Traffic Management (Managementul traficului aerian)
ATSP – Air Traffic Service Provider (Furnizor de servicii de trafic aerian)
ATSEP – Air Traffic Safety Electronics Personnel (Personal electronist care asigură siguranța traficului aerian)
ATSU – Air Traffic Service Unit (Unitate pentru furnizarea serviciilor de trafic aerian)
CNS – Communication Navigation Surveillance (Comunicație Navigație Supraveghere)
FIR – Flight Information Region (Regiune pentru informarea de zbor)
MET – Meteo (Seviciul Meteo)
NM – Network Manager (Managerul de rețea)
SES – Single European Sky (Cer unic European)
SESAR – Single European Sky ATM Research (Cercetare ATM pentru SES)s
VC – Virtual Centre (Centru Virtual)

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Towards a smart democracy: increased trust in political leaders

Irina-Ana DROBOT,
Lecturer, PhD, Technical University of Civil Engineering Bucharest, Romania, Faculty of Engineering in Foreign Languages, Department of Foreign Languages and Communication
anadrobot@yahoo.com,, ana.drobot@utcb.ro

Abstract
Among the objectives of the present paper we can mention finding an answer as to how the democracy has been changing in order to adapt to the contemporary world and to the contemporary needs. How can technology help us, and how can technology make the distance between the people and the elites or those in power become smaller? Prior work includes papers by Walters (2011) and Scholl & Scholl (2014), discussing the way that electronic, or smart governance can lead on to a new dimension of democracy, that of smart democracy. Hofstede's (2011) cultural dimensions will also be used. The approach will consist of the cultural dimensions of individualism, rising worldwide, and that of lowering power distance, as the world tends towards liberal democracy as an ideal form of government and on the wish towards people becoming equal. The results show that there is more trust in the political leaders with a smart democracy tools. As the information is laid bare through technology, there may be less worries about corruption and manipulation. Among the Implications, we can see an improvement of the liberal democracy with adapting it to the needs and opportunities of the world today. The value of the paper consists in understanding the dimensions of individualism, low power distance and liberalism through the use of technology. Technology helps against the fears of people of corruption, which has been the driving force of protests in Romania quite recently. While these seem general ideas which have been around throughout history, they are achieving a new dimension within the smart city, where we have a higher level of security due to the presence of web cameras for surveillance, and where all systems of bureaucracy and politics, have become openly available due to the possibilities offered by technology.

Keywords: individualism, liberalism, low power distance.

1. Introduction
The issue of trust in political leaders is a major one in today's world. Various leaders competing for elections try their best to bring about the voters' trust. This can be a difficult task once the voters have been deceived in their expectations regarding their previous choice of candidates. However, we could claim that this is the way elections and the voting process goes. Voters get various illusions regarding the candidates' promises, and then they start hoping again with their vote for the following elections.

Nowadays, we do not rely on the politicians' speeches and on their public image to witness the way they are inspiring trustworthiness to us. Trust in political leaders includes several traits, such as, first of all, honesty, related to indeed placing the interest of the people at the centre of their activity, regarding especially their life standards, and second, responsibility, which is related to the means through which they solve various issues such as dealing with the country's budget and with the possible debts to other countries. The political leaders are also expected to ensure the safety of their citizens in cities in their country.

The issues of trust and safety have been adapted to our contemporary, highly technologized world, under the form of smart cities, where institutions, public transport, parking services, stores, and almost all areas in the city all benefit from webcameras which are believed to help prevent theft and other crimes.

While technology presents us citizens with means of monitoring through webcams to help prevent various crimes, and, thus, ensure our safety in big cities, this supervision system poses various questions regarding our personal privacy. We are being reassured that everything is a matter of GDPR, and that the personal data will not be used in an abusive manner. Some countries have been reported of becoming safer and with a declining rate of crime, due to the webcam supervision system.

All information about the way various institutions work and use the budget that is available online for public consultation is supposed to ensure lack of suspicions and expose everything in an honest manner. Citizens can feel that political activity is always under control, and then they can understand political leaders as acting simply as managers of the citizens' and country's situation, fulfilling their duty, which is very clear. Political leaders may not, from this point of view, be suspected of hiding anything, or of using the country's resources for their and their family's personal use.

However, this is not necessarily enough to reassure citizens of the good intentions of the political leaders. Citizens may have much too high expectations and then they can be disappointed regarding other areas of the activity of political leaders, such as, for example, raising the salaries for certain professions. Not even the benefits of high technology can solve all issues that preoccupy our society.

All the same, the issue of trust still remains one of the most significant aspects in the relationship between citizens and political leaders.

1.1. Literature Review

The smart city is focused on the keyword of technology, if we look at its definition, and on the way that technology can be used for aspects such as its being suitable for communication, data processing and sharing of information, but also for making the city sustainable, in managing its issues such as pollution, and production of energy, functioning of various services, institutions and elements of infrastructure, among which, democracy [1].

The issue of smart city is strongly connected to the type of democracy adapted to them, namely smart democracy. It is a topic of actuality and relevance to all citizens and all members of political life, which has been and is being frequently discussed in mass media and in academic research.

Nowadays, we can speak about e-governance in a smart city [2]. This research also brings about a significant question with respect to the access to and use of technology, which is available to any citizen right now, namely whether or not technology unites us or, on the contrary, draws us apart, while referring to "The pervasive reach of electronic data and media," which "can help bind the disparate elements of a community together as much as it may seek to disperse them" [2].

However, we could claim that this issue has been about in large cities even before the high-rate use of technology nowadays. People from all over the country, at least, if not from

other parts of the world as well, would gather in a big city and then it would be difficult for them to relate to one another, mainly since they were so different. Large cities would also lead to feelings of isolation and alienation, as families and friends would remain in other cities or rural areas, while only the young generation members would move to the city and start a new and more comfortable life there.

Another issue has been brought about to the aspect of communication, which is implied to be among citizens or among citizens and political leaders: "a balance" should, ideally, "be achieved where both physical and virtual realms enhance the unique character of particular locations" [2].

Communication among citizens and political leaders can be regarded as occurring through the events political leaders such as the representatives of the city halls and others organize in the city for their citizens with the occasion of various holidays and celebrations, such as Christmas and Easter fairs, which include decorations for the special occasions, such as festive lights. This is an example of concrete action which citizens can directly and clearly benefit from.

Other researchers refer to "a tightly interconnected global society," to which "democratic self-governance in 21st century market economies apparently needs to develop new institutional formats and novel mechanisms" in order to adapt to this state of affairs [3].

What is self governance? The term is understood as referring to "the exercise of authority over oneself – whether that is at the individual, organization or national level – without outside interference" [4].

The structure of the smart, as well as democratic, form of government relies on "actionable and omnipresent information along with its underlying technologies," since these models of governance "foster smart, open, and agile governmental institutions as well as stakeholder participation and collaboration on all levels and in all branches of the governing process" [3].

We can see how the structure of the smart government is portrayed as placing emphasis on the relationship between citizens and political leaders. While we may think that this has been a necessity, at all times, and that this is all that we could sum up for political activity to be about, we can see how the focus is on a relationship of collaboration, and not on one of authority, namely that of the political leaders, over the citizens, those that are supposed to obey those in power.

With respect to the relationship with authority, the general move at world level is that tending towards equality in all areas of life. Supranational organizations are focused on promoting equality through democratic values, accepting diversity and not discriminating anyone on grounds of ethnicity, lifestyle, personal values, and cultural mindset.

Judging by this state of affairs, the approach relying on Hofstede's cultural dimensions [5], namely that of high vs low power distance, which refers to a tense or more relaxed

relationship with authority, at all levels, political, educational, in schools, at work and within the family, is very relevant. High power distance means that individuals should do as they are told by those in a higher position than them, while low power distances implies that there is the possibility of negociation and of suggesting solutions, and discussing on equal terms to those in a position of authority whose role is, ultimately, to organize a certain group, institution, or state.

According to research, there is the notion of "implicit smart politics," a genre of politics which is "not subjected to a real process of political institutionalization," and which is "strongly diffused among the various social actors" [6]. Since smart politics is not institutionalized, it "may favor the excessive power of economic-financial and technological actors" [6].

This may be since, as much as we believe everyone has access to technology in an equal measure, some areas may have poorer signal or even poorer possibilities to own gadgets allowing access to the Internet.

2. Materials and Methods

The democracy is considered the most suitable form of government nowadays, since it is adapted to the needs of the mindsets of today's people. We are living in a world where individualism, or the focus on the interests of the individuals, understood as separate from being subsumed to the interest of the entire community [5], has been on the rise at world level [7]. The rising individualism comes with the rise in the situation regarding the economic conditions [8], and, on general, with good and comfortable living conditions [9].

The democracy has been placed in opposition with totalitarian types of government, compared to which it can be considered, at all times, "the best form of government" [10].

We could relate democracy to a large sense of freedom and personal choice of action. The intervention of the state in the citizens' personal lives is not considered desirable at any time during history.

The wish towards equality, at least in the Western world, and to the breaking up of hierarchical social order has appeared once the Medieval Ages social structure was dissolved. Afterwards, a bureaucratic order of society based on relationships not of hierarchical difference of status acquired from birth, but based on social contract, such as the one between employer and employee, followed. The hierarchy is based on a business-type of structure, yet both employer and employee have their own, specific rights, mentioned in the work contract and based on established law.

Nowadays, citizens have equal rights established by law. There are no more aristocratic individuals, who are aristocratic based on birth, and lower working classes, once again, established by birth. Nowadays, everyone needs to work in order to gain their existence. Of course, some earn more than others, but the social hierarchy is not fixed and unmovable. Starting from Victorian times, the social hierarchy has been subject to easier social mobility. Previously, social mobility was condemned, as the belief that everyone had his

or her right place already established by God and by birth and which could not be changed, was held. Becoming rich from being poor was regarded, by society, with suspicion, leading even to believing that uncorrect, unethical means had been used. The United States of America represented a fresh perspective when they claimed that everyone going there, to be part of the Gold Rush, or simply willing to start a new life, could become anything they wanted. Individual freedom allowed them to be part of a spectacular rise from being poor and unknown to becoming rich and a celebrity. This was a radical break-up with the fixed mentality of the Old World.

We can see, in the way the world has progressed in mentality regarding status, from high power distance to low power distance societies in general. Nowadays, we value democracy and liberalism to a high extent, and do not tolerate authoritarian forms of government.

Liberalism could be defined as "the belief that the freedom of the individual is the highest political value" [11]. The high rise of technology and its presence in our lives enhances this feeling. Nowadays, the masses appear to judge harshly the political leaders making use of dishonest means and corruption, as they protest against such behaviour on the part of political leaders. Mass media stirs their actions of protest. People may have come to believe that technology nowadays, mass media included, appear to reveal the truth behind the scenes of political activity. However, various scandals may prove to be unfounded, exaggerated, or part of other rival political groups' action to ruin the popularity and the public image of a certain political leader or political party.

Together with the use of technology, we expect equality among citizens to be on the rise, accompanied by the manner in which they establish dialogue with the political leaders. Through voting, the citizens already have a certain degree of choice over their lives, yet, to what extent can they be sure that they can trust the system, regarding the extent to which the results are presented in an honest way and are not, actually arranged? Mass-media has contributed to plenty of suspicions, and the Internet can be used spread various news and information that can undermine the trust in political leaders and in their activities.

We may have acquired an ideal form of lifestyle, that which is based on personal expression of opinion. We, as citizens, expect to be taken into account with our opinions, and with our suspicions regarding certain political leaders. We are given the most of freedom of speech, as well as right to safety and even privacy, if we want, to post online our opinions regarding the activity of certain political leaders. We can post these opinions anonymously or under a pseudonym on online forums, online social media for our friends to see, under various posts on online social media, and as comments related to online articles. While we satisfy our needs for self-expression, however, the results of the expression of these rights are not available unless we count other citizens sympathizing with us and agreeing with our opinions. The question that comes to the fore is related to what extent we can actually change anything as citizens. What power do we have to expose what we believe to be the truth about certain political leaders which we feel have failed our expectations and their own promises?

The answer to such a question remains open, for both usual democracies and smart democracies. The power of decision and influence the citizens have over their chosen

political leaders remains unknown, practically, while, theoretically, we are supposed to have, as citizens, our say with respect to choosing the political leaders we judge as best suited to carrying out our interests.

While it is can be assumed that we have all the right to information and even more opportunities regarding the chosen political leaders through the Internet and through technology in general, there are still some drawbacks. For example, there is the drawback regarding privacy in a smart city, which may lead to the danger "to transform cities into Orwellian dystopia" [12]. This sensation may be had due to the supervision systems available by means of webcams, as well as through the "urban-scale of intelligent sensors," and through using the payment of a fee for using "a smart city service, and implicitly" by having a citizen's "trading his/ her privacy for the service provided [13],, [12]. Privacy is believed to be "one of the preconditions of democracy [14]; [15] […])" [12].

The right to the protection of sensitive personal information, as well as to personal data, has been ensured through supranational organizations' rules and laws such as the GDPR. This is one example of the way in which the EU seeks to support the ideals of democracy in the member countries.

The democracies can be seen as facing, even if they are considered the only form of government that is acceptable nowadays, as facing a crisis, from the point of view of trust: "Citizen trust has been eroding over the last decades, posing difficulties in engaging citizens in democratic participation, thus tearing on a pillar on which democratic society rests" [16].

Even if, through democratic means, and coupled with the idea of smart cities, we can have, as citizens, access to information regarding the activity of political leaders, and the way life in a smart city, meaning in a highly technologized city goes, we may still wonder as to how reliable the information given is. A question that arises immediately, is how has the information to be publicly be shared been filtered? Has there been a selection of the information to be presented for the public, and according to which criteria? It can be tempting to think that, once we have surveillance systems, and all data is stored and used when needed, car thefts and various crimes have declined, as the thiefs can be found right away. Similarly, we may be tempted to think that the activity of political leaders can be laid bare for public consultation and, thus, nothing can be hidden any more. Yet, once we are suspicious, or once our suspicions have been underlined by others' comments and proofs given online regarding political leaders, trust remains an issue. What is more, technology can have its failures and not work properly, which can give rise to even further suspicions, and actions taken to hide various aspects in the activity of the political leaders.

While "crime reduction, security, and urban governance" [17] are issues specific to smart cities and sound positive, and could be considered in the direction of improving safety and organization in the city with the help of technology, these can still be questioned. One of the questions that comes to our mind could be related to whether all areas in the city are under webcamera surveillance, and whether or not pickpockets can be monitored at all times. Political leaders should have all this in view, since the quality of life of citizens may depend on how safe they can feel in the city when they realize that at the mall, in the street,

or in a store, with all surveillance systems, they can still be robbed of their wallet. It may be difficult for them to access the recordings of the webcamera and, even more so, it may be difficult for the police to identify the thieves if they have their head covered with a cap or face covered with a scarf, or if they are not present in their database. Eventually, there may not even be any recordings at all, function of the area where the robbery took place or of how crowded the place was.

Once citizens go through certain situations which are unpleasant for them, they may lose their trust in the safe environment and conditions of living in the city the political leaders may ensure. This is one concrete situation which can significantly erode trust in political leaders, and the relationship between them and the citizens may suffer.

No matter the organization and the promises of high technology, it is concrete situations which can lead to questioning the competence and interest of political leaders to actually improve the citizens' living conditions. Besides the example of safety in the city with respect to pickpockets, we can have the example of whether or not the paid parking sstem through an application or through text messages works. Once there are errors, and once citizens are taxed for more or fined in a dishonest manner, they may lose trust in the way that their smart city works. Additionally, once the system of scanning the card on public transport does not work and citizens are fined, this is considered by them a detail which relates to the responsibilities of political leaders, at national level or local level, such as at City Hall representatives' level.

Otherwise, leaving aside the direct contact of citizens in their daily lives with smart cities' possibilities, big deeds on the part of political leaders such as building highways and promising good relationships at international level may not even be seen by all the citizens, if they are not directly involved or affected by them in a direct way.

3. Results

Once we are speaking of democracy, we are speaking about the personal freedoms and rights of the individuals. These are also associated with the idea that everyone is equal and that there should be low power distance between citizens and political leaders. Technology can be seen as offering equal access to information and to dialogue to any citizen, as well as between citizens and political leaders. Smart cities are correlated with smart democracies, and once city is managed politically through a smart democracy we, citizens, expect to have the right to access all information, which is expected to be made public, regarding the political leaders' activities. In this way we may ensure that they are not stealing from the country's budget and that they are being honest with the timeline of their various plans and promises regarding the citizens' lives in the respective city. Some political leaders may build up their public image on social media and they may engage in dialogue with the citizens, function of how much this is possible. If they are accused by citizens of not being honest, then there would not be much of a dialogue. Likely, the political leaders would ignore the questions.

Democracies, and even smart democracies, may, thus, not ensure the possibility of dialogue between citizens and political leaders, all the more so as the communication becomes

accusing and conflictual. No political leader would engage online in proving and arguing in favour of their honesty. This would be too time consuming, and, besides, citizens would end up, likely, not even being convinced. Once citizens start out a conflictual dialogue, they may be impossible to be persuaded that the situation is, in fact, otherwise. Citizens would continue to believe that they have been deceived and their trust would not be restored easily.

Ideally, smart democracies would have everything transparent, and there would be no suspicions, and nothing to be hidden from the public. The citizens would have access to all the political agenda of the political leaders and to all their activity. However, even if this happened, citizens would still have their suspicions which would be difficult to prove wrong, as this would be a really time consuming process. Besides, how would the citizens know if other persons surrounding the political leaders would not be accomplices and have done their best to hide compromising facts and documents from the public eye?

From this point of view, smart democracies do not differ much from usual democracies, where technology is not used to such a large extent.

Technology remains a simple tool in the hands of both political leaders and citizens. It cannot be expected to show the truth or some lies related to the political leaders' activity.

4. Discussion

One of the main issues is related to whether or not smart democracy can lead to an increased trust in political leaders. Apparently, it facilitates the processes of keeping up all information within anyone's reach, through making it visible publicly. This coud be one means through which we, as citizens, may become less suspicious regarding the hidden self-interests of political leaders. However, the question that comes next is how do we know that the leaders are actually presenting the truth and not hiding anything in the respective publicly shown information? Still another question arises from whether or not citizens have, indeed, equal access to technology, so that they can check the facts. Even more so, we cannot ignore the phenomenon of fake news, which can undermine citizens' trust in political leaders or even be used to express the distrust in political leaders by certain citizens. Then, they can influence the others. Therefore, technology is not a reliable solution to the trust or lack of trust in political leaders. It may even raise further doubts, and not make things clearer. Technology is just not anything more than another means of communication. In-person communication, which is still around, does not differ much from technologically-based communication. When we see how much fake information can be circulated online, we can lose our trust in technologically-based communication as well and we may not feel that political leaders' honesty and responsibily can actually be verified through online information display means.

5. Conclusions

We could look at the smart city and smart democracy as an ideal situation, where everything should be going on as best as possible. Yet, we have all had numerous examples in our personal and professional lives as citizens where we dreamt about the benefits of technology, yet, at some point or another, something about it ended up by not working properly. The same can be visible in the case of smart cities, in the ways in which

institutions and payment systems at the bank, in stores, and for public transport can work. This state of affairs can be, in the mind of the citizens, psychologically be blamed on an external side, namely that of political leaders. Political leaders are charged, psychologically by citizens, with a difficult role to fulfill, namely that of ensuring that everything goes on fine in everyday life in the city, regarding the way citizens can use technology and the way that this technology could work at absolutely all times.

Citizens are granted an apparently equal positions to political leaders, since citizens are allowed to express their doubts about the competences of political leaders and to criticize their activity when they feel so. Citizens may be the ones deciding whether or not they would choose again certain political leaders by giving their vote.

We may claim that smart cities and smart democracies are still in progress, and they are still being improved. Meanwhile, trust in political leaders is more a matter of psychology of the citizens and of their personal perception than of rational checking of facts using publicly accessible documents through the means of technology available to us all.

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Industrial afterlife: a tale of three cities

Monica-Mihaela FRANGULEA,
"Ion Mincu" University of Architecture and Urbanism , Bucharest, Romania
monica_frangulea@yahoo.com

Iulia TOADER,
"Ion Mincu" University of Architecture and Urbanism , Bucharest, Romania
arhiuliatoader@yahoo.ro

Abstract
Decommissioned old factories constitute valuable real estate assets as they are often placed in important positions inside the urban areas, they can be quite large in size and surface and they used to play a key role in the past in the development, economic and social life of the communities. Along the historical value, the sheer size of those "dead spaces" in our times, built according to long time gone size and structure of the cities or communities formed around them or even created specifically for their functionality, give today a new meaning to these structures that can hold a great potential of developing new focus points for the smart cities we are trying to create. For those reasons these buildings are reinvented as mixed-use spaces incorporating commercial, residential, cultural and recreational uses. The latest trend is to focus on the buildings' original features, such as brickwork, metalwork, arches and high ceilings, while incorporating contemporary technologies and modern amenities. Reusing these structures helps to preserve the area's historical character while introducing new life into the community and reconnect old circulation routes between the surrounding areas. In addition to boosting local economies and property values, these repurposed factories also reduce the environmental impact of new construction projects. Urban planners worldwide are recognizing the potential of these structures for revitalizing cities. We are going to present two Romanian old repurposed factories that were a valuable addition to the cities in their proximity, and the story of the oldest oil refinery in Romania that is now in the process of being totally transformed, hoping to bring new life to the city that was built around it. Three cities with three interesting stories and three historical industrial landmarks that are making the future of those cities look brighter, smarter, environmentally friendly and beautiful.

Keywords: historical landmarks, old building reused, emblematic buildings, famous structures, recycled architecture.

1. Introduction
Decommissioned old factories constitute valuable real estate assets as they are often placed in important positions inside the urban areas, they can be quite large in size and surface and they used to play a key role in the past in the development, economic and social life of the communities. Along the historical value, the sheer size of those "dead spaces" in our times, built according to long time gone size and structure of the cities or communities formed around them or even created specifically for their functionality, give today a new meaning to these structures that can hold a great potential of developing new focus points for the smart cities we are trying to create.

For those reasons these buildings are reinvented as mixed-use spaces incorporating commercial, residential, cultural and recreational uses.

The latest trend is to focus on the buildings' original features, such as brickwork, metalwork, arches and high ceilings, while incorporating contemporary technologies and modern amenities.

Reusing these structures helps to preserve the area's historical character while introducing new life into the community and reconnect old circulation routes between the surrounding areas. In addition to boosting local economies and property values, these repurposed factories also reduce the environmental impact of new construction projects. Urban planners worldwide are recognizing the potential of these structures for revitalizing cities.

We are going to present two Romanian old repurposed factories that were a valuable addition to the cities in their proximity (Brașov and Suceava), and the story of the oldest oil refinery in Romania that is now in the process of being totally transformed, hoping to bring new life to the city that was built around it: the Steaua Română Rafinery in Câmpina City.

Three cities with three interesting stories and three historical industrial landmarks that are making the future of those cities look brighter, smarter, environmentally friendly and beautiful.

2. The successful transformation of two old factories to vibrant urban areas

We are noticing that the industrial heritage may be in many cases a complex mixture of very different types of structures: brick and mortar buildings, massive concrete structures, technological structures of steel and iron with towers, pipes, tanks, railways, a.s.o.

Due to the scale of those structures and the strength of the materials they have been built with, those intricate engineering jewels are difficult to be demolished and some of them really shouldn’t, considering the historical, architectural or cultural value they have.

One of the major problems is the extended level of depreciation some of the structure may be in, raising the real safety concern about the surrounding areas for potential polluting reasons or security for the people that may be passing by, risking to be injured by collapsing components of those structures.

A tall rusted metal structure may be in danger of being damaged or collapsing in a severe winter storm with strong winds and snowfall.

Another major reason for concern is the big amount of urban space those old industrial decommissioned structures are occupying. Factories can be placed on massive plots of land, they are usually inaccessible to the public, surrounded by fences, useless for the city. Just a reminder, a shadow of their former selves.

The reintegration of those areas as a surface alone can be significant for the city, not to mention that the better preserved or valuable heritage structures can be restaurated and converted into useful and meaningful new buildings, that would have a better visibility that before, when they were fenced in or could not be perceived but only from a great distance.

The reconversion of old industrial structures is not an easy task to undertake, from many points of view: financial, logistic and as timeframe. Building a new development of any

kind on an empty plot is already a difficult task. But an old factory plot with the old rusted or collapsing structures on it is a totally different story.

After the difficult step of structural solidity analysis of all the existing structures and the decision of what needs and can be kept and restaurated or not, it follows the "decontamination" step, which is comprised of eliminating all pollution threats to the surrounding areas through old remains of any chemical pollutants stored or leaked by the factory through the air (evaporation), water or soil (by seeping into the underground waters).

After that, the restoration of the structures or buildings that are not about to be demolished is a financial effort almost equal to building the same structure from scratch. What fuels the developers to do this effort is of course the respect for the valuable original architectural structure that holds a great amount of historical and cultural significance for the community, for the city, for the entire region or maybe, in some cases, for the whole world.

The matter of properly connecting the new area with the surrounding one is also very important, the access and new circulation routes need to create a correct circulation flow and also improve the connectivity between the neighboring parts of the city, especially because in most cases the circulation routes were designed to go around the enclosed factory area and not right through it.

The reintroduction of decommissioned old factories in the city can encourage people to explore different parts of the city, potentially leading to the development of pedestrian-friendly streets, bike lanes, or even public transportation options. As a result, this effort can contribute to a more vibrant and accessible urban environment for the whole city.

2.1. Tractorul Plant – Brașov City

Brașov is a beautiful mountain town of around 415.000 inhabitants with a rich history that goes back all the way to the Neolithic.

Fig. 1. Brașov City, Romania
Source: https://www.destinatiaanului.ro/destinatia-anului-2023/brasov/

In 1925, a large aircraft factory was constructed in this city: IAR Brașov (Industria Aeronautică Română – Romanian Aviation Industry). In the period between the two wars and during the Second World War, Romanian planes were manufactured here and used in the war.

Fig. 2. IAR – Romanian Aviation Industry, which became Stegul Roșu Factory, production hall and administrative building, Brașov, 1927
Source: professor emeritus arch. Sorin Vasilescu, PhD (historical archive images)

Famous Romanian architects have designed the beautiful structures in an industrial style architecture. George Matei Cantacuzino designs the Assembly hall, cell section and central hangar in 1927.

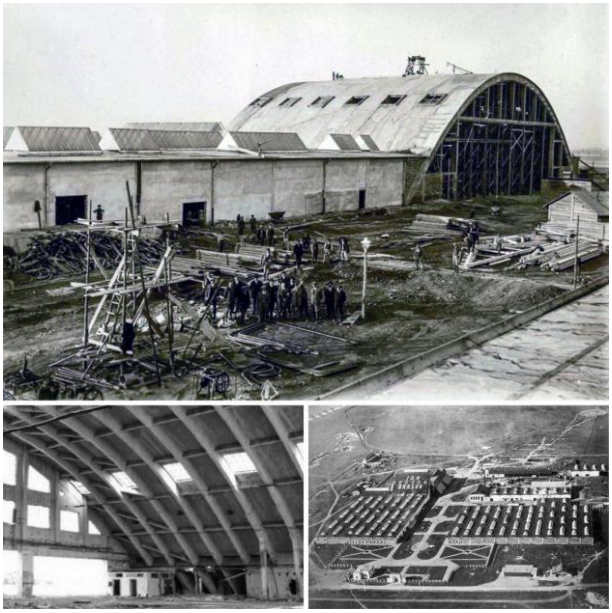

Fig. 3. Assembly hall, cell section and central hangar designed by architect George Matei Cantacuzino, IAR Plants, Brașov, 1927

Source: professor emeritus arch. Sorin Vasilescu, PhD (historical archive images)

Architect Octav Doicescu designs the Administrative complex and the Club, beautifully decorated on the exterior brick wall with a stone bas-relief by Constantin Baraschi, built between 1937-1938.

Fig. 4. Administrative complex and club designed by architect Octav Doicescu, IAR-Brașov, 7 Turnului Street, Brașov 1937-1938

Source: professor emeritus arch. Sorin Vasilescu, PhD (historical archive images)

After the war ended, with the arrival of the Russians, they confiscated much of the equipment as spoils of war, so the factory had to change its profile.

Thus, in 1946, *Uzina Tractorul Brașov* (Tractorul Brașov Plant) was founded, one of the most famous and appreciated Romanian companies, both in Romania and abroad. The first tractor to come out of the factory gate was an IAR 22, but over the years the factory's products have led Romanian agriculture to unprecedented development.

In 1990, the plant employed 23,000 people, but with the economic and political changes that came in the period after the fall of the Communist Regime the factory slowed down its production capacity, reaching less than 2000 employees and finally it was closed in 2007. With a total surface of about 100 ha, 1.000.000 msq (10.763.910 sq. ft.), the old and abandoned plant, practically a massive “dead space” in the city has been cleaned up and cured with a private investment of a British investment fund and transformed in a new development comprising a shopping mall, apartment buildings and office spaces.

Known as Coresi Business Park in Brașov, this is one of the most ambitious business projects in the centre of the country and the largest urban regeneration project in Romania.

The entire project is estimated to be finished by 2030, with a total investment of about 350 million euro. [1]
The development integrates four functionalities: shopping centre – Coresi Shopping Resort, residential – Coresi Avantgarden, developed together with Kasper Development, office – Coresi Business Campus developed together with Ascenta, and Qosmo hotel, opened in July 2021 and operated by Kronwell.

Fig. 5. Coresi Development project, Brașov
Source: https://coresibrasov.ro/tag/urbanizehub/

Some of the valuable historical buildings have been restored and transformed into luxurious office spaces, keeping the elegance and the majestic architectural style of the original design. For example the old Administrative complex and club designed by architect Octav Doicescu with the tall water tower, with an area of 8,300 sqm, was put into use after restauration and interior redesign in September 2016.

The first phase of Coresi Business Park development comprises approximately 26,000 sqm of converted unconventional office space with industrial architectural elements.

The refurbished and converted buildings offer all class A facilities and have a 100% occupancy rate for the refurbished office spaces. [2]

Fig. 6. The Old Water Tower transformed in order to accomodate office spaces and apartments, Brașov
Source: https://www.bizbrasov.ro/2023/03/03/turn-simbol-uzina-tractorul-brasov-consolidare/

The massive development also has a shopping mall (Coresi Shopping Resort), with shops and restaurants,eight cinemas, playgrounds and a performance stage. The shopping centre is the biggest investment made in Brașov city in the last ten years with a cost of €60 million and created 800 jobs.

Fig. 7.Coresi Shopping Resort, Brașov
Source: https://coresibrasov.ro/tag/urbanizehub/

The high circulation flow to the shopping centre has prompted Brașov city autonomous transport authority to set up three new bus stops around the mall and some bus routes have been rerouted to make it easier for the city inhabitants to get to the shopping centre. [3]

Fig. 8.Coresi Shopping Resort, Brașov
Source: https://www.mmcite.com/en/brasov-coresi-shopping-center

2.2. The Artificial Fiber Enterprise (IFA) – Suceava

Suceava is the largest urban settlement of the Romanian Suceava County, with a population of 84,308 inhabitants [4] and a surface of 52 km².

The town is a beautiful historical city, among the oldest and most important settlements in Romania. It was documented in 1388 and during the late Middle Ages was the capital of the Principality of Moldavia, being strategically located at the crossroads of several trade routes linking Central Europe with Eastern Europe.

During the last years of the communist regime, the buildings of the Suceava Artificial Fibres Enterprise – Întreprinderea de Fibre Artificiale (IFA) – were built, and the factory started operating in 1984, producing artificial fibers.

Fig. 9. Suceava City, Romania
Source: https://www.facebook.com/photo/?fbid=4424819804231337&set=p.4424819804231337, photo by Nelu Scripciuc

Fig. 10. Suceava Industrial Zone, with the Pulp a Paper Mill in operation – view from the plane.
Source: https://www.monitorulsv.ro/foto/ouMkoOyR/1 , photo: Dumitru Vințilă

At the beginning of 1990, IFA's activity was discontinued because the manufacturing process there was very polluting for the city and the surrounding area.

The IFA Tower is the name under which the former gas dispersion stack at the Artificial Fibres Enterprise in Suceava became known. This is the tallest building in the town, standing 230 metres high. [5]

Lined on the inside with special stainless steel materials, the tower was used to remove sulfides resulting from the industrial process of manufacturing man-made fibers.

It was designed and built by the former Trust of *Lucrări Speciale Bucureşti, Antrepriza de Coşuri Industriale, Glisări şi Precompatimari, Brigada Săvineşti*, brigade chief Eng. Meglei Adrian, supervisors of the works Eng.Țepeș Bibescu Ioan and Găman Corneliu. [6]

Fig. 11. The the Artificial Fibres Enterprise with the IFA Tower on the right
Source: https://suceavalive.ro/social-democratii-au-identificat-o-suprafata-de-teren-pentru-un-viitor-parc-industrial/

In 2006, the Iulius Mall group from Iasi purchased from FAMOS Suceava the 131,977 square meters of land on which the former IFA Suceava buildings were located, intending to open there the largest supra-regional center in the group's national shopping mall network.

In 2007, the developers began demolishing the massive concrete buildings that belonged to the former IFA: the hall that housed the silk spinning section, which covered an area equivalent to a football pitch, tanks, production halls, workshops, tanks for acids and other toxic substances, pump stations, warehouse platforms, the administration building, the fire station, the guards' huts, the 39-metre-high cooling tower (demolished in a controlled explosion), etc.

The only building remaining in the IFA complex was the chimney stack, the 230m high tower.

The Iulius Mall Suceava shopping complex was built around this tower and inaugurated in November 2008. On this occasion, a series of works were carried out on the tower to integrate it into the Iulius Mall complex. The metal structures providing access to the levels were replaced, sources of rust were removed and it was painted in the colours of the Iulius Mall complex (yellow, orange, blue).

Fig. 12. The Iulius Mall Suceava shopping complex with the IFA Tower
Source: https://www.discoverbucovina.info/un-cos-de-fum-este-cea-mai-inalta-constructie-din-suceava-privelistea-din-varf-este-spectaculoasa/

There have been several proposals to give the tower a practical use: its illumination and the placement of illuminated signs, which would be visible from all over the city, especially at night, the installation of a restaurant or an astronomical observatory on top of the tower.

In April 2009, the Vinci Club was set up at the base of the tower, with more than 600 seats and armchairs available in the concrete rooms. The walls of the club have been decorated in various colours, with dozens of words from Leonardo da Vinci's work strung on the walls, sketches of designs, drawn with reflective paint, to be visible in the disco light. In the centre of the IFA's old smoke stack, a mini-cascade has been set up. [7]

Fig. 12. The Iulius Mall Suceava shopping complex with the IFA Tower base
Source: https://www.centruturistic.ro/suceava/iulius-mall-suceava-suceava-id2176.html

The mall covers an area of 51,500 sqm and offers a complete mix of retail and entertainment: over 200 shops, international and national brands, the largest multiplex cinema Cinema City in the north of the country, with 8 screens, food court, Auchan hypermarket, seasonal ice rink, numerous relaxation and entertainment options, multiple services and offices of public institutions.

Fig. 13. The Iulius Mall Suceava shopping complex seasonal ice rink
Source: https://suceava.media/s-a-deschis-patinoarul-ice-dream-de-la-iulius-mall-suceava/

The shopping and recreation destination attracts around 10 million visitors annually, including from neighboring counties and even across the border.

Fig. 14. The Iulius Mall Suceava shopping complex
Source: https://orasulsuceava.ro/unde-iesim/mall-uri-si-centre-comerciale/iulius-mall/

Now, after 15 years, the project is expanding, continuing its mission to keep the public connected to retail trends, with access to famous fashion brands right in their city, new entertainment concepts and services that make life easier every day, the Iulius investment in Suceava will thus reach the amount of 110 million euros.

Fig. 15. The Iulius Mall Suceava shopping complex extended project
Source: https://www.hotnews.ro/stiri-esential-25339152-iulius-mall-suceava-cea-mai-mare-destinatie-shopping-entertainment-din-nordul-tarii-investeste-40-milioane-euro-extindere.htm

New regional premiere fashion brands, restaurants with outdoor terraces, leisure facilities and services will be added, a park and recreation area, as well as an expansion of parking to a total of 2,150 spaces.

The expansion will have 14,000 sqm of leasable space in the form of a retail park, with direct access from the outside, but also connected to the mall. A further 10,000 sqm of the existing Iulius Mall Suceava will be reconfigured and redeveloped. In total, Iulius Mall Suceava will have over 65,000 sqm, consolidating its status as the largest shopping and entertainment destination in the north of the country.

The new development will also integrate a green and pedestrian area of approximately 10,000 sqm, a hallmark of the projects carried out by the developer, which will bring an infusion of nature and a space for outdoor events, complementing the existing entertainment offer at Iulius Mall Suceava.

With the expansion, the area will benefit from an urban makeover, with upgraded project entrances, pedestrian access and road connections. Almost 800 new parking spaces will contribute to the accessibility of the project, bringing the total capacity to more than 2,150 parking spaces, as well as new facilities for electric, alternative and public transport. [8]

3. The trend keeps on going: a promising future reintegration of an old industrial landmark into the urban structure

3.1. Steaua Română Rafinery – Câmpina City

Câmpina city is located in the historical region of Muntenia, in the western part of Prahova County. The small town of 29.000 inhabitants is situated in a hilly region, at the southern end of the Prahova Valley, on the banks of the river Prahova, in between the rivers Câmpinița and Doftana.

Fig. 16. Câmpina city, Romania
Source: Camil Iamandescu

Its existence is first attested in a document of 1503. [9] Formerly a customs point on the trade route between Transylvania and Wallachia, the town developed at the end of the 19th century and the beginning of the 20th century as an oil extraction and processing center.

Between 1897 and 1898, Câmpina became the site of the largest oil refinery in Europe: Steaua Română Rafinery.

Fig. 17. Steaua Română Rafinery, Câmpina, România
Source: https://proiectsteauaromana-acc.ro/

Throughout its 127 years of existence, the Câmpina refinery has played an essential role in the development of the Romanian state, producing and refining oil, which has not only fuelled the entire nation, but has also positioned Romania as a key player in global energy markets during crucial historical periods.

In 2010, the old and very polluting refinery closed down its activity.

With a total surface of 49.6 ha, the industrial colossus have slowly slowly started to depreciate, the dozens of exposed metallic towers, massive fuel tanks, kilometers of intricate tangled pipes, the railways and all the other structures started to rust, lose their stability and get invaded by the wild nature, as the terrain has remained closed to the public that could be exposed by entering the premises to dangerous hazards as inflammable gasses and fluid still being present on the refinery's ground.

Fig. 18. Steaua Română Rafinery, Câmpina, România
Source: https://proiectsteauaromana-acc.ro/, photo: Emil Dico

Recently, the Refinery has been purchased by the company Ecogen Power that has already started the process of decontaminating the ground of all pollutants and it is planning on creating a new urban development hub by reintroducing the area in the city life.

The central building and a couple of metallic structures will be kept and restaurated as mementos of the glorious edifice from the past and also for their historical and architectural value, but they will be repurposed as art/culture galleries and art installations. But most of the mechanical installations, in very poor shape, have to be removed, leaving a great amount of free space that can be returned to the city by inclusion in the urban tissue.

Fig. 19. Railways of the Steaua Română Rafinery, Câmpina, România
Source: https://proiectsteauaromana-acc.ro/, photo: Adrian Bercaru

This year the new owners had the initiative of launching a nationwide contest of documentary photography, where over 300 photographers came to the old refinery to take photos of the still existing structures.

Last month the public ceremony of the photo contest awards and the photo gallery display gathered in the Refinery's premises hundreds of visitors that came to say goodbye to the soon to be gone crumbling refinery.

Fig. 20. Interior of the Steaua Română Rafinery, Câmpina, România
Source: https://proiectsteauaromana-acc.ro/, photo: Mihaela Tulea

Most of the visitors from Câmpina city had never in their lives the chance to visit or see inside images of the great industrial asset from their own town.

The following step is the launching of a national contest for architects in order to find the best ideas of the future development of the Refinery premises.

This example shows us a positive direction in the efforts of improving our cities, eliminating unused and useless spaces, bringing into the urban life more facilities, circulation routes, parking spots, green spaces, and, as result, more comfort, better mobility and more fun!

Fig. 21. Interior of the Steaua Română Rafinery, Câmpina, România
Source: https://proiectsteauaromana-acc.ro/, photo: Ștefan Mareș

The title of this presentation refers to the parallel between the old industrial city and a possible future city in which old industrial structures are reinterpreted and reintroduced. These are the two possible smart cities in the title with their story.

The first idea of representing these variants started from the Dickensian narrative which is the best-selling book of all time. Especially from its famous opening paragraph. But more recently, a steam punk story by the enfant terrible of contemporary fantasy literature, Neil Gaiman, has opened up the same perspective on the coexistence of two possible cities with opposing visions of the technological idol, mutually denying each other. [10] And a recent TV show, Peripheral, launched in 2022 by Amazon Prime, depicts an alternative city, London of a virtual future, dominated by classical idols reconfigured as urban landmarks: reclaiming a cultural identity.

The behavioural prediction will be verified as smart cities become more and more impressive in their performance. We can already find examples where predictions can be tested, but we are still in the early stages of implementation. One example is Songdo the first smart city in South Korea, and declaratively in the world, built with the help of IT company Cisco [11] at a relatively short distance from Seoul, just 60 kilometres, an hour and a half drive for residents attracted by the unique project. Launched in 2003 and implemented in 2015 on 600 hectares reclaimed from the Yellow Sea.

Fig. 22. London of a virtual future in Peripheral TV production, produced in 2022 by Amazon Prime
Source: https://climatecrocks.com/2022/10/30/the-peripheral-future-london-with-giant-spoiler-alert/

Conceived as a major economic centre aided by an attractively priced luxury residential area offering a quality of life that becomes a standard to be achieved and a model to be followed. Yet the press declares it "an impersonal project that is not a great success". [12] The project is made up of metal and glass volumes gathered around a 305-metre tall landmark, the North East Asia Tower, and contains no museums or cinemas. It's only half as populated as expected, with residents attracted by the novelty of the project and the amenities on offer: generous green spaces, a 25-kilometre bike trail, a quality education offer, but employees of the (only) 58 companies based in Songdo say they can't live there.

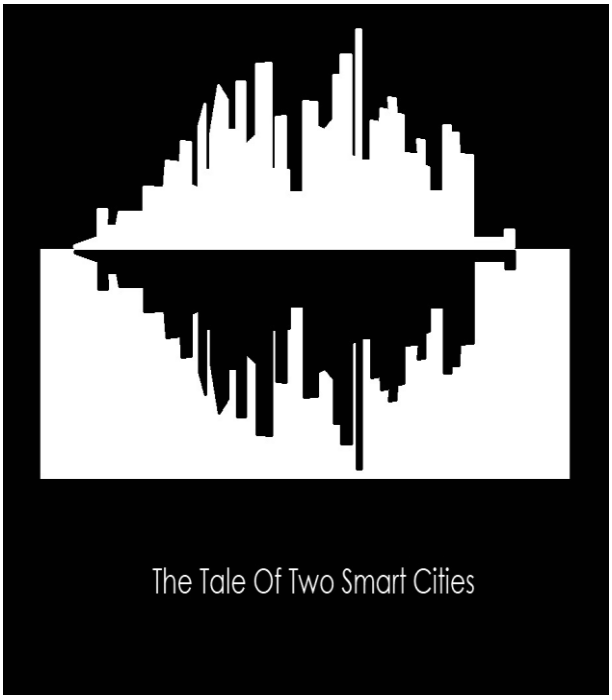

Fig. 23. The Tale Of Two Smart Cities – a possible skyline
Source: arch. Iulia Toader, Ph.D.

The city is highly developed technologically, there are 500 surveillance cameras in constant contact with the police, there is internet everywhere and an IoT innovation project is in development. The electricity grids are running on an efficiency programme, there are garbage collection systems that achieve 76% recycling. And yet, what is the cause of the lack of attachment of Songdo employees and residents?

On the graph above, the point corresponding to the atmosphere of the projected place is in the dual range, and since the technological control is not forced (although we can say that the city is under constant surveillance) the reaction is not very violent. The identity of Songdo – the smart place, tends towards neutral values, due to the complete neglect of the scene for a complex social life, making Songdo "A ghetto for the rich", as Le Monde calls it [11].

Stories are always fascinating and contain ideational and, why not, behavioral archetypes, which on close examination we can see repeated over and over again. It is very important to relate to the stories of the place to shape a complete *genius loci*, so much so that, separated from urban myths or regional mythology, places are difficult to understand on a de-anticipated basis for architecture consumers who are strangers to the place.

In the search for the defining story, we will always associate principles such as "the first of its kind", "the last of its kind", "the oddity/out of the ordinary as opposed to normality", "the best one – the hero" or "the one the most hated – the bad square", all these ways of interpreting the architectural object that gives the place its character being preserved and passed down through generations through stories. The presented locations, with their industrial character, are stories for the future. They speak of courageous existence in times of innovation, or of absolute resilience in times of destruction.

We cannot now assess the future role that such buildings will play in preserving the identity of place, and why not, of national identity. But we can try to treat them the way that oral tradition handles lores, passing them from mouth to mouth, until they find their particular context where they become relevant. We currently have that role of keepers that Heidegger talks about in *The Origin of the Work of Art*, in our case talking about an origin of communities, hinged around avant-garde industrial goals at a certain point in history. With the recommendation to abandon any tabula rasa attitudes, with the understanding of the immensity of the resources needed to rehabilitate such objectives and the lack of opportunity for such approaches, we are looking for a means of preserving and transmitting their living stories written in the mere matter put into the work. With this in mind, we conclude with Jean Luc Marion's famous quotation, which puts before us a mirror that makes us think. "Name your idol, and you will know who you are. The first visible of a look is thus also equivalent to an invisible mirror". [13]

We may be leaning towards the idol of progress-at-any-price, a globalizing and consumerist attitude leading to an urban reconfiguration at the expense of the vestiges of early industrial eras. Such an attitude is appropriate to a revolution of technocracy versus an era of care and respect, almost idolatry for the past, resulting in the creation of cities and communities of the future elliptical to their own histories. Or we can reconfigure a future in which stories of trial and error, or of outdated technologies becoming obsolete, are the new archetypes

of self-aware cities with a high potential for resilience, because stories and archetypes are unequivocally recipes for the survival over time of communities and settlements.

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Implications of the circular economy for cultural heritage protection in smart cities

Rodica-Mariana ION,
National Institute of Research and Development for Chemistry and Petrochemistry – ICECHIM, Research Group "Evaluation and Conservation of Cultural Heritage", Bucharest, Romania / Doctoral School of Materials Engineering, "Valahia" University, Targoviste, Romania
rodica_ion2000@yahoo.co.uk, rodica.ion@valahia.ro

Abstract
The following objectives are addressed in the paper: identification of indoor and outdoor environmental factors in some monuments, practical ways and solutions for recovery and recycling of construction materials from demolition. Preliminary studies: this paper is based on the author's expertise in the field of conservation and restoration of stucco, facades decoration or stone substrates, pollutants identification, mechanisms of degradation and conservation of important Romanian monuments from the architectural heritage. Also, the work is based on the author's expertise in the field of Archaeometry and Restoration and Heritage Regeneration, with implications in the Study of Materials for Architecture. Approach: cultural heritage buildings occupy an unique niche in the urban landscape, and their protection and preservation is a matter of particular interest for a smart city. The microclimate and the present pollutants (tourists, oil lamps, candles, urban pollution) contribute to the building degradation. In this context, the concept of circular economy encourages the restoration and reuse of cultural heritage monuments, which represent a valuable resource in developing the tourist offer and promoting a smart city. Results: the paper will present the identification of indoor and outdoor environmental factors in some monuments such as SOx, NOx, chlorides, pH, RH, T, in monuments: Corvin Castle, Hunedoara, Roman mosaic, Constanta, Basarabi-Murfatlar Churches, Adamclisi Monument, Constanta, and ways to recover and recycle construction materials from demolition: ceramics (brick, marble), plastic waste (polyurethane) and wood waste (eg sawdust). Implications: the solutions presented will address the present challenges for reusing construction and demolition waste, promoting local business opportunities for the transition to a circular economy and developing a smart city. Value: the paper has a high level of originality and will present examples of ecological materials and technologies for the conservation/consolidation of buildings with waste materials resulting from construction and demolition.

Keywords: circular economy, pollutants, sustainability, waste recycling, smart city.

1. Introduction
1.1. General aspects. Definitions and legislation
According to the Europeana White Paper on smart cities, "cultural heritage defines the identity of our communities, contributes to social cohesion and enhances innovation and tourism (Europeana 2015)" [1, 2, 3]. In the same context, the "Agenda 2030 for sustainable development of the General Assembly of the United Nations", approved in 2015 by the UN member countries, promoted the "Sustainable Cities" model, which involves reducing the negative environmental impact on cities by 2030, granting special attention to the management and recycling of generated waste [4, 5, 6, 7]. Sustainable and smart cities assume, through technological innovation, the replacement of a «linear economy" with a «circular economy", in which waste is incorporated into the production processes of new products and/or materials (in order to achieve the objective of "zero waste") [8].

In every city, construction and demolition waste (DCW) represents a serious environmental pollution problem, due to its inadequate management and low rates of recycling or utilization. Globally, 25-30% of the total solid waste worldwide, equivalent to 3 trillion tons per year, is the result of waste from the construction industry. Every year, in Europe, approximately 750 million tons of C&D waste are generated, representing approximately 32.6% of the total waste resulting from: households and industry [9].

Without a doubt, the massive amounts of waste resulting from human activities imply a decision-making management in an intelligent city. And the new concepts of linear, recycling and circular economy compete in the strategy and decision-making management of these cities.

Nowadays, many cities around the world are faced with abandoned heritage buildings. These buildings are mainly located in central urban areas and are in continuous decay due to the action of several external factors. The regeneration and rehabilitation of these buildings is not always a point of interest, as it involves high costs. Because they ensure the continuity of traditions and shared values, heritage buildings have become an important resource in urban regeneration and evolution. Saving industrial heritage buildings brings cultural, social and ecological benefits as avoiding demolition allows them to save resources and energy as well as avoid pollution.

The objective of this work consists in:

- Studying the state of conservation and chemical-physical degradation of historical buildings, evaluating environmental conditions, different historical know-how (manner) and/or previous restoration;
- Digital reconsidering of the monuments or historical buildings;
- Providing indications regarding the properties of waste materials resulting from construction and demolition, the creation and use of new compositions of recycled aggregate materials, compatibility and availability for maintenance and restoration interventions;
- The establishment of correct investigation and intervention procedures that are based on solutions with historical, artistic and documentary relevance, to use the interdisciplinary skills of laboratories capable of providing technical and scientific answers to the complex problems of restoring and preserving the surfaces of monuments.

1.2. Classification

Regarding DCDs, they can be classified into two categories: usable and non-usable waste. If the unusable waste is that contaminated with hazardous waste, which imposes specific environmental regulations, in the category of usable waste within concrete, ceramics, clay bricks, masonry, and mortar waste, glass, polyethylene terephthalate (PET), polyurethane from household appliances, tires, waste concrete, agricultural waste, silica cloud, fly ash, etc., can be used in concrete production to reduce the disposal of large volumes of DCD by substituting aggregates [9] used for fine aggregates and rudeness. DCDs are classified from A to D according to the Brazilian standard NBR 15113 [10] as follows:

- Class A: mortar, concrete and ceramic components (eg bricks, blocks, tiles, and coatings);
- Class B: plastics, paper, cardboard, metals, glass and wood;
- Class C: plaster-based residues;
- Class D: hazardous waste such as asbestos, tars and paints, heavy metals (chromium, lead, mercury), varnishes, paints, adhesives, polyvinyl chloride, solvents, polychlorinated biphenyl compounds, various types of resins used for preservation, flame retardant, waterproofing etc.

In the same context, the adoption of the circular economy emerged as a promising strategy to reduce the negative environmental impact of DCD [11].

2. Waste from construction and demolition activities within the circular economy

2.1. Circularity of construction materials

The main contributor to the circular economy in the construction sector is the recovery, reuse and recycling of CDW. The recovery, reuse and recycling of DCD are essential components of the circular economy in the construction sector.

The linear economy involves the following stages: production, sorting, use, disposal. The recycling economy implies: production, sorting, use (with recycling) and then disposal. The circular economy involves the assembly of both types of economy above, as follows: production, sorting, use through recycling and/or return, reuse, reuse. Building components should be selected according to their circularity potential, following the hierarchy of the 3Rs (reduce, reuse, recycle) of the circular economy [12, 13].

Paper waste is the most common waste encountered in most spheres of activity and is an important source of cellulose fibers. It is found in different forms (writing paper, wrapping paper, newspapers, magazines, catalogs, postal waste, boxes or other packaging made of plain and corrugated cardboard from cosmetics, household appliances, drinks, including TetraPak packaging, etc.), paper occupies approximately 41% of the total household waste that we produce today. Through the recycling process, each ton of recycled paper can save 17 trees, and it takes a 15-year-old tree to produce 700 paper bags. Paper and cardboard can only be recycled 10 times. By recycling paper, approximately 25% of the amount of electricity and 90% of the amount of water (300 l) needed to produce 1 kg of white paper are saved. Also, the toxic chlorine required for the production of white paper is eliminated [14].

Plastic waste: By recycling each ton of recycled plastic, between 700 and 800 kg of crude oil is saved. The toxicity of plastic can be found both after burning, resulting in substances that cause lung diseases, or because the ink used to print the bags contains cadmium, a very toxic metal, released into the air when the bags burn. A single plastic bottle through recycling leads to saving energy for the operation of a 60W light bulb for 6 hours.

According to the latest reports, in 2017, demand for plastics in Europe in 2016 was 49.9 MTn, 3.1% higher than in 2014. Of this demand, 7.5% is polyurethane, implying a annual demand of 3.78 MTn in 2017. Of the 2.62 MTn of polyurethane foam (PU), approximately 27% of waste is generated (700,400 Tn), of which, 31.1% is recycled (220,000 Tn), 41 .3% is incinerated (294,278 Tn) and the remaining 27.3% is taken to the landfill (193,120 Tn). The industrial sectors responsible for these quantities are: construction and demolition (24.5%); automotive (19.5%), refrigeration (21.3%) and other sectors (34.7%).
Several works are known in which polyurethane foam waste, combined with pitch binders, are used as dry aggregates in various cements or gypsum matrices. In cement mortars, PU as recycled aggregates provides excellent durability, and is able to reduce the amount of sand in cement mortars by replacing sand in the proportion of 13-33%, 25-50% or even 25-100% [15, 16, 17, 18, 19, 20].

Wood waste: Wood waste represents a set of products and materials whose origin can be found in all stages of the wood industry, from logging to the manufacture of finished products. The main sources of wood waste are:

- From forestry operations: bark, sawdust, thin wood;
- From the wood processing industry (cutting, carpentry, furniture factories, parquet): chips, sawdust, scraps;
- Waste: construction site wood, railway sleepers, pallets, formwork wood.

Wood waste is classified by European rules as ordinary waste, not presenting a dangerous or toxic nature for the environment. In Romania, according to HG 856/5.10.2002 (MOF 659), wood waste is classified according to origin:

- Waste from agriculture, forestry, hunting and fishing, from food preparation and processing;
- Waste from wood processing and the production of tiles and furniture, pulp, paper and cardboard.

Depending on the condition in which the wood waste is found, it can be:

- Wood in its natural state – bark, sawdust;
- Wood residues – results from carpentry, construction, planing sawdust;
- Used wood – beams, windows, treated wood pallets – railway sleepers, PVC.

Wood waste is classified as follows in 3 types of waste:

- Non-impregnated waste: such as wood processing waste: dust, sawdust, sawdust (61% of the total generated);
- Weakly impregnated waste: they were treated with non-hazardous products such as wooden beams, solid furniture, chipboard and PAF waste. This waste can be used for combustion (28%);
- Highly impregnated waste: telephone poles treated with creosote or copper, sawdust that has served to absorb a hazardous product, etc. This waste cannot be used for combustion and goes to the landfill or another specialized center (11%) [21].

Glass waste: Glass needs 1 million years to break down into small pieces. Recycling glass reduces manufacturing pollution by 75% and air pollution by 14-20%. Recycling a glass jar saves enough energy to power a 100W light bulb for 4 hours. Recycling one ton of glass saves 1.2 tons of raw materials (soda, sand, feldspar) and 25% of energy [22]. The glass is 100% recyclable, its recovery saving an important volume of energy resources.

Marble and ceramic waste can also be processed into fine particles or aggregates to replace some of the natural aggregates used in concrete production. The use of marble, ceramics and recycled tiles in concrete can help improve the mechanical properties (compressive strength, flexural strength and abrasion resistance) and durability of concrete, while reducing permeability and water absorption [23]. The use of marble, and recycled ceramics in concrete can help reduce waste generation and conserve natural resources. According to some references [24, 25, 26, 27], the density of concrete containing ceramic waste

aggregates decreases linearly as the ceramic concentration increases. At the same time, the depth of penetration of chlorine ions, extremely aggressive, in concrete decreases with the increase in the ceramic content, and the electrical resistance of the concrete increases with the increase in the amount of ceramics, the durability of the concrete increases with the increase in the ceramic percentage.

3. Smart Cultural Heritage and Smart City

The development of the smart city concept in the last two decades has directly contributed to the emergence of the Smart Heritage concept. The "smart" concept has distinguished itself from other visions in which information technology is combined with infrastructure, architecture, everyday activities to address social, economic and environmental issues [28], and in 2018, Yigitcanlar et al. identified three main drivers of smart cities; Community, Politics and Technology [29], to produce productivity, sustainability, accessibility, well-being, viability and governance outcomes. The smart city is becoming a "dominant concept" without a universally accepted definition of a smart city. The definition is different for different people. The concept of Smart City varies from city to city and country to country, depending on the level of development, the desire for change and reform, the resources and aspirations of the city dwellers.

In this context, heritage buildings as distinct entities in smart cities are unique and irreplaceable. Conservation, restoration and rehabilitation of heritage buildings represents in many countries more than 35% of total construction output [30].

The concept of "smart cultural heritage" implies a connection between users of a common digital platform, between the institution and its visitors, between objects/territory and the visitor, and between the real and the virtual world.

Smart heritage connects a physical reality to a virtual reality, but offers a wide range of possibilities to access its representations.

4. Digital solutions. Case studies

4.1. The case of the chalk churches from Basarabi-Murfatlar

Temperature variations and the presence of water are the most aggressive factors affecting this monument, Fig.1, and some measures are required to save this important monument, and virtual digitization could be the first step in this context.

The application of new technologies and the digitization of the Basarabi monument is a preventive measure, helping us to achieve a virtual reconstruction as a model for its preservation, to provide access to the widest possible audience. Laser scanning, 3D modeling, digital scanning and photogrammetry are the most used methods for digitizing cultural heritage, in order to provide 3D models. By means of the laser scanning technique, for this monument it was possible to measure the topographical quantities, the direction of a virtual optical line joining some points on the surface of the monument to a reference point on the measuring device, and the morphological features on the monument, which can be acquired and measured with a very high precision [31]. A mathematical representation of a 3D surface was obtained through the CAD modeling program to create

the 3D model of the external projection of the church, Fig. 2. As an alternative, common digital photographs can be used to obtain 2D or 3D coordinates of several photos. In our case, by using 3D photogrammetry, the 3D model of the church envelope was obtained, which should be applied over the church, Fig. 2. a-c. The 3D model created was with an accuracy of 0.72-0.95%.

Fig. 1. The chalk churches of Basarabi-Murfatlar
Source: personal photo

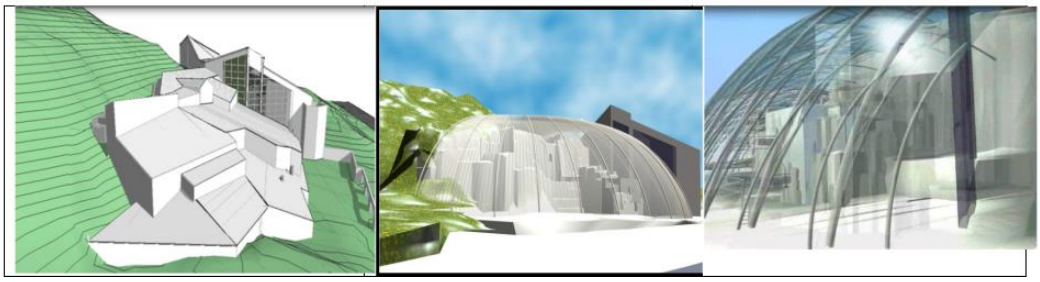


Fig. 2. (a) External digital protection of the monument; (b) Roof protection scheme; (c) The view of the church envelope

4.2. Case study: Adamclisi triumphal monument

A first factor affecting the sustainability of heritage buildings in a smart city is the damage to the surfaces of heritage buildings due to air pollution with effects on limestone or marble facades, stone surface soiling, glass soiling, medieval stained glass damage, metal corrosion and the accumulation of biomass in the urban environment. Internal combustion engines contribute fully to the pollution inside big cities, through high concentrations of sulfur dioxide, carbon dioxide (CO2), ozone (O3). The deposition of pollutants on surfaces depends on the atmospheric concentrations of the pollutants and the climate and microclimate around them. And here we will exemplify the state of pollution in the monuments in Romania, with reference to the triumphal monument from Adamclisi, measurements that were carried out during a research project carried out in the years 2018-2020 [32].

Fig. 3. Adamclisi triumphal monument
Source: personal photo

The concentrations of pollutants sulfur dioxide (SO_2), nitrogen oxides (NOx), nitrogen monoxide (NO), carbon monoxide (CO), ozone (O_3) and the concentration of dust (PM10) measured with specialized sensors are presented in Fig. 4. They vary depending on the season, being more intense in the cold season, when traffic in the area is supposed to be much reduced, and human activities in the area are much reduced.

4.3. Roman Mosaic

Another category of factors is represented by the degradation of building surfaces, caused by physical processes, such as: crystallization of salts in porous walls (stone, brick, plaster, frescoes, murals), deterioration by freeze-thaw cycles in porous materials, sea level rise, swelling-shrinkage of clay minerals in soils affecting the stability of monument foundations, accumulation of biomass (lichens, algae, mosses, fungi) closely related to rain and temperature, depending only on climatic parameters. The degradation phenomenon occurs in a gradual manner and manifests itself differently depending on the materials used in construction. By using high-performance equipment pH meters, digital microscopes with image processing software, pH values, salts, humidity, and organic carbon content caused by ash dust resulting from internal combustion engines were measured, Fig.5. These data were measured and compared for all monuments in the same area: Roman Mosaic, Hippogeus Tomb and Adamclisi Monument, Fig.6.

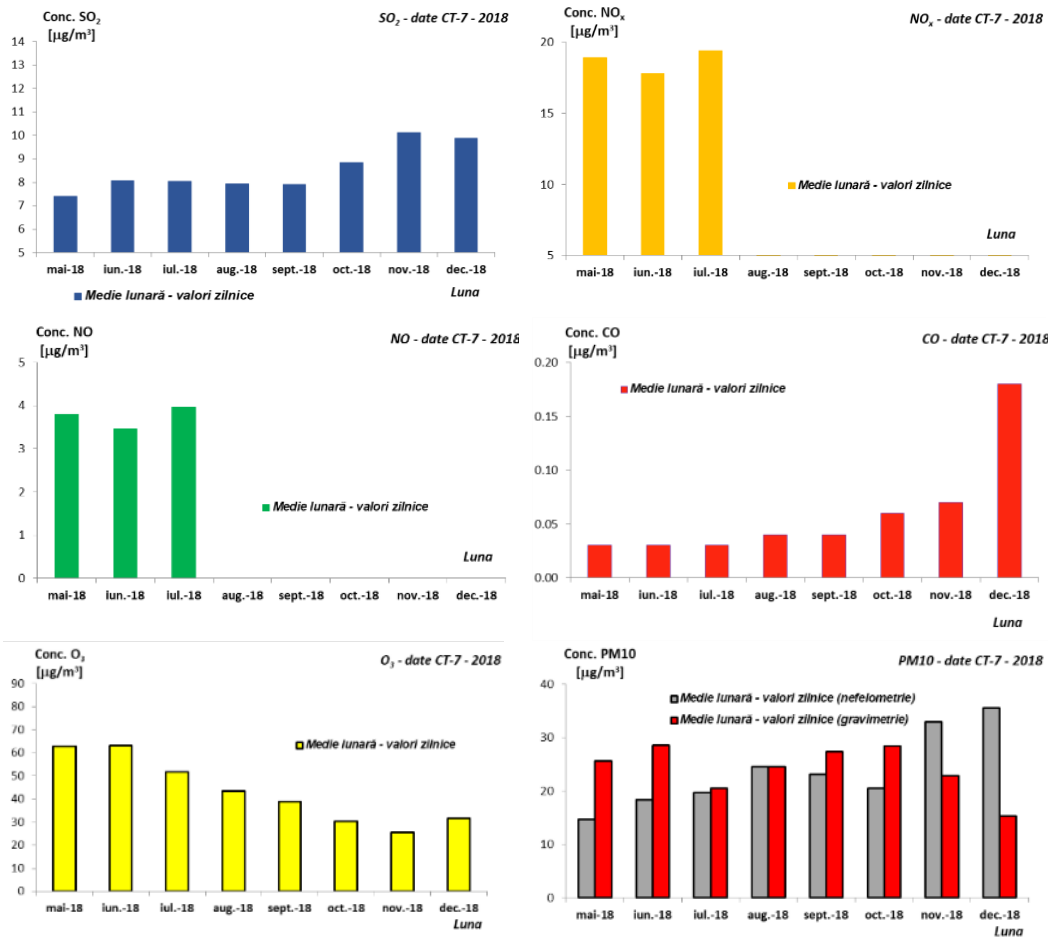


Fig. 4. The level of gaseous pollutants SO_2, NOx, NO, CO, O_3, PM10 in the area of the Adamclisi monument

Fig. 5. Roman mosaic, Constanta
Source: personal photo

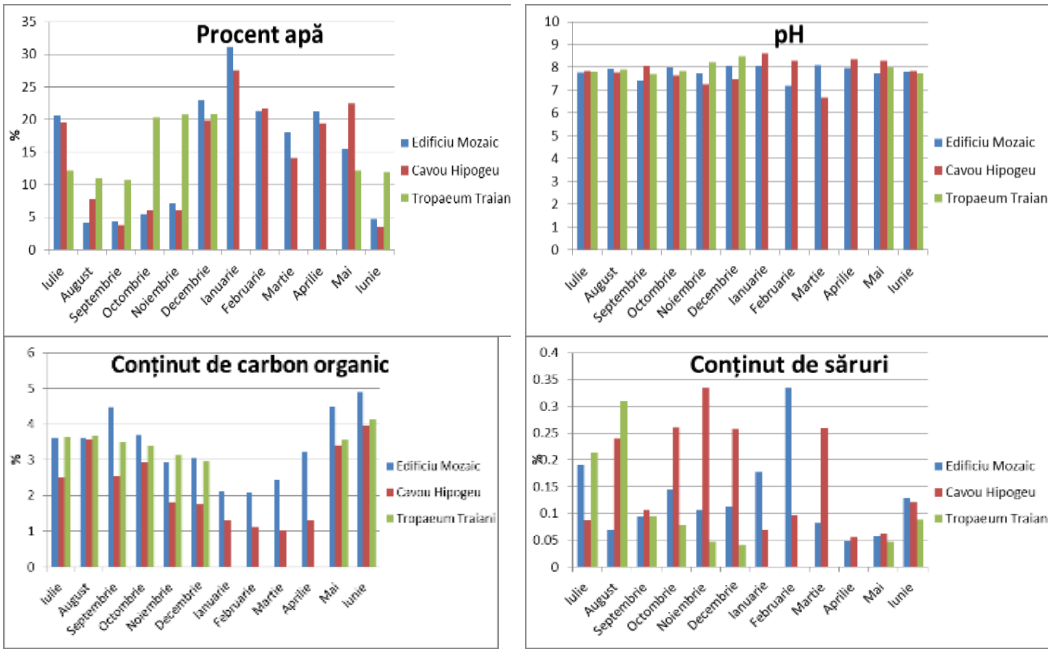


Fig. 6. pH, salts, humidity, and organic carbon content measured by Roman Mosaic, Hippogeus Tomb and Adamclisi Monument

The same trend is visible in this case: increasing pH parameters, organic carbon in spring-summer, and aggressiveness of degradation processes by crystallization of salts and moisture in autumn-winter months [33]. For the use of high-performance equipment pH meters, digital microscopes with image processing software, it was possible to evaluate both degraded areas and the effect of previous restorations on these samples. For the Roman Mosaic, in order to better observe the details of the mosaic samples, 3D simulations in "GIF" format were made using software for editing computer graphics, Fig.7.

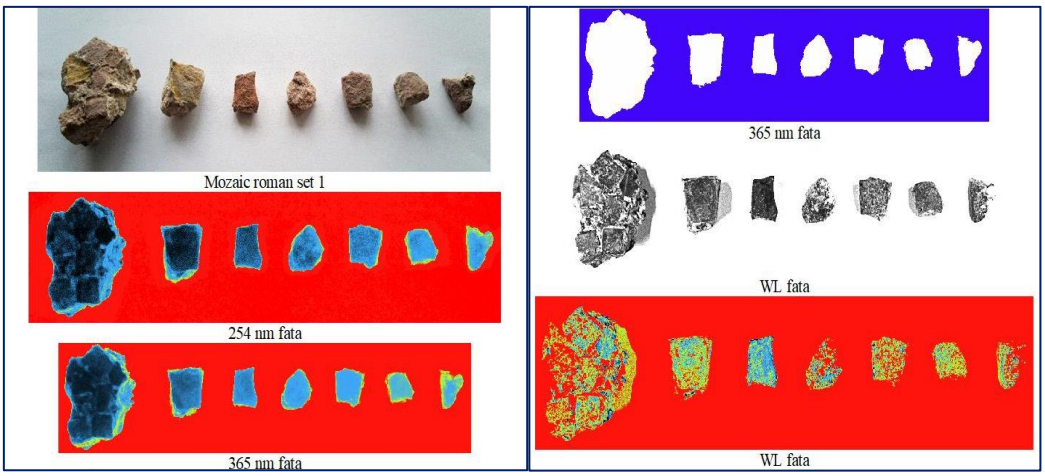


Fig. 7. S3D images for computer graphics editing of mosaic samples.

Cracks and deposits of degradation products can be observed especially when viewed with UV lamps with wavelength 254 nm.

4.4. Case study: Casa Fantaneanu, Slatina

For digital analysis and patrimonial regeneration of stucco and façade decorations, a 3D portable scaner was used Exascan is a portable optical system for data acquisition that captures every detail and provides accurate high-resolution geometries for an accurate representation of the scanned object, Fig. 8. The scanning process is plug&play. It uses the triangulation method to determine its position relative to the part in real time. It is a data acquisition system and at the same time its own positioning system. We exemplify the case of some façade decorations collected by collaborating restuaurators, Fig. 9.

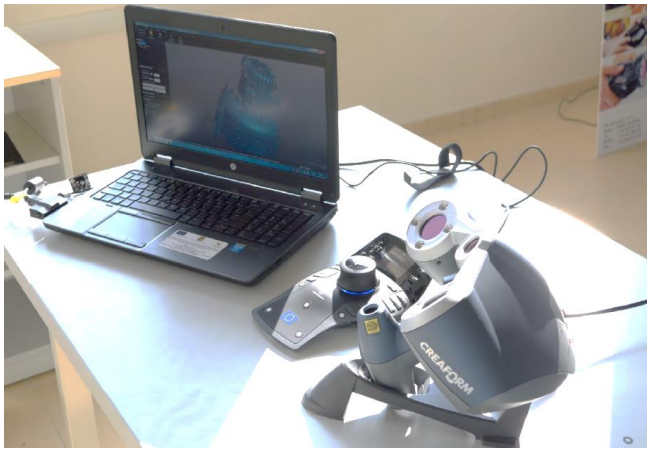


Fig. 8. Exascan Portable 3D System
Source: personal photo

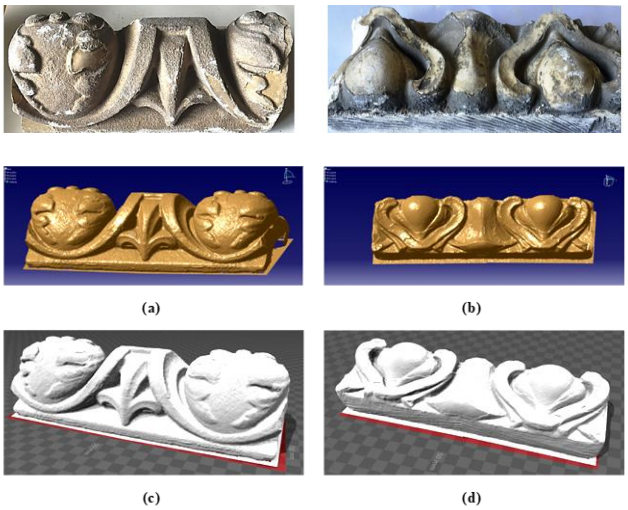


Fig. 9. Digital reconstruction of façade decoration with Exascan portable 3D system

4.5. Corvin Castle

Corvin Castle, also known as Hunyadi Castle in Hunedoara, is the most important Gothic-Renaissance architecture ensemble in Romania, Fig.10. On its site initially functioned an ellipsoidal fortress given to Voicu, the father of John of Hunedoara, on October 18, 1409, by Sigismund of Luxemburg, King of Hungary. The construction of the current Castle started around 1442, by building a new enclosure equipped with rectangular and circular defense towers, when Ioan de Hunedoara occupied the position of voivode of Transylvania. Since 1446, when John Hunyadi became governor regent of the Kingdom of Hungary, a series of civil and religious constructions appear inside the precinct. After the death of John Hunyadi in 1456, numerous Renaissance elements were added to the architecture of the building. The construction stage attributed to Matthias Corvin lasts until 1480, when the castle was recognized as one of the largest and most impressive buildings in Eastern Europe.

Fig. 10. Corvin Castle
Source: personal photo

The general appearance is due to the seventeenth-century constructions and their restoration works from the nineteenth to the twentieth century, some of the latter without reasons of compatibility between the materials used. Today, Corvin Castle is an imposing structure, with tall towers, bastions, an inner courtyard, variously colored roofs and countless windows and balconies adorned with decorative stone elements [34, 35, 36, 37, 38, 39, 40].

Through the methods offered by digitization, and the location of the samples taken, temperature measurements were made at Logia Matia, Fig. 11, 12.

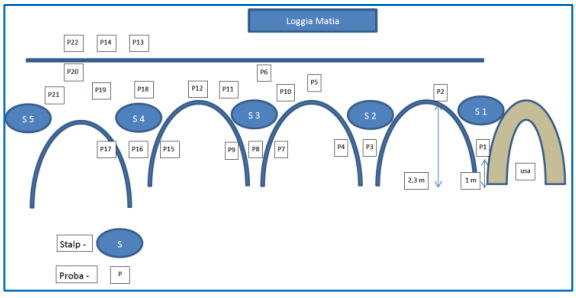


Fig. 11. Location of temperature measurements, Logia Matia

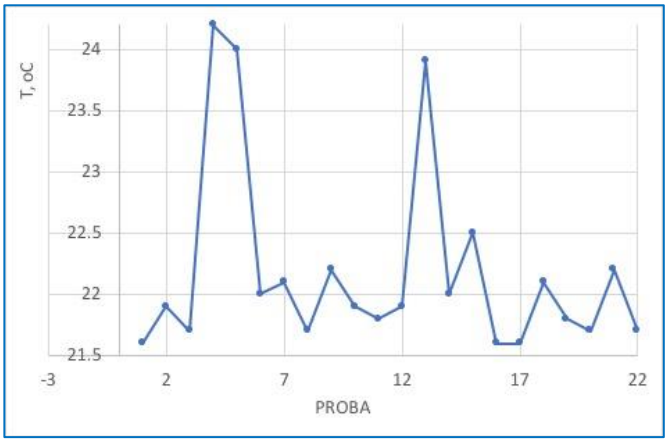
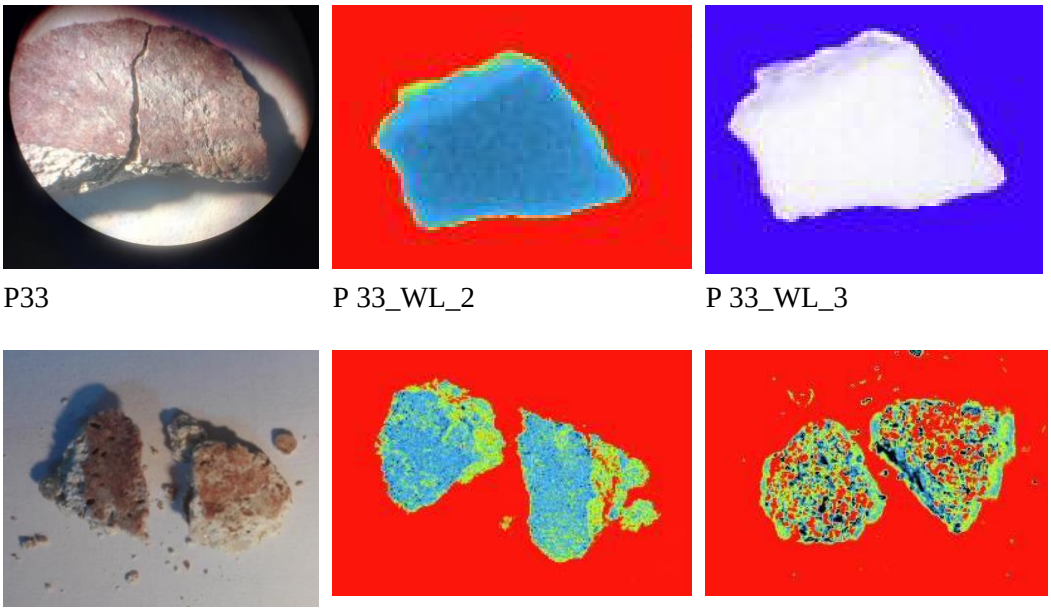


Fig. 12. Graph of temperature variations

The lowest temperatures were measured at the outer pillars of Logia Matia.

In this case, too, 3D simulations were made in the “GIF” format using software for editing computer graphics, especially on the red pigments present on the traces of the picture left on the poles. At 254 nm we can observe the presence of several layers of paint, proof being the multiple interventions at the level of this monument, Fig.13.



P33 P 33_WL_2 P 33_WL_3

P31 P 31_4 UV 365 nm P31_VERSO_2 UV 254 nm

Fig. 13. 3D images for computer graphics editing of Logia Matia samples

5. Use of the aggregat's recycled concrete

Most of the waste produced by the demolished structures was disposed of by throwing it away as filler. The dumping of waste on land causes a lack of landfills in urban areas. Therefore, it is necessary to start recycling and reusing demolition concrete waste to save the environment, costs and energy. The use of recycled aggregates from construction and demolition waste has a prospective application in construction as an alternative to natural aggregates [41].

Many old buildings, concrete pavements, bridges and other structures have exceeded their age and limit of use due to structural damage beyond repair and need to be demolished. The structures, even suitable for use, are being demolished because they do not serve the needs of the current scenario. The structures are turned into debris resulting from natural disasters such as earthquake, cyclone and floods, etc. New construction is necessary for better economic growth [42].

Recycled concrete aggregates (RCA) contain not only the original aggregates, but also hydrated cement paste. The recycling of aggregates can take place either at the site of the materials, with the help of crushers, or the materials can be transported to a central recycling facility where large stocks can accumulate. Recycled aggregates from these central recycling facilities undergo a number of processes to ensure high quality [43].

Various processes involve, crushing, pre-sizing, sorting, sieving and removing contaminants. Then to start with clean, quality aggregates, to easily meet design criteria and finally get a quality product that will go into end use. Further cleaning is also done to ensure that the recycled concrete product does not contain dirt, clay, wood, plastic and organic materials. This is done by floating water, manual choice, air separators and electromagnetic separators.

Brick rubble has been used since antiquity in construction. Thus, in Vitruvius' work on architecture, published in 13 BC, we find in book VII, chapter 4, the following: “In the plaster for the wet foundation, instead of sand, crumbs of burnt bricks will be used, so that this part of the plaster is not damaged by moisture”. In the research carried out by Prof. Steopoe on mortar samples from Sarmisegetuza, it was found that mortars in pavements or lower parts of walls contained as aggregate a mixture of brick debris and dust. It is reported that brick debris can also be used as aggregates for lightweight concrete, which have good insulating properties [44].

6. Original experimental results

By using various assortments of waste (ceramics, marble, wood – polymer sawdust), specimens were made 5x5x5 cm (Fig.14) subjected to structural, compositional and microscopive analyzes, but also resistance to external factors and mechanics

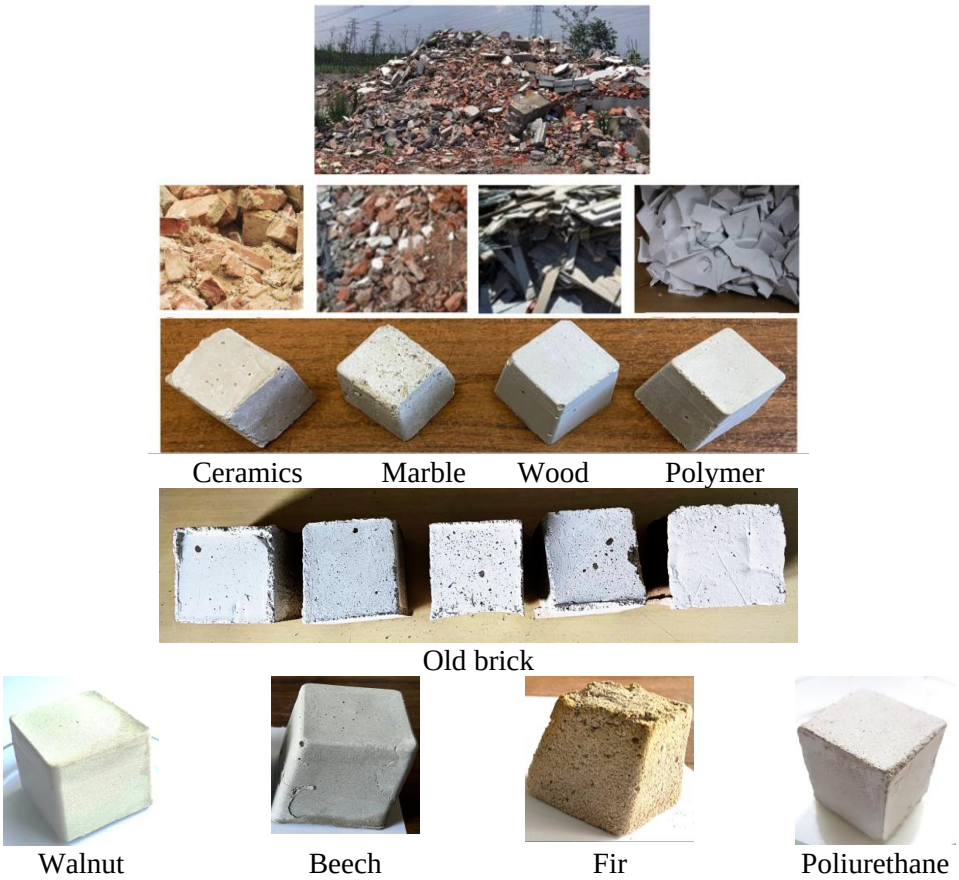


Fig. 14. Specimen samples made with various aggregates

The mechanical strength of polyethane mortar samples is shown in Fig. 15, indicating a mechanical strength close to that of a normal cement [45, 46, 47].

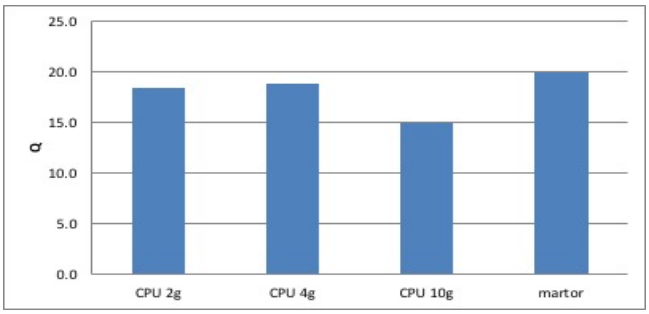


Fig. 15. Variation of mechanical resistance in specimens with polyethane RCA

In the case of old RCA, the pore volume is ten times smaller, making it more compressive and resistant [48, 49]. This could explain the higher mechanical strength (7 MPa) than the initial mechanical strength (5 MPa) after 24 hours. At 28 days, these values became 10 MPa, and after 50 days they became 18 MPa.

6.1. Behaviour of bricks made from recycled materials and their testing

Resistance to repeated freeze-thaw cycles was tested on these specimens, an example being shown on walnut sawdust specimens, Fig. 16.

Fig. 16. Resistance to repeated freeze-thaw cycles specimens with walnut sawdust

7. Conclusions

Research has shown that coarsely recycled aggregates can be used in concrete up to a compressive strength of 80 N/mm2 and can be used in the range of 20-30% of the mass of aggregates required together with natural aggregates [50].

The acceptability of recycled aggregates is hindered for structural applications due to technical problems associated with them, such as weak interfacial transition areas between cement paste and aggregates, porosity and transverse cracks in demolished concrete, high level of sulfate and chloride content, impurities, cement residues, poor classification and high quality variation.

The broken material is cornered and therefore it is possible to give less workable concrete. However, this disadvantage is counteracted by the use of modern means of vibration, through which good compaction of concrete is achieved.

The aggregate obtained by crushing concrete from demolition is also loaded at the cost of crushing labor. It is therefore necessary that the material is not used alone, but mixed with gravel and gravel sand. As regards the proportion of the mixture and the required dosage, these will be determined by the destination of the concrete and the results obtained in the preliminary tests.

The porosity of a hardened concrete is higher than that of concrete made with ordinary siliceous aggregates, the concrete mixture will therefore require a lot of water to reach the plastic consistency, which will produce a reduction in mechanical resistance and an increase in shrinkage when drying.

Such materials can be used to make lightweight concrete with apparent densities towards the upper limit of the permissible values for this type of concrete made with light aggregates. Possible fields of use for such concretes refer to the realization of masonry blocks, non-loadbearing walls, filling for sandwich walls. Realization of exterior arrangements on the site of the historical monument and realization / rehabilitation /

modernization of related constructions including rehabilitation, modernization of roads / direct access ways, or extension of historical monuments.

Acknowledgement
This work was supported by the projects: PNII 222/2018, PNIII 51PCCDI / 2018 from MCID-UEFISCDI. Special thanks to all collaborators.

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Implicațiile economiei circulare în protecția patrimoniului cultural din orașele inteligente

Rodica-Mariana ION,
Institutul National de Cercetare-Dezvoltare pentru Chimie si Petrochimie – ICECHIM, Grupul de Cercetare "Evaluarea si Conservarea Patrimoniului Cultural", Bucuresti, Romania / Școala Doctorală de Ingineria Materialelor, Universitatea "Valahia", Târgoviște, România;
rodica_ion2000@yahoo.co.uk, rodica.ion@valahia.ro

Abstract
În această lucrare sunt abordate următoarele obiective: (I) identificarea factorilor de mediu interior și exterior din unele monumente, precum si degradarea acestora, (II) modalități și soluții practice de recuperare și reciclare a materialelor de construcție de la demolari, (III) utilizarea materialelor de la demolari la mortare pentru lucrari de restaurare a cladirilor de patrimoniu. Studii de caz. Clădirile de patrimoniu cultural ocupă o nișă unică în peisajul urban, iar protecția și conservarea acestora este o chestiune de interes deosebit pentru un oras inteligent. Microclimatul și poluanții prezenti (turiști, lămpi cu ulei, lumânări, poluarea urbană) contribuie la degradarea cladirilor. In acest context, conceptul de economie circulară încurajează restaurarea și reutilizarea monumentelor de patrimoniu cultural, care reprezintă o resursă valoroasă în dezvoltarea ofertei turistice si promovarea unui oras inteligent. Prezenta lucrare se bazează pe expertiza autoarei in domeniul conservarii și restaurarii de stucaturi, decoratiuni de fațadă sau substraturi de piatră, identificarea poluanților, precum si a mecanismelor de degradare si conservare ale unor importante monumente românești din patrimoniul arhitectural. Lucrarea are la baza si expertiza autoarei in domeniul Arheometriei și Restaurarii și Regenerarii Patrimoniale, cu implicatii in Studiul Materialelor pentru Arhitectură. Lucrarea va prezenta identificarea factorilor de mediu interior și exterior din unele monumente precum SOx, NOx, cloruri, pH, RH, T, in monumente precum: Castelul Corvinilor, Hunedoara, Mozaicul Roman, Constanta, Bisericutele Basarabi-Murfatlar, Monumentul Adamclisi, Constanta, si modalitati de recuperare și reciclare a materialelor de construcție de la demolari: ceramică (cărămidă, marmură), deșeuri din plastic (poliuretan) și deșeuri de lemn (ex. rumeguș). Soluțiile prezentate vor aborda provocările prezente pentru reutilizarea deșeurilor din construcții și demolări, promovarea oportunităților de afaceri locale pentru tranziția către o economie circulară si dezvoltarea unui oras inteligent. Lucrarea are un inalt nivel de originalitate si va prezenta exemple de materiale și tehnologii ecologice pentru conservarea/consolidarea clădirilor cu materiale-deșeu rezultate din construcții si demolări.

Cuvinte cheie: economie circulară, poluanți, patrimoniu cultural, reciclarea deșeurilor, oraș inteligent.

1. Introducere

1.1. Aspecte generale. Definiții și legislație

Conform Cartei albe Europeana privind orașele inteligente, "patrimoniul cultural definește identitatea comunităților noastre, contribuie la coeziunea socială și sporește inovarea și turismul (Europeana 2015)" [1, 2, 3]. In acelasi context, "Agenda 2030 pentru dezvoltare durabilă a Adunării Generale a Organizației Națiunilor Unite", aprobat din 2015 de țările membre ale ONU, a promovat modelul "Orașe durabile", ce presupune până în 2030 reducerea impactului negativ al mediului asupra orașelor, acordand o atenție deosebită gestionării și reciclării deșeurilor generate [4, 5, 6, 7]. Orașele durabile si inteligente presupun prin inovare tehnologică, înlocuirea unei «economii liniare" cu o «economie circulară", în care deșeurile sunt încorporate în procesele de producție a produse și/sau materiale noi (în vederea atingerii obiectivului "zero deșeuri") [8].

În fiecare oraș, deșeurile din construcții și demolări (DCD) reprezintă o problemă gravă de poluare a mediului, din cauza gestionării lor inadecvate și a ratelor scăzute de reciclare sau

utilizare. La nivel global, 25-30% din totalul deșeurilor solide la nivel mondial, echivalente la 3 trilioane de tone pe an sunt rezultate din deseuri provenite din industria constructiilor. Anual, la nivel european, aproximativ 750 de milioane sunt generate tone de deșeuri C&D, reprezentând aproximativ 32,6% din totalul deseurilor au rezultat din: gospodării și industrie [9].

Fara indoiala, cantitatile masive de deseuri rezultate din activitatile umane, implica un management decisional intr-un oras intelligent. Iar noile concepte de economie liniara, de reciclare si circulara concura la strategia si managementul decizional al acestor orase.

În zilele noastre, multe orașe din întreaga lume se confruntă cu clădiri de patrimoniu abandonate. Aceste clădiri se află în principal în zonele urbane centrale și sunt într-o continuă degradare ca urmare a acțiunii mai multor factori externi. Regenerarea și reabilitarea acestor clădiri nu este întotdeauna un punct de interes, deoarece implică costuri mari. Deoarece asigură continuitatea unor tradiții și a unor valori comune, clădirile de patrimoniu au devenit o resursă importantă în regenerarea și evoluția urbană. Salvarea clădirilor de patrimoniu industrial aduce beneficii atât culturale, sociale, cât și ecologice, deoarece evitarea demolării le permite salvarea resurselor și energiei, precum și evitarea poluării.

Obiectivul acestei lucrări constă în:

- studierea stării de conservare și degradare chimico-fizică a clădirilor istorice, evaluarea condițiiloe de mediu, know-how-ul istoric diferit (maniera) și/sau restaurarea anterioară;
- reconsiderarea digitală a monumentelor sau clădirilor istorice;
- furnizarea de indicatii privind proprietatile materialelor deseu rezultate din constructii si demolari, crearea si utilizarea unor compozitii noi de materiale agregate reciclate, compatibilitatea si disponibilitatea pentru interventiile de intretinere si restaurare;
- stabilirea unor proceduri corecte de investigare și intervenție care să fie bazate pe soluții cu relevanță istorică, artistică și documentară, să utilizeze competențele interdisciplinare ale unor laboratoare capabile să ofere răspunsuri tehnice și științifice la problemele complexe de restaurare și conservare a suprafețelor monumentelor.

1.2. Clasificare

În ceea ce privește DCD-urile, acestea pot fi clasificate în două categorii: deșeuri utilizabile și neutilizabile. Daca deseurile neutilizabile sunt cele contaminate cu deseuri periculoase, ce impun reglementări specifice de mediu, in categoria de deșeuri utilizabile intra beton, ceramică, cărămizi din argilă, zidărie, și deșeuri de mortar, sticlă, polietilen tereftalat (PET), poliuretan provenit de la aparatele electrocasnice, anvelope, deșeuri de beton, deșeuri agricole, nor de silice, cenușă zburătoare etc., pot fi utilizate în producția de beton pentru a reduce eliminarea unor volume mari de DCD prin înlocuirea agregatelor [9] utilizate la agregate fine și grosiere. DCD sunt clasificate de la A la D conform standardului brazilian NBR 15113 [10] după cum urmează:

- Clasa A: mortar, beton și componente ceramice (de exemplu, cărămizi, blocuri, țigle, și acoperiri);
- Clasa B: materiale plastice, hârtie, carton, metale, sticlă și lemn;
- Clasa C: reziduuri pe bază de ipsos;
- Clasa D: deșeuri periculoase, cum ar fi azbestul, gudroanele şi vopselele, metalele grele (crom, plumb, mercur), lacurile, vopselele, adezivii, policlorură de vinil, solvenţi, compuşi bifenili policloruraţi, diverse tipuri de rășini utilizate pentru conservare, ignifugare, impermeabilizare etc.
- In acelasi context, adoptarea economiei circulare a apărut ca o strategie promițătoare de reducere a impactului negativ asupra mediului al DCD [11].

2. Deșeurile provenite din activități de construcție și demolări în cadrul economiei circulare

2.1. Circularitatea materialelor de construcție

Principalul contribuitor la economia circulară din sectorul construcțiilor este recuperarea, reutilizarea și reciclarea CDW. Recuperarea, reutilizarea și reciclarea DCD sunt componentele esențiale ale economiei circulare în sectorul construcțiilor.

Economia liniară presupune urmatoarele etape: producere, sortare, folosire, aruncare.

Economia de reciclare presupune: producere, sortare, folosire (cu reciclare) si apoi aruncare

Economia circulara presupune asamblarea ambelor tipuri de economie de mai sus, dupa cum urmeaza: producere, sortare, folosire prin reciclare si/sau returnare, refolosire, reutilizare.

Componentele clădirilor ar trebui selectate în funcție de potențialul lor de circularitate, urmând ierarhia celor 3R (reducere, reutilizare, reciclare) a economiei circulare [12, 13].

Desurile de hârtie reprezintă cel mai frecvent deseu intalnit in mai toate sferele de activitate si constituie o importanta sursa de fibre de celoloza. Se regăsește sub forme diferite (hartie de scris, hartie de ambalaj, ziare, reviste, cataloage, deseuri postale, cutii sau alte ambalaje din carton simplu si ondulat de la produsele cosmetice, electrocasnice, pentru bauturi, inclusive ambalajele de tip TetraPak, etc.), hartia ocupa aproximativ 41% din totalul gunoiului menajer pe care il producem astazi. Prin procesul de reciclare, fiecare tona de hartie reciclata poate salva 17 copaci, si este nevoie de un copac de 15 ani pentru a produce 700 pungi de hartie. Hartia si cartonul pot fi reciclate doar de 10 ori. Prin reciclarea hartiei, se ecocnomisesc aproximativ 25% din cantitatea de electricitate si a 90 % din cantitatea de apa (300 l) necesara pentru producerea a 1 kg de hartie alba. De asemenea, se elimina clorul toxic necesar producerii hartiei albe.

Deșeuri de plastic: Prin reciclarea fiecarei tone de plastic reciclat se economisesc între 700 si 800 kg de petrol brut. Toxicitatea plasticului se regaseste atat in urma arderii, rezultand substante care produc boli de plamani, sau din cauza cernelii utilizate imprimarea pungilor contine cadmiu, metal foarte toxic, eliberat in aer odata cu arderea pungilor. O singura sticla de plastic prin reciclare conduce la economisirea energiei pentru functionarea unui bec de 60W timp de 6 ore.

Conform celor mai recente rapoarte, în 2017, cererea de plastic în Europa în 2016 a fost de 49,9 MTn, cu 3,1% mai mare față de 2014. Din această cerere, 7,5% este poliuretan, ceea ce implică o cerere anuală de 3,78 MTn în 2017. Din cei 2,62 MTn de spumă poliuretanică (PU), aproximativ 27% din deșeuri sunt generate (700.400 Tn), din care, 31,1% este reciclat (220.000 Tn), 41,3% este incinerat (294.278 Tn) și restul de 27,3% este dus la groapa de gunoi (193.120 Tn). Sectoarele industriale responsabile de aceste cantități sunt: construcții și demolări (24,5%); auto (19,5%), refrigerare (21,3%) și alte sectoare (34,7%).

Se cunosc mai multe lucrări în care deșeurile de spumă poliuretanică, combinate cu lianți smoală sunt utilizate ca agregate uscate în diferite cimenturi sau matrici de gips. În mortarele de ciment, PU ca agregate reciclate asigură o durabilitate excelentă, și este capabil să reducă cantitatea de nisip din mortarele de ciment prin înlocuirea nisipului în proporție de 13-33%, 25-50 % sau chiar 25-100 % [14, 15, 16, 17, 18, 19, 20]

Deșeurile din lemn: Deșeurile de lemn reprezintă un ansamblu de produși și materiale a căror origine se regăsește în toate etapele industriei lemnului, de la exploatarea forestieră până la fabricarea produșilor finiți. Principalele surse ale deșeurilor lemnoase sunt:

- de la exploatările forestiere: scoarță, rumeguș, lemn subțire;
- din industria de prelucrare a lemnului (debitare, tâmplărie, fabrici de mobilă, parchet): așchii, rumeguș, resturi;
- rebuturi: lemn de șantier, traverse de cale ferată, paleți, lemn de cofraj.

Deșeurile lemnoase sunt clasificate de normele europene ca fiind deșeuri banale, neprezentând caracter periculos sau toxic pentru mediu. La nivelul României, conform HG 856/5.10.2002 (MOF 659) deșeurile lemnoase se clasifică în funcție de proveniență:

- deșeuri din agricultură, silvicultură, vânătoare și pescuit, de la prepararea și procesarea alimentelor:
- deșeuri de la prelucrarea lemnului și producerea plăcilor și mobilei, pastei de hârtiei, hârtiei și cartonului
- In funcție de starea sub care se găsesc deșeurile lemnoase pot fi:
- lemn în stare naturală – coajă, rumeguș de gater
- reziduuri de lemn – rezultate din tâmplărie, construcții, talaș de rindeluire
- lemn uzat – grinzi, ferestre, paleți lemn tratat – traverse de cale ferată, PVC

Deșeurile din lemn se clasifica astfel in 3 tipuri de deșeuri:

- Deșeuri ne-impregnate: precum deșeurile generate de prelucrarea lemnului: praf, rumeguș, talaș: (61% din total generat)
- Deșeuri slab impregnate: au fost tratate cu produse ne-periculoase sănătății precum grinzi de lemn, mobilier masiv, deșeuri de PAL si de PAF. Aceste deșeuri pot fi folosite pentru combustie: (28%)
- Deșeuri foarte impregnate: stâlpi telefonici tratați cu creozot sau cupru, talaș care a servit pentru a absorbi un produs periculos, etc. Aceste deșeuri nu pot fi folosite pentru combustie si merg la groapa de gunoi sau un alt centru specializat: (11%) [21]

Deșeurile de sticlă: Sticla are nevoie de 1 milion de ani pentru a se descompune in bucatele mici. Reciclarea sticlei reduce poluarea de fabricare cu 75% si poluarea aerului cu 14-20%. Reciclarea unui borcan de sticla economiseste energie suficienta pentru alimentarea unui bec de 100W timp de 4 ore. Reciclarea unei tone de sticla economiseste 1,2 tone de materii prime (soda, nisip, feldspat) si energie in proportie de 25% [22].

Sticla este 100% reciclabilă, recuperarea ei salvând un volum important de resurse energetice.

Deșeurile de marmură și ceramică pot fi, de asemenea, prelucrate în particule fine sau agregate pentru a înlocui o parte din agregatele naturale utilizate în producția de beton. Utilizarea marmurei, ceramicii și plăcilor reciclate în beton poate contribui la îmbunătățirea proprietăților mecanice (rezistența la compresiune, rezistența la încovoiere și rezistența la abraziune) și a durabilității betonului, reducând în același timp permeabilitatea și absorbția apei [23]. Utilizarea marmurei, și ceramicii reciclate în beton poate contribui la reducerea generării de deșeuri și conservarea resurselor naturale. După unele referințe [24, 25, 26, 27], densitatea betonului care conține agregate de deșeuri ceramice scade liniar pe măsură ce crește concentrația ceramică. În același timp, adâncimea de penetrare a ionilor de clor, extrem de agresivi, în beton scade odată cu creșterea conținutului de ceramică, iar rezistența electrică a betonului crește odată cu creșterea cantității de ceramică, durabilitatea betonului crescând odată cu creșterea procentului ceramic.

3. Patrimoniu cultural inteligent și Oraș inteligent

Dezvoltarea conceptului de oraș inteligent în ultimele două decenii a contribuit direct la apariția conceptului Patrimoniu Inteligent (Smart Heritage). Conceptul "inteligent" s-a distins de alte viziuni în care tehnologia informației este combinată cu infrastructura, arhitectura, activitatile de zi cu zi pentru a aborda problemele sociale, economice și de mediu [28], iar în 2018, Yigitcanlar et al. au identificat trei factori principali ai orașelor inteligente; Comunitate, politică și tehnologie [29], pentru a produce productivitate, durabilitate, accesibilitate, bunăstare, viabilitate și rezultate de guvernanță. Orașul inteligent devine ca un "concept dominant" fără a exista o definiție universal acceptată a unui oraș inteligent. Definiția este diferită pentru oameni diferiți. Conceptualizarea Smart City variază de la oraș la oraș și de la țară la țară, în funcție de nivelul de dezvoltare, dorința de schimbare și reformă, resursele și aspirațiile locuitorilor orașului.

În acest context, clădirile de patrimoniu ca entități distincte în orașele inteligente sunt unice și de neînlocuit. Conservarea, restaurarea și reabilitarea clădirilor de patrimoniu reprezintă în multe țări peste 35% din producția totală în domeniul construcțiilor [30].

Conceptul de "patrimoniu cultural inteligent" implică o conexiune între utilizatorii unei platforme digitale comune, între instituție și vizitatorii săi, între obiecte/teritoriu și vizitator și între lumea reală și cea virtuală.

Patrimoniul inteligent conectează o realitate fizică la o realitate virtuală, dar oferă o gamă largă de posibilități de accesare a reprezentărilor sale.

4. Soluții digitale. Studii de caz

4.1. Cazul Bisericutelor de cretă de la Basarabi-Murfatlar

Variațiile de temperatură și prezenta apei sunt factorii cei mai agresivi care afectează acest monument, Fig. 1, și se impun unele măsuri pentru salvarea acestui monument important, iar digitizarea virtuala ar putea fi primul pas în acest context.

Fig. 1. Bisericutele de creta de la Basarabi-Murfatlar
Sursa: Fotografie personală

Aplicarea noilor tehnologii și a digitalizării monumentului Basarabi este o măsură preventivă, ajutându-ne să realizam o reconstrucție virtuală ca model pentru păstrarea acestuia, pentru a oferi acces unui public cât mai larg. Scanarea laser, modelarea 3D, scanarea digitala si fotogrammetria sunt cele mai utilizate metode pentru digitizarea patrimoniului cultural, în scopul de a oferi modele 3D. Prin intermediul tehnicii de scanare cu laser, pentru acest monument a fost posibil să se măsoare cantitățile topografice, direcția unei linii optice virtuale care unește unele puncte de pe suprafața monumentului la un punct de referință de pe dispozitivul de măsurare și caracteristicile morfologice asupra monumentului, care poate să fie achiziționate și măsurate cu o precizie foarte mare [31]. S-a obținut o reprezentare matematică a unei suprafețe 3D, prin intermediul programului CAD de modelare pentru a crea modelul 3D al proiecției externe a bisericii, Figura 2. Ca o alternativă, fotografiile digitale comune pot fi folosite, pentru a obține 2D sau 3D coordonatele de câteva fotografii. În cazul nostru, prin utilizarea fotogrammetricã 3D a fost obținut modelul 3D al anvelopei bisericii, care ar trebui să fie aplicat peste biserică, figurile 2 a-c. Modelul 3D creat a fost cu o precizie de 0.72-0.95%.

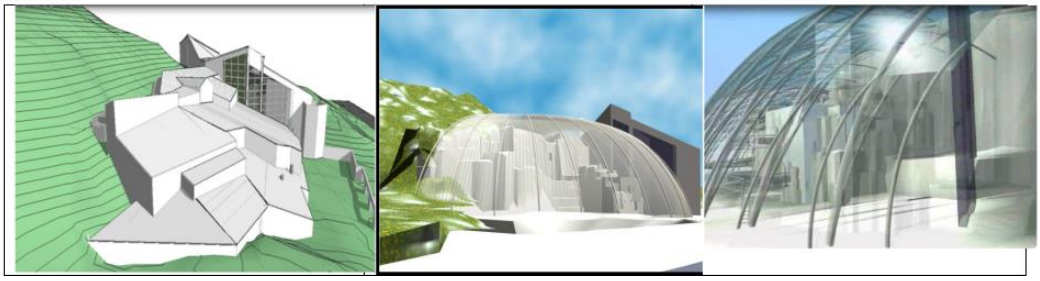


Fig. 2. (a) Protectia digitala exterioara a monumentului ; (b) Schema protectiei acoperisului ; (c) Peoiectia anvelopei bisericii

4.2. Studiu de caz : Monumentul triumfal Adamclisi

Un prim factor ce afecteaza sustenabilitatea cladirilor de patrimoniu intr-un oras inteligent il reprezinta deteriorarea suprafetelor cladirilor de patrimoniu datorita poluarii aerului cu efecte asupra fațadelor din calcar sau marmură, murdărirea suprafeței de piatră, murdărirea sticlei, deteriorarea vitraliilor medievale, coroziunea metalică și acumularea de biomasă în mediul urban. Motoarele cu ardere interna contribuie din plin la poluarea din interiorul marilor orase, prin concentratii mari de dioxid de sulf, dioxidul de carbon (CO_2), ozonul (O_3). Depunerea poluanților pe suprafețe depinde de concentrațiile atmosferice ale poluanților și de climatul și microclimatul din jurul acestora.

Si aici vom exmplifica prin stadiul poluarii in monumentele din Romania, cu referire la monumentul triumfal de la Adamclisi, masuratori ce s-au efectuat in cursul unui proiect de cercetare derulat in anii 2018-2020 [32].

Fig. 3. Monumentul triumfal Adamclisi
Sursă: foto personal

Concentratiile de poluanti dioxid de sulf (SO2), oxizi de azot (NOx), monoxid de azot (NO), monoxid de carbon (CO), ozon (O_3) si concentratia de pulberi (PM10) masurate cu sensori specializati, sunt prezentate in Fig. 4. Acestea variaza in functie de anotimp, fiind mai intense in sezonul rece, cand traficul in zona se presupune ca este mult redus, iar activitatile umane in zona sunt mult diminuate.

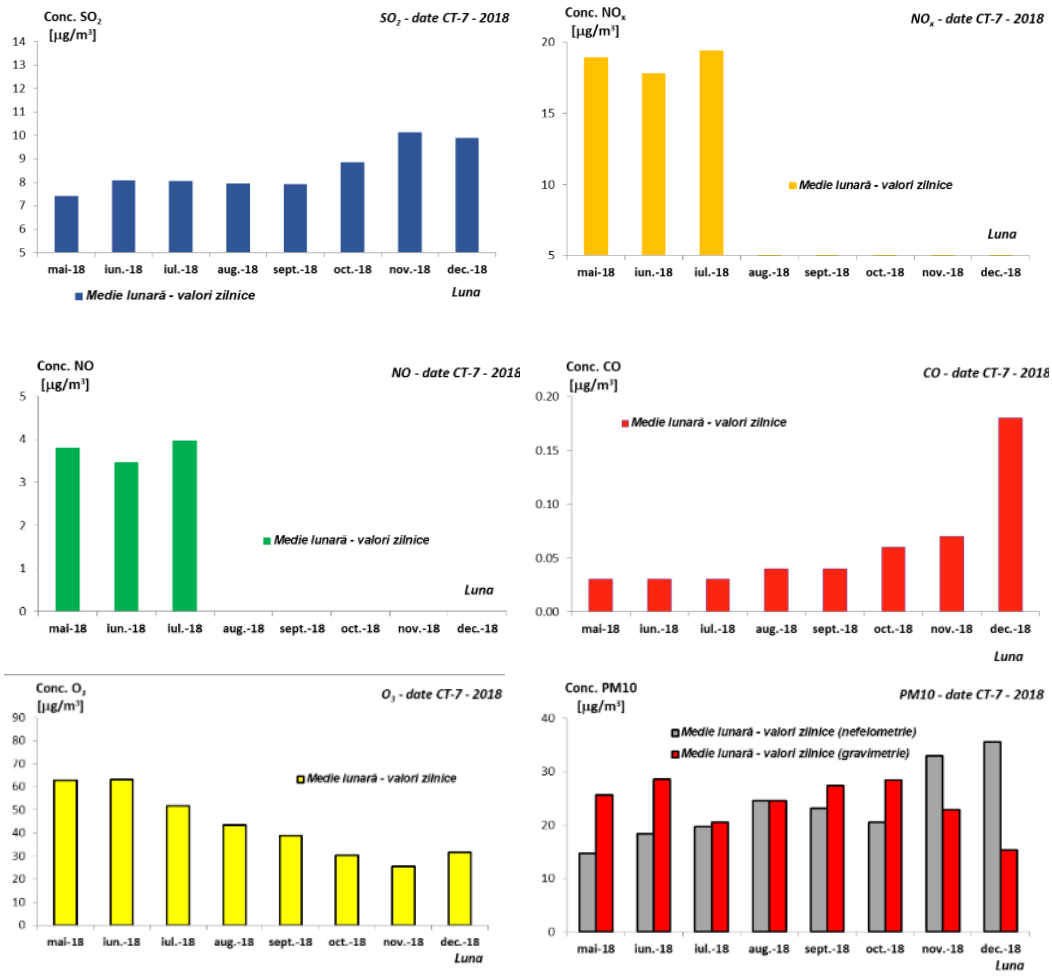


Fig. 4. Nivelul poluantilor gazosi SO_2, NO_x, NO, CO, O_3, PM10 in arealul monumentului de la Adamclisi

4.3. Mozaicul Roman

O alta categorie de factori este constituita de degradarea suprafetelor cladirilor, provocata de procese fizice, precum: cristalizarea sărurilor în ziduri poroase (piatră, cărămidă, tencuială, fresce, picturi murale), deteriorarea prin cicluri îngheț-dezgheț în materiale poroase, creșterea nivelului mării, umflarea – contracția mineralelor argiloase din soluri care afectează stabilitatea fundațiilor de monumente, acumularea de biomasă (licheni, alge, mușchi, fungi) strâns legată de ploaie și temperatură, depinzând doar de parametrii climatici. Fenomenul de degradare are loc într-o manieră graduală și se manifestă diferit în funcție de materialele folosite la construcție. Prin utilizarea unor echipamente performante pH-metre, microscoape digitale cu softuri de prelucrare imagini, s-a masurat valorile pH, sarurile, umiditatea, si continutul de carbon organic provocat de pulberile de cenusi rezultate de la motoarele cu ardere interna, Fig. 5. Aceste date au fost masurate si comparate pentru toate monumentele din acelasi areal: Mozaicul Roman, Cavoul Hipogeu si Monumentul Adamclisi, Fig. 6.

Fig. 5. Mozaicul Roman, Constanta
Sursă: foto personal

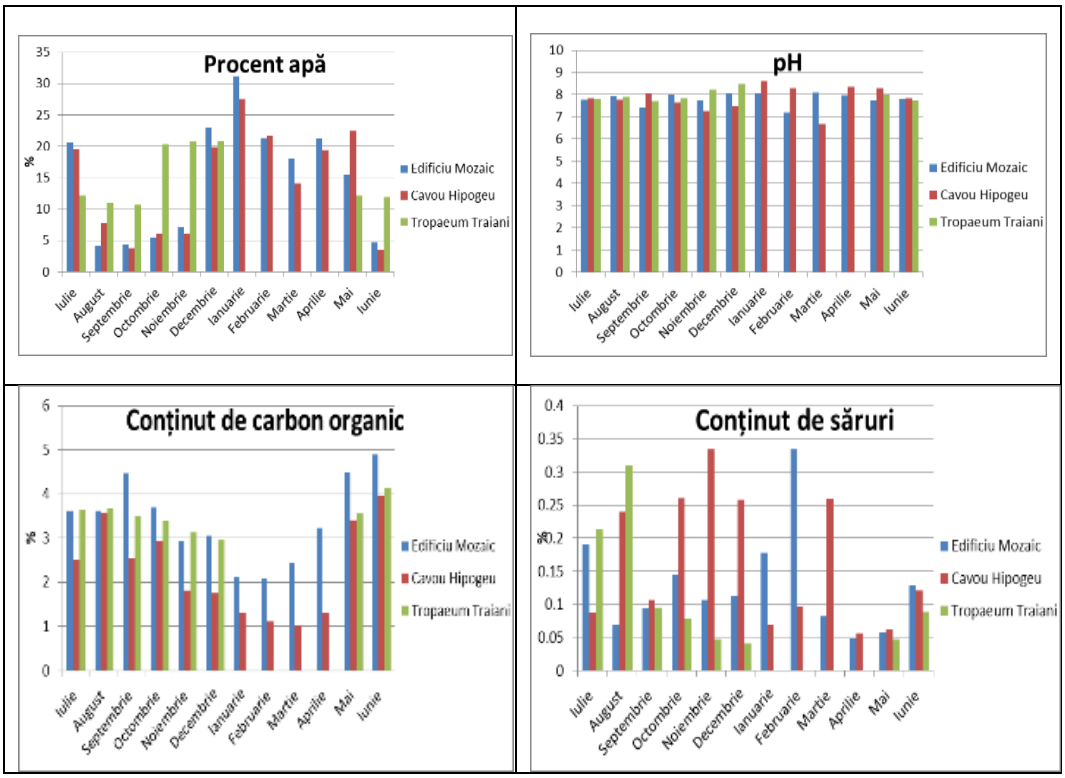


Fig. 6. pH, sarurile, umiditatea, si continutul de carbon organic masurate lamoumentele Mozaicul Roman, Cavoul Hipogeu si Monumentul Adamclisi

Aceeasi tendinta este vizibila si in acest caz: cresterea parametrilor pH, carbon organic in lunile de primavera-vara, si agresivitatea proceselor de degradare prin cristalizarea sarurilor si a umiditatii in lunile toamna-iarna [33].

Prin utilizarea unor echipamente performante pH-metre, microscoape digitale cu softuri de prelucrare imagini, s-a putut evalua atat zonele degradate cat si efectul restaurarilor anterioare asupra acestor probe.

Pentru Mozaicul Roman, in scopul observarii mai clare a detaliilor privind probele de mozaic au fost realizate si simulari 3D in formatul “GIF” utilizand software-uri pentru editarea grafica pe computer, Fig.7.

Fig. 7. Simulari 3D pentru editarea grafica pe computer a probelor de mosaic.

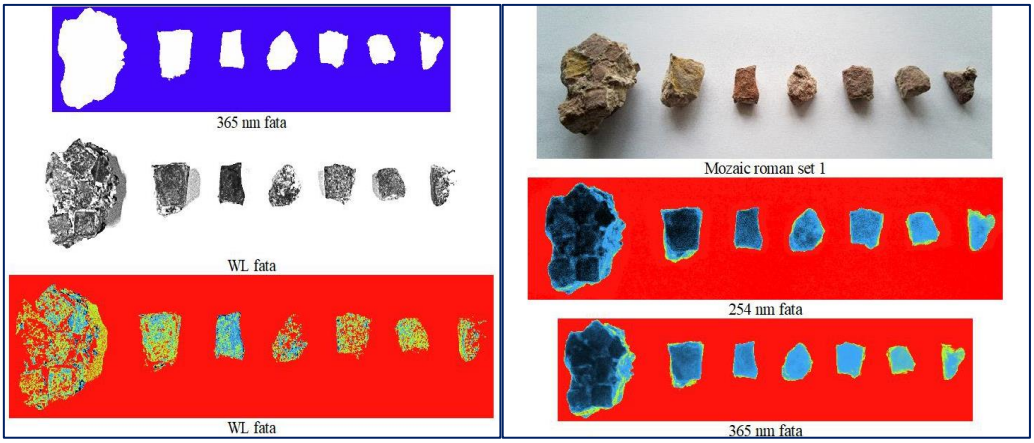


Fig. 8. Sistemul portabil 3D Exascan

Se pot observa fisurile si depunerile de produsi de degradare in special la vizualizarea cu lampi de UV cu lungimeade unda 254 nm,

4.4. Studiu de caz: Casa Fantaneanu, Slatina

Pentru analiza digitala si regenerarea patrimoniala a stucaturilor si decoratiunilor de fatada, s-a utilizat un scanerul portabil 3D Exascan este un sistem optic portabil, pentru achiziţie de date care captează fiecare detaliu şi oferă geometrii exacte de înaltă rezoluţie pentru o reprezentare exactă a obiectului scanat, Fig.8. Procesul de scanare este de tipul plug&play. Utilizează metoda triangulaţiei pentru a determina poziţia sa în raport cu piesa în timp real. Este un sistem de achiziţie de date şi în acelaşi timp şi propriul sistem de poziţionare. Exemplficam cazul unor decoratiuni de fatada colectate de restuauratorii colaboratori, Fig.9.

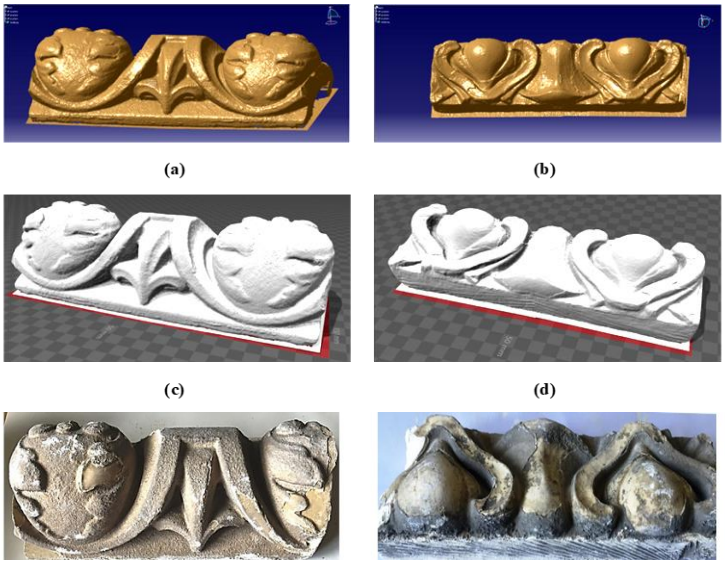


Fig. 9. Reconstituirea digitala a decoratiunii de fatada cu sistemul portabil 3D Exascan

4.5. Castelul Corvinilor

Castelul Corvinilor, cunoscut și sub numele de Castelul Huniazilor din orașul Hunedoara, este cel mai important ansamblu de arhitectură gotico-renascentistă din România, Fig.10. Pe amplasamentul acestuia a funcționat inițial o cetate elipsoidală dăruită lui Voicu, tatăl lui Ioan de Hunedoara, la 18 octombrie 1409, de către Sigismund de Luxemburg, regele Ungariei. Constucția actualului Castel a demarată în jurul anului 1442, prin construirea unei noi incinte dotată cu turnuri de apărare rectangulare și cir-culare, moment în care Ioan de Hunedoara ocupa poziția de voievod al Transilvaniei. Începând cu anul 1446, când Ioan de Hunedoara a devenit guvernator regent al Regatului Ungariei, apar în interiorul incintei, o serie de construcții civile și religioase. După moartea lui Ioan de Hunedoara în 1456, au fost adăugate numeroase elemente renascentiste în arhitectura clădirii. Etapa de construcție atribuită lui Matia Corvin durează până în 1480, moment în care castelul era recunoscut ca fiind una dintre cele mai mari și mai impresionante clădiri din Europa de Est.

Fig. 10. Castelul Corvinilor
Sursă: foto personal

Aspectul general se datorează construcțiilor din secolul al XVII-lea și lucrărilor de restaurare din secolul al XIX-lea până în secolul al XX-lea, unele dintre acestea din urmă fără motive de compatibilitate între materialele folosite. Astăzi, Castelul Corvinilor este o structură impunătoare, cu turnuri înalte, bastioane, o curte interioară, acoperișuri divers colorate și nenumărate ferestre și balcoane împodobite elemente decorative din piatră [34, 35, 36, 37, 38, 39, 40].

Prin metodele oferite de digitalizare, si amplasamentul probelor prelevate, s-au efectuat masuratori de temperatura, la Logia Matia, Fig. 11, 12.

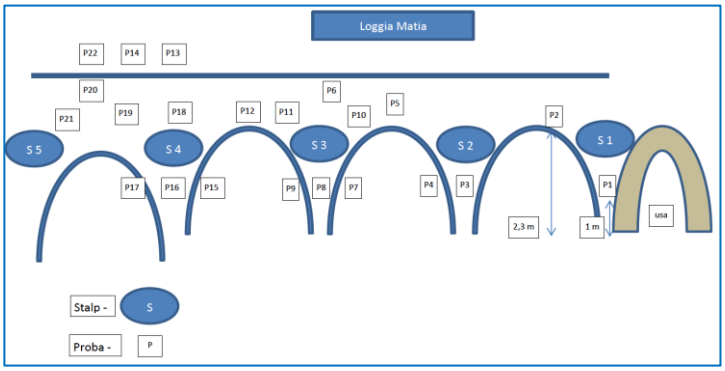


Fig. 11. Locatia masuratorilor de temperatura, Logia Matia

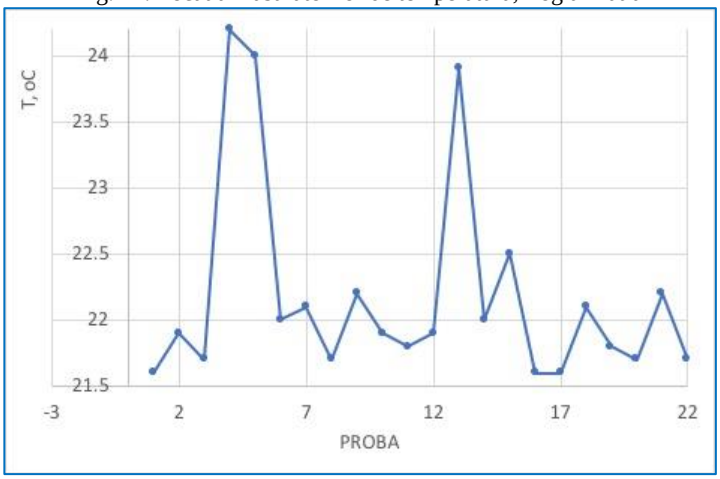


Fig. 12. Graficul variatiilor de temperatura

Cele mai mici temperaturi au fost masurate la stalpii exteriori ai Logiei Matia.
Si in acest caz, au fost realizate si simulari 3D in formatul “GIF” utilizand software-uri pentru editarea grafica pe computer, in special pe pigmentii rosii prezenti pe urmele de picture ramasa pe stalpi. La 254 nm se poate observa prezenta mai multor straturi de vopsea, dovada fiind multiplele interventii la niveul acestui monumente, Fig.13.

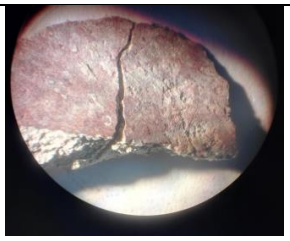
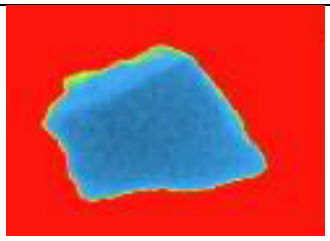
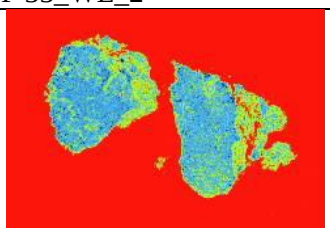
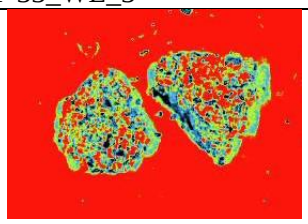
		
P33	P 33_WL_2	P 33_WL_3
		
P31	P 31_4 UV 365 nm	P31_VERSO_2 UV 254 nm

Fig. 13. Simulari 3D pentru editarea grafica pe computer a probelor Logia Matia.

5. Utilizarea agregatlore din beton reciclat

Majoritatea deșeurilor produse de structurile demolate au fost eliminate prin aruncarea lor ca umplutură. Deversarea deșeurilor pe terenuri cauzează lipsa gropilor de gunoi în zonele urbane. Prin urmare, este necesar să se înceapă reciclarea și reutilizarea deșeurilor de beton din demolări pentru a economisi mediu, costuri și energie. Utilizarea agregatelor reciclate din deșeurile din construcții și demolări prezintă o aplicare prospectivă în construcții ca alternativă la agregatele naturale [41].

Multe clădiri vechi, pavaje din beton, poduri și alte structuri și-au depășit vechimea și limita de utilizare din cauza deteriorării structurale dincolo de reparații și trebuie demolate. Structurile, chiar adecvate pentru utilizare, sunt în curs de demolare, deoarece nu servesc nevoilor din scenariul actual. Structurile sunt transformate în resturi rezultate din dezastre naturale, cum ar fi cutremurul, ciclonul și inundațiile etc. Construcția nouă este necesară pentru o creștere economică mai bună [42].

Agregatele din beton reciclat (RCA) conțin nu numai agregatele originale, ci și pasta de ciment hidratată. Reciclarea agregatelor poate avea loc fie la locul din care provin materialele, cu ajutorul concasoarelor, fie materialele pot fi transportate la o instalație centrală de reciclare unde se pot acumula stocuri mari. Agregatele reciclate din aceste instalații centrale de reciclare sunt supuse unui număr de procese pentru a asigura o calitate superioară [43].

Diverse procese implică, zdrobirea, predimensionarea, sortarea, cernerea și eliminarea contaminanților. Apoi, pentru a începe cu agregate curate, de calitate, pentru a îndeplini cu ușurință criteriile de proiectare și, în cele din urmă, pentru a obține un produs de calitate care va intra în utilizarea finală. Curățarea ulterioară se face, de asemenea, pentru a se asigura că produsul din beton reciclat nu conține murdărie, lut, lemn, plastic și materiale organice. Acest lucru se face prin plutirea apei, alegerea manuală, separatoarele de aer și separatoarele electromagnetice.

Sfărâmăturile de cărămidă au fost întrebuinţate încă din anticitate în construcţii. Astfel, în lucrarea despre arhitectură a lui Vitruvius, apărută în anul 13 î.H., găsim în cartea VII-a, cap.4, următoarele: “La tencuiala pentru fundaţia umedă, în loc de nisip se vor întrebuinţa sfărâmături de cărămizi arse, pentru ca această parte a tencuielii să nu fie vătămată de umiditate”.

În cercetările efectuate de prof. Steopoe pe probe de mortar provenite de la Sarmisegetuza, s-a constatat că mortarele din pavaje sau din părţile inferioare ale zidurilor, conţineau drept agregat un amestec de sfărâmături şi praf de cărămidă. Se semnalează faptul că sfărâmăturile de cărămidă pot fi întrebuinţate şi ca agregate pentru betoane uşoare, care au proprietăţi izolatoare bune [44].

6. Rezultate experimentale originale

Prin utiizarea diverselor sortimente de deseuri (ceramica, marmura, lemn -rumegusm polimer), s-au realizat specimene 5x5x5 cm (Fig.14) supuse analizelor structurale, compozitionale si microscopive, dar si de rezistenta la factori externi si mecanica.

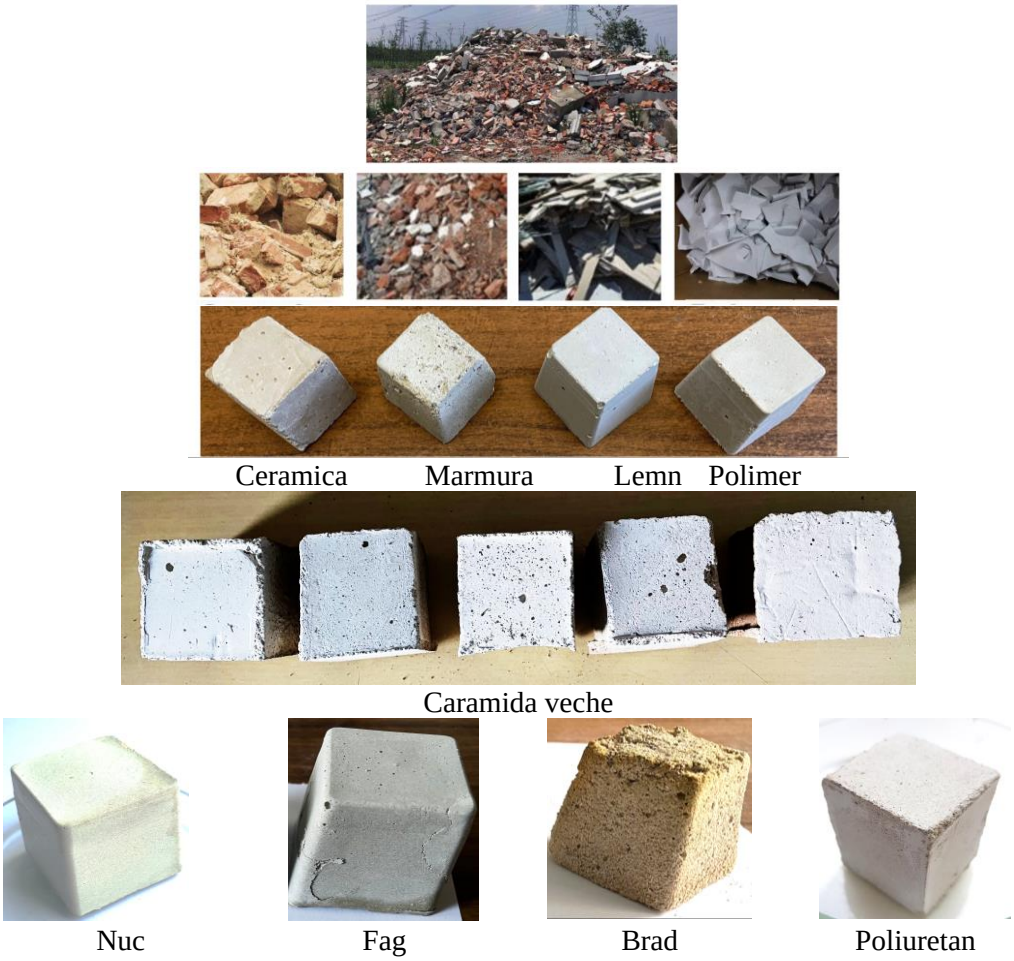


Fig. 14. Mostre de specimene realizate cu agregate diverse

Rezistenta mecanica a probelor de mortar cu poliretan, este prezentata in Fig.15, indicand o rezistenta mecanica apropiata de a unui ciment normal [45, 46, 47].

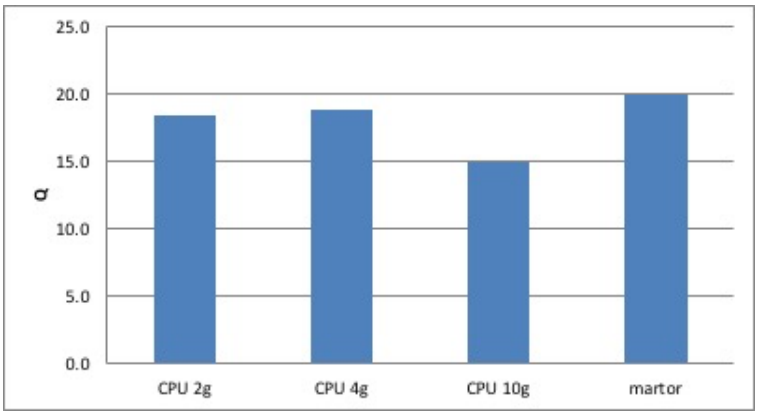


Fig. 15. Variatia rezistentei mecanice la specimene cu RCA poliretan

In cazul RCA caramoda veche, volumul porilor este de zece ori mai mic, făcându-l mai compresiv și mai rezistent [48, 49]. Acest lucru ar putea explica rezistența mecanică mai mare (7 MPa) decât rezistența mecanică inițială (5 MPa) după 24 de ore. La 28 de zile, aceste valori au devenit 10 MPa și după 50 zile au devenit 18 MPa.

6.1. Comportamentul caramizilor din materiale reciclate si testarea lor

Rezistenta la cicluri repetate inghet-dezghet a fost testata pe aceste specimene, o exemplificare fiind prezentata pe specimenele cu rumegus de nuc, Fig. 16.

Inițial	După 10 cicluri	După 20 de cicluri

Fig. 16. Rezistenta la cicluri repetate inghet-dezghet specimene cu rumegus nuc

7. Concluzii

Cercetările au arătat că agregatele reciclate grosier pot fi utilizate în beton până la o rezistență la compresiune de 80 N/mm^2 și pot fi utilizate în intervalul 20-30% din masa agregatelor necesare împreună cu agregatele naturale [50].

Acceptabilitatea agregatelor reciclate este împiedicată pentru aplicații structurale din cauza problemelor tehnice asociate cu acestea, cum ar fi zonele slabe de tranziție interfacială între pasta de ciment și agregate, porozitatea și fisurile transversale din betonul demolat, nivelul

ridicat al conținutului de sulfat și clorură, impuritățile, resturile de ciment, clasificarea slabă și variația mare a calității.

Materialul spart este colţuros şi prin urmare este posibil să dea betoane mai puţin lucrabile. Acest dezavantaj este contracarat însă de utilizarea mijloacelor moderne de vibrare, prin care se realizează o bună compactare a betonului.

Agregatul obţinut prin concasarea betoanelor provenite din demolări este încărcat şi cu costul manoperei de concasare. Este deci necesar ca materialul să nu fie întrebuinţat singur, ci în amestec cu pietrişul şi nisipul de balastieră. În ceea ce priveşte proporţia amestecului şi dozajul necesar, acestea vor fi determinate de destinaţia betonului şi de rezultatele ce se vor obţine la încercările preliminare.

Porozitatea unui beton întărit este mai mare decât aceea a betoanelor realizate cu agregate silicioase obişnuite, amestecul de beton va cere deci, multă apă spre a ajunge la consistenţa plastică, fapt ce va produce o reducere a rezistenţelor mecanice şi o mărire a contracţiei la uscare.

Asemenea materiale se pot folosi pentru realizarea de betoane uşoare cu densităţi aparente spre limita superioară a valorilor admise pentru acest tip de betoane realizate cu agregate uşoare. Domenii de utilizare posibile pentru asemenea betoane se referă la realizarea de blocuri de zidărie, pereţi neportanţi, umplutură pentru pereţi tip sandwich. Realizare amenajări exterioare pe amplasamentul monumentului istoric şi realizarea/reabilitarea/modernizarea construcţiilor conexe inclusiv reabilitarea, modernizarea drumurilor / căilor de acces direct, sau extinderea monumentelor istorice.

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Această lucrare a fost susținută de proiectele: PNII 222/2018, PNIII 51PCCDI / 2018 de la MCID-UEFISCDI. Multumiri speciale tuturor colaboratorilor.

Landscaping of a park in the area of the former Military Units in the Municipality of Alexandria

Anne Marie GACICHEVICI,
Architect Chief of Municipality of Alexandria, County of Teleorman, Romania
anne.marie_gacichevici@yahoo.com

Abstract
The general objective of the project is the functional conversion and reuse of an unused land in Alexandria's urban area and its transformation into a recreational and leisure area for the population, in order to improve the living conditions of the citizens. The investment aims at transforming the unused land into an area friendly to the inhabitants, a recreation, sport and leisure area, rich in vegetation. The specific objectives of the project are represented by O.S.1 Reuse of the park space through the development of public green spaces (19,368.00 sqm of open space, 17,972 sqm of green space), equipping with specific equipment and commissioning and O.S.2 Improvement of the urban environment by reducing pollution. The objective was to achieve the horizontal principles through specific actions on sustainable development by creating public spaces, unitary, that meet the requirements of civilized citizens of the city, with unlimited access, a place for rest, contemplation, leisure and recreation; providing facilities by installing street cysts, fountains, equipment for playgrounds and sports, ecological public toilets, gazebo; positive impact on the environment by preventing noise and other pollution – by providing planted areas around the perimeter of the park to screen the space, with green spaces as one of the most important tools for improving air, water and soil quality and equal opportunities and non-discrimination by adapting the pedestrian space for the visually impaired by installing tactile and visual pathways; providing specific facilities for disabled access to public services by ensuring that no steps are provided along the park's pedestrian routes. The positive effects expected through the realisation of the investment objective will be: sustainable urban development by exploiting the land and transforming it into a recreational and leisure area, improving the environment of the municipality by reducing noxious and noise pollution, reducing human heat islands, reducing exposure to UV radiation; increasing the standard of living and comfort of the residents.

Keywords: sustainable urban development, city revitalization, brownfield regeneration, conversion, recreation, relaxation, leisure, air pollution reduction, noise reduction.

1. Introduction

1.1. Definition of territory and accessibility

The municipality of Alexandria is the county seat of Teleorman and the main economic and social centre of the county with complex industrial, tertiary, administrative, political, educational and cultural functions.

Because of its location, Alexandria has been and continues to be a hub of communication routes. It connects the country's capital, Bucharest, with many of the provincial towns or links these towns together: DN 6 connects Bucharest via Alexandria to Roșiorii de Vede, Caracal, Craiova, Timișoara; DN 52 connects Alexandria to Turnu Măgurele, Corabia, Calafat, etc.; DN 51 connects Alexandria to Zimnicea; DJ 504 connects Alexandria to Pitești and Câmpulung; DJ 601 connects Alexandria, via Găești, to Târgoviște; DJ 506 connects Alexandria to Giurgiu.

Located in the south of the Romanian Lowland, on the right side of the Vedea River, Alexandria is 89 km away from the country's capital, Bucharest.

1.2. General information on the project

The measures proposed by the Territorial Development Strategy of Romania, applicable to the Municipality of Alexandria, provide for the development of instruments to support the specific development of polarizing cities, those county seats – as main poles at county level.

The municipality of Alexandria, as a county municipality and urban centre with a population of between 20,000 and 50,000 inhabitants, is included in a series of measures leading to the development of the national, county and local territory:

- Improving connectivity at national level: building a road infrastructure with technical characteristics allowing fast access on the Bucharest-Alexandria-Craiova-Drobeta Turnu-Severin route;
- Ensuring increased urban mobility by creating integrated transport systems that efficiently manage the flow of people: building multi-storey, above and underground car parks in the central area; extending cycle lanes, including in peri-urban areas, and setting up bike-sharing systems;
- Expansion and development of public utility infrastructure to connect and ensure access to quality services for the population in urban areas and functional urban areas: Structural rehabilitation and increase of energy performance of housing blocks, including promotion of the use of renewable energy resources to power them;
- Rehabilitation of built urban heritage and enhancement of architectural identity: Implementation of restoration and rehabilitation operations of built urban heritage (monuments and architectural and archaeological complexes, etc.), especially in cities with a very high concentration of built heritage of cultural value of national interest, according to Law No 5/2000;
- Ensuring access of the urban population to services of general interest: rehabilitation, modernization and equipping of county emergency hospitals; rehabilitation, modernization and equipping of integrated hospital outpatient clinics; construction, expansion and rehabilitation of school campuses in urban areas; establishment of resource centres for education and development in all county seats to train and advise teachers, parents, disadvantaged families, etc. construction of housing for doctors; provision of financial incentives for doctors working in hospitals and medical centres; construction, rehabilitation, modernisation and equipping of secondary schools; rehabilitation, modernisation, expansion and equipping of technological and vocational high schools; construction and rehabilitation of family-type housing for children and young people from disadvantaged groups; construction and rehabilitation of sheltered housing for adults with disabilities in urban areas, construction, extension, rehabilitation and equipping of residential centres for the elderly; establishment, extension, modernisation and equipping of social canteens; construction of after-school centres for children;
- Housing policy implementation: construction of rental housing for young people;
- Housing policy: rehabilitation and conversion of brownfield sites, including former railways and former military units in urban areas into residential areas or public spaces, particularly in cities with large areas of such sites;
- Protecting cities against natural vulnerabilities and mitigating the risks of climate change: rehabilitation, upgrading and equipping of urban green and recreational spaces.

In this context, in line with the Smart Specialisation Strategy of the South-Muntenia region for the period 2021-2027 [1]- which aims to provide and ensure a coherent framework for the future development of the region, based on the concept of smart specialisation proposed as a development vision: "*The South Muntenia Region innovates and develops its economic competitiveness at home and abroad, by developing the regional innovation ecosystem, developing skills for industrial, energy and circular economy transition and improving framework conditions for smart specialization"* – and the Regional Development Plan for the South Muntenia Region 2021-2027 [2]- which has the overall objective of stimulating smart, sustainable and balanced economic growth in the South Muntenia region, leading to an improvement in the quality of life of local communities by supporting the innovation and digitization capacity of local public administration and the regional economy, the sustainable development of infrastructure and services and the enhancement of the cultural and tourism potential of the region – Alexandria Municipality represented by Mayor Victor Dragușin, as beneficiary under grant contract no. 5009/17.12.2019 concluded with the Ministry of Public Works, Development and Administration – as Managing Authority for the Regional Operational Programme 2014-2020 and the Intermediate Body Agency for Regional Development South-Muntenia, implements the project "Landscaping of the former U.M. Park in Alexandria Municipality".

The project registered with SMIS code 127071 is co-financed by the Regional Operational Programme 2014-2020, Priority Axis 4, Supporting sustainable urban development, Investment Priority 4.2.- Implementation of actions aimed at improving the urban environment, revitalizing cities, regeneration and decontamination of brownfield sites (including redevelopment of areas), reducing air pollution and promoting noise abatement measures, Specific objective: Reconversion and redevelopment of derelict, vacant or unused land and areas in the municipalities of the county seat.

The specific objectives of the project are represented by O.S.1 Reuse of the park space through the development of public green spaces (19,368.00 sqm of open space, 17,972 sqm of green space), equipping with specific equipment and putting into operation and O.S.2 Improving the urban environment by reducing pollution.

The total value of the project is 8.854.658,09 lei, of which the European non-reimbursable financing is 7.474.821,29 lei.

The project implementation period is 41 months, i.e. from 01.03.2018 to 30.07.2021.

2. Description of the investment

2.1. Necessity and desirability of promoting the investment

The area which is the object of this investment is located in the western part of the locality in the immediate vicinity of Valahia University, accessible by car and pedestrian from Turnu Măgurele Road and from the premises of the educational establishment.

By taking over the buildings that belonged to Military Unit 01462 located on Turnu Măgurele Street, peripheral area of Alexandria, in accordance with H.G.R. no. 1270/ 17.10.2007 and transferring them to the private local interest of the municipality by H.C.L.

no. 114/ 22.05. 2009, the opportunity was created to realize some public utility objectives for investments and decentralized services which have in their investment program the realization of modern premises that satisfy the new conditions and operating requirements imposed both from the functional and constructive point of view. In this context, the Teleorman County Court has free use of the land on which the imposing building of the new headquarters will be built, in accordance with H.C.L. no. 74/17.04.2008.

At the same time, with a view to building a headquarters, "Valahia" University of Targoviste has developed a university campus – public institution of higher education, promoted by the local community of Alexandria and, last but not least, Alexandria City Hall has handed over to the National Investment Company in 2021, on the basis of a protocol, a land area of 2940.00 square meters for the implementation of the investment objective "Construction of a small nursery – project type" through the National Program for Recovery and Resilience, which is in the implementation phase.

Considering that the area presented is in continuous urban development in accordance with the regulations of the general urban plan of the municipality, which considered it a favourable area for the consolidation of a housing area with complementary functions: public institutions or non-polluting services, which raise the level of the basic function of the area: culture, education, tourism, public food, trade, and taking into account the development directions detailed in the Development Strategy of the municipality [3]and in the Mobility Plan [4]in accordance with the provisions of H. C.L. no. 252/30.11.2010 on the approval of the Zoning Urban Plan for the land located on Turnu Măgurele Road in the Municipality of Alexandria (former UM 01462), the territorial balance of the area studied from a functional point of view provides for the development of an area with planted spaces with the function of agreement and sport.

In this regard, the need arose to prepare a feasibility study for financing the works for the development of the area, taking into account the publication of the Financing Guidelines for the Regional Operational Programme 2014-2020 [5]the specific Guidelines for Priority Axis 4 – Supporting Sustainable Urban Development, Investment Priority 4.2 – Actions to improve the urban environment, revitalize cities, regenerate and decontaminate brownfield sites (including redevelopment areas), reduce air pollution and promote noise reduction measures. Thus, U.A.T. Alexandria, represented by Mayor Victor Drăgușin, as beneficiary of the funding contract no. 5009/17.12.2019 concluded with the Ministry of Public Works, Development and Administration, is currently implementing the project "Landscaping of the former U.M. park in Alexandria municipality", worth 8.854.658,09 lei, of which the European non-reimbursable funding is 7.474.821,29 lei.

Taking into account the development direction of the locality, due to the position of the area in the urban context, it can be estimated that the area will become an area dominated by housing with complementary functions, and the development of the park is absolutely necessary both to improve the aesthetic appearance of the area – *by reusing a space located in the area of the educational unit, a space that has not been used so far,* and the urban environment – *by mitigating air pollution and regulating air humidity and temperature.*

For a population of Alexandria of about 45434 (in the 2011 census), the area of green spaces is 26.98 sqm/inhabitant.

Green spaces in highly urbanized localities have a major influence on the quality of life of citizens, and if well managed, green spaces, parks, planted alignments and squares can become distinct and attractive places in the urban area.

Green spaces are also important for the biodiversity of the locality. By landscaping green spaces, residents can be brought into contact with native or acclimatised species of flora, so that this interaction leads to increased awareness of environmental issues.

Green areas are an indispensable prerequisite for a normal urban life, providing the framework and environment for public and private outdoor recreation, beautifying both the area and the whole, and having a visible social importance through the positive influences they bring to the living and working environment.

In this context it was considered necessary and opportune to develop the park, an investment that will have a recreational, educational and aesthetic impact on the inhabitants, contributing to the improvement of the quality of the environment and implicitly the quality of life of the inhabitants and at the same time will become an attractive place for the flow of the educational unit.

At the same time, the landscaping project of the former U.M. area strengthens the major network of public spaces and the network of green spaces as an integrated part of the network of public spaces within the U.A.T. area Alexandria.

From the category of surface green spaces, which are developed on large areas of land, Alexandria boasts the most important objective: the Vedea Forest Park (0.97ha), which in addition to recreational activities includes sports facilities (tennis courts, basketball courts, football field), children's playgrounds, restaurants.

Another area with significant potential for the development of recreational activities is the Vedea river bank, with a green space area of about 30 ha that can be developed in direct connection with the Vedea Forest Park and that the municipality intends to turn into a recreational pole of the municipality, where a series of leisure and sports activities will be located, which will contribute to the shaping of the green-blue corridor of the municipality.

Other surface areas of between 0.5 ha and 1 ha can be found in the central area, along the main axis of the municipality, running north-west to south-east: Cathedral Park, City Hall Park, Prefecture Park, Cinema Park and Youth Park.

The analysis of these spaces illustrates the need to arrange and equip the spaces with versatile furniture, multifunctional spaces that allow the development of various activities that attract various categories of users, so that these spaces become poles of attraction in the municipality. The relatively poor accessibility of the population in the peripheral areas – especially the western area – to these spaces is noted, requiring the use of public transport or private cars.

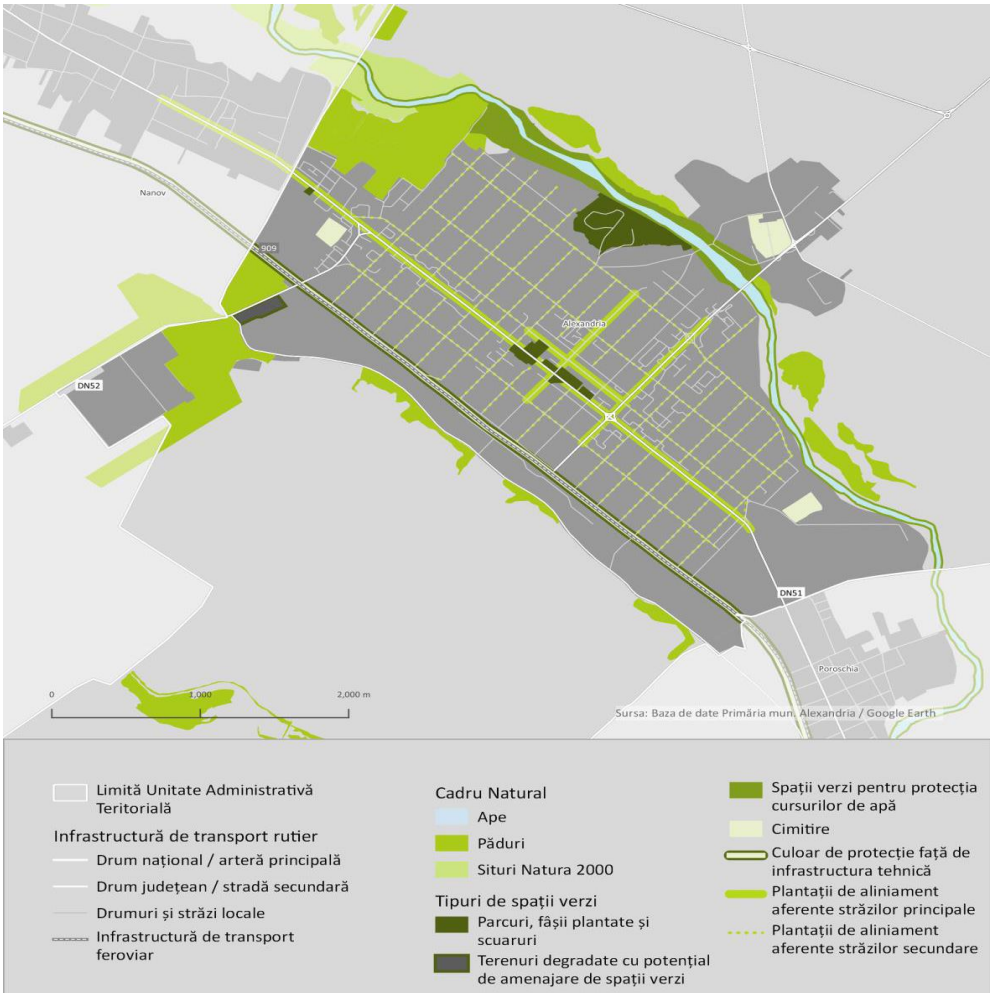

Fig. 1. Green spaces located in the intraurban territory of Alexandria municipality
Source: Local Development Strategy of Alexandria Municipality for the period 2021-2027

In the period 2014-2020, a series of projects for the development of public spaces and green spaces in Alexandria municipality were developed. Significant investments were made in the development and modernization of the Vedea Forest Park and the introduction of smart facilities in order to diversify outdoor recreational activities:

- Development of Vedea Forest Park: infrastructure, landscaping, sports fields, 2014, 2016, 2017-2018;
- Radio and public address system in Vedea Forest Park, 2018.

2.2. Presentation of the context: policies, strategies, legislation, relevant agreements, institutional and financial structures

The post-2020 period marks a substantial increase in resources allocated to research-innovation and digital technologies (+160%), but also to climate change mitigation and environmental protection.

At national level, the increase will be around 65% for the first 2 policy objectives, with an increase of 35% allocated to *Priority Objective 1 – Smarter Europe* and 30% for the implementation of interventions related to *Priority Objective 2 – A greener, low carbon Europe.* [6]

Relevant for the sustainable development of Alexandria municipality are also the two general objectives of the Territorial Agenda, which aim at the 2030 time horizon, namely "A fair Europe" and "A green Europe". [7]
The two are supported by 6 priorities oriented towards the development of the European territory, as follows:

- Balanced Europe- Better balanced territorial development, using Europe's diversity;
- Functional regions- Convergent local and regional development, less inequality between places;
- Integration across borders- Easier living and working across national borders;
- Healthy environment- Better ecological environment, climate neutral and resilient cities and regions;
- Circular economy – Strong and sustainable local economies in a globalised world;
- Sustainable connections – Sustainable physical and digital connectivity of places.

In terms of the regional and county strategic context, the relevant regional and county documents are as follows:

- Regional Development Plan (RDP) for the South-Muntenia Region 2021-2027;
- Smart Specialisation Strategy of the South-Muntenia Region for the period 2021-2027;
- Sustainable Development Strategy of Teleorman County 2010-2020;

The Regional Development Plan (RDP) for the South-Muntenia Region 2021-2027 [2]proposes as an overall objective to stimulate smart, sustainable and balanced economic growth in the South-Muntenia Region, leading to an improvement in the quality of life of local communities by supporting the innovation and digitisation capacity of local public administration and the regional economy, the sustainable development of infrastructure and services and the valorisation of the cultural and tourism potential of the region.

In accordance with the South-Muntenia RDA guidelines, the projects proposed through this strategy will be in line with the following specific objectives:

- OS1.2. To fructify the benefits of digitisation for the benefit of citizens, companies and governments;
- Improving nature and biodiversity protection, green infrastructure especially in urban areas and reducing pollution;
- SO2.8 Promote sustainable multimodal urban mobility;
- SO. 5.1 Foster integrated social, economic and environmental development at local level and cultural heritage, tourism and security in urban areas;

The Smart Specialisation Strategy of the South-Muntenia Region for the period 2021-2027 [1] provides a coherent framework for the future development of the region, based on the concept of smart specialisation and proposes the following development vision: "*The South Muntenia region is innovating and developing its economic competitiveness at home and abroad by developing the regional innovation ecosystem, developing skills for industrial and energy transition and towards a circular economy and improving the framework conditions for smart specialisation".*

The key sectors and areas identified in the strategy are:

- Increasing the level of research, development and technological innovation and generating competitive and high added value products and services;
- Generation of internally and externally competitive products and services and related activities that foster inclusion;
- Stimulating research, development and innovation, technology transfer and other branches of the regional economy;
- Increasing the attractiveness of the region for external markets, both production and sales;
- Creating a favourable context for sustainable development at regional and national level.

With regard to the Local Development Strategy (LDS.) of Alexandria Municipality 2014-2023 [3]has the following general objective: "*the development of Alexandria municipality by increasing its economic capacity, so that it becomes a reference center in the economic field, as well as a cultural, sports center, a modern educational base, a fully modernized utility infrastructure, streamlined public services, a green municipality, pollution-free, with increased mobility and accessibility both pedestrian, and cycling, implementation of policies to reduce CO2 emissions, coherent and environmentally friendly urban development, human resource development through training and retraining, encouraging the acquisition of new skills, a modern and efficient health infrastructure and competitive social protection services".*

The S.D.L. aims to develop Alexandria in accordance with the principles of sustainable development and proposes measures to reduce the economic and social disparities of the municipality in relation to other large urban centres.

The development directions of Alexandria municipality, identified in the LDS, are the following:

- Urban development, infrastructure modernization and environmental protection in Alexandria municipality;
- Development of infrastructure and economic sectors;
- Development of local human resources.

Accordingly, by achieving the objective "Landscaping of the former U.M. park in Alexandria municipality", the horizontal principles were pursued through specific actions on sustainable development by:

- creation of public spaces, unitary, which meet the requirements of civilized citizens of the city, with unlimited access, a place for rest, contemplation, leisure and recreation – *by creating the park with areas for sports, play, relaxation, rest, reading;*
- providing building facilities by installing street water pumps, water fountain, equipment for play and sport areas, ecological public toilets, gazebo;
- positive impact on the environment by preventing pollution due to noxious substances, including noise pollution – by providing planted areas all around the park to screen the space, green spaces being one of the most important tools to improve air, water and soil quality;
- and equal opportunities and non-discrimination through actions on:
- adapting pedestrian space for the visually impaired by installing tactile-visual pathways and acoustic information elements;
- providing specific facilities for disabled access to public services.

3. The technical solution, from a technological, constructional, technical, functional-architectural and economic point of view

The technical solution of the landscaping project includes an impact piece represented by a digital water curtain marking the central area of the park.

The central area of the park is represented by steps in the form of concentric circles arranged at different heights, with the central circle reaching a height of 2.70m, serving as a post for the Digital Water Curtain which acts as a display panel for information such as time, date, temperature and other useful information.

The digital water curtain works with a water control computer. This fountain prints letters and images on an interactive water wall, creating a dynamic effect. It has a built-in RGB lighting system that complements the water play that can be controlled via a dedicated computer.

The urban landscaping project also includes rest and relaxation areas with benches located in the alleyways and gazebo area, litter bins, drinking water fountains, wooden pergolas, wooden gazebo furnished with benches; recreational area with a circulating fountain with water games – used for cooling and accessible to the public through water games, with stone slab floor on waterproof support and water jets in the floor and furniture (fixed tables and chairs for chess games, tables); reading area with street furniture: organically shaped laminated wooden benches and sets of sails for shade and hammocks; amphitheatre area provided with projection screen and 6 bleachers 0.20m high with grass seating; sensory garden area, consisting of an irregularly shaped mound, organically designed and provided with laminated wooden benches following the shapes of the mound and sets of sails for shade and hammocks; children's playgrounds, with specially designed playgrounds for different categories of users, with benches for adults supervising the children, litter bins and ecological toilets; sports areas, with: concrete mosaic tables for table tennis, space for skateboarding with ramps for rollers and climbing walls; pedestrian walkways, bicycle paths – the project consists in the development of a route composed of a natural stone

pedestrian walkway, elliptical in shape, including the bicycle path, which connects the two main entrances to the park from Turnu Măgurele Road and intersects with the path along which the areas of interest of the park develop.

Adjacent to the pathways are urban objects and furniture: bicycle parking racks; decorative lighting poles; wooden benches; litter bins; drinking water fountains; wooden pergolas for shading resting places; wooden pergolas along the promenade areas treated with reinforced grass, in the digital curtain area and the reading area; guard booths – provided at the entrances to the park; ecological public toilets.

The total area of landscaped land is 19 368.00 m² of which the proposed built-up area (gazebo, guard booths, ecological toilets) is 26.70 m² and the total area of green spaces proposed is 17 925 m².

Table 1. Balance of developed areas

Mineral surfaces	m^2
Natural stone walkway surface (120x30cm)	280
Natural stone walkway surface (12x12cm)	434
Bicycle path surface asphalt mass coloured	245
Waterproof surface – water fountain, water curtain	203
Skate park surface	260
Green surfaces	
Playground area	189
Green area	12 294
Area of reinforced green spaces	2 330
Green areas – terraces	2 787
Green areas – flowerbeds	312
Garden areas (fencing)	202

Source: Alexandria City Hall Archive

In the general distribution of the woody vegetation, a number of functional aspects were taken into account, such as the creation of shaded areas along the paths *(the aim was to achieve a well-proportioned silhouette and a balance between light and shade areas by placing tall trees in a south-south-west direction, so that the park is sheltered from the heat and shaded even on hot summer days);* the relief was partially shaped so as to create the dynamics of the park; disease- and pest-resistant species adapted to the climate of the area and to atmospheric pollution, with a high proportion of fast-growing species, and the planting of multi-stemmed or short-stemmed trees and hardy shrubs with a high branching and flowering capacity in the protection areas; to create a colourful and diverse landscape by diversifying species, with different textures of tree trunks, leaves, flowers and fruit throughout the year, and to attract insects and animals of all kinds in order to restore the balance of fauna and flora in the area.

Fig. 2. Landscaping of the former U.M. park in Alexandria municipality
Source: Alexandria City Hall archive

Among the proposed species, we chose creepers and flowering shrubs of Wisteria sinensis, Lonicera japonica, Cotoneaster horizontalis, Vita canadiana Ampelopsis veitchii, Clematis westerplatte, Clematis blue, Hedera helix in a total number of 925 pieces, shrubs of Tamarix gallica, Cotinus coggygria, Viburnum opulus, Forsythia intermedia, Weigella floribunda, Cornus alba "Elegantisima", Prunus laurocerasus, Cotoneaster dammerii, Juniperus horizontalis, Picea pungens glauca, Berberis atropurpurea, Euonymus fortune Emerald Gold, Philadelphus coronarius, Lemon, Magnolia soulangeana alba, Magnolia galbena, Magnolia soulangeana, for a total of 380 pieces.

The tall vegetation is arranged according to the architectural design, predominantly in the spaces on the west and south side of the park, arranged in such a way as to create interesting perspectives towards the different areas of the park.

The tree species used include: Prunus cerasifera Nigra, Albizzia julibrissin, Robinia pseudoacacia, Tilia tomentosa, Salix matsudana Tortuosa, Acer platanoides Sango Kaku, Acer platanoides Krimson King, Betula pendula, Betula nigra, Liriodendron tulipifera, Quercus rubra, Picea abies, Picea pungens argentea, Abies concolor, Pinus nigra, Pinus sylvestris, Pinus strobus, Pinus strob, Liquidambar styraciflua, Quercus robur, Acer saccharinum – Silver fir, maple in a total number of 235 pieces.

Throughout the green area, there is an automatic installation for the irrigation of green spaces, calculated and sized according to the vegetation, climate and soil characteristics, pipes for water supply to the wells and a sewerage network for waste water collection, ornamental public lighting system with video surveillance system of the landscaped areas and Wi-FI.

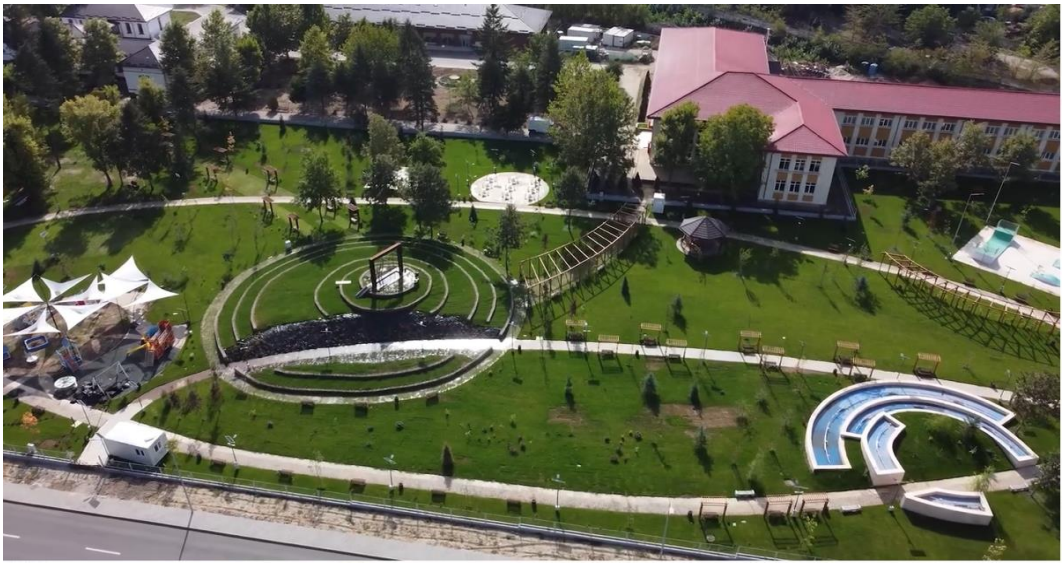

Fig. 3. Landscaping of the former U.M. park in Alexandria municipality
Source: Alexandria City Hall archive

Fig. 4. Landscaping of the former U.M. park in Alexandria municipality
Source: Alexandria City Hall archive

The entire park is perimeter fenced with a metal structure, concrete plinth and metal grid panels, with a total height of 1.30m from the level of the pedestrian walkways, of which 0.30m high will be the plinth and the panels will be 1.00m high. Planters for hanging plants will be built into the concrete plinth.

The green space is accessible to disabled people through all four accesses. There are no slopes or level differences between the landscaped walkways and the green space.

Fig. 5. Landscaping of the former U.M. park in Alexandria municipality
Source: Alexandria City Hall Archive

Other elements that ensure accessibility by all people, regardless of their physical, sensory and cognitive abilities proposed are the 300x300 x 80mm tactile slabs with a structured surface, located at changes of direction along the paved pedestrian walkways.

4. Objectives expected to be achieved by the implementation of the public investment

The green space on the site of the former military unit is the second largest park in Alexandria, after the Vedea Forest Park, an urban space that is intended to become one of the city's favourite recreational areas.

The 80% investment aims to transform the area into a public space friendly to the city's residents and tourists, a recreational area rich in vegetation, bringing an added quality of life both in terms of air and aesthetics, a new oasis of peace, relaxation and good cheer.

The proposed project idea responds to the major development directions of the Municipality of Alexandria resulting from the diagnostic analysis, SWOT analysis, vision and development objectives of the Local Development Strategy [3]and the need to carry out this investment derived from the need to revitalize the urban area in the Municipality of Alexandria.

The target group targeted by the project is the inhabitants of Alexandria Municipality.

Through functional reconversion, reuse of unused land and its transformation into an area of agreement and recreation, the proposed project is expected to contribute to:

- revitalization of a degraded and unused land in the Municipality of Alexandria through actions that will transform 90% of the surface of the degraded land into green space;
- the location of the land is at a distance of less than 500 m from the housing area and complementary functions: public institutions or non-polluting services, which

raise the level of the basic function of the area: culture, education, tourism, public food, commerce: “Valahia” University of Targoviste, Telorman County Court, small type 1 nursery, chapel, etc.

Fig. 6. Landscaping of the former U.M. park in Alexandria municipality
Source: Alexandria City Hall archive

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Amenajare peisagistică a unui parc în zona fostei Unități Militare în municipiul Alexandria

Anne Marie GACICHEVICI,
Arhitect șef al municipiului Alexandria, Teleorman, România
anne.marie_gacichevici@yahoo.com

Abstract
Obiectivul general al proiectului este conversia funcțională și reutilizarea unui teren neutilizat în intravilanul municipiului Alexandria și transformarea lui în zonă de agrement și recreere pentru populație, în scopul îmbunătățirii condițiilor de viață ale cetățenilor. Investiția își propune transformarea terenului neutilizat într-un spațiu prietenos locuitorilor, un spațiu de recreere, sport și agrement, bogat în vegetație. Obiectivele specifice ale proiectului sunt reprezentate de O.S.1 Reutilizarea spațiului parcului prin amenajarea de spații verzi publice(19,368.00 mp spațiu deschis, 17.972 mp de spațiu verde), dotarea cu echipamente specifice și darea în funcțiune și respectiv O.S.2. Îmbunătățirea mediului urban prin reducerea poluării. Prin realizarea obiectivului s-a urmărit atingerea principiilor orizontale prin acțiuni specifice privind dezvoltarea durabilă prin realizarea de spații publice, unitare, care să corespundă exigenţelor cetăţenilor civilizaţi ai urbei, cu acces nelimitat, loc prielnic pentru odihnă, contemplare, destinat petrecerii timpului liber și agrementului; asigurarea dotărilor edilitare prin montarea de cișmele stradale, fântână arteziană, echipamente pentru zonele de joacă și sport, toalete publice ecologice, foișor; impact pozitiv asupra mediului prin prevenirea poluării din cauza noxelor, inclusiv a poluării fonice- prin amenajarea de zone plantate pe tot perimetrul parcului pentru ecranarea spațiului, spaţiile verzi înscriindu-se ca unele dintre cele mai importante instrumente de îmbunataţire a calitaţii aerului, apei şi solului și egalitatea de șanse și nediscriminarea prin acțiuni privind adaptarea spațiului pietonal pentru persoanele cu deficiente de vedere prin montarea de căi de deplasare tactilo-vizuale; asigurarea dotărilor specifice accesului pentru persoane cu dizabilități la serviciile publice asigurându-se ca în lungul traseelor pietonale ale parcului să nu fie prevăzute trepte. Efectele pozitive previzionate prin realizarea obiectivului de investiții, vor fi: dezvoltarea urbană durabilă prin valorificarea terenului și transformarea acestuia în spațiu de agrement și de odihnă, îmbunătățirea mediului din municipiu prin reducerea noxelor și a poluării sonore, reducerea insulelor de căldură umană, reducerea expunerii la radiația UV; creșterea nivelului de trai și a confortului riveranilor.

Cuvinte cheie: dezvoltare urbană durabilă, revitalizare oraș, regenerare teren dezafectat, conversie, agrement, relaxare, odihnă, reducerea poluării aerului, reducerea zgomotului.

1. Introducere

1.1. Definirea teritoriului și accesibilitatea

Municipiul Alexandria este reședința județului Teleorman și principalul centru economic-social al județului cu funcțiuni complexe industriale, terțiare, administrative, politice, educaționale și culturale.

Datorită așezării sale, municipiul Alexandria a fost și continuă să fie un nod de căi de comunicație. Face legătura între capitala țării, București și multe dintre orașele de provincie sau leagă aceste orașe între ele: DN 6 leagă București prin Alexandria de Roșiorii de Vede, Caracal, Craiova, Timișoara; DN 52 leagă Alexandria de Turnu Măgurele, Corabia, Calafat etc.; DN 51 leagă Alexandria de Zimnicea; DJ 504 leagă Alexandria de Pitești și Câmpulung; DJ 601 leagă Alexandria, prin Găești, de Târgoviște; DJ 506 face legătura între Alexandria și Giurgiu.

Poziționat în sudul Câmpiei Române, pe partea dreaptă a râului Vedea, municipiul Alexandria se află la o distanță de 89 km față de capitala țării, București.

1.2. Informații generale privind proiectul

Măsurile propuse de Strategia de Dezvoltare Teritorială a României, aplicabile municipiului Alexandria, prevăd dezvoltarea unor instrumente de sprijinire a dezvoltării specifice orașelor polarizatoare, acele reședințe de județ- poli principali la nivel județean.

Municipiul Alexandria, în calitatea sa de municipiu reședință de județ și centru urban cu o populație cuprinsă în categoria 20.000-50.000 locuitori, este inclus într-o serie de măsuri care conduc la dezvoltarea teritoriului național, județean și local:

- Îmbunătățirea conectivității la nivelul teritoriului național: realizarea unei infrastructuri rutiere cu caracteristici tehnice care să permită accesul rapid pe ruta București-Alexandria-Craiova-Drobeta Turnu-Severin;
- Asigurarea unei mobilității urbane crescute prin crearea unor sisteme integrate de transport care să gestioneze în mod eficient fluxurile de persoane: construcția de parking-uri multietajate, supra și subterane în zona centrală; extinderea pistelor de biciclete, inclusiv în zonele periurbane și amenajarea de sisteme de tip "bike-sharing";
- Extinderea și dezvoltarea infrastructurii de utilități publice în vederea conectării și asigurării accesului populației din zonele urbane și zonele urbane funcționale la servicii de calitate: Reabilitarea structurală și creșterea performanței energetice a blocurilor de locuințe, inclusiv promovarea utilizării resurselor regenerabile de energie pentru alimentarea acestora;
- Reabilitarea patrimoniului urban construit și punerea în valoare a identității arhitecturale: Realizarea operațiunilor de restaurare și reabilitare a patrimoniului urban construit (monumente și ansambluri de arhitectură, arheologice etc.), cu precădere la nivelul orașelor cu o concentrare foarte mare a patrimoniului construit cu valoare culturală de interes național, conform Legii nr. 5/2000;
- Asigurarea accesului populației urbane la servicii de interes general: reabilitarea, modernizarea și dotarea cu echipamente a spitalelor județene de urgență; reabilitarea, modernizarea și dotarea ambulatoriilor integrate spitalelor; construcția, extinderea și reabilitarea campusurilor școlare din mediul urban; înființarea de centre de resurse pentru educație și dezvoltare, la nivelul tuturor reședințelor de județ, cu scopul de a forma și consilia cadrele didactice, părinții, familiile defavorizate etc.; construcția de locuințe pentru medici; oferirea de stimulente financiare medicilor care activează în spitalele și centrele de permanență medicală; construcția, reabilitarea, modernizarea și echiparea școlilor gimnaziale; reabilitarea, modernizarea, extinderea și echiparea liceelor cu profil tehnologic și a școlilor profesionale; construcția și reabilitarea de locuințe de tip familial pentru copii și tinerii proveniți din categorii defavorizate; construcția și reabilitarea de locuințe protejate pentru persoanele adulte cu dizabilități din mediul urban, construcția, extinderea, reabilitarea și dotarea centrelor de tip rezidențial pentru vârstnici; înființarea, extinderea, modernizarea și dotarea cantinelor sociale; construcția de centre de tip after-school pentru copii;
- Realizarea unei politici în domeniul locuirii: construcția de locuințe pentru tineri destinate închirierii;

- Realizarea unei politici în domeniul locuirii: reabilitarea și reconversia siturilor industriale total sau parțial abandonate (brownfield), inclusiv a căilor ferate uzinale și a fostelor unități militare din mediul urban în zone rezidențiale sau în spații publice, cu precădere în orașele cu suprafețe extinse de acest tip;
- Protejarea orașelor împotriva vulnerabilităților naturale și diminuarea riscurilor generate de schimbările climatice: reabilitarea, modernizarea și dotarea spațiilor verzi și de agrement din mediul urban.

În acest context, în conformitate cu Strategia de specializare inteligentă a regiunii Sud-Muntenia pentru perioada 2021-2027 [1]- ce urmărește să ofere și să asigure un cadru coerent pentru dezvoltarea viitoare a regiunii, bazată pe conceptul de specializare inteligentă propunând ca viziune de dezvoltare: "*Regiunea Sud Muntenia inovează și își dezvoltă competitivitatea economică pe plan intern și internațional, prin dezvoltarea ecosistemului regional de inovare, dezvoltarea competențelor pentru tranziția industrială, energetică și către o economie circulară și îmbunătățirea condițiilor cadru pentru specializare inteligentă*" – și Planul pentru dezvoltarea regională Regiunea Sud-Muntenia 2021-2027 [2] – ce propune drept obiectiv general stimularea creșterii economice inteligente, durabile și echilibrate a regiunii Sud Muntenia, care să conducă la îmbunătățirea calității vieții comunităților locale prin sprijinirea capacității de inovare și digitalizare a administrației publice locale și economiei regionale, dezvoltarea sustenabilă a infrastructurii și a serviciilor și valorificarea potențialului cultural și turistic al regiunii- Municipiul Alexandria reprezentat prin primar Victor Drăgușin, în calitate de beneficiar în cadrul contractului de finanțare nr. 5009/17.12.2019 încheiat cu Ministerul Lucrărilor Publice, Dezvoltării și Administrației- în calitate de Autoritate de Management pentru Programul Operațional Regional 2014-2020 și Organismul Intermediar Agenția pentru Dezvoltare Regională Sud-Muntenia, implementează proiectul: "Amenajare peisagistică parc fosta U.M. în municipiul Alexandria".

Proiectul înregistrat cu cod SMIS 127071 este co-finanțat prin Programul Operațional Regional 2014-2020, Axa Prioritară 4, Sprijinirea dezvoltării urbane durabile, Prioritatea de Investiții 4.2.- Realizarea de acțiuni destinate îmbunătățirii mediului urban, revitalizării orașelor, regenerării și decontaminării terenurilor industriale dezafectate(inclusiv reconversii de zone), reducerii poluării aerului și promovării măsurilor de reducere a zgomotului, Obiectiv specific: Reconversia și refuncționalizarea terenurilor și suprafețelor degradate, vacante sau neutilizate din municipiile reședință de județ.

Obiectivele specifice ale proiectului sunt reprezentate de O.S.1 Reutilizarea spațiului parcului prin amenajarea de spații verzi publice(19,368.00 mp spațiu deschis, 17.972 mp de spațiu verde), dotarea cu echipamente specifice și darea în funcțiune și respectiv O.S.2. Îmbunătățirea mediului urban prin reducerea poluării.

Valoarea totală a proiectului este de 8.854.658,09 lei, din care finanțarea europeană nerambursabilă este de 7.474.821,29 lei.
Perioada de implementare a proiectului este de 41 de luni, respectiv între data de 01.03.2018 și data de 30.07.2021.

2. Descrierea investiției

2.1. Necesitatea și oportunitatea promovării investiției

Zona ce face obiectul acestei investiții se află amplasată în partea de vest a localității în imediata vecinătate a Universității Valahia, accesibilă auto și pietonal din Șoseaua Turnu Măgurele și din incinta unității de învățământ.

Prin preluarea imobilelor ce au aparținut Unității militare 01462 situată pe strada Turnu Măgurele, zona periferică a localității Alexandria, în conformitate cu H.G.R. nr. 1270/ 17.10.2007 și trecerea acestora în domeniul privat de interes local al municipiului prin H.C.L. nr. 114/ 22.05.2009, s-a creat oportunitatea realizării unor obiective de utilitate publică pentru investiții și servicii descentralizate care au în programul lor investițional realizarea unor sedii moderne care să satisfacă noile condiții și exigențe de exploatare impuse atât din punctul de vedere funcțional cât și constructiv. În acest context, Tribunalul Județean Teleorman, deține în folosință gratuită, conform H.C.L. nr. 74/ 17.04.2008, teren pe care se conturează clădirea impunătoare a noului sediu.

Totodată, în vederea edificării unui sediu, Universitatea "Valahia" din Târgoviște a dezvoltat un campus universitar- instituție publică de învățământ superior, promovată de comunitatea locală a municipiului Alexandria și nu în ultimul rând Primăria municipiului Alexandria a predat Companiei Naționale de Investiții în anul 2021, pe bază de protocol un teren în suprafață de 2940,00 mp pentru realizarea obiectivului de investiții "Construire creșă mică- proiect tip" prin Programul Național de Redresare și Reziliență, aflat în faza de execuție.

Având în vedere că zona prezentată este în continuă dezvoltare urbanistică în conformitate cu reglementările planului urbanistic general al localității prin care s-a considerat că este o zonă favorabila pentru consolidarea unei zone de locuințe cu funcțiuni complementare: instituții publice sau servicii nepoluante, care ridică nivelul funcțiunii de bază a zonei: cultură, educație, turism, alimentație publică, comerț și ținând cont de direcțiile de dezvoltare detaliate în Stategia de dezvoltare a municipiului [3] și în Planul de mobilitate [4], în conformitate cu prevederile H.C.L. nr. 252/30.11.2010 privind aprobarea Planului Urbanistic Zonal pentru terenul situat pe Șoseaua Turnu Măgurele în Municipiul Alexandria (fosta UM 01462), bilanțul teritorial al zonei studiate din punct de vedere funcțional prevede amenajarea unei zone cu spatii plantate cu funcțiunea de agreement și sport.

În acest sens, a apărut necesitatea elaborării unui studiu de fezabilitate în vederea finanțării lucrărilor de amenajare a zonei ținând cont și de apariția Ghidului de finanțare pentru Programul Operațional Regional 2014-2020 [5], Ghidul specific pentru Axa prioritară 4- sprijinirea dezvoltării urbane Durabile, Prioritatea de investiții 4.2 – realizarea de acțiuni destinate îmbunătățirii mediului urban, revitalizării orașelor, regenerării și decontaminării terenurilor industriale dezafectate (inclusiv a zonelor de reconversie), reducerii poluării aerului și promovării măsurilor de reducere a zgomotului. Astfel, U.A.T. Alexandria, reprezentată prin primar Victor Drăgușin, în calitate de beneficiar al contractului de finanțare nr. 5009/17.12.2019 încheiat cu Ministerul Lucrărilor Publice, Dezvoltării și Administrației, implementează în momentul de față proiectul "Amenajare peisagistică parc

fosta U.M. în municipiul Alexandria", în valoare de 8.854.658,09 lei din care finanțarea europeană nerambursabilă este de 7.474.821,29 lei.

Ținând cont de direcția de dezvoltare a localității, ca urmare a poziției zonei în contextul urbanistic, se poate aprecia că zona va deveni o zonă dominată de locuințe cu funcțiuni complementare, iar amenajarea parcului este absolut necesară atât pentru îmbunătățirea aspectului estetic al zonei- *prin refuncționalizarea unui spațiu aflat în zona unității de învățământ, spațiu care nu a fost utilizat până în prezent*, cât și a mediului urban- *prin atenuarea poluării atmosferice și regularizarea umidității aerului și a temperaturii*.

La un numar de locuitori ai municipiului Alexandria de circa 45434 (la recensământul din 2011), suprafața de spații verzi este de 26,98 mp/locuitor. Spaţiile verzi din localitaţile puternic urbanizate au o influenţă majoră asupra calitaţii vieţii cetaţenilor, iar dacă sunt bine administrate, spaţiile verzi, parcurile, aliniamentele plantate şi scuarurile pot deveni locuri distincte şi atractive din arealul urban. De asemenea, spaţiile verzi sunt importante pentru biodiversitatea din localitaţi. Prin amenajarea spaţiilor verzi se poate da posibilitatea locuitorilor să intre în contact cu specii din flora indigenă sau aclimatizată, astfel încât această interacţiune să conducă la creşterea conştientizarii problemelor de mediu.Zonele verzi reprezintă o condiție indispensabilă a unei vieți urbane normale, asigurând cadrul și mediul favorabil pentru recreerea publică sau privată în aer liber, înfrumusețând atât punctual zona cât și global, având în mod vizibil și importanță socială prin influențele pozitive aduse la locul de viață și de muncă.

În acest context s-a considerat necesară și oportună amenajarea parcului, investiție ce va avea asupra locuitorilor un impact recreativ, educativ si estetic, contribuind la îmbunătățirea calității mediului si implicit a calității vieții locuitorilor si in același timp va deveni un loc atractiv pentru fluxul unității de învățământ.
Totodată, proiectul de amenajare peisagistică a zonei fostei U.M. consolidează rețeaua majoră de spații publice și rețeaua de spații verzi ca parte integrată a rețelei de spații publice de pe raza U.A.T. Alexandria.

Din categoria spațiilor verzi de tip suprafață, care se desfășoară pe suprafețe mari de teren, Alexandria se mândrește cu cel mai important obiectiv: Parcul Pădurea Vedea (0,97ha), care pe lângă activități de recreere include facilități sportive (terenuri de tenis, terenuri de baschet, teren de fotbal), locuri de joacă pentru copii, restaurante.

O altă zonă cu un semnificativ potențial de dezvoltare a unor activități de recreere este malul râului Vedea, cu o suprafață de spații verzi de cca 30 ha care se poate dezvolta în legătură directă cu Parcul Pădurea Vedea și pe care municipalitatea intenționează să îl transforme într-un pol de agrement al municipiului, în care să fie amplasate o serie de activități de petrecere a timpului liber și sportive ce vor contribui la conturarea culoarului verde-albastru al municipiului.

Alte spații de tip suprafață, cu suprafețe cuprinse între 0,5 ha și 1 ha, se regăsesc în zona centrală, în lungul axului principal al municipiului, desfășurat pe direcție NV-SE: Parcul Catedralei, Parcul Primăriei, Parcul Prefecturii, Parcul Cinematografului sau Parcul Tineretului.

Fig. 1. Spații verzi amplasate în teritoriul intravilan al municipiului Alexandria
Sursa: Strategia de dezvoltare locală a municipiului Alexandria pentru perioada 2021-2027

Analiza acestor spații ilustrează necesitatea amenajării și dotării spațiilor cu mobilier versatil, spații multifuncționale care să permită desfășurarea de activități variate care să atragă categorii variate de utilizatori, astfel încât aceste spații să devină poli de atracție în municipiu. Se remarcă accesibilitatea relativ redusă a populației din zonele periferice – cu precădere zona de vest- la aceste spații, fiind necesară utilizarea mijloacelor de transport în comun au a autoturismelor personale.

În perioada 2014-2020 au fost elaborate o serie de proiecte de amenajare a spațiilor publice și spațiilor verzi din municipiul Alexandria. Investiții importante au fost realizate în amenajarea și modernizarea Parcului Pădurea Vedea și introducerea de facilități smart, în scopul diversificării activităților recreative desfășurate în aer liber:

- Amenajare Parc Pădurea Vedea: infrastructură, amenajare peisagistică, terenuri de sport, 2014, 2016, 2017-2018;
- Sistem de radioficare și adresare publică în Parc Pădurea Vedea, 2018.

2.2. Prezentarea contextului: politici, strategii, legislaţie, acorduri relevante, structuri instituţionale şi financiare

Perioada post-2020 marchează o creștere substanțială a resurselor alocate pentru domeniile cercetare-inovare și tehnologii digitale (+160%), dar și pentru atenuarea schimbărilor climatice și protecția mediului înconjurător.

La nivel național, creșterea va fi de aproximativ 65% pentru primele 2 obiective de politică, cu o creștere de 35% alocată *Obiectivului Prioritar 1 – O Europă mai inteligentă* **și** 30% pentru realizarea intervențiilor aferente *Obiectivului Prioritar 2 – O Europă mai ecologică, cu emisii reduse de carbon.* [6].

Relevante pentru dezvoltarea durabilă a municipiului Alexandria sunt și cele două obiective generale ale Agendei Teritoriale, ce vizează orizontul de timp 2030, respectiv "O Europă justă" și "O Europă verde". [7]

Cele două sunt susținute de 6 priorități orientate către dezvoltarea teritoriului european, după cum urmează:

- Europa echilibrată- Dezvoltare teritorială mai bine echilibrată, utilizând diversitatea Europei;
- Regiuni funcționale- Dezvoltare locală și regională convergentă, mai puțină inegalitate între locuri;
- Integrare peste granițe- Locuire și muncă mai ușoare peste granițele naționale;
- Mediu sănătos- Mediu ecologic mai bun, orașe și regiuni neutre din punct de vedere climatic și reziliente;
- Economie circulară- Economii locale puternice și sustenabile într-o lume globalizată;
- Conexiuni sustenabile- Conectivitate fizică și digitală sustenabilă a locurilor.
- Din punct de vedere al contextului strategic regional și județean, documentele relevante de la nivel regional și județean sunt următoarele:
- Planul pentru Dezvoltare Regională (PDR) Regiunea Sud-Muntenia 2021-2027;
- Strategia de Specializare Inteligentă a Regiunii Sud-Muntenia pentru perioada 2021-2027;
- Strategia de Dezvoltare Durabilă a Județului Teleorman 2010-2020;
- Planul pentru Dezvoltare Regională (P.D.R.) Regiunea Sud-Muntenia 2021-2027 [2] propune drept obiectiv general stimularea creșterii economice inteligente, durabile și echilibrate a Regiunii Sud-Muntenia, care să conducă la îmbunătățirea calității vieții comunităților locale prin sprijinirea capacității de inovare și digitalizare a administrației publice locale și economiei regionale, dezvoltarea sustenabilă a infrastructurii și a serviciilor și valorificarea potențialului cultural și turistic al regiunii.
- În conformitate cu instrucțiunile ADR Sud-Muntenia, proiectele propuse prin prezenta strategie se vor încadra în următoarele obiective specifice:

- OS1.2. Fructificarea avantajelor digitalizării, în beneficiul cetățenilor, al companiilor și al guvernelor;
- OS2.7. Îmbunătățirea protecției naturii și a biodiversității, a infrastructurii verzi în special în mediul urban și reducerea poluării;
- OS2.8 Promovarea mobilității urbane multimodale sustenabile;
- OS. 5.1 Favorizarea dezvoltării integrate sociale, economice și de mediu la nivel local și a patrimoniului cultural, turismului și securității în zonele urbane.

Strategia de specializare inteligentă a Regiunii Sud-Muntenia pentru perioada 2021-2027 [1] furnizează un cadru coerent pentru dezvoltarea viitoare a regiunii, bazată pe conceptul de specializare inteligentă și propune următoarea viziune de dezvoltare: "*Regiunea Sud Muntenia inovează și își dezvoltă competitivitatea economică pe plan intern și internațional, prin dezvoltarea ecosistemului regional de inovare, dezvoltarea competențelor pentru tranziția industrială, energetică și către o economie circulară și îmbunătățirea condițiilor cadru pentru specializare inteligentă*".

Sectoarele și domeniile cheie identificate în cadrul strategiei sunt:

- Creșterea nivelului de cercetare, dezvoltare și inovare tehnologică și generarea de produse și servicii competitive și cu valoare adăugată ridicată;
- Generarea de produse și servicii competitive atât pe plan intern cât și extern, precum și de activități conexe ce favorizează incluziunea;
- Stimularea activităților de cercetare, dezvoltare și inovare, transfer tehnologic și în celelalte ramuri ale economiei regionale;
- Creșterea atractivității regiunii pentru piețele externe, atât de producție cât și de desfacere;
- Crearea unui context favorabil pentru o dezvoltare durabilă la nivel regional și național.

În ceea ce privește Strategia de Dezvoltare Locală (S.D.L.) a municipiului Alexandria 2014-2023 [3] are următorul obiectiv general: "*dezvoltarea municipiului Alexandria prin creșterea capacității sale economice, astfel încât acesta să devină un centru de referință în domeniul economic, precum și un centru cultural, sportiv, o bază educațională modernă, o infrastructură utilitară modernizată în întregime, servicii publice eficientizate, un municipiu verde, fără poluare, cu o mobilitate și accesibilitate crescută atât pietonală, cât și velo, implementarea unor politici de reducere a emisiilor de CO2, o dezvoltare urbanistică coerentă și în spiritul protejării mediului, dezvoltarea resursei umane prin formare profesională și reconversie, încurajând dobândirea de noi competențe, o infrastructură de sănătate modernă și eficientă și servicii de protecție socială competitive*".
S.D.L. urmărește dezvoltarea municipiului Alexandria în acord cu principiile dezvoltării durabile și propune măsuri de reducere a disparităților economice și sociale ale municipiului, în raport cu alte mari centre urbane.
Direcțiile de dezvoltare ale municipiului Alexandria, identificate în cadrul SDL, sunt următoarele:

- Dezvoltarea urbanistică, modernizarea infrastructurii și protejarea mediului în municipiul Alexandria;

- Dezvoltarea infrastructurii și a sectoarelor economice;
- Dezvoltarea resurselor umane locale;
- În consecință, prin realizarea obiectivului "Amenajare peisagistică parc fosta U.M. în municipiul Alexandria", s-a urmărit atingerea principiilor orizontale prin acțiuni specifice privind dezvoltarea durabilă prin:
- realizarea de spații publice, unitare, care să corespundă exigenţelor cetăţenilor civilizaţi ai urbei, cu acces nelimitat, loc prielnic pentru odihnă, contemplare, destinat petrecerii timpului liber și agrementului- *prin realizarea parcului cu zone pentru sport, joaca, relaxare, odihna, lectură;*
- asigurarea dotărilor edilitare prin montarea de cișmele stradale, fantana arteziana, echipamente pentru zonele de joaca si sport, toalete publice ecologice, foișor;
- impact pozitiv asupra mediului prin prevenirea poluării din cauza noxelor, inclusiv a poluării fonice- prin amenajarea de zone plantate pe tot perimetrul parcului pentru ecranarea spațiului, spaţiile verzi înscriindu-se ca unele dintre cele mai importante instrumente de îmbunataţire a calitaţii aerului, apei şi solului;
- Si egalitatea de șanse și nediscriminarea prin acțiuni privind**:**
- adaptarea spațiului pietonal pentru persoanele cu deficienţă de vedere prin montarea de căi de deplasare tactilo-vizuale şi elemente de informare acustică;
- asigurarea dotărilor specifice accesului pentru persoane cu dizabilități la serviciile publice.

3. Soluţia tehnică, din punct de vedere tehnologic, constructiv, tehnic, funcţional- arhitectural şi economic

Soluția tehnică a proiectului de amenajare peisagistică cuprinde o piesă de impact reprezentată de o cortină digitală de apă ce marchează zona centrală a parcului.

Zona centrală a parcului este reprezentată din gradene în formă de cercuri concentrice dispuse la înălțimi diferite, cercul central ajungând la o cotă de 2,70m, servind ca postament pentru Cortina digitală de apă ce se comportă ca un panou de afișaj pentru informații precum ora, data, temperatura și alte informații utile.

Perdeaua de apă digitală lucrează cu un computer de control al apei. Această fântână imprimă litere și imagini pe un perete de apă interactiv, realizând un efect dinamic. Are încorporat un sistem de iluminare RGB ce completează jocul de apă ce poate fi controlat prin intermediul unui calculator dedicat.

Proiectul de amenajare a spațiului urban mai cuprinde și spații de odihnă și relaxare prevăzute cu bănci amplasate în zona aleilor și foișor, coșuri de gunoi, fântâni cu apă potabilă, pergole de lemn, foișor din lemn mobilat cu bănci de odihnă; zone de agrement cu fântână arteziană circulabilă cu jocuri de apă- utilizată pentru răcorire, fiind accesibilă publicului prin jocurile de apă create, cu pardoseală din dale de piatră montate pe suport impermeabil și jeturi de apă amplasate în pardoseală și mobilier (mese și scaune fixe pentru jocuri de șah, table); zonă pentru lectură**,** prevazută cu mobilier urban**:** bănci din lemn stratificat cu forme organice și seturi de vele pentru umbrire și hamace; zona amfiteatrului prevăzută cu ecran pentru proiecție și 6 gradene cu înălțimea de 0,20m cu șezut din gazon;

zona grădinii senzoriale**,** compusă dintr-o movilă cu forma neregulată, conceptută organic și prevăzută cu bănci din lemn stratificat ce urmăresc formele movilei și seturi de vele pentru umbrire și hamace; locuri de joacă pentru copii, prevăzute cu terenuri special amenajate pentru diferite categorii de utilizatori și prevăzute cu bănci pentru adulții care supraveghează copiii, coșuri de gunoi și toalete ecologice; zone pentru sport**,** prevăzute cu: mese din beton mozaicat pentru tenis de masă, spațiu pentru skateboard cu rampe pentru role și pereți pentru escaladă; alei pietonale, piste pentru biciclişti- proiectul constă în elaborarea unui traseu compus dintr-o alee pietonală din piatră naturală, în formă eliptică, ce cuprinde și pista pentru biciclişti, ce unește cele două accesuri principale în parc din Șoseaua Turnu Măgurele și se intersectează cu aleea de-a lungul căreia se dezvoltă zonele de interes ale parcului.

Adiacent aleilor sunt amplasate obiecte și mobilier urban: suport parcare biciclete; stâlpi pentru iluminat decorativi; bănci din lemn; coșuri de gunoi; fântâni apă potabilă; pergole din lemn pentru umbrirea locurilor de odihnă; pergole din lemn de-a lungul spațiilor de promenadă tratate cu gazon ranforsat, din zona cortinei digitale și a zonei de lectură; cabine pază -prevăzute la intrările în parc; toalete publice ecologice.

Suprafața totală de teren amenajată este de 19 368.00 m² din care suprafață construită propusă (foișor, cabine pază, toalete ecologice) este de 26,70 m², iar suprafață totală spații verzi propuse de 17 925 m².

Tabel 1. Bilanț suprafețe amenajate

Suprafețe minerale	m^2
Suprafață alei pietonale din piatră natural(120x30cm)	280
Suprafață alei pietonale din piatră natural(12x12cm)	434
Suprafață piste biciclete asphalt turnat colorat în masă	245
Suprafață impermeabilă- fântână arteziană, cortină apă	203
Suprafață skate park	260
Suprafețe verzi	
Suprafață teren loc de joacă	189
Suprafață spații verzi	12 294
Suprafață spații verzi ranforsate	2 330
Suprafețe spații verzi- gradene	2 787
Suprafețe spații verzi- parterre florale	312
Suprafețe jardinière(împrejmuire)	202

Sursa: Arhiva Primăriei Municipiului Alexandria

În repartizarea generală a vegetației lemnoase s-a ținut cont de o serie de aspecte funcționale precum realizarea de zone de umbră de-a lungul aleilor(*s-a urmărit realizarea unei siluete bine proporționate și a unui echilibru între zonele de umbră-lumină prin amplasarea arborilor înalți în direcția sud, sud-vest, astfel încât parcul să fie ferit de căldură și umbrit și în zilele toride de vară);* relieful modelat parțial astfel încât să creeze dinamica parcului; de speciile rezistente la boli și dăunători, adaptate la clima zonei și la poluarea atmosferică, cu o pondere însemnată a speciilor repede crescătoare și de plantarea de arbori multitulpinari sau conduși cu trunchiul scund și arbuști rustici cu capacitate mare de ramificare și lăstărire în perimetrele de protecție; obținerea unui peisaj divers colorat prin diversificarea speciilor, cu texturi diferite ale trunchiurilor copacilor, frunzelor,

florilor, fructelor pe parcusul întregului an, cât și atragerea insectelor, animalelor de toate felurile, pentru restabilirea echilibrului fauna-flora în zonă.

Fig. 2. Amenajare peisagistică parc fosta U.M. în municipiul Alexandria
Sursa: arhiva Primăriei Municipiului Alexandria

Printre speciile propuse s-au optat pentru liane și arbuști curgători din speciile Wisteria sinensis, Lonicera japonica, Cotoneaster horizontalis, Vita canadiana Ampelopsis veitchii, Clematis westerplatte, Clematis blue, Hedera helix într-un număr toatal de 925 buc, arbuști din speciile Tamarix gallica, Cotinus coggygria, Viburnum opulus, Forsythia intermedia, Weigella floribunda, Cornus alba "Elegantisima", Prunus laurocerasus, Cotoneaster dammerii, Juniperus horizontalis, Picea pungens glauca, Berberis atropurpurea, Euonymus fortune Emerald Gold, Philadelphus coronarius, Lămâiță, Magnolia soulangeana alba, Magnolia galbena, Magnolia soulangeana, într-un număr total de 380 bucăți.

Vegetația înaltă este dispusă conform concepției arhitecturale, cu preponderență în spațiile situate în partea de vest și sud a parcului, ordonată astfel încât să creeze perspective interesante spre diferitele zone ale parcului.

Printre speciile de arbori utilizați se numără: Prunus cerasifera Nigra, Albizzia julibrissin, Robinia pseudoacacia, Tilia tomentosa, Salix matsudana Tortuosa, Acer platanoides Sango Kaku, Acer platanoides Krimson King, Betula pendula, Betula nigra, Liriodendron tulipifera, Quercus rubra, Picea abies, Picea pungens argentea, Abies concolor, Pinus nigra, Pinus sylvestris, Pinus strobus, Pin Strob, Liquidambar styraciflua, Quercus robur, Acer saccharinum – Paltin argintiu, arțar într-un număr toatal de 235 bucăți.

Pe toată suprafața verde, s-a prevăzut instalație automată pentru irigarea spațiilor verzi, calculată și dimensionată în funcție de vegetație, climă și caracteristicile solului, conducte pentru alimentarea cu apă a fântânilor și o rețea de canalizare pentru preluarea apelor uzate, sistem de iluminat public ornamental cu sistem de supraveghere video a spațiilor amenajate prin proiect și Wi-FI.

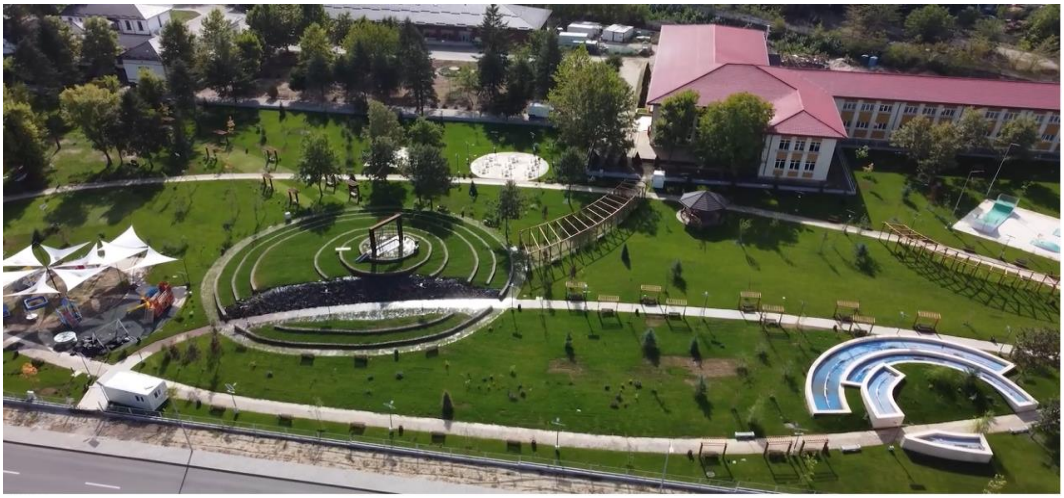

Fig. 3. Amenajare peisagistică parc fosta U.M. în municipiul Alexandria
Sursa: arhiva Primăriei Municipiului Alexandria

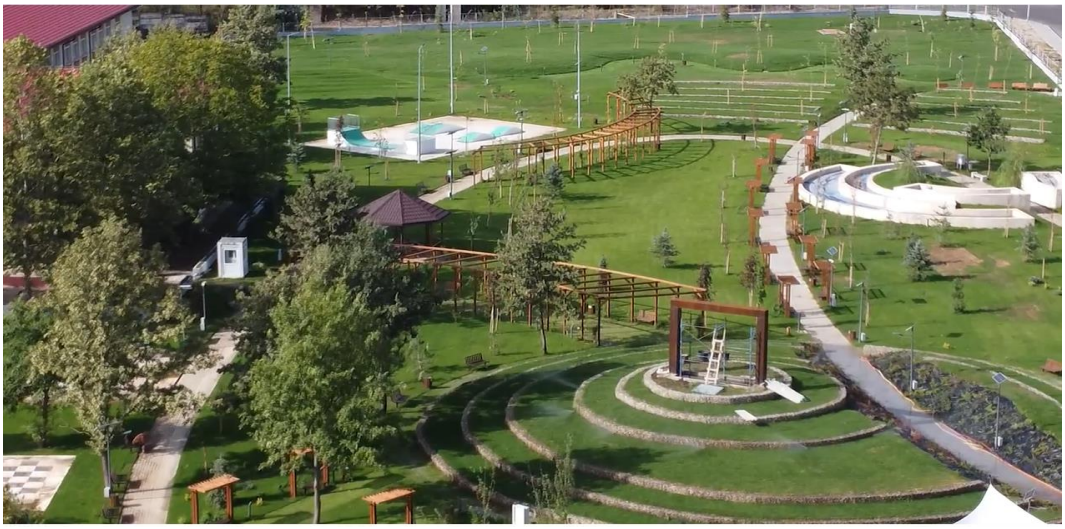

Fig. 4. Amenajare peisagistică parc fosta U.M. în municipiul Alexandria
Sursa: arhiva Primăriei Municipiului Alexandria

Întregul parc este împrejmuit perimetral cu o structură metalică, soclu de beton și panouri de grilaj metalic, cu înălțimea totală de 1,30m de la cota aleilor pietonale, din care 0,30m înălțime va avea soclul și panourile vor avea 1,00m înălțime. Se vor realiza jardiniere pentru plante agățătoare în soclul de beton.

Spațiul verde este accesibil pentru persoanele cu dizabilități prin toate cele patru accesuri. Nu există denivelări sau diferențe de nivel între aleile pietonale amenajate și spațiul verde. Alte elemente ce asigură accesibilitatea de către toate persoanele, indiferent de capacitățile lor fizice, senzoriale și cognitive propuse sunt dalele tactile 300x300 x 80mm, cu suprafață structurată, amplasate la schimbările de direcție, de-a lungul aleilor pietonale pavate.

Fig. 5. Amenajare peisagistică parc fosta U.M. în municipiul Alexandria
Sursa: arhiva Primăriei Municipiului Alexandria

4. Obiective preconizate a fi atinse prin realizarea investiţiei publice

Spațiul verde amenajat pe locul fostei Unități Militare este al doilea parc de anvergură din municipiul Alexandria, după Parcul Pădurea Vedea, spațiu urban ce se dorește a deveni unul din locurile de recreere preferate de locuitori din oraș.

Investiția realizată în proporție de 80% își propune transformarea zonei într-un spațiu public prietenos locuitorilor orașului și turiștilor, un spațiu de recreere bogat în vegetație, aducând un plus în calitatea vieții atât din punct de vedere al aerului respirat cât și din punct de vedere estetic, o nouă oază de liniște, relaxare și voie bună.

Ideea de proiect propusă răspunde direcțiilor majore de dezvoltare a Municipiului Alexandria rezultate în urma analizei diagnostic, analiza SWOT, viziunea și obiectivele de dezvoltare din Strategia de Dezvoltare Locală [3], iar necesitatea realizării acestei investiții a derivat din necesitatea revitalizării zonei urbane în Municipiul Alexandria.

Grupul țintă vizat prin proiect este reprezentat de locuitorii din Municipiul Alexandria.

Prin reconversia funcțională, reutilizarea terenului neutilizat și transformarea acestuia în zona de agreement și recreere, se estimează ca proiectul propus va contribui la:

- revitalizarea unui teren degradat si neutilizat din Municipiul Alexandria prin acțiuni ce vor transforma în spațiu verde 90% din suprafața terenului degradat;
- amplasamentul terenului este la o distanta mai mica de 500 de m fata de zona de locuințe și functiunile complementare: institutii publice sau servicii nepoluante, care ridica nivelul functiunii de baza a zonei: cultura, educatie, turism, alimentatie

publica, comert: Universitatea “Valahia” din Târgoviște, Tribunalul Județean Telorman, Creșa mică tip 1, capela, etc.

Fig. 6. Amenajare peisagistică parc fosta U.M. în municipiul Alexandria
Sursa: arhiva Primăriei Municipiului Alexandria

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Marketing insights when shifting cybersecurity technologies to the cloud or hybrid cloud in the context of smart cities

Guy WAIZEL,
Alexandru Ioan Cuza University of Iasi, Romania
guy.waizel@gmail.com

Abstract
This research aims to identify marketing insights that can assist marketing departments at cybersecurity vendors in persuading their customers to transition from on-premises deployment to a cloud application when the vendor decides to develop a new product on the cloud and discontinue the on-premises version. With the global trend of customers migrating to the cloud and vendors adapting their technologies accordingly, the need for such marketing insights in developing a strategic marketing plan is evident. Its purpose is to deter customers from abandoning the service and switching to competitors offering on-premises solutions. Previous studies indicate that the global rise in customer migration to the cloud is primarily driven by cost savings and efficiency. However, other studies have shown that while vendors develop and adjust their technologies for the cloud, many organizations are not yet ready for such a shift and prefer to maintain on-premises deployments. There is also an extensive body of literature that describes challenges related to security concerns, small organizations unprepared for migration, regulatory readiness, and issues with training and resource availability. Moreover, numerous cybersecurity research papers, frameworks, and methodologies are associated with cloud adoption. In this research, a qualitative analysis is conducted through in-depth interviews with 13 security professionals, focusing on a case study of active defense cybersecurity. Through the use of content analysis and thematic analysis, we aim to identify the primary themes that will contribute to a more comprehensive future model for researching and explaining consumer behavior during the transition of cybersecurity technologies from on-premises to the cloud or a hybrid cloud environment.

Keywords: cloud adoption, marketing plan, migration to cloud, security professionals, deception technology.

1. Introduction: Bridging the Knowledge Gap in Cybersecurity Cloud Migration

In the rapidly evolving landscape of cybersecurity and smart cities, the literature has extensively explored the benefits of cloud adoption in various sectors, highlighting efficiency gains and cost savings, as well described in [1], [2], [3], [4], [5]. However, a critical gap exists in the specific realm of cybersecurity enterprise software vendors and their migration strategies to the cloud, particularly in the context of smart cities. While vendors strive to adapt to cloud technologies, a significant number of organizations remain hesitant, opting for on-premises deployment due to security concerns, regulatory issues, and resource constraints, as well covered by [6], [7], [8], [9], [10], [11], [12], [13], [14], [15].

This research aims to address this knowledge gap by delving into the specific challenges faced by cybersecurity vendors in migrating clients from on-premises to cloud solutions within the context of smart cities. The literature lacks a focused exploration of migration plans and marketing strategies tailored to the unique needs of cybersecurity clientele, especially in the context of smart city infrastructure. Additionally, gaps persist in understanding comprehensive cloud features, ecosystem integrations, trust issues, and perception factors influencing customers' willingness to migrate in the specific context of smart cities.

1.1. Motivation and Significance: Enhancing Marketing Strategies in Cybersecurity

Motivated by the necessity to fill this void, this research seeks to contribute to the decision-making processes of enterprise security vendors. The significance lies in aiding these vendors to make informed marketing decisions, particularly in developing tailored marketing strategy plans for transitioning clients from on-premises to Software as a Service (SaaS) or hybrid cloud deployments. Such strategic plans are crucial for retaining customers, preventing revenue loss, and safeguarding the vendor's reputation.

The chosen case study focuses on active cyber defense technology, specifically the shift from on-premises deployment to hybrid or full SaaS models. Understanding how organizations perceive this transition is essential for vendors looking to convince their clients to embrace the cloud platform. This move promises immediate cost reductions for customers but poses risks for vendors in terms of subscription renewals and potential customer churn. Addressing these challenges requires an early adoption of the right marketing strategy.

The shift to cloud-based solutions also influences organizational behavior, requiring new training and skill sets, potential workforce changes, and challenges in adapting to cloud-oriented functionalities as indicated also by Stewart [8] and Meersman [9]. This research explores these social and organizational impacts, providing valuable insights for both vendors and organizations contemplating the shift.

Furthermore, the research extends its significance beyond the cybersecurity domain by contributing to universal strategic marketing methodologies. The development of primary data instruments, including open-ended questionnaires for security leaders.

1.2. Research Problem: Navigating the Complex Landscape of Cloud Adoption in Cybersecurity

The research problem stems from the ongoing debate surrounding on-premises versus cloud adoption in various industries. While some sectors have embraced cloud technologies for cost-saving reasons, the cybersecurity domain, especially in federal and government industries, exhibits hesitancy due to security concerns [13]. This hesitation prompts cybersecurity vendors to invest in alternative solutions, such as hybrid cloud or fully SaaS models, leading to a myriad of challenges.

Our research focuses on the dilemma faced by cybersecurity vendors in migrating on-premises customers to the cloud. The potential loss of customers, profitability, and trust looms large as vendors transition to new business and pricing models. The shift not only affects customers' perceptions of cost-saving but also raises concerns about security, data privacy, and the ability to integrate with other ecosystem security software.

Strategically managing this transition is critical for vendors to avoid customer churn and loss of trust. This qualitative analysis research is the first stage in a wider research which aims to develop and execute a comprehensive strategic marketing plan that addresses these challenges, ensuring a smooth migration process for both vendors and clients.

1.3. Research Questions, Aims, and Objectives: Unveiling Perceptions in Cybersecurity Cloud Migration

The research questions guide our exploration into organizations' perceptions of the shift from on-premises software to cloud applications in the realm of cyber-active defense technology. We aim to uncover insights related to extended features, new cloud ecosystem integrations, cost-saving perspectives, and the impact of trust in cloud security.

The objective of this first stage research are:

- To examine how organizations using cyber-active defense technology perceive the shift from on-premises software to a cloud application concerning extended features and functionalities.
- To explore organizations' perceptions of the shift from on-premises software to a cloud application when leveraging new cloud ecosystem integrations.
- To investigate how organizations utilizing cyber-active defense technology view the shift from on-premises installation to a cloud application from a cost-saving perspective.
- To assess organizations' perceptions of the shift from on-premises software to a cloud application based on their trust in cloud security.

1.4. The Context of the Research: Active Defense Cybersecurity Technology

The research contextualizes the investigation within the realm of active defense cybersecurity technology, focusing on solutions like deception technology. Traditionally deployed on-premises for network segmentation, vendors are now steering clients toward hybrid cloud or fully SaaS environments. This context provides a rich case study for understanding the dynamics of transitioning from on-premises solutions to cloud applications.

1.5. Literature Review: Navigating Challenges and Advantages in Cloud Adoption

A comprehensive literature review identifies the challenges and advantages of cloud adoption across public and private sectors. Security concerns, regulatory readiness, training gaps, and resource constraints have been cited as barriers to adoption [6], [7], [8], [9], [10], [11], [12], [13], [14], [15]. While studies acknowledge the benefits of cloud adoption in various sectors [1], [2], [3], [4], [5], there remains a dearth of literature addressing the specific challenges and marketing strategies for security software migration to the cloud.

1.6. Theories Related to the Study: A Theoretical Framework for Informed Decision-Making

Theoretical frameworks such as transaction cost theory, diffusion of innovations theory, resource dependence theory, UTAUT, stakeholder theory, theory of reasoned action, theory of planned behavior, and theory of buyer behavior provide a robust foundation for understanding the complexities of cloud adoption and marketing strategies [16], [17], [18], [19], [20], [21], [22], [23], [24], [25], [26], [27]. These theories offer valuable insights into the factors influencing customers' decisions, trust in the cloud, and the development of effective marketing strategies for cybersecurity vendors navigating the transition from on-premises to cloud solutions.

In conclusion, this research endeavors to bridge the knowledge gap in the specific context of cybersecurity enterprise software vendors, providing actionable insights to guide informed marketing decisions in the dynamic landscape of cloud adoption.

2. Method

2.1. Pilot

A pilot study aimed to improve data collection quality by refining questions for relevance and appropriateness adopted from similar pilot method previosely used by Teijlingen, E. R., & Hundley, V [28]. The study also measured interview time alignment and ensured meaningful responses to each question [28]. Additionally, it confirmed the accurate interpretation of responses for required data collection and the provision of sufficient data for subsequent research stages, facilitating deductions related to research concepts, aims, and objectives as suggested by Berg, B. L [29].

In the pilot study phase, three carefully selected participants (Participants 1-3) met specific criteria for the first stage of the research, representing various industries, being over 18, with at least two years of cybersecurity software experience and decision-making authority in procurement. An additional participant (Participant 4), a Social Science Psychology and Communication student with two years of experience, offered a unique perspective on the questionnaire's structure, question order, clarity, language, and communication. In this pilot study phase, Participant 1 was an IT & Security Team Leader with six years of experience in the education sector, Participant 2 is a Security Project Manager with three years of experience in government, and Participant 3 is an IT & Security Engineer with eight years of experience in the high-tech industry.

Insights from these pilot interviews informed the revised questionnaire. (Appendix A)

2.2. Participant Selection and Data Collection

After the pilot study, a combination of stratified sampling and purposive sampling was employed to select participants for the main study. Recruitment was carried out through LinkedIn, resulting in a sample of thirteen Israeli security leaders across diverse industries. The criteria for inclusion were individuals aged eighteen or above, possessing a minimum of two years of experience with cybersecurity software, and familiarity with cyber active defense solutions. Additionally, participants were required to have decision-making authority for cybersecurity software procurement within their organization, including the potential transition from on-premises security software to the cloud. A detailed participant demographic profile is provided in Appendix B.

The sample size aligns with the recommendations from similar qualitative studies, suggesting that between ten and fifteen participants are adequate for meaningful analysis [7]. Data collection involved semi-structured interviews lasting 45 minutes, conducted uniformly using the same interview protocol. These interactions occurred either over Zoom or via field notes for participants who objected to recording. A voluntary consent form was administered, granting participants the right to withdraw from the research at any point. Additionally, permission to record remote interviews using Zoom was sought.

2.3. Data Analysis Procedures

In this phase of content analysis, several steps were undertaken to derive meaningful insights from the collected data.

Step 1: Data Collection and Organization: Zoom sessions were conducted, lasting approximately 45 minutes each, and the recorded content was meticulously collected, prepared, and organized. A comprehensive review of the data involved both holistic and floating reading approaches. Transcripts were created, and participant identities were anonymized.

Step 2: Identification of Units of Analysis: To streamline the analysis, the data were minimized, and units of analysis were defined. Ideas and concepts expressed in words and phrases were carefully identified.

Step 3: Code and Category Development: A systematic process of code and category creation and refinement ensued. Codes were generated for responses from all participants, emphasizing those aligned with the research's objectives. Participant quotes relevant to the study were also selected during this step.

Step 4: Quote Selection and Memo Writing: Memos were written for each participant's responses to ensure comprehensive data gathering at the conclusion. Essential participant quotes were carefully selected to capture key insights.

Step 5: Validation and Verification: A rigorous validation process was implemented, involving code testing, correction, and thorough checks for consistency in the coding structure.

Step 6: Coding and Verification of Associated Text: All text from both interviews was coded based on the identified categories, and a meticulous verification process was carried out.

Step 7: Theme Identification and Relation Mapping: Distinct themes emerged, and their relationships with categories were defined. This step involved a comprehensive analysis of the connections between identified themes and selected participant quotes.

Step 8: Results Documentation: The findings, conclusions, and discussions were documented in a summarized format, providing a cohesive overview of the content analysis results.

This detailed methodological approach ensured a thorough exploration of the collected data, offering valuable insights into the research's aim and objectives.

3. Results

The content analysis conducted in this research followed a systematic approach encompassing seven key steps. In Step 1, data collection and organization set the foundation for the subsequent stages. Step 2 involved the identification of units of analysis,

followed by Step 3, which focused on code and category development. Step 4 encompassed quote selection and memo writing, while Step 5 concentrated on validation and verification. The subsequent steps, Step 6 and Step 7, involved coding and verification of associated text and theme identification with relation mapping.

A total of 234 codes emerged from this comprehensive analysis, as illustrated in Figure 1. Additionally, 24 categories were identified, each linked with pertinent quotes. The synthesis of these categories led to the derivation of five overarching themes in response to the defined research questions.

For Research Question 1, exploring organizations' perceptions of the shift to the cloud with extended features and functionalities in the context of cyber-active defense technology, two themes emerged. Theme 1 highlighted the empowerment of AI-enhanced and other advanced cloud capabilities for efficiency, security, and organizational evolution during the transition. Theme 2 focused on innovative cloud deception solutions and strategic approaches for seamless migrations.

Addressing Research Question 2 regarding organizations' perspectives on the shift to the cloud with new cloud ecosystem integrations, Theme 3 emerged—emphasizing integrated cloud security and orchestrating the cloud security ecosystem for resilience.

Research Question 3, delving into organizations' perceptions of the cloud shift from a cost-saving perspective, resulted in Theme 4—optimized cloud operations and a unified approach to economic efficiency.

Finally, Research Question 4, investigating organizations' perceptions of the cloud shift based on trust in cloud security, revealed Theme 5—trust in cloud security, navigating risks, challenges, compliance, and buyer dynamics during the transition from on-premises to the cloud or a hybrid cloud in the context of cyber-active defense technology. These findings are visually represented in Figures 2, 3, and 4, alongside corresponding categories and quotes, providing a comprehensive overview of the thematic outcomes derived from the content analysis.

The findings presented herein constitute preliminary results from the initial stage of a broader and more comprehensive research initiative. As the first stage of an ongoing investigation, these themes are subject to refinement and improvement pending review and recommendations from the researcher's committee. Given the iterative nature of the research process, subsequent stages and committee input are anticipated to enhance the precision and depth of the identified themes.

3.1 Results- Selected Codes

Cloud Adoption and Future Trends	Maturity of Cloud Security	Hybrid Cloud Complexity	System Health and Decoy Functionality	Reduced Infrastructure Costs	Data Security
Benefits of Cloud	Integration with On-Premises	Quick Adoption	Mapping and Customization Complexity	Scalability	Compliance Requirements
Security Concerns	Evolving Understanding of Cloud Risk	Training for Adoption	Initial Mapping of the Network	Pay-as-You-Go Model	Data Privacy and Sovereignty
Hybrid Cloud Approach	Customization and Vendor Selection	Transition from On-Premises	Challenges in Network Mapping	Lower Maintenance Overhead	Access Control and Identity Management
Use Cases and Specific Applications	Value of Native Cloud Solutions	Noise During Implementation	Resource Allocation for Deployment	Enhanced Security Features	Third-Party Security
Organizational Priorities	Focus on Cloud Assets	Technical User Adoption	Bureaucracy and Administrative Efforts	Global Reach	Incident Response
Transition to Cloud Services	Importance of Reputable Vendors	Control and Security in On-Premises	Resource Involvement for On-Prem Deployment	Improved Disaster Recovery	Vendor Lock-In
Complexity and Integration	Security in Specific Industries	High-Tech Industry Process	Agentless Implementation	Efficiency in Resource Allocation	Data Residency
Cloud Vendor Selection	Multi-Cloud Environment	Simplicity and Scalability	Effective Threat Detection	Impact on IT Staff Workload	Cloud Configuration
Value and Expertise	Data Encryption and Compliance	Vulnerability Scanning	Reduced False Positive Alarms	Initial Capital Expenditure Reduction	Cost and Resource Management
Industry-Specific Considerations	Threat Detection and Incident Response	User Feedback for Refinement	Early Threat Detection	Cost-Benefit Analysis	Policy Adherence
Data Privacy and Compliance	User Education and Vendor Assessments	Access Controls and Permissions	Enhanced Security Posture	Data Transfer and Subscription Costs	Multi-Tenant Concerns
Cloud Management and Resources	Security Posture and Defense Layers	Cloud Center of Excellence (CoE)	Strategic Placement of Decoys	Impact on Energy and Cooling Expenses	Audit and Compliance Checks
Challenges in Transition	Importance of Access Controls	Efficiency and Flexibility of Cloud Services	Dynamic Adaptation for Changing Threat Landscape	Flexibility in Resource Allocation	Network Security
Public Sector Considerations	Data Protection in Transit and at Rest	Data Migration for Minimal Disruption	Regulatory Compliance Considerations	License Management	Privacy Regulations
Vendor Relationship and Trust	Vendor Selection and Solution Integration	Change Management for Smooth Transition	Infrastructure Maintenance	Security Check	Mindset Change
Demand-Driven Adoption	Continuous Monitoring and Compliance	Monitoring and Optimization for Efficiency	Scalability and Resource Allocation	Immediate Adoption	Saving Time, Resources, Maintenance
Transitioning and Skill Development	Security Challenges in High-Tech Industry	Vendor Selection and Evaluation	Automated Backup and Recovery	Hybrid Model Preference	Management in the Cloud
Data Security in Cloud	Identification and Monitoring of Cloud Activities	User Training and Awareness	Security Patching	Critical vs. Non-Critical Data	Pricing Pays Off
Multi-Cloud Strategy	Balancing Security and Efficiency	Adoption Due to COVID-19	Global Accessibility	Resilience Perspective	Scalability and Cost Efficiency
Use of Cloud in Pandemic	Staff Education and Awareness	IT and Security Collaboration	Incident Response	Combining Elements	Scalability
Government Data Store Marketplaces	Due Diligence with Cloud Service Providers	Real-Time Monitoring for Compliance	Enhanced Security Features	Strategic Consideration	Cost Savings
Transition Challenges	EDR (Endpoint Detection and Response)	Integration with Anomaly Systems	Compliance Tools	Maintaining Control	Accessibility
Collaboration and Expertise	SIEM (Security Information and Event Management)	Integration Must Be Easy	Resource Optimization	Worthwhile Migration	Automatic Updates
Rapid Changes in Cloud	Attack Simulations	Importance of Ecosystem Integration	Real-Time Monitoring	Flexibility and Gradual Transition	Disaster Recovery
Compliance with Regulations	XDR (Extended Detection and Response)	All Systems Playing Together	Reduced Hardware Costs	Aligning with Specific Needs	Data Privacy and Compliance
Cloud for Business Continuity	NAC (Network Access Control)	Cautious Approach to Integrations	Automation of Repetitive Tasks	Balancing Control and Flexibility	Security Risks
Cloud for Real-Time Data	Firewall	Benefits of Third-Party Integrations	Reduced On-Site Presence	Data Sensitivity and Compliance	Internet Dependency
Threat Intelligence Integration	Sandbox	Challenges of Integration	Centralized Reporting and Analytics	Vulnerability Assessment and Management	Data Transfer Costs
Scalability and Auto-scaling	Proxy	Compatibility and Security	Data Center Maintenance	IAM (Identity and Access Management)	Integration Complexity
Cloud-Native Integration	Antivirus (AV)	Ease of Integration	Dynamic Scalability	Encryption	Vendor Dependency
Real-time Threat Intelligence Feeds	Sunblast	Vendors Offering Integrations	Enhanced Accessibility and Remote Management	Multi-Factor Authentication (MFA)	Latency
Behavioral Analysis	Mail Filter	Advantages of Integration	Cost Savings	Security Awareness and Training Programs	Data Sovereignty and Compliance
Threat Attribution	SOAR (Security Orchestration, Automation, and Response)	Integration Complexity	Regulatory Compliance Simplification	API Protection	Security Trust
Machine Learning and AI	IDPS (Intrusion Detection and Prevention System)	Customization and Tailoring	Streamlined Log Management	Data Exfiltration Monitoring	Reduced Physical Footprint
Automation and Orchestration	DLP (Data Loss Prevention)	Multi-Layered Defense	Advanced Security Features in the Cloud	Geographic Diversity	Reduced Chain of Approvals
User and Entity Behavior Analytics (UEBA)	Active Defense and Deception Technology	Data Privacy and Protection	Global Threat Intelligence Feed Integration	Geo-Fencing	Ongoing Maintenance and Updates
Incident Response Integration	Intune	Incident Response Efficiency	Reduced Time Spent on Troubleshooting	Compliance Orchestration	WAF (Web Application Firewall)
Enhanced Reporting and Analytics	Anomaly Detector	Flexibility and Adaptability	Improved Security Patch Management	Dynamic Scalability	Cloud-Native SIEM Integration

Fig.1. Selected Codes

3.2 Results- Selected Categories Themes and Quotes

Research Question 1: How do organizations perceive the shift to the cloud when leveraging extended features and functionalities in the context of cyber-active defense technology/deception technology?

Theme 1	**Theme2**
Empowering AI-enhanced and other advanced and cloud capabilities for efficiency, security and organizational evolution when shifting from on-premises to the cloud or a hybrid cloud	**Innovative Cloud Deception Solution and Strategies Approach for Seamless Migrations from on-premises to the cloud or a hybrid cloud**
Related Categories:	**Related Categories:**
Cloud Adoption and Future Trends:	Advantages and Strategic Planning of Deception Technology
Cloud Deployment Strategies:	Early Threat Detection
Cloud Infrastructure Management and Security:	Reduction in Dwell Time
Quick Adoption:	Mimicking Actual Network
Efficiency and Flexibility of Cloud Services:	Migration Decision Factors
Infrastructure Maintenance:	Migration Approaches
Scalability and Resource Allocation:	Security Check
Automated Backup and Recovery:	Strategic Consideration
Security Patching:	Worthwhile Migration
Global Accessibility:	Hybrid Model Preference
Adaptive Security:	Critical vs. Non-Critical Data
Organizational Change Management:	Flexibility and Gradual Transition
User Adoption and Training:	**Related Quotes:**
Geo-fencing and Data Sovereignty:	The layout of the deception solution has been strategically designed to mimic our actual network infrastructure.
Protection of Cloud APIs and Data Exfiltration Detection:	requirements, compliance considerations, and the overall strategic goals of our organization.
Related Quotes:	each environment.
The adoption was very quick; non-tech users take some more time to adopt but also faster than on-prem.	Yes, I would migrate immediately to hybrid mode.
We succeeded in benefiting from the efficiency and flexibility of cloud services while maintaining a strong security posture.	I think a hybrid model is the best in this case; it will reduce time for approval for such migration.
With the cloud, the responsibility for infrastructure maintenance, such as server updates, hardware management, and data center maintenance, largely shifts to the cloud service provider.	I will definitely recommend migrating in hybrid mode... the world is moving there, and we should not stay behind.
Cloud environments offer dynamic scalability. This means we no longer need to manually allocate and provision resources, optimizing resource utilization and potentially reducing costs.	
Many cloud providers offer automated backup and disaster recovery solutions. This simplifies the backup process and ensures data is protected and recoverable in case of a failure.	
Cloud providers typically handle security patching and updates, reducing the time and effort required to keep the deception solution secure and up to date.	
Cloud-based solutions often offer improved accessibility and remote management, enabling security teams to monitor and manage the deception solution from anywhere, improving overall efficiency and response times.	
Advanced threat attribution capabilities to help identify the origin and intent of attacks and attackers, providing valuable insights for incident response.	
Adding behavioral analysis to the deception solution to track and profile the behavior of attackers and provide insights into their motivations and methods.	
Leveraging machine learning and AI to continually improve the deception's ability to mimic real assets and adapt to evolving attacker techniques.	
Incorporating UEBA capabilities to detect anomalous user and entity behavior patterns within the cloud environment, enhancing threat detection and mitigation.	
The ability to dynamically scale deception assets based on cloud resource availability and demand, ensuring that the deception environment can adapt to varying workloads.	
Implementing deception assets in multiple geographic regions to diversify the deception environment and cover a broader range of potential attacker locations.	
All technical users adopted these cloud applications very easily, with other users, it took some more time but also less time than the on-prem application.	
If it's hybrid cloud then sometimes it's more complicated because you need to use jump servers, use segmentation and isolation.	
The CoE team helps manage the organizational change associated with cloud adoption, ensuring a smooth transition for our staff and teams	
We succeeded in benefiting from the efficiency and flexibility of cloud services while maintaining a strong security posture.	
Training and user awareness are critical for successful adoption.	
Implementing deception elements to protect cloud APIs, as they are often targeted by attackers seeking to exploit vulnerabilities.	
Enhancing the solution's ability to monitor and detect data exfiltration attempts in the cloud environment.	
Implementing geo-fencing capabilities to control and limit the geographic locations where deception assets are active, addressing data sovereignty concerns and regulatory compliance.	

Fig. 2. Research Question 1: Themes 1&2- Selected Categories and Quotes

Research Question 2: How do organizations perceive the shift to the cloud when leveraging new cloud ecosystem integrations in the context of cyber-active defense technology/deception technology?
Theme3
Integrated Cloud Security: Orchestrating Cloud Security Ecosystem for Resilience
Related Categories:
Threat Intelligence Integration
Cloud-Native Integration
Unified Incident Response and Cloud Security Integration
Automation and Ecosystem
Incident Response Integration
Compliance Orchestration
Related Quotes:
Enhancing detection and response capabilities by integrating with threat intelligence feeds specific to cloud environments.
Improving threat detection and incident response within the cloud infrastructure through integration with cloud-native security tools and services.
Developing automated incident response capabilities to take predefined actions in response to specific threats within the cloud environment.
Seamless integration with our Security Information and Event Management (SIEM) system provides a comprehensive view of security events, enabling more efficient incident response.
Customizing security solutions according to organizational needs is crucial for a robust and tailored defense approach.
Advanced reporting and analytics provide comprehensive insights into threat activity, facilitating informed decisions and improved security strategies.
Integrating with cloud-native SIEM solutions centralizes event and log management for better visibility and correlation of security data.
Introducing third-party solutions creates a multi-layered defense approach that is often more effective in thwarting advanced threats.
Integration of compliance orchestration features automates compliance checks and reporting, ensuring continuous adherence to regulatory requirements.
Ecosystem integration, like isolating threats or placing decoys based on information received from NAC, helps remediate threats effectively.
Integrating third-party solutions into our cloud-based deception solution enhances security capabilities by keeping deception technology up to date with the latest threat intelligence and security innovations.

Fig. 3. Research Question2:Themes 3- Selected Categories and Quotes

Research Question 3: How do organizations perceive the shift to the cloud from a cost-saving perspective in the context of cyber-active defense technology/deception technology?
Theme 4
Optimized Cloud Operations: A Unified Approach to Economic Efficiency
Related Categories:
Cost Efficiency and Infrastructure Benefits
Reduced Infrastructure Costs
Scalability
Pay-as-You-Go Model
Reduced On-Site Presence
Resource Optimization
Operational Excellence in the Cloud
Saving Time
Accessibility
Automatic Updates
Disaster Recovery
Related Quotes:
By leveraging cloud-based services, we can eliminate the need for maintaining on-premises hardware.
Cloud services often operate on a pay-as-you-go model, meaning we only pay for the resources we actually use, optimizing cost efficiency.
Shifting our deception solution to the cloud offers advantages such as scalability, cost efficiency, global reach, redundancy, and automatic updates.
Scalability: Cloud-based solutions can easily scale to accommodate changing security needs, allowing us to quickly adapt to evolving threats.
Cloud-based deception solutions allow us to scale resources up or down as needed, reducing the cost of over-provisioning.
If our organization expands globally, cloud-based solutions can provide cost-effective coverage and accessibility across different geographic locations.
Cloud providers often offer advanced security features, including DDoS protection and encryption, which can augment the security of our deception solution.
Many repetitive security tasks can be automated in the cloud, reducing manual workload and the risk of human error.
We can eliminate the need for on-premises hardware and data center infrastructure, which can be a substantial cost-saving measure.
Shifting our deception solution to the cloud offers advantages such as scalability, cost efficiency, global reach, redundancy, and automatic updates.

Fig. 4. Research Question3:Themes 4- Selected Categories and Quotes

Research Question 4: How do organizations perceive the shift to the cloud according to their trust in cloud security in the context of cyber-active defense technology/deception technology?
Theme 5
Trust in Cloud Security: Navigating Risks and Challenges, Compliance and Buyer Dynamics When Shifting Cybersecurity Technologies From On-Premises to the Cloud or a Hybrid Cloud in the Context of Cyber-Active Defense
Related Categories:
Security, Compliance, and Operational Considerations:
Security Concerns:
Vendor Relationship and Trust:
Buyer Behavior Aspects:
Risk Mitigation and Cloud Adoption Challenges:
Data Privacy and Compliance:
Data Sovereignty and Compliance:
Security Risks
Integration Complexity
Vendor Dependency
Security Trust:
Internet Dependency
Data Transfer Costs
Latency
Related Quotes:
Private cloud is very secure; public cloud is less secure.
Choosing trusted and compliant solutions.
Managing data privacy and compliance in the cloud can be complex, especially if sensitive data is involved. It requires careful adherence to regulatory requirements.
Relying on a cloud provider requires a level of trust in their security practices, which may raise concerns about data protection and control.
Choosing reputable vendors is important.
Understanding increased with real events and threats.
It's a must today; people have to move to cloud environments.
The concept and future are cloud.
Cloud is the next thing everyone moves to. It brings great improvements for business organizations.
Storing and processing sensitive information in the cloud requires robust data security measures to prevent unauthorized access or data breaches.
Prioritize using authorized government data store marketplaces.
Responding to business demands for cloud services.
In the logistics industry, cloud solutions can benefit from scalability and accessibility.
In the financial sector, agility and flexibility are essential.
Cloud security solutions are essential for protecting data and applications.
Data encryption is a standard practice for data at rest and in transit.
Compliance monitoring is crucial for audits and regulatory reporting.
Implementing strong access controls for cloud resources.
Security policies need to be adapted to the cloud environment to ensure they align with security objectives.
When considering third-party solutions, careful vendor selection is vital.
Ensuring data sovereignty and compliance with healthcare regulations may be more complex in a cloud environment.
Cloud environments can introduce new security risks if not properly configured or if third-party integrations are not thoroughly vetted.
Relying on a cloud provider means that we may be dependent on their services and security measures, which can limit control over the environment.
Cloud solutions rely on internet connectivity, and any network disruptions can impact accessibility and security operations.
Moving data to and from the cloud can incur data transfer costs, which should be considered in the overall budget.
Latency issues can arise when certain security tasks require real-time responses, as cloud-based solutions might introduce delays compared to on-premises alternatives.
The potential for cost savings is evident in a cloud-based deception solution, it's essential to conduct a thorough cost-benefit analysis, factoring in migration costs, ongoing subscription expenses, and the specifics of our security needs.

Fig. 5. Research Question 4: Theme 5- Selected Categories and Quotes

4. Discussion

The qualitative content analysis undertaken in this study has revealed compelling themes that delve into organizations' viewpoints on the shift to the cloud within the domain of cyber-active defense technology and specifically deception technology. These emergent themes serve as the cornerstone for a nuanced discussion, offering immediate implications, acknowledging limitations, and paving the way for future research avenues.

The first theme, emphasizing the empowerment of AI-enhanced capabilities and advanced cloud functionalities (Theme 1), underscores a paradigm shift towards efficiency, security, and organizational evolution during cloud transitions. Concurrently, Theme 2 sheds light on the strategic importance of innovative cloud deception solutions for seamless

migrations. These findings prompt an exploration into the specific technologies and methodologies deployed by organizations in realizing these themes and the associated implications for evolving cybersecurity strategies.

In tandem, Theme 3 surfaces the critical need for integrated cloud security, advocating for the orchestration of the cloud security ecosystem to enhance resilience. This theme necessitates further examination of the challenges and opportunities inherent in integrating diverse elements within the cloud security landscape. Understanding the nuances of these integrations will contribute to a comprehensive grasp of the complexities involved in securing cloud environments effectively.

Furthermore, Theme 4 highlights the paramount importance of optimized cloud operations and a unified approach to economic efficiency. Delving into the operational practices and cost-saving strategies adopted by organizations becomes imperative for comprehending the broader economic implications of cloud migration within the context of cyber-active defense technology.

The exploration of Theme 5 brings to the forefront the intricacies surrounding trust in cloud security. It underscores the challenges, risks, compliance considerations, and buyer dynamics organizations grapple with during the transition. This theme invites deeper scrutiny into the factors influencing trust and the strategies employed by organizations to mitigate potential risks in the cybersecurity landscape.

As we consider the immediate implications of these findings, it is essential to acknowledge the limitations inherent in this qualitative analysis. The qualitative nature of the study provides depth but lacks the breadth that quantitative methodologies could offer. Future research endeavors should thus integrate quantitative approaches to validate and expand upon these qualitative insights, providing a more comprehensive understanding and the researcher plans to continue these research next stages.

Moreover, recognizing that this study represents the preliminary qualitative analysis of a broader mixed research initiative is crucial. The iterative nature of this research process ensures that subsequent stages will build upon these preliminary findings. Future research should aim to refine and expand the understanding of this critical intersection in the evolving landscape of cybersecurity, thus contributing to the ongoing discourse on cybersecurity buyer behaviour and developing a marketing startegic plan when shifting cybersecurity technologies from on-premises to the cloud or the hybrid cloud.

4.1. Disclosure and conflict of interest

The author of this article is a doctoral student researcher at “Alexandru Ioan Cuza” University of Iasi with more than 25 years of experience in high-tech, specializing in cybersecurity. Additionally, he works at Commvault (a global provider of cyber resilience solutions) as Field Security CTO. For this research paper, in order to avoid any conflicts of interest and remain as unbiased as possible, the author purposely selected participants who do not have any contractual, direct, or indirect obligations with his company. Furthermore, they did not have any work relations with him during the interviews.

Appendix A. The revised questionnaire following the pilot:

1. What are your general thoughts on cloud environments?
2. What do you think about cloud security solutions?
3. Do you currently have any applications or cybersecurity solutions deployed in the cloud within your organization? If yes, could you elaborate on the process of their adoption by end users?
4. What challenges and advantages have you encountered with your deception solution and what comments would you have about the layout and coverage?
5. How do you perceive the potential cost-saving for your organization if you were shifting your deception solution from on-premises to the cloud?
6. Are there any specific security concerns, that you believe are relevant to address when shifting your deception solution to the cloud? Do you see issues related to internal policy restrictions or external regulations, for example?
7. What additional features would you be interested in incorporating into your deception solution after shifting to the cloud?
8. Which security solutions are you currently utilizing?
9. How do you perceive the idea of integrating third-party solutions into your deception solution once shifted to the cloud?
10. What security, maintenance, or process activities do you think will become unnecessary or improved once you shift your deception solution to the cloud?
11. Would you consider migrating your deception solution from on-premises to the cloud or implementing a hybrid model where some components are on the cloud and some are on-premises?
12. What other advantages or disadvantages do you perceive when shifting your deception solution to the cloud?

Appendix B. Interviewees Participants Profile

Table 1. Interviewees Participants Profile

Participant Number	Age	Gender	Education	Role	Industry	Experience in IT & Cybersecurity
1	28	Female	Undergraduate degree andcertifications in the field of cybersecurity	SOC Manager	Defense Industry	8 years
2	47	Male	Undergraduate and graduate degrees and certifications in the field of cybersecurity	Chief Information Security Officer	Recycling	26 years
3	56	Male	Undergraduate degree and certifications in the field of cybersecurity	CEO	Managed Security Service Provider	33 years

4	51	Male	Undergraduate degree	Chief Information Officer	Real Estate	20 years
5	39	Male	IT and cybersecurity technical certifications	System Manager	Beverage	15 years
6	34	Male	IT and cybersecurity technical certifications	IT and Security Specialist	Government	7 years
7	42	Female	Undergraduate degree and certifications in the field of cybersecurity	Information Security Manager	Food producer/ Manufacturing	15 years
8	28	Male	IT and cybersecurity technical certifications	Security Analyst	High-Tech -Internet	4 years
9	32	Male	IT and cybersecurity technical certifications	IT& Security Specialist	Education	6 years
10	29	Female	Undergraduate degree and certifications in the field of cybersecurity	IT& Security System Administrator	Logistics	5 years
11	42	Male	Undergraduate degree and certifications in the field of IT & Cybersecurity	IT & Security infrastructure Manager	Financial-Private sector	15 years
12	28	Male	Certifications in the field of cybersecurity	Security Specialist	Financial-Public sector	4 years
13	36	Female	Undergraduate and certifications in the field of cybersecurity	Security Operations Control Manager	Healthcare	8 years

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Challenges and opportunities in designing data structures for a smart city

Costel CIUCHI,
PhD, Assoc. Prof., Faculty of Electronics, Telecommunications and Information Technology, National University of Science and Technology POLITEHNICA Bucharest, Romania
costel.ciuchi@upb.ro

Alin BONCIU,
Faculty of Automatic Control and Computer Science, National University of Science and Technology POLITEHNICA Bucharest, Romania
alin.bonciu@stud.acs.upb.ro

Ana-Maria DINCĂ,
Faculty of Electronics, Telecommunications and Information Technology, National University of Science and Technology POLITEHNICA Bucharest, Romania
ana_maria.dinca@stud.etti.upb.ro

Mihai STOIAN,
Faculty of Automatic Control and Computer Science, National University of Science and Technology POLITEHNICA Bucharest, Romania
mihai.stoian1609@stud.acs.upb.ro

Abstract
The Internet of Things generates a vast amount of data in smart cities. However, with the increasing popularity of cloud storage and the ever-improving hardware, data storage is no longer a problem. Despite this, there may still be a need to conduct research and analyze aspects such as data variety and velocity to address some technological issues. This paper explores the concepts of normalization and denormalization in SQL and NoSQL databases, highlighting their advantages and disadvantages. It emphasizes the importance of carefully designing data structures in smart city applications. It is essential to consider the best approach to organize and manage information, taking into account the various areas of interest. To identify relevant data, analytics techniques are required to discover patterns, insights, and trends from large and complex data sets. One way to do this is through AI linked with Machine Learning. This approach can provide a better understanding of policy formulation, resource allocation, infrastructure planning, and service optimization. Additionally, we present a case study of a smart city application called SmartSantander, which illustrates how the use of NoSQL databases and denormalization can improve query performance. This could be a solution for addressing the data velocity problem. The article also emphasizes the importance of interoperability and cybersecurity in smart city data structure design. It highlights the use of JSON as a data interchange format and the need for secure data warehousing to protect sensitive information. Finally, our goal is to outline a solution that a smart city could implement to manage data effectively and securely. We propose using a hybrid approach that satisfies all its needs.

Keywords: database principles, big data, JSON, NoSQL.

1. Introduction
The Internet of Things (IoT) represents the solution for something that our society has been looking forward to since the late twentieth century: the concept of “Smart City”. In the beginning, to process data structures, the US Community Analysis Bureau started using databases, so the term “Smart City” was developed [1]. Nowadays, smart city architectures work around the same principle: data collection. Let’s see how the technology changed and aligned its lifespan until our days. The majority of databases followed the relational model.

However, in the following years, there has been a notable increase in the popularity of NoSQL databases, marking significant changes in the landscape of database technologies. We are living in a time of transition, in which questions such as: "*Which is better?*" or "*Why don't we use only NoSQL Databases?*" emerge.

From 1970 (implementation of the first relational DB models using the SEQUEL language) until 2006 (development of the first table structured on NoSQL principles – Google Big Table), SQL databases have been the benchmark of data storage and retrieval, offering well-defined schemas and ACID (Atomicity, Consistency, Isolation, Durability) compliance. However, the rigid structure of SQL databases poses limitations when confronted with the diverse and unstructured data characteristic of IoT-generated datasets. On the other hand, NoSQL databases, designed to handle vast amounts of unstructured data, provide a more flexible and scalable alternative. The choice between these two paradigms becomes particularly crucial in the context of smart cities, where the diversity of data types, the velocity of data streams, and the need for real-time analytics are key factors in determining which is the best choice.

2. SQL / NoSQL or both?

For the longest time, designing a persistence mechanism for a software application was limited to selecting one of the relational databases existent on the market, that could only be differentiated by performance criteria, the complexity of the query language and the costs. Over the years, software platforms and their associated business flows have evolved significantly, becoming increasingly sophisticated with each passing decade (see Figure 1). This evolution has led to a growing demand for additional resources, more powerful technologies, faster query executions, and the introduction of entirely new persistence features [2]. As businesses have expanded and their requirements have become more complex, software platforms have had to adapt to meet these changing needs. This has resulted in the development of more robust and resource-intensive systems that can handle larger workloads and process data more efficiently.

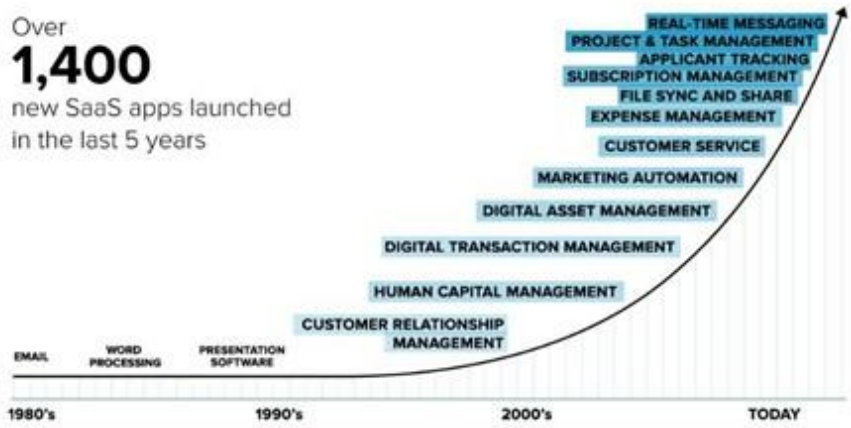

Fig. 1. Evolution of software platform capabilities and operations.
Source: [2]

To keep up with the demands of modern business operations, software platforms have incorporated new technologies that can deliver faster query executions and quick data retrieval and processing, enabling businesses to make informed decisions promptly. Overall, software platforms and workflows must offer enhanced collaboration, mobility, user-friendliness, and productivity, making it a requirement to operate more efficiently in an increasingly digital world.

One of the more difficult demands to tackle was the storage of non-strictly structured data and big objects, as they did not fit in the data models persisted by the relational database management systems (RDBMS). The exponential evolution of the volume of data leads to significant operational and maintenance challenges and pressures. Traditional relational databases have limitations when it comes to efficient scalability because they store all data in a single box, which can pose challenges for users.

Therefore, a new type of database emerged in 2006, the Google Bigtable, the first non-relational database (NoSQL) [3] .This new approach was quickly adopted for business development and exploration, and in 2007 Amazon researchers published a paper on the technical details of Dynamo, which laid the prototype of a non-relational database [4].

This innovative approach was developed using a robust set of distributed system principles, leading to the creation of a database system that is both highly scalable and exceptionally reliable. Nowadays, non-relational databases have evolved into 4 separate types, depending on how the data is modelled and saved: document databases, key-value databases, wide-column store databases, and graph databases [5]. The objects used to structure NoSQL and their corresponding usage are outlined in Table 1.

Table 1. NoSQL Database Types

NoSQL database types	Structure
document databases	consists of sets of key-value pairs stored in a document. These documents are basic units of data which you can also group into collections (databases) based on their functionality.
key-value databases	dictionary data structure and consists of a set of objects that represent fields of data. Each object is assigned a unique key. To retrieve data stored in a particular object, you need to use a specific key. In turn, you get the value (i.e. data) assigned to the key.
wide-column store databases	data is stored and grouped into separately stored columns instead of rows. Such databases organize information into columns that function similarly to tables in relational databases.
graph databases	Graph databases use flexible graphical representation to manage data. These graphs consist of two elements: Nodes (for storing data entities) and Edges (for storing the relationship between entities)

Source: Authors' own work

The persistence mechanism is a vital component of any software platform, as it directly influences the performance metrics. Consequently, it is compulsory to analyze the business requirements, in the interest of reaching a deep understanding of the features that are to be implemented, and to design an efficient and reliable database architecture. Traditional relational databases are primarily designed to operate on single servers, which can result in performance challenges when dealing with substantial data volumes. On the other hand,

NoSQL databases are specifically engineered to scale horizontally across multiple servers. This horizontal scalability enables them to efficiently manage and process extensive amounts of data without encountering performance issues.

In the context of smart cities, the information is modelled in various and different data structures, the data is continuously generated and sent for processing, and therefore, there have been identified business flows that are both built on flexible data models and handle massive amounts of data and should be managed using a NoSQL database [6]. A NoSQL document database such as MongoDB would fit flawlessly in a scenario where the data is sent through JSON files, and it stores its data in BSON documents, which are the binary representation of JSON files [7], and the information persistence operations should require little to no additional processing. While traditional relational database management systems cannot store Big Data efficiently and should be avoided for such applications, it is unlikely that a software platform that manages a smart city would implement only features that require the use of non-relational databases. Normally, the generated data is stored, and processed and the refined data has to be stored in a more organized data structure, which is accommodated better by a light RDBMS, such as PostgreSQL.

The research has underlined that to build an efficient and reliable database system for a platform that handles and manages Big Data for a Smart City, the architecture should include both, a non-relational database, such as MongoDB, OrientDB, RedisGraph, or Neo4j, for the entities that have a dynamic structure, and a lightweight traditional relational database, such as MariaDB, PostgreSQL, for refined data, or other information that is described by a rigid data model, such as a user profile.

3. The 3Vs of big data (Volume, Velocity, and Variety)

It is crucial for a smart city to have a significant amount of data to be analysed by city administrators to identify patterns, trends, and areas for improvement, leading to more sustainable and livable urban environments. Additionally, the availability of data enables the development of innovative technologies and services that can further enhance the quality of life for residents and promote economic growth. But the data is diverse and dynamic and this includes data related to traffic flow, energy consumption, and public transportation, among others. The essential attributes for data in a smart city context are the 3Vs of big data, which are *Volume*, *Velocity*, and *Variety*.

3.1. First V (Volume)

The astonishing amount of data that could be generated by IoT devices in 2025 is predicted to be 79.4 zettabytes. To put this number into perspective, let's think that an average computer has a storage capacity of around 512GB. Considering this amount of data as being a single drop of water, 79.4 zettabytes would be equivalent to around 3 Olympic pools. As mentioned before the data quantity will soon no longer be a problem because of the technological developments. Looking below (Figure 2) we will see a graph from a popular ML article written by Microsoft researchers [8], in which they worked on natural language disambiguation problems (*homophones = each of two or more words having the same pronunciation but different meanings, origins, or spelling, for example, new and knew).

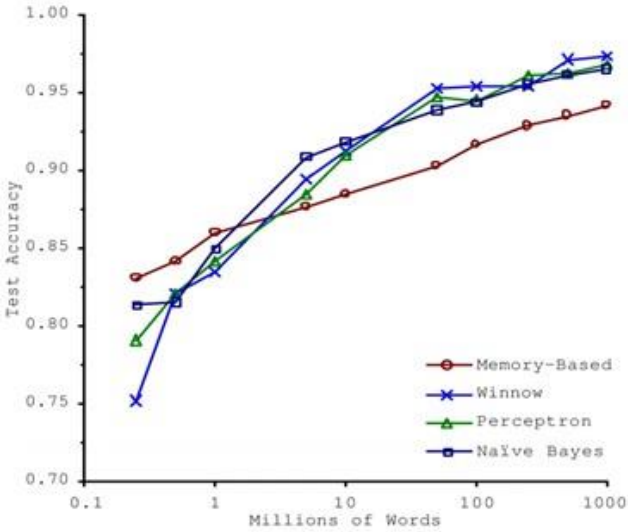

Fig. 2. Machine learning: Learning Curves for Confusion Set Disambiguation.
Source: [8]

In this graph we can see different Machine learning (ML) algorithms and that the larger the dataset, the precision increases. Should we just collect more data, in order to make the models more accurate in a smart city? We can generate our own data that is also relevant for our model. For example, there are Machine learning models that can do image classification, in this scenario we can just rotate the image that is fed to the model to obtain new data.

3.2. Second V (Velocity)

A Machine learning model after it is trained, is a set of parameters that define behavior. In some cases, it remains the same, but sometimes in the context of a smart city, it is not. Because of its dynamic nature, we have to consider that some of the models need to be retrained. Now computational complexity needs to be taken into consideration.

In a smart city, data comes at a faster pace than it can be processed. We can store the data, then process it later and also speed up the procedure with parallel processing. Data cleaning is essentially correcting errors, inconsistencies and inaccuracies by standardizing and normalizing data. We still need to clean data, although we would store it in a NoSQL database because providing uncleaned data to a ML model will affect its performance and reliability. Also, dimensionality reduction is a key improvement, consisting of transforming the original set of characteristics into a new set, which has reduced dimensions (for example, Principal Component Analysis by using linear combinations of the original characteristics). This leads to reduced computational complexity but also affects the performance of the model, as in the graph [9] shown in Figure 3.

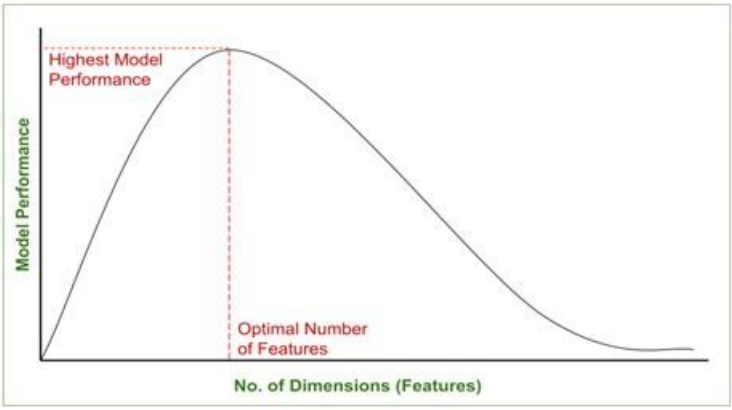

Fig. 3. Model Performance vs No. of Dimensions (Features) – Curse of Dimensionality.
Source: [9]

3.3. Third V (Variety)

The variety of the data comes from the fact that it can be structured, unstructured and semi-structured data. Structured data is often found in SQL databases as it fits neatly into tables, the semi-structured data consists of video files, images, and text documents. So unstructured data needs to undergo processing to extract the important features. The unstructured data consists of files such as JSON, XML, and BJSON and it is most often used in NoSQL databases.

From another perspective, the data could also be categorized as temporal data, geospatial data, multimedia data, numeric data and text data. The sources vary and the opportunities are endless. Having access to abundant data provides a better view of insights, giving the opportunity for a clearer understanding of the complex urban ecosystem that a smart city implies. Machine learning can determine correlations between the data that the human eye cannot perceive, but it is our duty to determine how to use this to our advantage to get closer to the ideal of a smart city.

Before moving forward, the key points of this would be that all the challenges that come when working with big data have a solution and overcoming them is taking our society a step closer to the concept of a smart city. The interconnection between big data, SQL, and NoSQL databases will continue to shape the future of smart cities. As we anticipate further improvements in technology and a growing influx of data sources, the importance of scalable database solutions cannot be overlooked.

4. Case study (some real example/s, e.g., Smart Santander)

In this section, we delve into practical, real-world applications of NoSQL databases in the realm of smart cities, with a focus on the SmartSantander project. SmartSantander proposes an experimental research facility in support of typical applications and services for a smart city. The project envisions the deployment of 20,000 sensors in Belgrade, Guildford, Lübeck and Santander, exploiting a large variety of technologies [10]. This case study exemplifies how NoSQL technology is being leveraged to address the complexities and challenges inherent in managing the voluminous and diverse data generated in a smart

urban environment. Through the SmartSantander project, we aim to highlight the practicalities, benefits, and innovations brought forth by the integration of NoSQL databases in large-scale, data-intensive smart city applications.

The SmartSantander project, a large, open and innovative city-scale experimental research initiative, exemplifies the vital role of NoSQL databases in managing the complex data ecosystem of a smart city. This unique venture aims to transform the city of Santander, Spain, into a smart city by deploying around 12,000 sensors across diverse urban environments. These sensors, utilizing various technologies, support a wide array of smart city applications, highlighting the project's scalability and heterogeneity [11].

The architecture of SmartSantander is designed to be both scalable and trustable, meeting the primary requirements for a real-world IoT experimental platform. This encompasses incorporating essential building blocks necessary for the IoT framework. SmartSantander focuses on validating approaches to the IoT architectural model, evaluating key components of IoT architecture, and assessing the social acceptance of IoT technologies and services. This comprehensive approach underscores the importance of flexible and scalable data management systems, like NoSQL databases, in smart city contexts.

In this context, the massive data sets generated by the extensive sensor network underline the need for databases capable of efficiently handling large and diverse data sets, a hallmark of NoSQL databases. Their inherent design to accommodate a variety of data types and formats makes them particularly suitable for the varied data generated in smart cities. Additionally, the real-time data analysis required for services such as traffic management and emergency response necessitates the speed and efficiency provided by NoSQL databases in data processing and querying. The platform's architecture is delineated into a three-tiered structure (see Figure 4), encompassing IoT devices, gateways, and server tiers, each serving distinct functions within the smart city infrastructure [12].

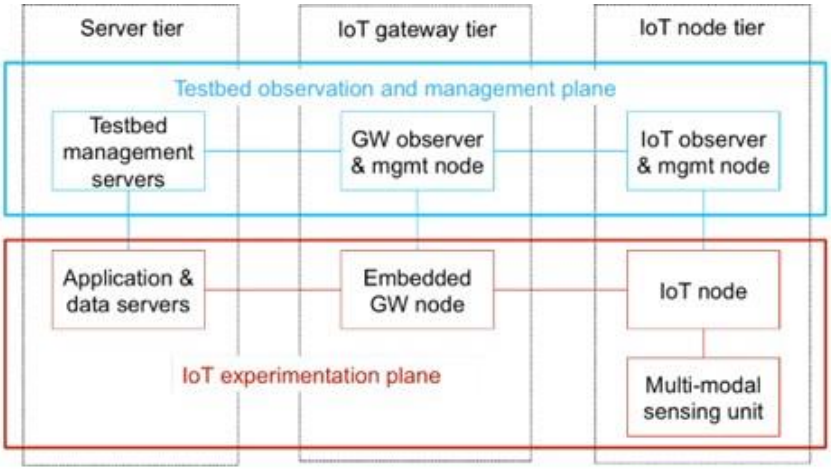

Fig. 4. Logical separation of 3-tier node architecture into a testbed observation and management and an experimentation plane.
Source: [12]

The platform's architecture is designed with a three-tiered structure, consisting of IoT devices, gateways, and server tiers. Each tier has its own specific role and function within the smart city infrastructure:

- *IoT Device Tier*: represents the primary experimental base, includes IoT devices and IoT nodes witch and are responsible for collecting data from various sources within the city. To ensure reliable operation in outdoor conditions, these devices are strategically placed in inaccessible locations and equipped with dual power supplies and communication interfaces, alongside robust management procedures for rapid malfunction detection.
- *IoT Gateway Tier*: serving as an intermediary between the IoT devices and the server tier, this tier links edge IoT devices to the core network infrastructure. Gateways aggregate and preprocess the data collected from the devices before transmitting it to the server tier. They also provide security and connectivity functionalities, ensuring reliable and secure data transmission.
- *Server Tier*: is responsible for processing and analyzing the collected data, it comprises server devices connected directly to the core network. Hosting IoT data repositories and application servers, this tier includes powerful servers and cloud infrastructure that can handle large volumes of data and perform complex analytics ensuring high reliability and availability. The server tier enables data storage, real-time analysis, and the generation of actionable insights that can be used for decision-making and optimizing city operations.

By organizing the architecture into these three tiers, the platform can efficiently manage and process the data collected from IoT devices, ensuring seamless communication, data integrity, and scalability within the smart city infrastructure. Also, this layer provides valuable insights for decision-making and resource optimization. The architecture's design is communication-agnostic, permitting diverse technological implementations. It's bifurcated logically into a *Testbed observation and management plane* and an *IoT experimentation plane*. The former manages dynamic, automated fault management and configuration, while the latter is used for configuring and controlling experiments through APIs. This logical separation does not imply physical segregation, allowing functionalities of both planes to coexist within a single device or to be physically separated to avoid performance impairment on constrained devices. This framework is pivotal in minimizing human intervention and enhancing the manageability of large-scale IoT infrastructures.

Transitioning from the broader perspective of the SmartSantander project's architecture, we delve into a more specific and concrete framework, focusing on the City Data and Analytics Platform (CiDAP) [13]. CiDAP is ingeniously designed as a middle layer interfacing between various data sources and the applications that serve a smart city. Its architecture consists of several critical components explained in Table 2.

Table 2. Base components in City Data and Analytics Platform (CiDAP)

IoT-Broker and IoT-Agents	These elements are pivotal for data collection. The IoT-broker harmonizes communication with IoT-agents, which function as intermediaries for different data sources, managing the intricate details of numerous sensor nodes.

Big Data Repository	This is the core where data storage is meticulously managed. The sensor data, harvested through IoT-agents, are securely stored as JSON documents within a NoSQL database. CouchDB has been selected for its robustness and suitability for handling the voluminous data characteristic of smart cities.
Big Data Processing	To handle the intensive data processing and analytics, this module leverages the power of a Spark cluster. This setup provides the necessary scalable and flexible computation resources to process and analyze large data sets effectively.
City Model Server	This server acts as the communication hub with external applications. It utilizes predefined City Model APIs to manage queries and subscriptions, facilitating a seamless flow of information between the platform and its users.

Source: Authors' own work

The data collection in CiDAP is diverse, encompassing semi-structured data like sensor information in JSON format and unstructured data such as social media texts and surveillance images/videos. This assortment of data is efficiently managed through the IoT-broker and IoT-agents. Data processing in CiDAP is categorized into two distinct types: internal and external. Internal processing is confined within the CouchDB database and mainly involves creating indexed views through map and reduce functions. In contrast, external processing, which encompasses more complex data analytics, is executed outside CouchDB, utilizing the extensive capabilities of the Spark cluster.

The CityModel API plays a crucial role in interfacing external applications with the CiDAP platform. It supports various types of queries, from simple ones that provide a snapshot of the latest sensor status to complex queries that delve into historical data. Additionally, it offers subscription services for continuous data updates. The IoT-broker, derived from NEC's open-source project Aeron, along with the CityModel server and platform management portal developed in JavaScript, based on the NodeJS platform, demonstrate the platform's versatility. The deployment of anomaly detection for traffic sensors and the integration of a comprehensive dashboard service highlight the platform's practical applicability in a real-world smart city scenario. Incorporated below is a diagram that visually represents the CiDAP architecture, illustrating the interconnectedness of its various components and the flow of data between them.

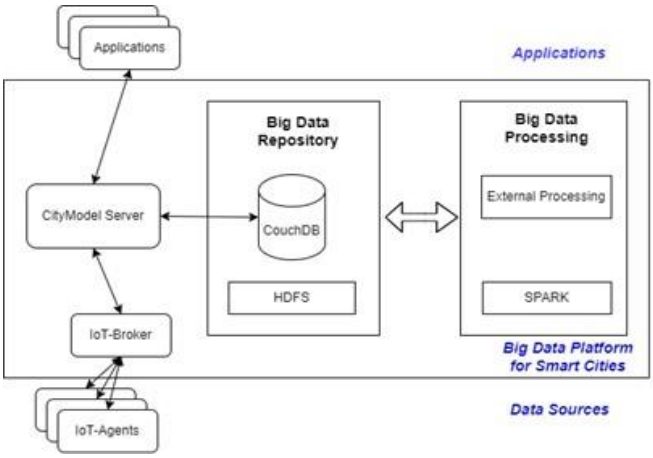

Fig. 5. CiDAP Architecture Diagram.
Source: [13]

This is achieved by including a broad set of applications that demonstrate the platform's utility and its impact on citizens, emphasizing the diversity, dynamics, and scale required for advanced protocol solutions. Based on this architecture, SmartSantander offers an Experimentation Facility among the scientific community, end users, and service providers including a set of applications that follow the development of measurements for utility and its impact on citizens, emphasizing the diversity, dynamics, and scale.

SmartSantander has become a model for smart cities worldwide for several key applications workflows and management that need to be implemented in all smart city frameworks [10]:

Table 3. SmartSantander applications

Environmental Monitoring	SmartSantander introduces a paradigm shift by deploying a vast network of low-cost IoT sensors, providing data on air quality, noise levels, and luminosity across extensive areas. While these sensors may not match the precision of traditional equipment, their widespread distribution allows for intelligent data processing to achieve sufficiently accurate environmental assessments.
Outdoor Parking Management and Driver Guidance	SmartSantander involves deploying ferromagnetic wireless sensors under the asphalt of parking bays in the city center. These sensors monitor parking space occupancy and connect to the internet through repeaters, enabling real-time dissemination of parking availability to drivers and traffic control centres. This system also aids municipal authorities in analyzing parking patterns and making informed decisions about parking provisions.
Parks and Gardens Precision Irrigation	SmartSantander has augmented existing automated irrigation systems in parks and gardens with IoT devices. These devices collect data on environmental conditions like air and soil temperature, humidity, leaf wetness, and rainfall. This precision approach replaces the traditional schedule-based systems, significantly enhancing irrigation efficiency and reducing water wastage.
Augmented Reality	This application involves enhancing the cityscape with IoT endpoints to provide context-sensitive information and services. Visitors interacting with these tags through their mobile phones receive information and services relevant to their location. For instance, tourists can enjoy an augmented reality experience with descriptions of monuments in their preferred language.
Participatory Sensing	Citizens' mobile phones double as sensors, contributing data like GPS coordinates, environmental conditions (noise, temperature), and direction to the SmartSantander platform. Users can subscribe to services like alerts for specific city events and contribute to the data pool by reporting occurrences, enhancing community engagement and responsiveness.

Source: Authors' own work

These real applications of the SmartSantander project showcase the transformative potential of IoT in urban environments. By integrating technology into everyday city operations and citizen engagement, SmartSantander leads the way in smart city development, enhancing urban living through technology-driven solutions. In conclusion, SmartSantander serves as a compelling case study for the application of NoSQL databases

in smart cities. Its scale, diversity, and technological sophistication underscore the advantages of using NoSQL databases in managing the complex and voluminous data inherent in smart city environments.

5. Conclusions

The evolution of devices and sensors in a city has led to a significant growth in data. As the volume, velocity, and variety of data continue to increase, there is a growing need for large, flexible, and open system databases. These databases play a crucial role in managing and accessing complex and large volumes of data, enabling efficient storage, retrieval, and analysis. By utilizing such databases, cities can effectively handle the diverse and dynamic nature of data generated by devices and sensors. The integration of both SQL and NoSQL database systems plays a crucial role in the advancement of data management within smart cities, contributing to the evolution of urban landscapes. Given the dynamic nature of smart cities, careful consideration is required when selecting a database architecture. SQL databases excel in managing structured data, providing robustness and reliability. On the other hand, NoSQL databases offer flexibility in handling unstructured and real-time data, accommodating the diverse and rapidly changing data generated in smart city environments. By leveraging the strengths of both SQL and NoSQL databases, smart cities can effectively manage and analyze data, enabling informed decision-making and facilitating the development of innovative solutions for urban challenges.

The SmartSantander project, particularly through the CiDAP framework, provides a vivid illustration of the practical applications of NoSQL databases in smart city environments. The strengths of NoSQL databases are clearly evident in this context: their ability to handle large volumes of diverse data efficiently, their scalability to accommodate the rapid expansion of urban IoT networks, and their flexibility in data modelling, which is crucial for processing the varied data generated by a smart city. These attributes make NoSQL databases particularly suitable for the dynamic and heterogeneous nature of smart city data. A lesson learned within the SmartSantander project was that the initial version of the database system was based on SQL relational databases (e.g. used to store resource descriptions) but to meet the new requirements, it was replaced with a MongoDB (NoSQL) to ensure flexible handling of various resource description documents and better performance [14] [15].

Also, there is a need to establish a universal standard that would increase the speed of the development process. Creating a standard means that all researchers work towards the same goal and after it is tested and implemented for the first time, the only thing left is to replicate that for another city from the European Union. By creating a common foundation, we can unlock the true potential of this data-driven system that could delve more into detail about the economic and social effects of implementing a benchmark [16]. On the other hand, some aspects should be taken into consideration, like resilience, reliability and security of NoSQL database systems. Cyber security and data privacy represent a concern, through securing and encrypt communications between IoT devices, sensors, fog and cloud architectures to avoid attacks on the city infrastructure and information theft.

In summary, while NoSQL databases offer significant advantages for smart city applications, there remains a need for ongoing innovation and development in areas of standardization, data integrity, and advanced analytics to fully realize their potential in this rapidly evolving field. The establishment of a standardized database framework propels the development of smart cities forward and sets the stage for interconnected smart cities taking humanity towards an intelligent and technology-driven future.

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Disinformation using artificial intelligence technologies – a key component of Russian hybrid warfare

Ina VIRTOSU,
PhD in EU Law, University of Macau, SAR Macau, China
yb67199@connect.um.edu.mo, ivirtosu3@gmail.com

Mihai GOIAN,
PhD Student, National School of Political and Administrative Studies SNSPA, Romania
mihai.goian.22@drd.snspa.ro

Abstract
For over a decade, the Russian Federation has been at the forefront of hybrid warfare, deploying highly developed capabilities to carry out cyberattacks, political and social subversion, the exploitation of societal tensions, corrupt financial influence, and disinformation operations campaigns worldwide. The primary objective of Russia's disinformation campaign is to distort public opinion formation, undermine confidence in institutions, denigrate political leadership, widen social divide, and meddle with election processes where it has a certain level of interest. The Russian invasion of Ukraine has brought with it a deluge of disinformation and misinformation. Although it became routine for major events to generate fabricated news, images, and video, the war in Ukraine is featuring a whole new set of characteristics and the extensive use of machine learning that will influence how readers react to fake media. Fast advancements in information technology, particularly the use of artificial intelligence (AI), have changed the methods in which information and disinformation may be created and disseminated, making more difficult to differentiate falsehood from real information. In such tensioned environment, websites born to churn out misinformation that operate purely for spreading Kremlin propaganda have launched a real campaign to defend Kremlin right to war. This research paper explores the use of AI in the context of Russian hybrid war, such as user profiling, bot farms, micro-targeting, and deep fakes. The article also examines the ways in which AI can be used to counter such disinformation online and reviews a number of solutions that could help address the spread of AI-powered disinformation for improving the online environment.

Keywords: social media, artificial intelligence, algorithms, fact-check, deep fakes.

1. Introduction
Months before Russian soldiers invaded Ukraine on February 24, 2022, false narratives about Ukraine and its allies began to circulate online, many of which were supported by the Kremlin's disinformation organization. These and hundreds of other charges, ranging from bogus claims of Ukrainian genocide intended towards Russian-speaking Ukrainians to statements that Nazi ideology drives Ukraine's political leadership, have been used to justify Russia's right to war and full-scale invasion of Ukraine.

Only NewsGuard alone has debunked more than 100 false narratives in only one year related to the Russia-Ukraine war and identified more than 350 sites spreading those myths [1]. While most myths disavow Russia's alleged atrocities and other abuses in Ukraine or demonize Ukrainians, NewsGuard has also debunked some pro-Ukrainian and anti-Russian myths, ranging from manipulated images of the mythical Ghost of Kyiv to misleading footage of alleged Russian attacks [2].

A prevalent concern is that modern warfare methods, like as large-scale Russian propaganda efforts, are being utilised to mould the narrative around the war, despite the

fact that relevant research is still in its infancy. On the one hand, the Russian government implemented new legislation that gave it control over conventional media sources in order to encourage its citizens to support the war. As a result, domestic news sources are compelled to follow the government narrative [3]. On the other hand, Russian propaganda has been suspected to influence other countries outside Russia, in particular, by using AI, and social media to promote hostility against the West.

AI and its subcomponents, such as algorithms and machine learning, are powerful instruments for creating and disseminating disinformation about the Russia-Ukraine conflict, particularly on social media. Even before the war, there have been extremely provocative reports concerning the emergence of a "weaponized AI propaganda machine".

2. The concept of hybrid warfare

2.1. Definition and characteristics of hybrid warfare

Hybrid warfare is a concept that describes the use of a combination of military and non-military tactics to achieve political and military objectives [4]. This concept has gained popularity in the context of contemporary conflicts, where actors use their available resources and tools to influence adversaries and promote their own strategic interests. In a hybrid war, military tactics such as special operations, espionage, special forces, and asymmetric operations are combined with non-military methods, such as propaganda, disinformation, manipulation of public opinion, cyber-attacks, and subversion [4]. This combination of diverse and flexible actions makes hybrid warfare difficult to identify and counter by the involved adversaries.

Russia has been one of the key players involved in hybrid warfare. Russia's strategic objectives in this context include weakening adversaries, destabilizing neighboring regions, and expanding their geopolitical influence [5]. To achieve these objectives, Russia uses a wide range of tactics and strategies in hybrid warfare. Among the tactics used by Russia are propaganda and disinformation. These aim to manipulate public opinion by creating and promoting false and manipulative narratives [6].Propaganda and disinformation are disseminated through state-controlled media, online platforms, and social networks, with the aim of influencing and undermining the position of adversaries. In addition, Russia uses cyber-attacks and hacking operations to distort and manipulate information, as well as to compromise the digital systems and infrastructure of other states [7]. These attacks can target government institutions, non-governmental organizations, private companies, and even critical infrastructure. Russia also uses subversive tactics to destabilize adversaries. These tactics include supporting insurgent and terrorist groups, organizing protests and civil unrest, and supporting separatism in targeted regions [4].

2.2. Disinformation as a key component of hybrid warfare

In the context of hybrid warfare, disinformation plays a crucial role in the strategies used by unfriendly states or actors to achieve their political and military objectives. Disinformation refers to the deliberate dissemination of false or manipulative information, with the aim of creating confusion, influencing public opinion, and undermining trust in legitimate information sources [8] [7].

It is important to understand the definition and characteristics of disinformation in the context of hybrid warfare, as they help us to recognize and counter the disinformation strategies used in this context [8]. By recognizing and understanding how disinformation is used to manipulate public opinion, we can develop effective strategies and tactics to counter this phenomenon [8].

Key characteristics of disinformation in the context of hybrid warfare include:

a) *Information manipulation.* Disinformation involves manipulating and distorting information to support the agenda or interests of the promoter. This can include creating false narratives, intentional omissions, distorted interpretations, or selectively presenting information to create a deceptive perception.
b) *Use of unidentified or false sources.* Disinformation in the context of hybrid warfare may involve the use of unidentified or false sources to support and promote manipulative information. This can make it difficult to verify and authenticate information and can create confusion among the public.
c) *Amplification and rapid spread through technology*. Modern technologies, such as social networks and online platforms, facilitate the rapid and massive spread of disinformation. They enable the propagation of false or manipulative information to a large number of people in a short time, thereby creating a significant impact on public opinion.
d) *Targeting key audiences.* Disinformation in the context of hybrid warfare is often directed towards certain key audiences, such as ethnic communities, interest groups, or specific socio-demographic categories. By tailoring the disinformation messages for these audiences, it aims to influence their perceptions and attitudes in a specific way.
e) *Creating chaos and instability*. Disinformation in the context of hybrid warfare often aims to create chaos, instability, and confusion in the target society. By spreading false and manipulative information, it seeks to undermine trust in institutions and fuel existing tensions and divisions in society.

It is also important to be aware of the impact disinformation can have on society and national security. The propagation of false information and the manipulation of public opinion can weaken social stability, create tensions and divisions, and undermine trust in institutions and democratic processes. Therefore, combating and countering disinformation in hybrid warfare must be a priority for governments, organizations, and civil society.

3. Pillars and composition of Russia disinformation and propaganda ecosystem

3.1. Pillars of Russian disinformation and propaganda

Russia has been using the whole playbook of information manipulation and interference, including disinformation, in an attempt to sow divisions in the societies, denigrate democratic processes and institutions and rally support for its imperialist policies. Russia's full-scale invasion of Ukraine on February 24, 2022 has shown, again, the wide spectrum of tactics, techniques and behaviour (TTPs) used in the information environment, while building mostly on well-known disinformation narratives.

Ukraine has been the first target of Russia's foreign information manipulation and interference. The invasion is the culmination of Russia's years-long propaganda campaign and involvement aimed at undermining Ukraine's sovereignty and territorial integrity. Almost all of the misinformation narratives employed by the Kremlin to explain and mobilise domestic support for the invasion can be traced back to 2013-2014, and the Euromaidan protests, during which the Kremlin attempted to depict Ukraine as a "Nazi state", a "failed state", and "not a state at all". For years, pro-Kremlin media has been setting ground for a military invasion. According to EU foreign policy chief Josep Borrell, "this war is not only conducted on the battlefield by the soldiers, but also waged in the information space trying to win the hearts and minds of the people", the EU agencies having plenty of evidence that Russia is behind coordinated attempts to manipulate public debates in open societies [9].

There are several pillars of disinformation and propaganda used by Russia to promote its agenda and influence public opinion. These pillars were identified in a report by the U.S. Department of State and include the following:

a) *Strategic disinformation.* Russia utilizes disinformation as a strategic tool to distort facts and create an alternate reality that supports its political and geostrategic objectives (Russia's Pillars of Disinformation and Propaganda Report, 2019). This is a complex process that involves creating false narratives and manipulating information in a coordinated manner.
b) *Emotional Manipulation*. Russia employs techniques of emotional manipulation to influence and evoke intense reactions among the public. This includes the use of shocking imagery, inflammatory speeches, and content that evokes fear, anger, or outrage (Russia's Pillars of Disinformation and Propaganda Report, 2019). The aim is to provoke strong emotional reactions that can impact individuals' judgment and critical reasoning.
c) *Creating diversions*. Russia uses disinformation and propaganda to create diversions and divert public attention from real issues or its own actions. This may include promoting conspiracy theories or spreading false information to create confusion and distract attention from important subjects (Russia's Pillars of Disinformation and Propaganda Report, 2019).
d) *Manipulation of the information environment*. Russia employs a variety of tactics to manipulate the information environment, including controlling and influencing the mass media, cyber attacks on websites and information platforms, as well as the use of bots and online trolls to amplify disinformation content (Russia's Pillars of Disinformation and Propaganda Report, 2019). These tactics contribute to the spread and amplification of manipulative and disinformation messages.

According to a report of the European External Actions Service, Russia uses a multitude of tactics to control narratives in its disinformation campaigns, which can be broadly divided in so-called 5D tactics:

a) Dismiss tactics is used to push back against criticism, deny allegations and denigrate the source;
b) Distort tactics to change the framing and twist and change the narrative;
c) Distract tactics to turn attention to a different actor or narrative or to shift the blame;

d) Dismay tactics to threaten and scare of opponents;
e) Divide tactics to create conflict and widen divisions within or between communities and groups [10].

According to the same report, in the case of incidents carried out by channels linked to Russia, 42% were intended to distract [10]. The large majority of incidents was used in the context of the Russian invasion of Ukraine, to turn attention to a different actor/narrative or to shift the blame (namely to Ukraine and the EU). Another 35% aimed to distort, twist and frame narratives around the Russian invasion of Ukraine and to deliver attacks against the Ukrainian government and EU officials and institutions (such as the HR/VP) [10]. All incidents related to the energy crisis were also linked to these two objectives. Russia used the divide objective in incidents highlighting the West's alleged Russophobia or promoting Russian worldwide influence in order to create conflict and widen divisions within or between communities and groups. Top-targeted entities by these incidents were the government of Kosovo (in the context of the tensions with Serbia) and Poland [10].

3.2. Disinformation methods used by Russia

3.2.1. Creation and promotion of false narratives

The use of informational technologies in disinformation often involves the creation and promotion of false narratives. Russia uses this tactic to manipulate public opinion and undermine adversaries. By creating false narratives, Russia tries to create and promote distorted versions of events and influence public perception [7]. These narratives can be propagated through state-controlled media, social media platforms, and websites.

A notorious example of using false narratives is Russia's intervention in the conflict in Ukraine. Russia has created and propagated false narratives that present Russia as a "protector" of the Russian-speaking population in Ukraine and claim that Ukraine is governed by fascists [5]. These narratives have resulted in an increase in tensions between Russia and Ukraine and have contributed to the escalation of the conflict.

3.2.2. Using bots and online trolls to amplify disinformation

Russia often uses bots and online trolls to amplify disinformation and influence public discourse. Bots are computer programs that mimic human behavior on online platforms, and trolls are individuals who deliberately post and promote false or manipulative information [11]. These bots and trolls are used to create the illusion that certain opinions or narratives are more popular and supported than they actually are. They can disseminate disinformative content en masse and generate a large volume of activity on social media platforms, making false information seem credible and have a greater impact on the public [12]. A notorious example of the use of bots and online trolls is Russia's intervention in the 2016 US presidential election. Russia used bots and trolls to amplify disinformative messages and influence public opinion, thus creating an atmosphere of disinformation and confusion during the election campaign [6].

3.2.3. Cyberattacks and hacks to distort and manipulate information

Russia uses cyberattacks and hacks to distort and manipulate information. These attacks can target the systems and digital infrastructure of other states, government institutions,

and non-governmental organizations, as well as individuals. Through cyberattacks, Russia can gain unauthorized access to sensitive information and modify or distort them for disinformative purposes [7]. It can also compromise systems and digital infrastructure to create chaos and disrupt the normal functioning of institutions and organizations. A significant example is the cyberattack on the Democratic National Committee (DNC) in the US in 2016, attributed to Russia. Through this cybercrime, the party's confidential information was compromised and revealed to the public, having a significant impact on the election campaign and the party's image [8].

3.2.4. Use of personal information and targeted disinformation to influence public opinion

Russia uses personal information and targeted disinformation to influence public opinion and manipulate individuals. By collecting and analyzing personal data, Russia can gain a deeper understanding of individual interests and preferences and can tailor disinformative messages to attract and manipulate them. Also, through targeted disinformation, Russia can create and distribute personalized content to specific groups of people. This approach allows for more efficient and precise influence over these groups, increasing the chances of achieving the desired results. A notorious example is the use of personal data stolen during the cyberattack on Facebook by Cambridge Analytica, a political consulting firm associated with Russia [13]. This data was used to create psychological profiles of users and deliver personalized messages to influence voting and manipulate public opinion in elections.

In conclusion, Russia uses a variety of methods in disinformation. These methods have a significant impact on public opinion, national security, and electoral processes, contributing to the spread of disinformation and undermining trust in information and institutions.

3.3. State and non-state Russian actors involved in disinformation

According to a report published by the Global Engagement Center (GEC) at the US Department of State, Russian propaganda ecosystem is composed by different networks of online and offline channels attributed and/or connected to the official infrastructure of the government or ruling party [14]. The array of disinformation channels is very diverse and the degree of connections with Kremlin range from visible to obscure and denied. These online channels, including websites, YouTube channels, groups, and profiles on social media, have been attributed according to high-confidence level indicators and can be classified in several groups:

1. Official communication channels.
    a) Official Government communication channels officially used by Kremlin and ministries, agencies, and its representatives to deliver statements, which includes official websites of a state or social media accounts;
    b) State-controlled media channels with an official affiliation to a state-actor. They are majority-owned by a state or ruling party, managed by government appointed bodies and they follow an editorial line imposed by state authoritie;
    c) Statement or quotes used by Russian officials.

2. State-linked global channels.
    a) State funded foreign audience media, such as Sputnik Mundo or RT Arabic;
    b) State funded national audience media, such as Pervîi Canal, RIA Novosti or Rossiya 24;
    c) State funded, foreign based media, such as Novosti Moldova or Newsmaker.md;
    d) International Russian socio-cultural institutions, such as different NGOs, think tanks and foundations that either it has funded by the government or Russian-government-associated oligarchs to spread false messages and propaganda.
3. channels facing with no transparent links nor an official affiliation to a state actor, but their attribution has been confirmed by organisations with access to privileged backend data sources, such as digital platforms, intelligence and cyber security entities, or by governments or military services based on classified information. These channels are also called proxy sources.
    a) Russia aligned outlet with global reach, such as Global Reach and News Front;
    b) Local language specific outlet, such as Compact Magazine (Germany);
    c) Witting proliferators of Russian narrative;
    d) Unwitting proliferators of Russian narrative;
    e) Foreign state narrative amplification.
    f) Weaponization of social media.
    g) Infiltration of domestic conversation;
    h) Standing campaign to undermine faith in institutions;
    i) Amplification of protests or civil discord.
    j) Cyber enabled disinformation
    k) Hack and release;
    l) Site capture;
    m) Cloned website;
    n) Forgeries;
    o) Disruption of official sources or objective media [15].

This ecosystem strategy is also well-suited to promote Russia's overarching goals of undermining democratic institutions and undermining the international legitimacy and cohesiveness of other democratic countries. Because some pillars of this ecosystem generate their own momentum rather than relying on specific orders from the Kremlin on every occasion, they can be responsive to specific policy goals or developing situations, and then pivot back to their status quo of generally slamming Russia's perceived adversaries.

Internet Research Agency (IRA) is a well-known Russian company engaged in online influence operations on behalf of Russian business and political interests. According to the Mueller Report released in 2017 [15], the IRA was using social media to subvert the political process and is at the core of the federal prosecution. They have been gathering sensitive information on thousands of Americans, such as names, addresses, phone numbers, email addresses, and other important data. The IRA campaign during the 2016

US presidential election was deeply sophisticated and mainly aimed at instigating the social media users against each other on socio-economic grounds, political sentiments, and voting perceptions [16].

As was stated previously, disinformation in the context of hybrid warfare is not limited to spreading false and manipulative information but also involves cyber activities and hackers supporting these disinformation efforts. Russia has a rich history of utilizing hacker groups to advance its political agenda and achieve strategic objectives. One notable example is the hacker group known as Fancy Bear or APT28. This group is believed to be associated with Russian intelligence agencies and is accused of numerous cyber attacks and disinformation operations. Fancy Bear has been involved in various incidents, including attacks on foreign government organizations and institutions, as well as hacking campaigns and cyber espionage [17].

Another hacker group with ties to Russia in Cozy Bear or APT29. This group has been associated with Russia's Foreign Intelligence Service (SVR) and is involved in sophisticated cyber attacks and global espionage operations. Cozy Bear has been identified as responsible for cyber attacks on government organizations, companies, and institutions in the United States, Europe, and other parts of the world [17].

These Russian hacker groups have played a significant role in supporting disinformation efforts through unauthorized acquisition of information, infiltration and manipulation of information systems, as well as the spread of false or manipulative content. Their activities are often coordinated and supported by state institutions, posing a serious threat to cybersecurity and informational integrity. Monitoring and countering Russian hacker groups are essential components in the efforts to combat disinformation in hybrid warfare. Enhancing cybersecurity capabilities, international collaboration in detecting and responding to cyber attacks, and implementing appropriate preventive measures are critical aspects in protecting infrastructure and sensitive information against these threats.

Pro-Kremlin outlets have also been instrumental in justifying and obfuscating war crimes and atrocities committed by Russian soldiers in Ukraine. Further enhanced by the Russian losses on the battlefield, hate speech and incitement to genocide became a regular occurrence in Russian outlets, both offline and online. Narratives supporting the war permeate not just political life and news, but also entertainment content. Print and TV media are the most frequent targets of Moscow’s impersonation, in particular when targeting Ukraine. Despite Russian state-controlled media being banned by some social platforms, such as Meta, Russian disinformation operations have continued on social networks with thousands of unsophisticated accounts flooding the online environment with Russian views on the invasion. They also can use the news anchor deep fakes on platforms including Facebook, Twitter and YouTube while monitoring disinformation operations that the research firm has dubbed “spamouflage”.

Spamouflage refers to an extensive network of Moscow linked accounts that disseminate pro-Russia propaganda. After Russia invaded Ukraine in February 2022, the EU moved to block RT and Sputnik, two of the Kremlin’s top channels for spreading propaganda and

misinformation about the war. Nearly six months later, the number of sites pushing that same content has exploded as Russia found ways to evade the ban. They have rebranded their work to disguise it. They have shifted some propaganda duties to diplomats. Indeed, Russia's diplomatic corps serves as a worldwide propaganda network, with hundreds of social media profiles on every continent, where the same statements may be rehashed and adjusted for various audiences in different countries.

Kremlin propaganda machine also has cut and pasted much of the content on new websites – ones that until now had no obvious ties to Russia. Some of the sites pose as independent think tanks or news outlets. About half are English language, while others are in French, German or Italian. Many were set up long before the war and were not obviously tied to the Russian government until they suddenly began parroting Kremlin talking points. For instance, Yala News claims to offer impartial news, but BBC analysis has shown most of its content directly mirrors stories on Russian state-backed media sites – and that it actually operates out of Syria [18].

According to Crovitz, NewsGuard co-CEO, Russian propaganda actors may establish sleeper sites, which are created for a disinformation campaign that lay largely dormant, slowly building an audience through innocuous or unrelated posts, and then switching to propaganda or disinformation at an appointed time [19]. The proliferation of sites spreading disinformation about the war in Ukraine shows that Russia had a plan in case governments or tech companies tried to restrict RT and Sputnik. Russian influence operations use third parties' news companies and their sites, which acts as a "Kremlin loudspeaker" in different parts of the world. These can be noticed by analysing the timeframe and similarities in their stories. This process is called "information laundering" and it is defined as the dissemination of news, whether true or misleading, from unconfirmed sources into the mainstream [20]. Meleshevich and Schafer compare such process with money laundering by stating that in advancing disinformation in such a way that makes it accepted as ostensibly legitimate information into ostensibly legitimate funds [21]. This process is done through occurrence of three phases: placement, layering and integration [21].

The initial publication of false material on a website or social media account is referred to as placement. Disinformation operations, like financial criminals, rely on specific sorts of social media accounts that may distribute information in a way that conceals both its goal and its source. Social media accounts offer disinformation campaigns free access to a platform from which information can be spread, and in many cases the public account ownership need not have any link to the true owner [21].

Layering describes how misinformation flows from one source to other plausible sources, acquiring credibility through reposts, likes, and shares. The phrase refers to the use of intermediate firms, banks, and people to transmit money across borders and through various types of financial instruments in order to break the link between origin and beneficiary. As proven by recent law enforcement instances highlighting how intermediaries transfer cash previously deposited into the financial system in order to offer more distance from the source, third-party money launderers play a critical role in successful money laundering schemes [21]. Layering has two forms in misinformation efforts. The first is the

employment of middlemen who appear to have no connection to the source of the material. The second sort of stacking occurs via indirect citations (also known as cascading citations) from unverified social media posts to seemingly reputable news sites.

Integration refers to the point at which purposely deceptive material is embraced by credible news sources or extensively distributed by genuine people on social media platforms. For misinformation peddlers, success translates to influence, and extensive political and social impact occurs when falsehood is woven into public discourse. Disinformation that has been successfully assimilated is difficult to spot. Once a false rumour enters the mainstream, it is nearly tough to disprove, even if it is later discredited [21]. To achieve their goal, propagandists just need to penetrate the permeable layer between doubtful and legitimate news sites – whether the content itself bears up to deeper investigation is practically immaterial.

Russia's ability to successfully conduct hybrid warfare is predicated on the creation of a fog of ambiguity between the Kremlin's actions and the Kremlin itself. By conducting operations through an ad hoc network of proxies, carve-outs, and cutouts – whose connection to the Kremlin is difficult to definitively establish – the Russian government is able to maintain plausible deniability and thus lower the diplomatic and military costs of its actions.

4. The use of information technology in disinformation

4.1. Impact of technology on the spread of misinformation

It has been already demonstrated that online fake news spreads much more quickly and more widely than real news [22]. According to Susarla, online posts with fake information get more views, comments and likes than those with accurate content [23]. In an online when viewers' attention spans are limited and material options abound, it appears that false information is more interesting or engaging to viewers. The problem is getting worse: nowadays are more fake news than real information. This could bring about a phenomenon that researchers have dubbed "reality vertigo" – in which computers can generate such convincing content that regular people may have a hard time figuring out what's true anymore [23].

Falsehood diffused significantly farther, faster, deeper, and more broadly than the truth in all categories of information, and contrary to conventional wisdom, robots accelerated the spread of true and false news at the same rate, implying that false news spreads more than the truth because humans, not robots, are more likely to spread it. Advancements with generative AI tools have sparked concerns about the technology's capacity to create and disseminate disinformation at an unprecedented scale. These technological advancements come with concerns that Russia are taking to try to control narratives about everything from foreign policy to the war in Ukraine using AI. The skill and efficiency with which AI can generate disinformation is particularly worrying as is more difficult to detect and make difference between fake and real news.

Thus, the use of information technologies in disinformation has broad-reaching societal effects, which can be followings:

a) *Weakening public trust in information sources and democratic institutions.* The use of information technology in disinformation significantly impacts public trust

in information sources and democratic institutions. Propaganda and disinformation, fueled by information technology, undermine trust in the media, government organizations, and other institutions essential to a democratic society. For instance, studies show that disinformation and information manipulation on social networks and online platforms have led to a decrease in public trust in traditional media and government institutions [24] [25]. This severely affects the functioning of democracy, as trust in democratic information and institutions is crucial for informed decision-making and civic participation.

b) *Dividing and polarizing society through propagation of conflicts and tensions.* The use of information technology in disinformation contributes to dividing and polarizing society by propagating conflicts and tensions. Targeted disinformation and information manipulation can fuel ideological, ethnic, political, and social disputes and conflicts. Studies show that the use of information technology in disinformation on social networks and online platforms has led to an increase in polarization and tensions among the population [24] [25]. This is because targeted disinformation and information manipulation contribute to the creation of information bubbles and the promotion of extremist beliefs and perspectives among users. This phenomenon can lead to increased divisions and tensions in society, weakening social cohesion and affecting the ability to reach consensus and act collectively to address common problems.

c) *Undermining electoral processes and influencing results.* The use of information technology in disinformation can undermine electoral processes and influence their outcomes. Through targeted disinformation and propaganda, Russia and other actors can manipulate public opinion and affect voters' decisions. Recent studies and investigations have highlighted the influence of disinformation on electoral processes [6]. For example, in the 2016 US presidential elections, disinformation and the spread of false content significantly impacted public opinion and the election outcome. Russia was accused of using disinformation, bots, and online trolls to amplify disinformation messages and influence public opinion in favor of certain candidates [25]. This type of intervention in electoral processes undermines democratic integrity and can compromise the representativeness and legitimacy of the results.

d) *Increasing confusion and uncertainty in society.* The use of information technology in disinformation contributes to increasing confusion and uncertainty in society. Information manipulation and disinformation spread can lead to the emergence of conspiracy theories, multiple versions of events, and misinterpretations of reality. This creates a climate of uncertainty and difficulty in determining the truth. People are exposed to a wide variety of information, and disinformation and information manipulation make the process of verifying and evaluating these more difficult [24]. The increase in confusion and uncertainty can have serious consequences for society, as people may be influenced to make uninformed decisions, adopt extreme attitudes, or fail to act appropriately in the face of real threats.

e) *Impact on national security and international relations.* The use of information technology in disinformation also has an impact on national security and international relations. By propagating disinformation and manipulating information, Russia and other states can create tensions and conflicts between

states and undermine international trust and cooperation. Disinformation can be used to fuel anti-Western, anti-EU, or anti-NATO sentiments in certain countries, which can weaken existing security alliances and relations. It can also be used to justify aggressive actions or military interventions, undermining regional stability and security. In international relations, the use of information technology in disinformation can create tensions and conflicts betweenstates, leading to the deterioration of diplomatic relations and possibly even escalation of hostilities. An example of this was seen in the conflict between Ukraine and Russia, where disinformation played a significant role in exacerbating tensions and conflicts [26].

f) *Manipulating public opinion through mass media and social networks.* The use of information technology in disinformation also involves manipulating public opinion through mass media and social networks. Russia and other states utilize media channels to disseminate false and manipulative information strategically, with the aim of influencing public perceptions and attitudes [27]. This manipulation of public opinion can have significant consequences in society. It can create divisions, fuel tensions, and contribute to the polarization of public opinion. Furthermore, it can undermine public trust in the media and presented information, thus affecting the functioning of democracy and the process of informed decision-making.

5. Russia's information war is being waged mostly on social media platforms

Throughout the Russia-Ukraine war, concerns regarding misinformation have risen across a range of social platforms. The variety of social media platforms in use, as well as the differences in their availability between countries, makes it difficult to coordinate efforts to counteract disinformation while generating various information ecosystems across different geographic territories. The narratives about the ongoing war that are developing on social media vary based on the platform and location, including within Russia and Ukraine. Although Facebook and Twitter are both banned within Russia, Russian propaganda and misinformation directed at external audiences continues to flourish and expand on both platforms. YouTube and TikTok are still available to ordinary residents in Russia, but with significant censorship. Nowadays the most popular social media platform used within Russia is VKontakte (VK), which hosts 90% of internet users in Russia, followed by Odnoklasniki (ok.ru) [28]. It was previously available and widely used in Ukraine until 2017, when the Ukrainian government blocked access to VK and other Russian social media in an effort to combat online Russian propaganda [29]. Also, on September 26, 2022, the VK application (as well as other applications of the holding services) was removed from the Apple App Store due to international sanctions.

Across Telegram – a social media network that is now a battleground between pro-Ukrainian and pro-Russian camps – channels with tens of thousands of subscribers have posted grainy war footage of alleged atrocities or of military vehicles heading toward Kyiv, though much of this content was either taken out of context or reused from previous conflicts. Nowadays, Telegram is the main social media platform accessible to both Russians and Ukrainians. Telegram is an encrypted messaging app that is being used in the war for everything from linking Ukrainian refugees to safe passage options to giving near-real-time footage of military events. However, Telegram has no official policies to censor or remove content of any nature for fighting disinformation. While some channels

on Telegram have been shut down, the company releases official statements only occasionally and it generally allows the majority of content posted by users to continue circulating, regardless of its nature [30]. The company claims that it cannot act against individual or group chats, which are “private amongst their participants”, however it can respond to requests in relation to sticker sets, channels and bots which are publicly available.

Telegram may be a fairly marginal social media channel in the West, but -unlike Twitter, Facebook, and YouTube -it is one free of restrictions for state-backed propaganda campaigns in Russia, where it remains popular. The Russian state broadcaster RT, for example, has more than 200,000 followers on the platform. Nevertheless, Telegram barred Kremlin-backed media outlets from using its platform within the EU, including RT, since Europe’s sanctions require such propaganda to be removed from television broadcasts, video-sharing platforms, internet service providers and other digital networks in an effort to prevent disinformation peddled by Moscow from reaching a large, mostly online, audience.

As the invasion began a handful of channels such as “Donbass Insider” and “Bellum Acta” started pumping out pro-Russian propaganda. Within minutes of explosions being reported in Donetsk, Odessa, and Kyiv, the channels supplied details, images, and video of the war in real time, in Russian, English, Spanish, and French. They showed Russian soldiers heading to war and the missiles landing just outside major Ukrainian cities. On other Telegram channels that trade in far-right memes, images were shared of Putin brandishing a handgun and promising to “crush those filthy Ukrainian”, earning heart emoji from followers. As result, the Ukrainian National Security and Defense Council issued a statement labeling which accounts are Russian backed. Ukrainian officials, in potential violation of the Geneva Convention, also have shared imagery of dead and captured Russian soldiers on the platform.

On February 27, 2022, Telegram CEO, Pavel Durov, posted that channels were becoming a source of unverified information and that the company lacks the ability to check on their veracity. He urged users to be mistrustful of the things shared on channels, and initially threatened to block the feature in the countries involved for the length of the war, however, he walks back this plan when it became clear that they had also become a vital communications tool for Ukrainian officials and citizens to help coordinate their resistance and evacuations. Telegram can thus serve as a mostly unfiltered source of disinformation within Russia and Ukraine, reaching audiences that Western social media platforms aren't able to reach. While Telegram does not filter content like many other platforms, it also does not use an algorithm to boost certain posts, and it relies on direct messaging between users. This design makes it difficult for AI tools to effectively boost disinformation.

In contrast, on other platforms such as Twitter and Facebook, AI is further enabling the rapid spread of disinformation about the war. Even before the war, there was much debate over how these platforms prioritized and monitored material on a wide range of political and social themes. In recent years, regulators in the US and the EU [31] have criticized Facebook and YouTube for prioritizing extremist material and failing to appropriately

remove disinformation despite some changes to automated and human-led mechanisms. Similar concerns have arisen across a range of platforms. For example, according to an analysis by anti-misinformation site NewsGuard, a new TikTok account may be presented lies about the Ukraine war within minutes of signing up for the app [32]. The organization, which assesses the credibility of news providers across the web, conducted two tests to see how the video-sharing app handled conflict-related content. It discovered that a new account that did nothing but scroll around the app's algorithmically curated For You Page watching war movies would be directed to inaccurate or misleading material within 40 minutes. The streams were nearly entirely filled with both true and fraudulent news on the Ukrainian war, with little difference made between disinformation and genuine sources. None of those videos contained any information about the trustworthiness of the source, warnings, fact-checks, or additional information that could empower users with reliable information. Users on TikTok were shown videos claiming that a "photoshopped" press conference given by Vladimir Putin in March 2020, false allegations about US bioweapon facilities in Ukraine, movies purporting to show the "Ghost of Kyiv" shooting down Russian jets were stolen from a video game, while real footage from the battle was slammed as fake by pro-Russian accounts. TikTok is also abundant with multiple Russian-language influencers parroted the same script in defense of Russia's invasion.

Although, Facebook claims that is continuously monitoring and take down separate multipronged disinformation operations, its algorithms routinely promoted disinformation about the war, including the conspiracy theory that the US is funding bioweapons in Ukraine. A study by the Center for Countering Digital Hate (CCDH) found that Facebook failed to label 80 % of posts spreading this conspiracy theory about US-funded bioweapons as disinformation [33].

Days after Russia invaded Ukraine, multiple social media platforms – including Facebook, Twitter and YouTube – announced they had dismantled coordinated networks of accounts spreading disinformation. Yet as Google, Facebook, Twitter and TikTok actively removed, or demoted, content associated with Moscow, new strategies have begun to bubble to the surface. These networks, which were comprised of fabricated accounts disguised with fake names and AI-generated profile images or hacked accounts, were sharing suspiciously similar anti-Ukraine talking points, suggesting they were being controlled by centralized sources linked to Russia. The Russian government creates accounts on Facebook, Telegram, Twitter, and other social networks that pretend to be organizations, phony social justice initiatives, anti-immigrant activists, and ordinary persons. Account types range from hired trolls using false online identities to bots and cyborg accounts, which are human-operated and employ automation to enhance their messaging. Account identities on Twitter were linked to the Kremlin-funded Internet Research Agency.

According to a research, such accounts can use generic Western names, a purported political leaning, an alleged affiliation with a news organization, a cultural reference, including fandom, or a single name followed by a string of numbers that sequentially change from one account to the next [30]. Many of these accounts post similar or almost identical content, frequently using bots engineered to boost and promote certain ideas.

Digital platforms are especially vulnerable to information laundering because faked videos (deepfakes) and images (photograph manipulation), for instance, can create media moments and spread disinformation bots, fake accounts and click farms "pretend to be people they're not and create a false sense of consensus" and commercial platforms "designed to keep users online to be served ads, end up prioritising engagement over truth or the public interest" [34].

6. The role of social AI in Russian disinformation and propaganda campaigns

AI has the potential to be used primarily for creating photo, audio, and video fakes, as well as for bot farms. AI can replace a significant part of the personnel in Russian "troll factories," Internet warriors who provoke conflicts on social networks and create the illusion of mass support for Kremlin narratives by users. Instead of trolls who write comments according to certain guides, this can be done by AI using keywords and the vocabulary offered to it. The influencers mentioned above (politicians, propagandists, bloggers, conspiracy theorists, etc.) have a decisive influence on the loyal audience, and not nameless bots and Internet trolls. However, with the help of AI, the weight of the latter can be increased by quantitative growth and "fine-tuning" for different target audiences.

If fake news served as the foundation for this new automated political propaganda and disinformation machine, social bots, or fake social media profiles, functioned as its foot soldiers – an army of political robots employed to manage social media discussions, intimidate, and misinform people.

A social bot, also described as a social AI, is a software agent that communicates autonomously on social media [35]. The messages that a social bot distributes can be simple and operate in groups and various configurations in hybrid mode, with partial human control via algorithm. Using AI and machine learning, social bots may think and act like people on social media sites, including expressing thoughts in more natural human discourse. While certain bots, such as auto-moderators and chat bots, are meant to provide better service/management, they may be abused by extremist organisations [36].

The challenge is that AI-powered bots can also engage in many harmful actions, such as escalating disputes, inflate influence and promote extreme ideologies performing scams and disseminating fake news. Such bots post using a fake account, with photo, posts, and a good number of followers or so-called friends. Thus, the account is created only to distribute its disinformation messages or political statements. This can be done via likes, sharing and retweets or in the form of posts or comments. Using a programming interface (API), a social bot can access social networks and receive and send data.

The presence of pro-Russian bots on social media is not a new phenomenon. The best-known case concerns Internet Research Agency nicknamed "troll factory", that in 2016 influenced the US presidential election by favoring candidate Donald Trump in the interest of the Kremlin. In 2018, Twitter found that the phenomenon involved over 50,000 Russia-linked bot accounts [30]. The Oxford Internet Institute analised how Twitter bots were used during the Brexit debate, and it was found that while many were used to spread messages about the Leave campaign, the vast majority of the automated accounts were very

simple [37]. They were made to alter online conversation with bots that had been built simply to boost likes and follows, to spread links, to game trends, or to troll opposition. According to Woolley it was controlled by small groups of human users who acknowledged the power of memes and virality, of spreading conspiracy theories online and watching them proliferate [38]. Simple bot-generated spam interrupted conversations by being purposefully attached to key hashtags in order to demobilise online debates. Links to news articles that portrayed a politician negatively were pushed by phoney or proxy accounts set up to publish and republish the same garbage over and again. These advertisements were employed bluntly: these bots were never meant to be conversational. Political bots play a key role in disinformation as smart AI tools allowed computers to pose as humans and help manipulate public conversation. On March 4, 2022, Twitter banned about 100 accounts that had relaunched the hashtag "#IstandwithPutin" for participating in "coordinated inauthentic behavior." However, the data we hold suggests that the phenomenon in Europe affects a much larger number of accounts, which avoided such a ban. European Digital Media Observatory (EDMO) established that since the beginning of the war in Ukraine, on February 24, 2022, a large number of accounts, whose main goal was to spread pro-Russian disinformation, were detected on Twitter [39]. Many of these profiles were suspected to be bots, but a large part could also be managed by actual human beings that act coordinately to spread false or misleading narratives about the conflict. Disinformation about the war in Ukraine started circulating in Europe immediately after Russia invaded the country and in a few weeks the topic became extremely popular among conspiracy theorists and their followers. Russian bots on Twitter typically operate by following and retweeting accounts that support their agenda, as well as posting their own content. This content can include false or misleading information, inflammatory language, and divisive political messages. The goal of these bots is to create the appearance of widespread support for a particular political view or candidate and to manipulate public opinion in their favour.

The use of bots on Twitter allows Russia to amplify its messages and create the appearance of widespread support for its views. Russian bots may give the impression that there is a huge and loud group of people who share their ideas by following and retweeting accounts that support their agenda and by uploading their own material. This has the potential to influence public opinion and shift the political environment in their favour [40]. In addition, the use of bots on Twitter allows Russia to bypass traditional forms of media and communicate directly with the public. By using Twitter, they can reach a large audience quickly and easily without needing to go through the editorial process of traditional news outlets. This allows them to spread their messages quickly and effectively, and to avoid being held accountable for the accuracy or veracity of their content.

A research from January 2023, realised by the analytical centre NewsGuard discovered that the popular chatbot ChatGPT is capable of generating texts that extend current conspiracy theories and integrate genuine events in their context [41]. This programme has the ability to automate the delivery of numerous messages (via bot farms), the topic and tone of which will be selected by a person and the direct text created by AI. NewsGuard analysts directed the chatbot to reply to a series of leading inquiries pertaining to a sample of 100 misleading narratives from NewsGuard's proprietary database of 1,131 top disinformation narratives in the press and their debunkings, published before 2022 [41]. The findings support

concerns, especially those highlighted by OpenAI, about how the technology may be weaponized in the wrong hands. ChatGPT developed fake narratives for 80 of the 100 previously detected false narratives, including complete news items, essays, and TV scripts [41]. For those who are inexperienced with the issues or themes addressed, the results may appear legitimate, even authoritative. For 80% of the prompts, ChatGPT provided answers that could have appeared on the worst fringe conspiracy websites or been advanced on social media by Russian government bots.

Another analysis regarding ChatGPT and its use in spreading of Russian propaganda was done by Centre for Democracy and Rule of Law. According to their research, although ChatGPT is not a propaganda platform, it displays information based on what data it has "learned" [42]. If the model is trained on texts that contain propaganda, there is a risk that ChatGPT will provide misleading and distorted information. After all, it will be relying on a data set it learned. The Centre discovered that ChatGPT provides incorrect information in its answers. For instance, "several cases of nuclear weapons use". Obviously, ChatGPT discovered references to nuclear weapons on the Internet but misinterpreted them [42]. ChatGPT is an interesting artificial intelligence model, however it lacks the capacity to filter out information more effectively. Thus, on the one hand, ChatGPT simplifies the work of journalists, writers and everyone involved in content creation, but on the other hand, it can become a generator of false news and distorted facts. To reduce the amount of disinformation in ChatGPT, developers have many ways to do this: a) Improve the Russian propaganda identification system with trigger words; b) Program ChatGPT to refuse to generate texts that could potentially contain Russian propaganda or assessment of the Russian-Ukrainian war; c) Integrate a system into ChatGPT that checks the generated text for the presence of pro-Russian narratives. It should be remembered that ChatGPT is only an algorithm that learns from the texts of human authors but it is not its creator. That is why the texts received from ChatGPT should be treated just as critically as anything else you read on the Internet.

7. Deepfakes and their role in disinformation

The 21st century's answer to photoshopping, deepfakes, use a form of AI called deep learning to make images of fake events. For decades it has been possible to alter video footage, however doing it took time, highly skilled artists, and a lot of money. Deepfake technology changed the game. As it develops and proliferates, anyone could have the ability to make a convincing fake video, including some those who might seek to "weaponize" it for political or hybrid war purposes.

Deepfakes are only possible because of recent breakthroughs in machine learning. Driven by the widespread availability of multimodal data, such as news articles, social media, audio, imagery, and video, as well as the dramatic reduction in costs of high-performance central processing unit (CPU) and graphics processing unit (GPU) computing clusters, machine learning techniques are now ubiquitous [43].

Deepfakes are defined as synthetic media that have been digitally manipulated to replace one person's likeness convincingly with that of another. The term describes both the technology and the resulting bogus content and is a portmanteau of deep learning and fake.

The main machine learning methods used to create deepfakes are based on deep learning and involve training generative neural network architectures, such as autoencoders, or generative adversarial networks (GANs) [42]. For computer vision, or the field of AI that enables computers to interpret and react to visual images, a GAN consists of two key components: a generator algorithm that tries to generate a fake image and a discriminator algorithm that tries to distinguish between real and fake images.

Audio can be deepfaked too, to create "voice skins" or "voice clones" of public figures. Deepfake technology also can create convincing but entirely fictional photos from scratch. Russia has been already creating AI – generated personas with full profiles and a human face. NBC News journalist Ben Collins discovered two specific people who are spreading disinformation from the city of Kyiv [44]. But not everything is what it seems, both of these profiles are not recognized by any system as real people. As it turns out, they were both created by a Russian troll farm in order to spread fake news about Kyiv. The first one Collins introduced is Vladimir Bondarenko, a blogger from Kyiv who despises the Ukrainian Government. Watching his artificially created face is downright scary when you see how real his picture is. On the Ukraine Today website, Vladimir has an antire backstory as if he was a real human being. He studied to become an aviation engineer, but he was later forced to become a blogger when the Ukraine aviation infrastructure collapsed. Russia also created an AI profile of a woman, Irina Kerimova from Kharkiv. She used to be a private guitar teacher, but she eventually became chief editor of this Russia propaganda website that is presumably founded by the RT company (the Kremlin) [44]. She also has a strage mismatch on her earrings. Facebook revealed to Collins that these two profiles are part of Russia's new propaganda operation that was identified by the State Department back in 2020. They are called News Front and South Front and were both created by Alexander Malkevich, the same man who ran the St. Petersburg troll farm after 2016.

On March 2, 2022, shortly after Russia started its full-scale invasion of neighboring Ukraine, a video message featuring Ukrainian President Volodymyr Zelensky emerged temporarily on the news website Ukraine 24 [45]. Dressed in his iconic olive shirt, Zelensky's tone and outfit mirrored his other statements of that period. However, the message itself was rather different: rather than encouraging Ukrainians to continue fighting, Zelensky urged them to lay down their arms and surrender. The video then shortly spread on VKontakte, Telegram, and other social media sites, where it was picked up and reported on by international media. 2 Zelensky's office instantly denied its validity, pointing out that it was the type of "deepfake" they had warned of before the conflict. Nonetheless, the episode was a watershed moment in information operations since it was the first high-profile use of a deepfake during an armed conflict.

Deceit and media manipulation have always been a part of wartime communications, but never before it has been possible for nearly any actor in a conflict to generate realistic audio, video, and text of their opponent's political officials and military leaders. As AI grows more sophisticated and the cost of computing continues to drop, the challenge deepfakes poses to online information environments will only grow. Policymakers and government officials will need to develop robust systems for monitoring and authenticating both public and private messages in real time, while also evaluating when – if at all – to leverage the

technology themselves. Deepfakes can be leveraged for a wide range of purposes, including falsifying orders from military leaders, sowing confusion among the public and armed forces, and lending legitimacy to wars and uprisings. While these tactics can and often will fail, their potential to impact an adversary's communications and messaging means that security and intelligence officials will inevitably use them in a wide range of operations.

Beyond deepfakes, experts have expressed concern that AI could be leveraged for more sophisticated disinformation techniques. These include using AI to better identify targets for disinformation campaigns, as well as using techniques such as Natural Language Processing (NLP), which allows AI to produce fake social media posts, articles, and documents that are nearly indistinguishable from those by human posters. It gets harder to make difference from real video as the technology improves. In 2018, US researchers discovered that deepfake faces do not blink normally [8]. No surprise there: most images show people with their eyes open, so the algorithms never really learn about blinking. At first, it seemed like a silver bullet for the detection problem. But no sooner had the research been published, than deepfakes appeared with blinking. Such is the nature of the game: as soon as a weakness is revealed, it is fixed.

For policymakers and officials in democratic states, deepfakes pose a particularly difficult challenge. Given the importance of a trusted information environment to democratic societies, democratic governments should generally be wary of deepfakes, which threaten to undermine that trust. This is particularly true when it comes to military and intelligence operations. Going forward, militaries and security services will need to assume that rival state and nonstate actors alike will have access to deepfake capabilities that can generate compelling audio and video of any state official, leader, or soldier. As a result, they will need to develop the kind of robust authentication mechanisms and "pre-bunking" strategies that Ukraine has already pioneered. Moreover, they will need to understand how deepfake technology adds further complexity to the communications challenges that militaries and insurgent groups already face. Democratic governments will need to develop strategies for how to operate in such an environment without undermining the integrity of their communications or key values and norms. Almost every day, neural networks display an advance in their ability to create graphic, textual, and audiovisual information. Its quality will improve as machine learning skills improve. Popular neural networks are being utilised by Internet users as a toy rather than a tool for manufacturing fakes. However, there are already examples of neural network-generated pictures that not only went viral but were also considered as real by users. Ironically, AI may be the answer to fight deepfakes. AI already helps to spot fake videos, but many existing detection systems have a serious weakness: they work best for celebrities, because they can train on hours of freely available footage. Tech firms are now working on detection systems that aim to flag up fakes whenever they appear. Another strategy focuses on the provenance of the media. Digital watermarks are not foolproof, but a blockchain online ledger system could hold a tamper-proof record of videos, pictures and audio so their origins and any manipulations can always be checked.

8. Countering disinformation in hybrid warfare

The use of disinformation for political and strategic reasons by countries such as Russia, both domestically and globally, increases instability and poses risks in the framework of hybrid warfare. Disinformation operations are intended to manipulate emotions, spread distrust, and cause chaos in order to sway public and political opinion. To avoid and minimize the consequences of disinformation there are necessary the following measures:

a) *Media education and literacy, raising awareness and public engagement.* Media education and literacy are key tools for countering disinformation. Developing critical skills to evaluate information and identify reliable sources can help people recognize and reject disinformation [46]. Promoting media education in schools and communities can contribute to increasing resilience to information manipulation. Media literacy can help individuals become more aware of the tactics used in disinformation and make informed decisions regarding the consumption and distribution of information. Raising awareness and engaging the public in countering disinformation is essential. Through education, information campaigns, and promoting individual responsibility in information consumption and distribution, the public can become more vigilant and resilient against disinformation [47]. Support and active participation of citizens in identifying and reporting disinformation can contribute to reducing its impact.

b) *Fact-checking and information verification.* Another important strategy is promoting fact-checking and information transparency. Fact-checking organizations play a crucial role in identifying and exposing false or manipulative information [46]. Governments and online platforms should support and collaborate with these organizations to promote verified information and expose disinformation. Additionally, transparency regarding the origin and funding of online content can help identify and better understand the sources of disinformation.

c) *Regulations and transparency in the online environment.* Effective regulation of the online environment is necessary to counter disinformation. Governments should implement policies and regulations that promote transparency and accountability of online platforms in combating disinformation [8] This may include requirements for disclosing content distribution algorithms, clear labeling of verified or unverified content, and sanctions for platforms that enable the widespread dissemination of disinformation [46].

d) Online platforms play a crucial role in combating disinformation. By promoting transparency in algorithmic operations, content selection, and user and data policies, they can enhance user trust and limit the impact of disinformation [24]. They can also enforce stricter measures to prevent and remove disinformation content.

e) *Collaboration among governments, organizations, and online platforms.* Combatting disinformation in hybrid warfare requires also strong international collaboration, among governments, organizations, and online platforms. Governments can implement policies and regulations to address disinformation, while organizations and online platforms can take measures to limit the spread of manipulative content and promote transparency and authenticity of information. Governments, international organizations, and relevant actors should enhance their

cooperation to exchange information, identify and counter disinformation campaigns, and promote common norms and standards in the information domain.[6] The exchange of best practices and experiences can contribute to the development of more effective strategies in combating disinformation.

f) *Public-private cooperation and civil society engagement.* Cooperation between the public and private sectors is essential in combating disinformation in hybrid warfare. Governments should work together with online platforms and other private entities to develop technological solutions and share relevant information regarding disinformation campaigns.[6] At the same time, civil society and non-governmental organizations can play a crucial role in monitoring and reporting cases of disinformation, promoting media literacy, and mobilizing public opinion to counter the phenomenon [8].

g) *Monitoring and data analysis.* Monitoring and analyzing data on the spread and impact of disinformation can provide valuable insights for countering disinformation. By monitoring online activities and analyzing patterns of disinformation spread, sources, tactics, and distribution networks can be identified. This information can be used to develop more effective strategies to counter disinformation.

h) *Investments in research and technological development*. Investments in research and technological development can contribute to the development of advanced tools and technologies for identifying and combating disinformation [6]. Artificial intelligence and automated content analysis can be used to detect and filter false or manipulative information, thus helping to reduce their spread in the online environment.

i) *Using AI tools to fight disinformation.* While AI is contributing to the spread of disinformation across social media, AI tools also show promise for combating it. The sheer volume of information uploaded to social media daily makes developing AI tools that can accurately identify and remove disinformation essential. For example, Twitter users upload over 500,000 posts per minute, well beyond what human censors can monitor. Social media platforms are beginning to combine human censors with AI, to monitor false information more effectively. Facebook developed an AI tool called SimSearchNet at the start of the COVID-19 pandemic to identify and remove false posts. SimSearchNet relies on human monitors to first identify false posts, and then uses AI to identify similar posts across the platform. AI tools are significantly more effective than human content moderators alone. According to Facebook, 99.5% of terrorist-related content removals and 98.5 % of fake accounts are identified and removed primarily using AI trained with data from their content-moderation teams.

AI offers enormous potential for content creation and processing. For instance, the Centre for Strategic Communication and Information Security in Ukraine monitors the media landscape and analyses a variety of online articles using AI capabilities, specifically automated tools, such as the SemanticForce and Attack Index platforms. Attack Index uses machine learning, cluster analysis, computer linguistics, formation, clustering, and visualization of semantic networks and correlation and wavelet analysis. SemanticForce, using AI, helps identify information trends, track changes in the response of users of social

networks to information events, identify hate speech, analyse in details the image to detect inappropriate or harmful content. Using AI, accessible solutions allow differentiating between natural and coordinated content distribution, detecting automated spam distribution systems, assessing the influence of different social network user accounts on the audience, separating bots from actual users, and so on.

Currently, AI aimed at combatting disinformation on social media still relies on both human and computer elements. This limits AI's ability to detect novel pieces of mis- and disinformation, and means that false posts routinely reach large audiences before they are identified and removed using AI. The current technical limitations on being able to proactively identify and remove false information, combined with the scale of information uploaded online, pose a continuing challenge for limiting disinformation on social media in the Russia-Ukraine war and beyond. Researchers are already planning to employ AI to detect these AI-generated fakes. Techniques for video magnification, for example, can detect variations in human pulse to determine if a person in a video is genuine or computer-generated. However, both fakers and detectors will improve. Some fakes may grow so complex that they are difficult to reject or dismiss, in contrast to previous generations of fakes, which utilised basic language and made readily debunked assertions. The best way to combat the spread of fake news may be to depend on people. Since the societal consequences of fake news are significant, eople shall be more wary of information and investigate it, rather than sharing it immediately.

9. Conclusions

Hybrid warfare represents a complex and flexible approach to conflicts, involving the combination of military and non-military tactics to achieve political and military objectives. Russia, as a key-actor in hybrid warfare, uses a wide range of tactics and strategies to promote its interests and extend its influence.

Disinformation in hybrid warfare poses a serious threat to society, national security, and democratic processes. Its impact is felt in various fields, including politics, public health, and electoral processes. Countering disinformation requires concerted efforts globally, involving governments, organizations, online platforms, and the general public. Education, fact-checking, collaboration, and monitoring are just a few of the strategies used to counter disinformation in hybrid warfare. By effectively addressing this phenomenon, we can protect society and democratic values, promoting authentic and verified communication and information.

The Kremlin tends to employ a full spectrum model of propaganda and disinformation. In some aspects, the present Russian approach to propaganda builds on Soviet Cold War-era methods, with a focus on disinformation and convincing targets to behave in the propagandist's interests without realising it. But from other perspectives, it is entirely new and driven by the peculiarities of today's information world. Russia has utilised technology and accessible media in ways that would have been unthinkable during the Cold War. The Internet, AI, social media, and the expanding landscape of professional and amateur journalism and media outlets are among its tools and channels.

Russian propaganda is generated in enormous volumes and transmitted via a wide range of outlets. This propaganda encompasses text, video, audio, and still imagery distributed over the Internet, social media, satellite television, and traditional radio and television transmission. A significant group of hired Internet "trolls" also frequently attacks or undermines opinions or material that runs opposite to Russian themes. But the most challenging to combat is propaganda built with AI. As AI grows more sophisticated and the cost of computing continues to drop, the challenge social bots and deepfakes pose to online information environments during armed conflict will only grow.

AI is going to be the most powerful tool for distributing disinformation on the Internet, assisting in the creation of a new false narrative on a massive scale and much more frequently. Personalised, real-time chatbots could disseminate conspiracy theories in increasingly believable and compelling ways, smoothing out human errors such as bad grammar and mistranslations and progressing beyond immediately detectable copy-paste operations. To navigate that challenge, security officials and policymakers need a far greater understanding of how the technology works and the myriad ways it can be used in international armed conflict. For decades, machine learning algorithms, a type of AI, have been successful in fighting spam email by analysing message text and determining how likely it is that a particular message is a genuine communication from an actual person or company. However, such solutions imply that individuals who distribute fake information will not modify their tactics. They often change strategies, changing the substance of phony postings to make them appear more trustworthy. The biggest challenge, however, of using AI to detect fake news is that it puts technology in an arms race with itself.

Responding to Russia's hybrid challenge requires a comprehensive strategic strategy that considers every element of hybrid warfare. The goal of any such approach would be to contain Russian hybrid initiatives by limiting and counteracting them. The strategy's fundamental components should be successful defence efforts, resilience in the face of Russian operations, and, if necessary, cost-imposing measures. In practice, combating disinformation and increasing awareness about disinformation may necessitate more strong and well publicised attempts to identify Russian propaganda sources and the nature of their activities. It might also take the form of sanctions, fines, or other barriers to the practice of propaganda disguised as journalism. Another suggestion is "to find ways to help put raincoats on those at whom the firehose of falsehood is being directed" [48]. Of course, a plan to tackle hybrid issues is not the sum of a Western policy for Russia. An overall strategic strategy would incorporate conventional and nuclear deterrence, as well as diplomacy to identify whether areas of possible collaboration exist.

Social media sites must also participate by correctly labelling their content and indicating whether an item claiming to be news has been validated by a reliable source. They could train AI through collaborations with news organisations and volunteers, continually improving the system to respond to propagandists' shifting concerns and techniques. Certainly, it is impossible to detect every piece of fake news released online, but it may make it simpler for a large number of individuals to make difference between true and false news.

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Mainstreaming New European Bauhaus for green innovation transformation in Romanian Regions – insights into South Muntenia Region

Nicoleta TOPÎRCEANU,
SNSPA Student, Bucharest, Romania
nicoletatopirceanu@yahoo.com, nicoleta.topirceanu.22@student.politice.ro

Abstract
As a creative and interdisciplinary initiative launched by the European Commission in 2020, the New European Bauhaus (NEB) aims to connect the European Green Deal with the space and life experience of the European citizen, giving him a cultural and creative dimension. Also, the NEB aims to support and accelerate the green transition of settlements and regions, societies and economy, the main objective being to integrate the values and principles promoted in policy-making at European and national level in order to bring positive changes at local level and improve people's quality of life. The paper provides a brief history of the concept, its actual European context, and the mechanisms for integrating the values and principles promoted in policy preparation at European, national and regional level. An important section of this paper is dedicated to a case study that explores compatibility, integration of the NEB concept and integrated approach to potential actions financed at the level of the South Muntenia Region in Romania. The paper also presents good practices regarding the concept. The paper is based on communications, reports, presentations and guidelines from the European Commission regarding the launch of the concept, the compass on the objectives and ambitions of the initiative, funding conditions, and also progress since its launch and to date. Thus, I have studied the documents presented by the European Commission and available on the website dedicated to the NEB initiative, the national legislation that integrates the concept as a priority at the level of relevant strategies. To determine the extent to which the NEB concept has been integrated into funding programmes and what actions are foreseen, I analyzed programmatic documents at regional level in Romania, particularly from South Muntenia Region. The results show that the NEB has become a catalyst for the European Green Deal transformation, a movement with an active and growing community in all EU Member States and beyond, including Romania. At the same time, thanks to broad funding from various EU programmes, NEB has begun to implement real change in the field. The paper can be useful to local, regional and managing authorities as well as citizens and people from various backgrounds (art and design, culture and cultural heritage institutions, educators, scientists and innovators) because it is a guide to support the NEB initiative that brings together sustainable development, inclusion and aesthetics.

Keywords: sustainable development, together, beautiful, nature, participation.

1. Introduction
The New European Bauhaus (NEB) is a creative and interdisciplinary initiative launched by the European Commission in 2020. This initiative aims to connect the European Green Deal with the space and life experience of the European citizen, giving him a cultural and creative dimension. Thus, The NEB promotes the green transition of societies and economy, the main objective being the integration of the values and principles promoted in policy making at European and national level. in order to bring positive changes at local level and improve people's quality of life. The New European Bauhaus aims at creating a new lifestyle that matches sustainability with good design, that needs less carbon and that is inclusive and affordable for all, while respecting the diversity that we have in Europe and beyond.

The New European Bauhaus aims to promote projects driving tangible transformation on the ground, from homes and neighbourhoods to urban and rural areas, to physical and virtual meeting spaces.

2. Brief history

The German word bauhaus (bau – to build and haus – house) designates a school of art, design and architecture, as well as an extremely influential artistic current that combines architectural elements, plastic arts, design, furniture and interior decoration of the XX century. The school was founded in 1919 in Weimar, Germany, by Walter Gropius.

This school and artistic movement functioned between 1919 and 1933 in three German cities, Weimar, Dessau and Berlin, becoming one of the most important and inspiring currents of modern architecture. After 1933 the school was closed as a result of Nazi pressure [1].

After the immigration into the United States of America of the founders of the Bauhaus School, in 1937 this artistic movement experienced a revival under the generic name of "The New Bauhaus", when it was founded, for a short time in Chicago, a new design school in order to improve the quality of local cultural and economic life [2]. It later merged with the Illinois Institute of Technology.

Also in 1950, in Ulm, Germany, was set up „ The Design High School" which had the same destination, "The New Bauhaus" [3].

These new impulses were classified as "International Styles", marked by the absence of decors and a strict connection between function and design.

The New Bauhaus has become an educative, inspiring and stimulating factor for many generations of architects and fine artists, who have propagated or still propagates the essence of the original Bauhaus style to this day.

The Bauhaus buildings in Weimar and Dessau were inscribed in 1996 on the UNESCO list of world cultural heritage [4].

3. European context

In September 2020, just one year after the centenary of Bauhaus, the President of the European Commission published an article aimed at relaunching a far-reaching cultural concept, the New European Bauhaus concept to represent a space for the shared creativity of architects and artists, engineers and designers, as it happened in the legendary schools of Weimar, Dessau and Berlin in the period between the two world wars [5].

The initiative is part of the overall objective of the European Green Deal, to achieve climate neutrality by 2050, as well as the objective of the Wave of Renovation Strategy to make the existing built fund more efficient [6] [7].

This statement has aroused great interest among design disciplines, especially in the academic world. Starting from these premises, the European Commission invited all European citizens to imagine and build together "a sustainable and inclusive future, that's nice for the eyes, mind and soul" [8].

Thus, on September 15, 2021, the European Commission communication was adopted which introduced the concept “New European Bauhaus – Beautiful, Sustainable, Together”.

NEB expresses the European Union's objective of creating beautiful, sustainable and inclusive products, lifestyles and places. This concept promotes a new way of life in which style intertwines with sustainability, being a catalyst for the green transition of our societies and our economy. Its aim is to transform different sectors of the economy, in particular the built-in fund, so that they contribute to climate objectives and improve the quality of life of all citizens.

4. New European Bauhaus concept

The NEB concept aims to provide all citizens access to low-carbon and circular economy goods that support nature regeneration and the protection of biodiversity.

As part of the European Green Deal, the NEB has the role of addressing current issues such as climate change, pollution and biodiversity loss, in conditions of tangible sustainability and taking into account these realities when designing living spaces for European citizens. The NEB is intended to be a bridge between two worlds: on the one hand, that of science and technology, on the other hand, that of art and culture, thus bringing the idea of transversality in the current era.

To achieve its goal, the NEB integrates three inseparable core values (Fig. 1a):

- Sustainability, from climate objectives to circularity, zero pollution reduction and protection of biodiversity. Thus, it supports the reduction of the impact of human activities on the environment and aims to reconnect citizens with nature by reducing the use of resources and pollution, promoting circularity, climate neutrality, etc, ecological design and nature-based solutions, as well as the promotion of economic activities that respect the limits of natural resources;
- Aesthetics, quality of experience and style beyond functionality. It promotes non-intrusive approaches that capitalize on local beauty and style, local authenticity and identity, integrates landscape, uses aesthetic and cultural means that lead to increased sense of belonging;
- Inclusion, valuing diversity, ensuring equality for all, accessibility and affordable prices. Actions should promote a sense of belonging, solidarity, give a “sens” to places and communities, remove barriers of accessibility, connect different entities and people.

Healthy and affordable housing involves “energy consumption, materials and water, quality and value of buildings, health, comfort, resilience to climate change and life cycle costs”.

Thus, a building-oriented approach is needed, towards the development and sustainability of the civil engineering sector and planning, using nature-based solutions.

The NEB also introduces three key principles (Fig. 1b)**:**

- A participatory approach. It is recommended to involve communities („stakeholders") in the phases of project design, decision-making and implementation, promoting collective thinking. Therefore, the participatory approach aims to involve civil society and people of all ages, in all their diversity, including disadvantaged women and groups (people at higher risk of poverty, marginalisation and/or discrimination) [9];
- A transdisciplinary approach. It is the principle that conveys the original Bauhaus concept, that of creating a bridge between different viewpoints and fields, culture and technology, innovation and design, engineering, handicrafts, and arts and science, between the local and global dimensions;
- A multilevel approach: from global to local. According to this principle, actions that connect the global level with the local one are promoted – global challenges such as climate change that find their response in small-scale projects/ initiatives, formulated by people, neighbourhoods, local communities and generate an effective exchange both horizontally (with people having similar projects) and vertically (with others operating on a different scale). The goal is to produce transferable and scalable solutions.

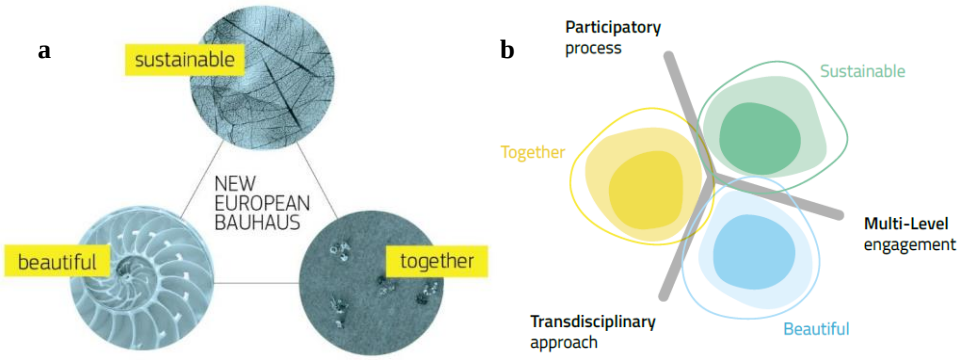

Fig. 1. (a) NEB Values; (b) NEB principles
Source: New European Bauhaus Compass, 2022,
https://new-european-bauhaus.europa.eu/document/405245f4-6859-4090-b145-1db88f91596d_en

The engagement of stakeholders in co-creation of the movement has provided four thematic axes [10]:

- Reconnecting with nature – renovation of existing buildings and public spaces in a spirit of circularity and carbon neutrality, greater opportunities for contact with green public spaces translate into better health indices for the population and reduce income-related health inequalities, nature-based solutions in cities can help addressing floods and other extreme weather events while making the built environment more attractive, building urban green corridors for active mobility and rethinking transport infrastructure;
- Regaining the sense of belonging – preservation and transformation of cultural heritage. Cultural assets (heritage, arts, local craft, know how, etc.), natural assets (landscapes, natural resources, etc.) as well as social assets (social economy

enterprises, local organisations and associations etc.) make a place unique. Cultural life, arts events, concerts are opportunities for connection and social interaction, the binding element that creates a sense of belonging;

- Prioritizing the places and people most in need – adaptation and transformation of buildings for affordable housing solutions. Due consideration should be given to the specific situation of groups and individuals who are the most vulnerable, for instance, at risk of exclusion or poverty or experiencing homelessness. A Design for All approach is to be pursued in oder to remove accessibility barriers to the built and virtual environments and to goods and services. This calls for territorial development avoiding spatial segregation of social groups, connections between rural and urban areas, delivering access to digital connectivity to all people is an essential in the green transition [11];
- The need for long-term life cycle thinking in the industrial ecosystem – regeneration, life extension and transformation of existing buildings should be prioritised over the construction of new buildings, recovered and renewable materials should be better recognised by all relevant disciplines and become part of design paradigms. The use of sustainably produced and procured nature-based building materials, such as wood, bamboo, straw, cork or stone should be improved, new production technologies should help reduce the carbon footprint of steel or cement, recycle otherwise wasted textiles and accelerate the green transition of energy intensive industries, new business models, bioeconomy, social economy approaches and design for sustainability can support the transformation of sectors such as textiles, tourism, waste management or energy production [12].

5. Mechanisms for transposing the values and principles of the initiative

The European Commission wants to create an enabling framework of the New European Bauhaus, integrated with the sustainable development goals (SDGs) and with relevant EU policies and initiatives. Thus, is proposing specific actions and tools in order to promote, and disseminate the NEB concept.

Such tools are: NEB Laboratory [13] for policy making, promotion of funding for NEB projects, financing of social housing projects aligned with NEB values, preparation of calls for projects for citizens' and start-ups' initiatives, etc, as well as an annual festival for awarding the best NEB projects.

Within the NEB Laboratory, an important project is the NEB Labelling Strategy [14] that will be conducted on two interdependent levels: the compass and the NEB (self)assessment tools.

Regarding the NEB (self)assessment tools [15], they are specific lists of measurable criteria for certain types of projects.

The NEB compass [16] provides a framework for policymakers and project promoters to implement NEB principles and criteria in their activities.

Specifically, the compass: exemplifies the meaning of “beautiful, sustainable, together”, on three levels of ambition (I, II, III) (Fig. 2) meant to inspire and guide the conception of a project from the very first stages; details the three core principles that define NEB work also on three levels of ambition (I, II, III) (Fig.3): participatory process, multi-level engagement and a transdisciplinary approach; emphasises the ability of NEB projects to promote new visions and processes with a long-term vision; builds on existing theories and models while remaining open to the prospect of evolving, in tune with the experimental nature of the initiative.

Level I of ambition sets out the mandatory basic rules for framing projects under the NEB category, and levels II and III indicate higher aspirations. An NEB project is that project that achieves at least the first level of ambition for the three values and the three principles. Achieving the highest levels of ambition for each value and principle leads to the initiation of a profound transformation of the way in which society is organized and requires full compliance with the requirements for levels I and II.

5.1. Sustainability:

I. Reuse: reuse to avoid/ reduce environmental impact by reducing pollution, minimal use of resources, materials and energy.
II. Closing the loop: reducing linear processes or turning them into circular processes the target being zero pollution.
III. Regeneration: paradigm shift towards regeneration and the use of nature-based solutions.

5.2. Aesthetics:

I. Activation: improving the physical and mental state of people, promoting the cultural, social and natural qualities of a place to create unique and positive experiences.
II. Connection: facilitating meaningful social interactions and collective experiences, strengthening the sense of belonging.
III. Integration: stimulating creativity, collective reinvention of places, lifestyle, community, integration of new cultural and social values, creating meaningful experiences that contribute to the creation of a more comprehensive “us”.

5.3. Inclusion:

I. Inclusion: non-discriminatory accessibility (physical, cultural, cognitive, psychological, etc.).
II. Consolidation: promoting relationships between users and/or communities, open access to services.
III. Transformation: potential to overcome outdated social models, create value and bring transformative societal benefits, influencing worldview, social paradigms and behaviors.

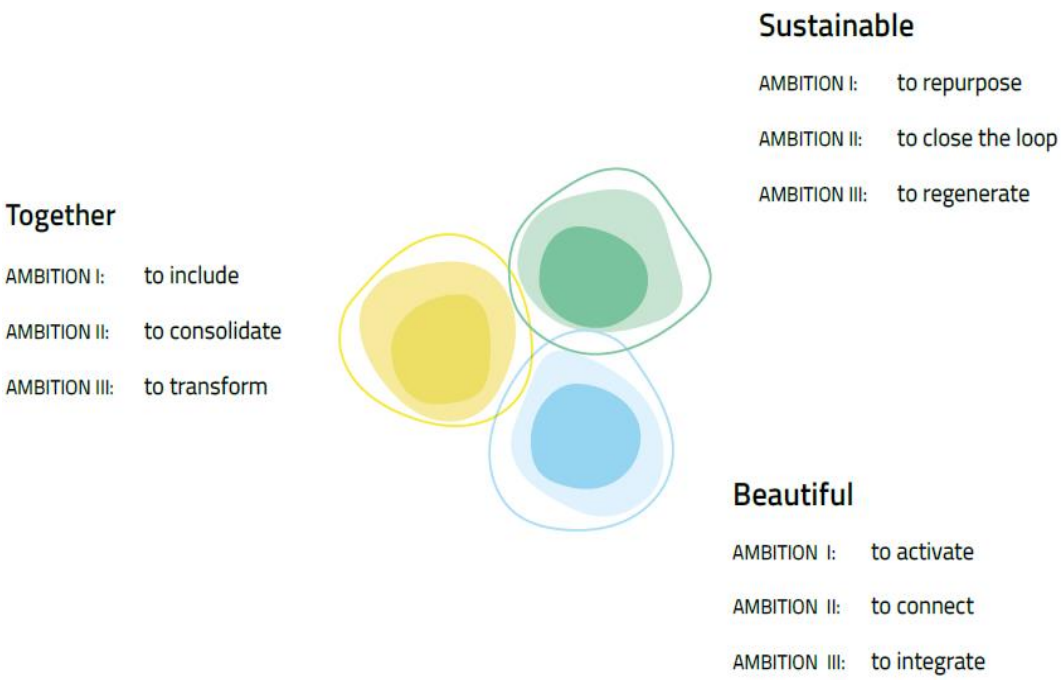

Fig. 2. The ambition levels of the NEB values
Source: New European Bauhaus Compass, 2022,
https://new-european-bauhaus.europa.eu/document/405245f4-6859-4090-b145-1db88f91596d_en

5.4. Participatory process:

I. Consulting: sending information about the project, consultation for decision making.
II. Co-development: involving stakeholders as key partners in setting project objectives based on a dynamic flow of information.
III. Self-government: empowering communities to make decisions and self-government.

5.5. *Transdisciplinary approach*:

I. Multidisciplinarity: addressing a common problem by stimulating multidisciplinary work.
II. Interdisciplinarity: addressing a common problem or problem targeting two or more areas of knowledge stimulating interdisciplinary work.
III. Overcoming disciplinarity: collaborative approach between local, traditional and academic knowledge holders in order to complement and transform scientific perspectives for the benefit of society.

5.6 Multi-level approach

I. Local interventions: horizontal connection between informal networks (groups of people, neighbourhoods, etc.) and/or formal institutions (sectoral departments, political groups, etc.) in order to crate a local living environment through a place-specific approach.

II. Multiple approach: vertical connection between informal networks and/or formal institutions at different scales in order to overcome their own dimension (local, regional, national).
III. Global perspective: multi-level structured engagement and linking local strategies to a global network taking into account the broader global impact of initiatives.

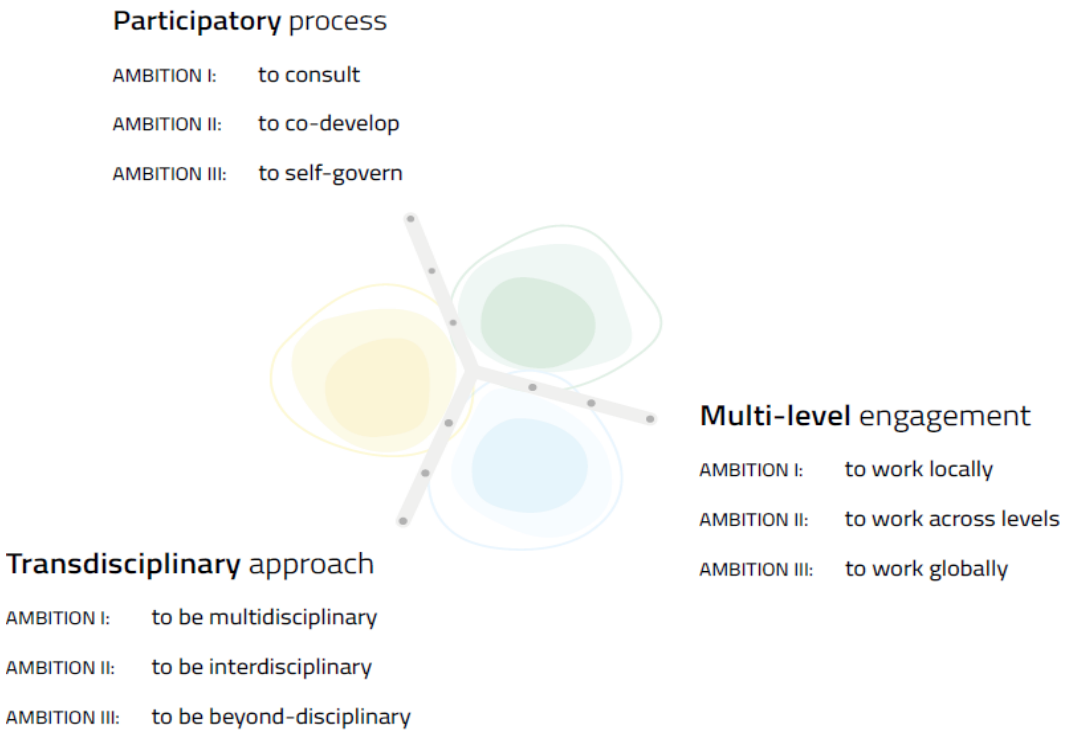

Fig. 3. The ambition levels of the NEB working principles
Source: New European Bauhaus Compass, 2022,
https://new-european-bauhaus.europa.eu/document/405245f4-6859-4090-b145-1db88f91596d_en

6. The power of examples

Only two years after its launch, the NEB has become a catalyst for the European Green Deal transformation. At the same time, thanks to a broad funding from different EU programmes, the NEB has started to implement real change on the ground.

The first call for projects was launched in 2021 [17], in 2022 the winners of the NEB awards were nominated and in 2023 other winners will be chosen. A few examples to highlight the inclusion of the NEB initiative are given below.

The Cano de Hierro project (Spain) [18] proposed the creation of a promenade using natural reed formwork to reproduce the irregular shape of the caves, and the color is in tune with that of the rocks (Fig. 4).

Fig. 4. The Cano de Hierro project, Spain
Source: European Union, Prizes, 2021, https://2021.prizes.new-european-bauhaus.eu/node/268908

Baubotanik, Germany [19], is an innovative form of sustainable architecture that partially replaces technological building materials with living, growing trees. Baubotanik structures continue to develop throughout their lives, evolving with nature (Fig.5).

Fig. 5. Baubotanik, Germany project
Source: European Union, Prizes, 2021, Baubotanik – Living Architecture | NEW EUROPEAN BAUHAUS (new-european-bauhaus.eu)

The wooden pavilion in Buga, Germany [20], highlights a new approach to wooden constructions, based on digital design, in a public event space with a diameter of 30 meters, the pavilion can be reassembled in another place, and at the end of its life the structure can be recycled (Fig.6).

Fig. 6. The wooden pavilion in Buga, Germany project
Source: European Union, Prizes, 2021, BUGA Wood Pavilion | NEW EUROPEAN BAUHAUS (new-european-bauhaus.eu)

The modular construction system Vivihouse [21], Austria, consists of modular wooden frames assembled with durable materials. The project invites users, planners, artisans and businesses to adopt the modular system and collaborate on exploring new forms of urbanism within the circular economy (Fig.7).

Fig. 7. The modular construction system Vivihouse project
Source: European Union, Prizes, 2021, vivihouse | NEW EUROPEAN BAUHAUS (new-european-bauhaus.eu)

Cristobal de Moura Green Street [22], Barcelona, Spain, is a park-like project that includes affordable public housing and gives people with low economic resources the opportunity to enjoy life in a park-like environment (Fig.8).

Fig. 8. Cristobal de Moura Green Street project
Source: European Union, Prizes, 2021, https://2021.prizes.new-european-bauhaus.eu/node/269172

Four Romanian projects applied for the NEB awards and were considered successful at national level: Healthy Places [23] (through which Timisoara regained two community gardens that act as places for dialogue, experimentation with sustainable principles and local exchange of knowledge) (Fig.9), ROD [24] (physical transformation of the built environment in Piatra Neamt) (Fig.10), Click on Romania [25] (donating computers to schools in vulnerable areas) and Metakitchen [26] (a nationwide project that brings together Romanian practices addressing gastronomy, textiles, ceramics and production of building materials).

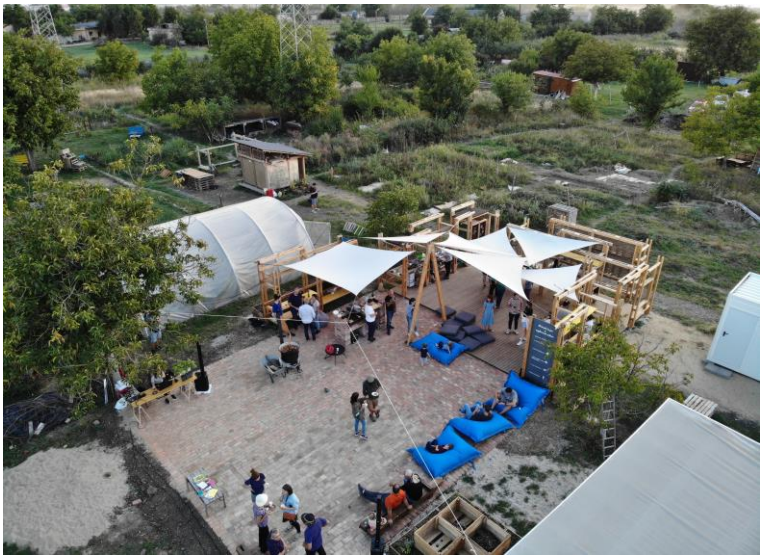

Fig. 9. Healthy Places project, Timisoara, Romania
Source: European Union, Prizes, 2021, Healthy Places | NEW EUROPEAN BAUHAUS (new-european-bauhaus.eu)

Fig. 10. ROD project, Piatra Neamt, Romania
Source: European Union, Prizes, 2021, https://2022.prizes.new-european-bauhaus.eu/application/rod

7. NEB at national level

Romania welcomes the European Commission's initiative on the approach and actions proposed for the NEB: beautiful, sustainable and together. In this respect, the Decision no.10 of 15 February 2022 [27] was adopted, recommending to integrate the objectives of increasing disaster resilience in the NEB, the relevance of artisanal techniques and the maintenance of traditional construction solutions in rural areas is emphasized, and also the responsible systematization of the areas intended for constructions in order to support traditional social approaches and relationships in communities, such as multigenerational housing. The Decision also stipulates that the NEB's development strategy should have distinct objectives for preserving soil biodiversity and expanding urban green areas.

At the same time, the concept was introduced as a priority and development direction within the National Strategy on Education for Environment and Climate Change 2023-2030 [28], as well as within the framework of the National Housing Strategy For The Period 2022-2050 [29].

In 2022, The European Commission achieved an increased commitment of Romania, as well as from the other Member States, to support NEB in Cohesion Policy Programmes, European Regional Development Fund (ERDF) being one of the funds that encourage the concept of NEB. Romania included NEB references in the programmes as a result. This fact paves the way to mainstreaming NEB’s implementation in Romania, at the regional and local level during the 2021-2027 period [30]. Specific operational programmes already foresee support to NEB projects, such as Regional Programmes approved by the European Commission [31].

Since 2021, with the process of decentralization of regional development, 8 Regional Programmes were needed, one for each development region in Romania: North-East Regional Programme, South-East Regional Programme, South-Muntenia Regional Programme, South-West Regional Programme, West Regional Programme, North-West Regional Programme, Centre Regional Programme and Bucharest-Ilfov Regional Programme. All these 8 Regional Programmes, supported by ERDF, one of the Cohesion Policy's shared management funds, foresee support to NEB projects, for instance:

North-West Regional Programme: "*PR NV will take into account the NEB initiative to implement the European Green Deal and create affordable, sustainable and quality housing places through the collaboration and interoperability of art, science and culture, encouraging investments that successfully combine the principles of sustainability, aesthetics and inclusion (according to the NEB initiative), in order to find affordable, inclusive, sustainable and attractive solutions to climate challenges*." [32].

South-West Regional Programme: "*The programme will encourage investments that successfully combine the principles of sustainability, aesthetics and inclusiveness of the New European Bauhaus initiative, with the aim of finding solutions to climate challenges*." [33].

West Regional Programme: "*The PRV will encourage the partnership principle inherent in the NEB initiative and will allocate resources to the preparation of NEB projects in consultation with stakeholders*." [34].

North-East Regional Programme: "*PR promotes intervention „ New European Bauhaus (NEB)" which operates the European Ecological Pact, supporting investments on OS b(i) and e(i) which successfully combine the principles of sustainability, aesthetics and inclusion of the NEB in order to find solutions to climate change*." [35].

South-East Regional Programme: "*…the interventions will take into account the NEB initiative to develop and implement projects with a participatory and transdisciplinary approach."* [36].

Centre Regional Programme: "*Support will be given to investments that successfully combine the principles of sustainability, aesthetics and inclusiveness of the NEB initiative, with the aim of finding affordable, inclusive, sustainable and attractive solutions to climate challenges."* [37].

Bucharest-Ilfov Regional Programme: "*The promotion of the NEB principles, implementing the European Green Deal, will be achieved by supporting the construction of new public buildings NZEB+ with a demonstrative role as well as for the actions aimed at conservation, protection and sustainable valorisation of cultural heritage and infrastructures for cultural activities. Thus, PR BI will support, under OS b (i), OS e(i) and OS e(ii), interventions that combine the principles of sustainable development, social inclusion, aesthetics, and, in harmony with nature and the environment so as to meet the needs of users."* [38].

8. Insights into South Muntenia Region- South-Muntenia Regional Programme. How does the programme contribute to the implementation of the NEB initiative?

As a strategy, the South-Muntenia Regional Programme 2021-2027 supports beneficiaries to use nature-based integrated solutions in space planning, urban design to encourage more efficient use and restoration of existing ecosystems and/or creating new ecosystems: "*The programme supports investments that successfully combine the principles of sustainability, aesthetics and inclusiveness of the NBE initiative in order to find affordable, inclusive, sustainable and attractive solutions to climate challenges"* [39]**.**

Within the South-Muntenia Regional Programme 2021-2027 there are a number of priorities, specific objectives and actions compatible with the NEB concept.

Thus, within Priority 2, Specific Objective 2.1 of the program energy efficiency and reduction of greenhouse gas emissions are promoted through investments in public and residential buildings (also individual and social housing) in order to ensure/improving energy efficiency.

Under Priority 2, Specific Objective 2.7 of the program are foreseen actions to protect and conserve nature, biodiversity and green infrastructure and reduce all forms of pollution through: creating public parks and gardens, urban forests, botanical gardens, restoring the ecosystem in the form of natural and semi-natural green spaces, creating blue-green corridors through rehabilitation, regularization, dredging and arrangement of rivers, lakes and canals with the aim of ensuring sustainable use for pedestrians, cyclists, educational activities, etc., and the creation of habitats for biodiversity.

Within Priority 6, Specific Objectives 5.1 and 5.2, there is support for integrated and inclusive development that encompasses social, economic and environmental fields, as well as culture and natural heritage, sustainable tourism and security, both urban and non-urban areas through actions regarding protection, conservation and sustainable valorisation of cultural heritage, investments in buildings intended for public use for cultural and recreational activities, with the aim of creating, improving or extending basic public services, urban regeneration investments in public use spaces, and setting up tourist routes and recreation areas using environmentally friendly solutions.

Through the above mentioned actions, the South-Muntenia Regional Programme 2021-2027 contributes to the implementation of the NEB concept, within the 4 thematic axes of the NEB initiative: renovation of existing buildings and public spaces in the spirit of carbon neutrality and circularity; conservation and transformation of cultural heritage; adapting and transforming buildings for affordable housing solutions; regeneration of urban or rural areas.

The above programme's actions and concrete projects will help promote the three values of NEB (sustainability, aesthetics and inclusion) and the three principles (participatory, transdisciplinary, multi-level approach).

Sustainability is supported through: the use of environmentally friendly insulation (wood fibre, hemp fibre, cork, cellulose, wool, jute, basaltic mineral wool) which reduce the need for electricity and are recyclable materials supporting circularity, solar roofs that provide electricity and reduce carbon emissions, green roofs/green walls/vertical gardens that contribute to the regulation of indoor temperature, air purification, create support for biodiversity, materials recovered in the arrangement, regeneration and greening of areas, permeable pavement.

Aesthetics is supported through: green roofs /green walls /vertical gardens that improve urban aesthetics; green-blue infrastructure ensuring visual harmony with the adjacent urban fabric; the use of suitable materials (with a low carbon footprint) which are in harmony with the local heritage and culture.

Inclusion is supported through: renovated buildings (public, residential, for cultural and recreational activities) that offer a sense of belonging and care to their users and the community; encouraging the participation of citizens, especially vulnerable groups, even as users; common spaces for physical, cultural, recreational activities that favor the interaction between residents of different ages, with different concerns, strengthen the sense of belonging to the community, and develop civic spirit.

The participatory approach is given by public consultations on the development of each project and encouraging stakeholders to participate in the decision-making process, transdisciplinary character involves collaboration between specialists from different fields (architects, builders, environmental experts, etc.) and citizens, and the multi-level approach is given by collaboration between informal groups (citizens, associations of owners, neighborhoods) and formal groups (institutions and local public authorities).

Projects proposing actions and approaches specific to the NEB initiative will be funded as a priority within the South-Muntenia Regional Program 2021-2027, and will ensure sustainability, increasing the resilience of urban/ rural spaces to climate challenges, and will also improve the quality of life of the inhabitants in the South-Muntenia Region.
This priority in financing is given by the additional scoring of projects that align with the NEB concept [40] [41] [42] [43] [44] [45] [46].

9. Conclusions

Climate change is a global emergency. The impact of human activity on greenhouse gas emissions and land use has compounded environmental harm and created an escalating crisis. This is our chance to build a better future.

The projects already implemented, presented in this paper, show that the NEB initiative has created beneficial results in the territory and can be an engine in terms of promoting the green transition of society and economy.

NEB will be based on the strength of the community. Cooperation of public authorities at international, national, regional and local level, including the participation of civil society, will be crucial. From promoting participatory co-design processes to being able to support the financing of local transformation projects, the NEB will require strong cooperation in this multi-level governance framework.

An integrated approach can lead to beneficial changes both locally and regionally, nationally and internationally.

Creating long-term solutions to climate change requires the participation of everybody in society. Cleaner and more efficient communities will raise the quality of life for all citizens.

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Space technologies, smart cities, and national security: a smart(er) state synergy

Ulpia-Elena BOTEZATU,
Romanian Space Agency, Bucharest, Romania
National Institute for Research & Development in Informatics – ICI Bucharest, Romania
ulpia.botezatu@rosa.ro

Abstract
In the Smart(er) State era, the dynamic synergy between space technologies, smart cities, and national security takes center stage, guided by practical examples that vividly illustrate the profound impact of this convergence. Space technologies, including Earth observation satellites facilitating urban planning, satellite-based communication networks empowering connectivity, and advanced navigation systems optimizing transportation, are at the forefront of reshaping urban landscapes and driving sustainability in smart cities. Practical examples spotlight the intricate interplay between smart cities and national security, shedding light on real-world cyber threats that challenge city infrastructure, vulnerabilities that jeopardize essential services, and the ethical concerns surrounding data privacy in urban surveillance. This paper goes further to showcase how space technologies actively enhance smart city security. Tangible instances include the use of satellite-based emergency services for swift disaster response, Earth monitoring systems for proactive disaster management, and space-based navigation for robust transportation security. In addressing the challenges and ethical considerations posed by this interplay, we emphasize the need for cross-sector collaboration, underpinned by rigorous governance and policy frameworks. This collaborative effort serves as the cornerstone for achieving a secure and resilient urban future. Finally, this paper casts its gaze toward the horizon, anticipating future trends that will be driven by space-based technologies, such as predictive policing and sustainability initiatives within smart cities. It concludes by offering actionable recommendations for building smart cities that are not only secure but also sustainable and resilient in the face of emerging challenges.

Keywords: infrastructure vulnerabilities, cyber threats, complex governance, resilience, predictive policy.

1. Introduction
In the dawning era of the Smart(er) State, the fusion of advanced technologies with urban development and national security strategies marks a transformative epoch. This new era is characterized by an unprecedented integration of space technologies into the fabric of urban life, reshaping how cities evolve, function, and protect their inhabitants.

The role of space technologies in urban development has seen a paradigm shift in recent years. Earth Observation satellites, once primarily tools for scientific exploration, have now become integral in urban planning and management. These satellites provide critical data for monitoring environmental changes, urban sprawl, and resource distribution, offering a bird's-eye view that is indispensable for sustainable urban development. For instance, the Copernicus program [1], initiated by the European Union, stands as a testament to how satellite imagery can be leveraged for urban planning and environmental monitoring.

Moreover, the proliferation of satellite-based communication networks has bridged significant gaps in urban connectivity. In regions where terrestrial networks are unfeasible or unreliable, satellite communications have provided a lifeline, ensuring seamless connectivity. An illustrative example of this is the Galileo [2] program, which aims to deliver high-speed internet across Europe, including remote urban areas.

The integration of space technologies into smart cities also plays a pivotal role in enhancing national security. Advanced navigation systems, such as the American Global Positioning System (GPS), are not just tools for wayfinding but also critical components in urban security infrastructure. These systems enable precise tracking and rapid deployment of emergency services, bolstering the resilience of cities against threats and disasters. Furthermore, the use of satellite technology in surveillance and communication aids law enforcement and security agencies in safeguarding urban areas against various threats, ranging from cyber-attacks to physical assaults.

As we venture further into the Smart(er) State era, the confluence of space technologies with urban development presents both opportunities and challenges. It is imperative to navigate this landscape with a keen eye on ethical considerations, particularly concerning surveillance and data privacy, while harnessing these technologies for the greater good of urban societies and national security.

Additionally, it's insightful to consider the historical evolution of space technologies in urban contexts. Initially, the utilization of these technologies was largely dominated by governmental and military entities. However, over the past few decades, there has been a significant shift towards civilian and commercial applications, largely driven by advancements in satellite technology and data analytics. This evolution has democratized access to space-derived data, enabling city planners, businesses, and public services to make more informed decisions [3].

Looking forward, the potential of space technologies in urban development is immense. The emerging concept of 'smart urbanism,' which envisions cities where technology and data are seamlessly integrated to enhance living conditions, is becoming increasingly feasible. For instance, predictive analytics derived from satellite data can play a pivotal role in urban planning, traffic management, and environmental monitoring, making cities more efficient and sustainable.

The integration of space technologies into smart cities also opens up new frontiers in national security. The ability to monitor urban spaces in real-time provides invaluable insights for emergency response and crisis management. This integration not only enhances the physical security of urban areas but also fortifies them against emerging cyber threats, which are increasingly becoming a concern for modern cities.

In conclusion, the synergy between space technologies, smart cities, and national security heralds a new era of urban development. The Smart(er) State era is not just about technological advancement; it's about reimagining how cities operate, protect, and serve their inhabitants. The subsequent sections of this paper will delve deeper into specific technologies, case studies, and strategic considerations, painting a comprehensive picture of this dynamic and rapidly evolving field.

2. The Role of Space Technologies in Urban Development

Space technologies, particularly those developed for Earth observation, satellite communication, and navigation, play a transformative role in urban development. Their

applications in urban planning, connectivity, and transportation have become indispensable in the era of smart cities, where efficient, sustainable, and secure urban environments are paramount.

Earth observation satellites offer a vantage point that is pivotal for modern urban planning. These satellites provide detailed, up-to-date imagery and data that are essential for various aspects of city planning, including land use analysis, environmental monitoring, and disaster management. For example, the Copernicus program, operated by the European Space Agency, offers a wealth of data used in urban growth analysis, helping city planners to make informed decisions about sustainable land use. The program's Sentinel satellites provide high-resolution images that can be used to monitor urban sprawl, assess the impact of urbanization on the environment, and plan infrastructural development in an eco-friendly manner.

Satellite-based communication networks have a profound impact on urban connectivity, especially in bridging the digital divide. These networks ensure reliable, high-speed internet access, essential for the digital infrastructure of smart cities. An example of this is the Starlink project by SpaceX, which aims to provide global broadband coverage through a constellation of satellites. This technology is especially beneficial for remote or underserved urban areas, where traditional broadband infrastructure is lacking. By facilitating seamless connectivity, these satellite networks enable various smart city applications, including IoT (Internet of Things) integration, smart grid management, and real-time data exchange for municipal services.

Advanced navigation systems, primarily those driven by satellite technology like the Global Positioning System (GPS), significantly optimize urban transportation. They enable efficient traffic management, route optimization for public transit, and facilitate emerging technologies such as autonomous vehicles. For instance, cities like Singapore utilize GPS-based systems to optimize bus routes and schedules, reducing wait times and improving the overall public transit experience. Furthermore, GPS technology is integral to ride-sharing services, which have transformed urban mobility by providing convenient, on-demand transportation options.

Geographic Information Systems (GIS), powered by satellite data, are instrumental in urban management and planning. GIS technology integrates spatial data with demographic and infrastructural information, providing city planners with comprehensive tools for urban design, resource management, and public service deployment. For example, the city of Los Angeles uses GIS for urban planning, environmental monitoring, and emergency response coordination, enhancing the city's ability to manage its resources effectively and respond to crises.

Space technologies play a crucial role in monitoring environmental factors such as air quality, water resources, and green spaces within urban settings. Satellites like NASA's Landsat or the European Space Agency's Sentinel-5P are critical in tracking urban pollution, water quality, and vegetation cover. This data is vital for cities aiming to improve environmental sustainability and mitigate the effects of climate change. For instance, the European Environment Agency

utilizes satellite data to monitor air quality across Europe, helping cities to implement targeted measures to reduce pollution and improve public health.
In the context of increasing urbanization and climate change, the ability to effectively manage and respond to disasters is paramount. Satellite technologies offer real-time data critical for disaster management and resilience planning in urban areas. For instance, satellite imagery was crucial in assessing the damage and coordinating response efforts in the aftermath of natural disasters like the 2011 Japan earthquake and tsunami. Urban centers are increasingly relying on such technologies for risk assessment, early warning systems, and post-disaster recovery planning.

The integration of space technologies into urban development processes marks a significant leap towards smarter, more sustainable cities. From the strategic use of Earth observation data in urban planning to leveraging satellite communications for enhanced connectivity, and harnessing advanced navigation systems for improved transportation, these technologies are at the heart of the smart city revolution. As urban areas continue to expand and evolve, the reliance on space technologies will only increase, paving the way for more innovative, efficient, and secure urban environments. The inclusion of GIS in urban planning, the use of space technology in environmental monitoring, and the application of satellite data in disaster management underscore the multi-faceted impact of space technologies in shaping the future of smart cities. These technologies not only enhance the efficiency and connectivity of urban areas but also play a pivotal role in ensuring their sustainability, resilience, and safety.

3. Smart Cities and National Security: A Complex Interplay

In the contemporary urban landscape, the nexus between smart cities and national security is increasingly complex and critical. This complexity is primarily driven by the digitalization of city infrastructures and the consequent rise in cyber threats targeting these sophisticated systems. The sophistication of cyber threats targeting smart cities is rapidly evolving. These threats not only disrupt municipal services but also pose risks to critical data and citizen safety.

An example is the 2017 WannaCry ransomware attack, which impacted over 150 countries, including disruptions in the UK’s National Health Service. The attack underscored the global reach of cyber threats and the necessity for international cooperation in cybersecurity efforts [4]. Another notable instance of such threats was the Atlanta ransomware attack in 2018. The city's computer networks were crippled, affecting municipal operations ranging from bill payments to court proceedings. This incident highlighted the vulnerability of smart city infrastructures to cyberattacks and the need for robust cybersecurity measures [5]. One more significant example is the 2015 cyberattack on the Ukrainian power grid, which left over 230,000 residents without electricity. This attack, attributed to sophisticated malware, underscored how critical infrastructure, often integrated with smart city technologies, can be targeted by national and international actors [6].

Smart cities, with their interconnected infrastructures, present unique vulnerabilities. Essential services such as water supply, electricity, and transportation systems rely heavily on internet-connected devices and sensors. The integration of Internet of Things (IoT)

devices in these services, while enhancing efficiency, also exposes them to potential breaches. The Mirai botnet attack in 2016, which turned a multitude of IoT devices into a massive botnet, disrupting internet services across the United States, serves as a stark reminder of these vulnerabilities [7].

The interconnected nature of smart city technologies means that a breach in one system can lead to cascading failures across multiple services. The concept of "cyber-physical systems" is at the heart of this challenge, where a cyberattack can have tangible physical consequences. For instance, a breach in traffic control systems can lead to widespread transportation chaos, emphasizing the need for resilient and redundant systems in smart city infrastructures [8].

Alongside security concerns, the increasing use of surveillance technologies in smart cities raises significant ethical issues, particularly regarding data privacy. The deployment of CCTV cameras, facial recognition technologies, and predictive policing tools have been met with concerns over privacy infringements and potential biases in surveillance practices.

For instance, the use of facial recognition technology by law enforcement in London has sparked debates about the balance between security and individual privacy rights. Critics argue that such technologies can lead to unwarranted intrusions into personal privacy and may disproportionately impact certain groups, leading to civil liberties concerns [9].

The ethical concerns regarding surveillance in smart cities extend beyond privacy to encompass issues of consent, transparency, and accountability. The deployment of "smart" technologies often occurs without explicit consent from citizens, raising questions about the balance between collective security and individual rights. Moreover, the potential for mass data collection by urban surveillance tools necessitates stringent data governance policies to prevent misuse and ensure accountability.

For example, in Toronto's Quayside smart city project, initially led by Sidewalk Labs (a subsidiary of Alphabet Inc.), there were significant public concerns about how data would be collected, used, and shared. The project sparked a broader debate about public space data governance and the role of private companies in smart city development [10].

In conclusion, the interplay between smart cities and national security is fraught with challenges ranging from cybersecurity threats to ethical dilemmas surrounding surveillance. Addressing these issues requires a multifaceted approach involving robust cybersecurity protocols, transparent governance, and ethical frameworks guiding the deployment of surveillance technologies.

To mitigate these challenges, it is imperative to adopt a proactive stance. Recommendations include the development of robust cybersecurity frameworks tailored to smart city contexts, increased investment in cybersecurity talent and technologies, and fostering public-private partnerships for better security solutions. Furthermore, establishing clear ethical guidelines and ensuring public involvement in decision-making processes are crucial for maintaining trust and legitimacy in the surveillance practices of smart cities.

4. Enhancing Smart City Security through Space Technologies

The incorporation of space technologies into the fabric of urban management is a significant leap forward in enhancing the security infrastructure of smart cities [11]. This integration not only provides immediate solutions to existing challenges but also paves the way for innovative approaches to urban resilience and sustainability. In this context, satellite-based emergency services, Earth monitoring systems, and space-based navigation emerge as key components in the strategic toolkit for smart city security.

The utilization of satellite-based emergency services in urban disaster management exemplifies a paradigm shift from traditional, ground-based communication systems. These services offer a robust platform for emergency communication, particularly in scenarios where terrestrial networks fail. Theoretical frameworks in disaster management, such as the "Resilience Theory," highlight the importance of adaptive and responsive systems in the face of crises. Satellites play a crucial role in this respect, as evidenced by their deployment during the Haiti earthquake in 2010, where they provided critical information for rescue and relief efforts [12]. This example underscores the transition towards more resilient urban systems, capable of adapting to and recovering from disaster scenarios.

Earth monitoring systems represent a proactive approach to urban disaster management, aligning with the principles of "Predictive Analytics" in urban planning. These systems harness satellite imagery and advanced analytics to monitor environmental changes, predict potential disasters, and enable timely interventions. The Copernicus program's contribution during the 2019 Amazon wildfires serves as a testament to the power of these technologies in managing complex urban environmental emergencies [13]. The strategic use of Earth monitoring data not only enhances disaster preparedness but also contributes to sustainable urban development by facilitating informed decision-making.

In the domain of urban transportation, space-based navigation systems like GPS introduce an unprecedented level of precision and efficiency. The application of these systems in urban mobility aligns with the "Smart Mobility" concept, which advocates for technologically advanced, efficient, and sustainable transportation solutions. GPS technology's role in optimizing traffic flow and enabling autonomous vehicle technologies marks a significant step towards smarter, safer, and more sustainable urban transportation networks. This advancement is indicative of a broader trend towards integrating digital technologies in urban infrastructure to enhance efficiency and security.

In summary, the integration of space technologies in smart cities presents a multifaceted approach to enhancing urban security and resilience. From enabling robust emergency responses to facilitating proactive disaster management and advancing smart mobility, these technologies are at the forefront of driving sustainable urban development. Theoretical underpinnings, such as Resilience Theory and Predictive Analytics, provide a framework for understanding the transformative impact of these technologies on urban landscapes. As smart cities continue to evolve, the strategic application of space technologies will undoubtedly play a pivotal role in shaping secure, resilient, and sustainable urban futures.

5. Addressing Challenges and Ethical Considerations

The integration of space technologies into the fabric of smart cities, while beneficial, presents a unique set of challenges and ethical considerations, particularly in the realms of national security, surveillance, and data management.

5.1 Challenges in Integrating Space Technologies with Smart Cities

The synergy between space technologies and smart cities, though promising, is fraught with complexities. One primary challenge lies in the technical integration and interoperability of space-based systems with terrestrial urban infrastructures. For instance, aligning satellite communication networks with ground-based systems requires substantial coordination and technological harmonization.

Furthermore, the reliance on space technologies for critical infrastructure poses risks, such as vulnerability to space weather or satellite malfunction. A notable example was the 1998 Galaxy IV satellite failure, which disrupted pagers and broadcast services across the United States, illustrating the potential impact on essential urban services.

Integrating space technologies into smart cities introduces complex challenges, straddling technical, legal, and operational domains. Technically, achieving interoperability between space-based and terrestrial systems demands sophisticated engineering solutions. For example, ensuring real-time data transmission from satellites to urban infrastructure requires overcoming latency issues, as seen in advanced telemetry systems.

Legally, the deployment of space technologies in urban settings intersects with international space law. The Outer Space Treaty of 1967, for instance, provides a legal framework but may not fully address the nuances of modern urban applications of space technology.

Operational challenges also emerge, particularly in maintaining the reliability and security of satellite communications. The incident of the Galaxy IV satellite malfunction, as noted by the Federal Communications Commission, underscores the criticality of contingency planning in space-dependent urban infrastructures.

5.2 Ethical Considerations in Surveillance and Data Management

The use of space technologies in urban surveillance raises significant ethical concerns, especially regarding citizen privacy and data protection. The European Union's General Data Protection Regulation (GDPR) offers a framework for balancing technological advances with privacy rights. However, the global nature of satellite data collection often transcends national jurisdictions, complicating regulatory compliance.

An ethical dilemma also arises from the potential for surveillance overreach. The case of the Chinese city of Rongcheng, which implemented a social credit system partially reliant on surveillance technologies, underscores the fine line between security and individual freedoms. Such systems, while enhancing security, can lead to invasive monitoring, raising concerns about civil liberties.

Ethically, the deployment of space technologies in urban surveillance walks a tightrope between public security and individual privacy rights. The GDPR in the EU sets a precedent in privacy protection but navigating compliance across different jurisdictions remains a challenge. The dilemma intensifies when considering global satellite networks that collect data across borders.

Moreover, philosophical and ethical debates surface around the extent of surveillance. Foucault's theory of 'panopticism,' as applied to modern surveillance, questions the balance between societal safety and personal freedom. The social credit system in Rongcheng, China, while an extreme example, highlights how surveillance can permeate daily life, potentially leading to societal control mechanisms that conflict with democratic values.

5.3 The Imperative for Cross-Sector Collaboration and Governance

To navigate these challenges and ethical quandaries, robust cross-sector collaboration and sound governance are essential. This involves a multi-stakeholder approach, engaging government agencies, technology providers, urban planners, and civil society. For example, the Smart City initiative in Singapore demonstrates effective cross-sector collaboration, where the government, industry partners, and academic institutions work together to develop sustainable and secure urban solutions.

Effective governance frameworks must also be established to oversee the deployment and operation of space technologies in urban environments. The United States' National Space Policy serves as an example, providing guidelines for space activities, including commercial and national security considerations.

Addressing these challenges necessitates a multi-faceted approach. Collaboration across sectors – government, private sector, academia, and civil society – is pivotal. Singapore’s Smart City initiative exemplifies this, involving diverse stakeholders in shaping a technologically advanced yet socially responsible urban ecosystem.

Governance frameworks need to evolve alongside technological advancements. The U.S. National Space Policy provides a comprehensive approach, yet further refinement is needed to address the specificities of space technology applications in urban settings. Scholars like Sassen and Castells have emphasized the need for governance models that account for the digital and physical convergence in urban spaces.

6. Future Trends and Predictive Policies

In the realm of space-based technologies and smart cities, the future holds transformative potential. Emerging trends and innovations are poised to redefine urban living and governance, particularly in the areas of predictive policing and sustainability initiatives.

The evolution of space technologies is set to offer unprecedented capabilities in urban management. Advancements in satellite imagery and analytics, for example, will enable more accurate and real-time monitoring of urban developments. Projects like the European Space Agency's Copernicus program are already providing critical data for urban planning and environmental monitoring. Furthermore, advancements in satellite communication

technologies, such as those led by SpaceX's Starlink project, promise to deliver high-speed internet connectivity even in the most remote urban areas, bridging the digital divide and fostering inclusivity in smart city services.

Predictive policing, an approach that utilizes data analytics to forecast potential criminal activities, is gaining traction in smart cities. This method leverages various data sources, including space-based technologies, to predict and prevent crime. A real-world example is the Los Angeles Police Department's (LAPD) use of PredPol, a predictive policing software that analyzes historical crime data to forecast crime hotspots. While promising in enhancing urban security, this approach raises significant ethical and privacy concerns, necessitating robust governance frameworks to ensure responsible use of data and technology.

Space technologies are increasingly central to sustainability initiatives in urban contexts. Satellite data is instrumental in monitoring environmental changes, enabling cities to respond to challenges like air pollution, deforestation, and climate change effectively. The European Union's Earth observation program, Copernicus, provides valuable data used in monitoring air quality, which cities like Copenhagen utilize to develop cleaner transportation solutions. Additionally, space technology is pivotal in solar energy advancements, with projects like the International Space Station's Solar Array Wings demonstrating the potential of space-based solar power as a sustainable energy source for smart cities.

In conclusion, the future trajectory of space technologies in smart cities is marked by exciting opportunities and complex challenges. As these technologies evolve, they will play a pivotal role in shaping urban landscapes, from predictive policing to sustainability. However, this progress must be underpinned by careful consideration of ethical implications and a commitment to sustainable development.

7. Conclusions and Recommendations

As we delve into the intricate synergy between space technologies, smart cities, and national security, several key insights emerge. Firstly, space technologies like Earth observation satellites, satellite-based communication networks, and advanced navigation systems are revolutionizing urban landscapes. They are not only enhancing the efficiency of urban planning and connectivity but are also playing a pivotal role in addressing sustainability challenges within smart cities.

The integration of space technology in urban development has also highlighted complex cybersecurity threats and infrastructure vulnerabilities. For instance, the use of satellite imagery in urban planning, as seen in the European Union's Copernicus program, has greatly enhanced environmental monitoring and urban sprawl management. However, it also raises concerns about data privacy and surveillance ethics.

In light of these insights, the following actionable recommendations are proposed for building secure, sustainable, and resilient smart cities:

- Robust Cybersecurity Frameworks: Implementing comprehensive cybersecurity measures is essential to protect smart city infrastructure from cyber threats. Cities

like Singapore, with their Smart Nation initiative, have set benchmarks in creating resilient urban digital infrastructure.

- Ethical Use of Surveillance and Data: As cities like London and Tokyo expand their use of urban surveillance systems, there is a pressing need to balance security with citizens' privacy rights. Developing ethical guidelines and transparent data policies is crucial.
- Leveraging Space Technology for Disaster Management: Incorporating satellite-based systems for early warning and disaster response can significantly enhance urban resilience. The use of NASA's Earth-observing satellites in disaster management across various U.S. cities serves as a model.
- Collaborative Governance: Establishing collaborative frameworks involving government, industry, and academia can foster innovation and ensure the sustainable development of smart cities. The partnership approach in Amsterdam's Smart City initiative is a prime example of this.
- Sustainability-Driven Urban Planning: Integrating space technology in urban planning for environmental monitoring and resource management, as seen in the European Space Agency's initiatives, can aid in sustainable urban development.

Looking toward the future, the trajectory of space technologies in urban development is poised to be transformative. With advancements in satellite technology and the increasing accessibility of space data, cities will have unprecedented capabilities in urban management and security. Future trends like predictive policing, powered by space-based data analytics, and sustainability initiatives leveraging Earth observation technologies, are set to redefine the smart city landscape.

In conclusion, the fusion of space technologies with smart city development presents both challenges and opportunities. As we navigate this terrain, a focus on ethical, collaborative, and sustainable approaches will be key to unlocking the full potential of this synergy, paving the way for a smarter and more secure urban future.

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Collective housing for seniors in Romania, in a paradigm of active and healthy ageing in community – from smart adaptation to architectural and design innovation

Mihaela ZAMFIR,
Lecturer PhD Architect, Synthesis of Architectural Design Department, Faculty of Architecture, "Ion Mincu" University of Architecture and Urbanism; MMZ- Individual Architecture Studio, Bucharest, Romania
mihaela.zamfir@uauim.ro, mmg_architecturestudio@yahoo.com

Ileana CIOBANU,
Scientific Researcher III, PhD Biol., Department of Neuro-Rehabilitation, "Elias" University Emergency Hospital, Bucharest, Romania
ileanacuk@yahoo.co.uk

Andreea Georgiana MARIN,
PhD Psych., Speech Therapist, Department of Neuro-Rehabilitation, "Elias" University Emergency Hospital, Bucharest, Romania
andreea.budrica@gmail.com

Mihai-Viorel ZAMFIR,
Assist. Prof. PhD, MD, Physiology Division, Faculty of Medicine, "Carol Davila" University of Medicine and Pharmacy, Bucharest, Romania
mihai.zamfir@umfcd.ro, mihaivzamfir@gmail.com

Abstract

Currently, the existing collective residential fund in Romania is neither adapted nor refreshed in order to meet the needs of seniors, nor to the challenges of an ageing society. The current research aims to investigate, in the key of 2023, the ways in which architectural design in the residential sector responds to the challenges of the current Romanian society, aiming two objectives: identifying ways of adaptation and accessorization for existing apartment-type dwellings in multi-storey residential buildings in Romania and scoring innovative design solutions for new collective housing, so as to support an active and healthy ageing in community. The research is based on concepts such as ageing in place, ageing in community, age-friendly architecture, universal design, sustainable communities. The study involves the narrative review methodology. Using the principles of user-centered design, changes brought about by ageing are discussed in an interdisciplinary approach, specific geriatric pathology (medical doctor) and implicitly synthesized the needs of the elderly, the ways of architectural adaptation of the apartments needed by seniors (architect) and their accessorization with gerontotechnology (architect, psychologist, biologist, medical doctor) are presented in order to become a safe and engaging environment. Using research by design method, innovative assistive living facilities projects for seniors are presented, carried out with the 5th year students from IMUAU (2020 and 2022) and visions of contemporary architecture as a support for intergenerational sustainable communities in degree projects (2023). The adaptation of apartments for seniors involves interventions in: access, floors, doors, windows, lighting, spatial configuration, furniture, landmarks, decorations, color palette, visual stimulation, smart technologies. Five levels of intervention were identified: 1. labelling, signage, painting, planting; 2. assistive technologies for activities of daily living; 3. interior-exterior changes for doors, windows, floors; 4. building, accessorization, accessibility; 5. spatial layout and structure. The costs of these interventions differ and increase from point 1 to point 5. Compared to adaptations, the *ab initio* design of seniors' dwellings practiced in students' projects offers increased comfort. The disadvantage is the need to change residence around the age of 60. Degree projects (2023) demonstrate sustainable strategic thinking at the community level, with an emphasis on architecture as a support for intergenerational relations. The research results reveal the importance of interdisciplinary teamwork and the need for a paradigm shift in the design discipline of higher architecture education. Seniors' housing adaptation, including accessorizing with gerontotechnology, must be supervised by the architect so the results to be optimal, both in terms of comfort and aesthetics. The need for education for active and healthy

ageing of the Romanian society is highlighted.The work proves the importance of residential architecture but also of the public spaces in supporting ageing in community, optimizing opportunities for autonomy, participation and security. This research was funded through the Active and Assisted Living Programme, Project AAL-CP-2020-7-108-SI4SI-1, co-funded by the European Commission and the Romanian National IRD Funding Authority – UEFISCDI.

Keywords: age-friendly architecture, ageing in place, apartments for seniors, research by design, interdisciplinarity.

1. Introduction

In Romanian cities, housing is predominantly collective and happens in the vast majority in multi-storey residential buildings, built during the communist period. In recent years, real estate developments in terms of residential complexes on the outskirts of big cities-an eloquent example being Bucharest-bring to the attention, especially of young families, new living standards, the European product model that seems to constitute a guarantee of quality and aesthetics compared to the unpleasant, outdated, stereotyped communist model. The western model is idealized by young people who are looking to purchase an apartment, who most of the time overlook the location of these new real estate developments, very often with a fragile urban structure, insufficiently developed at the level of streets, sidewalks, utilities and public transport. Romanians have the mentality of being owners [1], of having a home of their own for the rest of their lives. [2] Regardless of whether the Romanians live in an old multi-storey residential building – this tipically means built during the communist era – or whether they live in a new block of flats, recently built, the same questions it is asked. Can that apartment, purchased with a lot of effort, be an apartment in which to live comfortably for the rest of your life? Does the apartment have the right sized spaces and public conections so that it can be comfortably used by an older person and, moreover, by an older person with age-specific health problems?

The population of Romania is ageing at the same rate as the population of Europe. In 2020, statistics estimated Romania's population at 19.53 million [3], with a life expectancy at birth of 75.83 years. [4] The proportion of elderly people 65+ in 2019 was 18.5% and it is estimated that by 2030 the percentage of elderly people will reach 21% in 2030 and 27.7% in 2050. [3] Half of the Romanian population lives in the urban environment (53.8% in 2020) [3] and the trend is continuously increasing.

Currently, the existing collective residential fund in Romania is neither adapted nor refreshed in order to meet the needs of seniors, nor to the challenges of an ageing society. On the other hand, the new residential complexes are on the outskirts, poorly connected to the facilities necessary for a comfortable life at the age of seniority, such as parks, agro-food market, hospital, cultural buildings risking becoming enclaves that can isolate the future older adults and not support them for ageing in community and to continue a consistent social life.

2. Objectives

The current research aims to investigate, in the key of 2023, the ways in which architectural design in the residential sector responds to the challenges of the current Romanian society, aiming two objectives: identifying the ways of adaptation and accessorization for existing

multi-storey residential buildings in Romania and scoring innovative design solutions for new collective housing, so as to support an active and healthy ageing in community.

3. Prior work

The research is based on concepts such as ageing in place, ageing in community, age-friendly architecture, universal design, sustainable communities.

In the last 13 years, we have been concerned, at the research level, with how architecture can respond to the challenges of an ageing society. In this sense, in recent years we have published a series of articles on architecture as a support for active and healthy ageing [5], elderly-friendly architecture, architecture suitable for elderly people with neurocognitive disorders on the spectrum of Alzheimer's disease, known as dementia-friendly architecture. [6] In terms of collective housing, ageing in place today requires an apartment that meets the needs of an older person, a smart home that optimally combines architecture and design with technology that sometimes has to be assistive.

4. Approach

The study uses two types of research methods, narrative review and research by design.
In order to meet the specific dwelling needs of the elderly, residential architecture must take into account the health issues that may occure as we age. In this sense, with the help of the medical doctor fellow from the research team, the following clinical aspects in the elderly, related to the built environment, were identified: locomotor disability, bed-bounded, frailty syndrome, visual disorders, hearing loss, spatial disorientation, mood disorders, disorders of perception.

Using the principles of user-centered design, changes brought about by ageing are discussed in an interdisciplinary approach, specific geriatric pathology (medical doctor) and implicitly synthesized the needs of the elderly, the ways of architectural adaptation of the apartments needed by seniors (architect) and their accessorization with gerontotechnology (architect, psychologist, biologist, medical doctor) are presented so that to become a safe and engaging environment. Using research by design method, innovative assistive living facilities projects for seniors are presented, carried out with the 5th year students from IMUAU (2020 and 2022) and visions of contemporary architecture as a support for intergenerational sustainable communities in degree projects (2023).

5. Results

In Romania, living in multi-storey residential buildings is predominant in the urban environment. A useful tool for the local area, the interactive map of the blocks offers the possibility of consulting multi-storey residential buildings, according to the period in which these were built, respectively: 1950, 1950-1970, 1968-1978, 1977-1990, 1990-present. [7] On this map at the current moment, 2023, there are over 40,000 blocks from Bucharest and 10 other counties, in the future it is expected to develop this information. On this map, multi-storey residential buildings can be consulted according to certain criteria such as: height/number of floors, equipped with an elevator or not, number of apartments, seismic risk, year of construction completion, project year, project, structure, floor plans. For the discussed topic, namely the comfort of living for the elderly, we are specifically interested

in the aspects related primarily to accessibility. We are faced with two situations: low-rise residential blocks, ground floor and 3/4 floors, built without an elevator and high-rise buildings, over the ground floor+4 floors, which are equipped with an elevator. Most of them were built before the 90s.

Table 1 Apartments' areas in collective housing blocks in Romania built between 1950-1990

Planning years	1 room apartment Area (sqm)	2 rooms apartment Area (sqm)	3 rooms apartment Area (sqm)	4 rooms apartment Area (sqm)	5 rooms apartment Area (sqm)	Living Area (sqm)	Bedroom Area (sqm)
1984-1990 comfort 1	36-38	54-60	72-76	90-100	110-120	19-21	12-15
1978-1986 comfort 1	32-36	48-54	60-68	78-84	94-104	18-19	10-13
1966-1978 comfort 1	30-32	45-60	58-64	76-82	-	17-19	10-12
1960-1970 comfort 1	26-28	44-46	54-58	74-78	-	16-17	11-13
1950-1960	30-40	45-60	65-80	?	-	16-20	12-16
1978-1986 comfort 2	26-28	42-44	54-56	64-68	-	15-17	8-11
1966-1978 comfort 2	24-26	36-40	44-48	58-62	-	14-15	7-10
1966-1972 comfort 2	16-20	30-32	38-42	46-50	-	12-13	7-10

Source: https://www.hartablocuri.ro/planuri/

Living in an apartment in a multistory building implies, for the older person, risks such as [8]:

- Falls – by ignoring obstacles such as different barriers, stairs, glass doors or awkwardly positioned furniture;
- Fear- caused by inappropriate lighting, reflections, inappropriate prints, slippery or blunt finishes;
- Poor orientation- caused by insufficient lighting or blurred contrasts;
- Confusion- it can be caused or maintained by not keeping the routine and by changing certain elements in the design, lack of color contrasts, insufficient lighting;
- Safety – one of the most important aspects which involves the dimensions of the spaces (including the doors and how they open), the finishes of the floors and walls, the furniture in particular of the bathroom, various obstacles such as thresholds or unmasked cables.

The adaptation of apartments in order to meet seniors' needs involves interventions in: access, floors, doors, windows, lighting, spatial configuration, furniture, landmarks, decorations, color palette, visual stimulation, smart technologies.

The universal design guidelines for the adaptation of living space for elderly people with neurocognitive disorders identify five architectural levels of intervention: labelling, signage, painting, planting; assistive technologies for activities of daily living; interior-exterior changes for doors, windows, floors; building, accessorization,

accessibility; spatial layout and structure. [9] The costs of these interventions differ and increase from point 1 to point 5.

The adaptation of apartments, in addition to architectural and design interventions, can also be helped by smart technologies that, in the case of older adults, we will call gerontotechnologies.

In Romania, more than in Western European countries, people want to age in place, in their own homes, to grow old in the community where they have lived all their lives. In this sense, gerontotechnology integrated in residential architecture really increases the chances of living independently in old age, catalyzing the acquisition of an active and healthy lifestyle. Integrated into the residential living environment (but also in the indoor-outdoor common public spaces in the neighbourhoods) or in wearable devices, gerontotechnology involves sensors (presence and motion sensors, sensors for monitoring physiological and functional parameters, activity and participation levels, computer vision), data processing, application of decision and interpretation algorithms (including for behavioral and mood detection), artificial intelligence with the ability to provide constructive and assistive feedback to the user and caregivers [10] and a lot of work by interdisciplinary teams, side-by-side with potential users, in a user-centered and co-creation technology development approach. [11]

In order to stimulate active and healthy ageing in place and in community, more precisely, in the case of the present study, in an apartment in a multi-storey building, two types of solutions were identified: age-friendly architecture and ICT and sensored based gerontotechnologies. These two types of solutions can be applied to all five levels of intervention identified previously.

Gerontotechnology was created to be used by older people, with the aim of increasing the level of quality of life (QOL), by improving the safety and the level of performance of the activities of daily living (ADL). [12] Gerontotechnology is any product, tool, equipment or technical system used by an older person, produced specifically or generally available for the prevention, compensation, limitation of the disabilities associated with old age that may appear with ageing. [13] At the complex level, gerontechnologies can compose complex ecosystems, made up of independent and interdependent devices and programs that communicate with each other through a wired or wireless connection, that are able to respond and change continuously, according to the needs of the user. The integration of gerontotechnologies in residential architecture aims to: make ADL accessible & easier, improve the degree of functional independence in ADL, improve the QOL of both the older person and the family or the possible caregiver. Gerontotechnologies have three types of protective role: compensatory as support for an independent life as long as possible, recuperative as support for rehabilitation and preventive for safety, primary, secondary and tertiary prophylaxis. [14] Currently, smart home solutions are already on the market and include: presence sensors, physiological parameters sensors, inertial sensors, computer vision, processing algorithms, interpretation, even Artificial Intelligence. [15, 16, 17] The latest gerontotechnologies cover all the areas necessary to ensure the well-being of senior users, such as access and protection, indoor microclimate, the performance of ADL and

recreational activities, the performance of physical activities in safe conditions, participation in family life and other social activities.

From our personal experience, we would like to highlight the SI4SI project – Smart solutions for Senior Isolation [18], a recent finalized AAL project, in which age-friendly scenarios have been developed for the implementation of smart assistive technologies in users's homes for older adults. The SI4SI solution includes sensors of presence in spaces intended for certain categories of known activities, wearable sensors for monitoring physiological parameters and a smart application providing users with meaningful feedback and with the means to safely and efficiently communicate with peers and family. Starting from the analysis of the level of activity and the health condition of the user, we want to: stimulate activity for a good physical and mental condition, ensure a safe and stimulating environment for carrying out social communication with people with the same fields of interest, through digital means, stimulating interest in digital solutions that offer relevant information and possibilities and monitoring and also investigating anomalies in activity/functioning patterns by professional healthcare providers.

5.1. Smart apartments for the elderly: age-friendly architecture and gerontotechnology

A contemporary smart apartment involves the following aspects [19]:

- Safety: surveillance camera / CCTV, alert reminder system(s), automatic shut-off on gas, automatic power off, automatic stop of water supply, intelligent smoke detectors;
- Entertainment: smart TV, intelligent audio systems, noise control system, automatic lighting;
- Thermal: automatic air conditioning, automatic fan;
- Openings: automatic curtains/blinds, automatic window control, automatic door control;
- …and More: automatic lifting installations on tracks, smart appliances (including kitchen appliances and cleaning appliances), smart furniture, assisted breathing device, home backup generator.

Ten important aspects have been identified in the comfort and safety of the older person's residence, for which, in the following, solutions are presented in the two already identified categories: age-friendly architecture and gerontotechnology:

5.1.1. Home access

Access to multi-storey residential buildings in Romania is always achieved through a set of indoor or outdoor steps which for an older person using a mobility device (frame, crutch, cane or, in the most difficult case, a wheelchair) is risky, dangerous or even impractical.

- Age-friendly architecture: It is necessary the construction of an access ramp with slope inclination of maximum 15% for unevenness <20cm and of 8% (recommended 5%) for unevenness >20cm; [20]
- Gerontotechnology: Lifting platform [21] attached to the railing can be mounted that must accompany the stairs outside or inside the building. Lifting platforms are a solution for the unrestricted access for disabled elderly and these are generally

installed in buildings of public interest. For residential buidings with maximum groundfloor+3/4 levels, in order to become elderly-friendly, it is necessary the installation of an external elevator.

5.1.2. Floors

- Age-friendly architecture: It is recommended to give up carpets or rugs that can constitute a danger of obstruction and also cannot be maintained easily. The floor must be easy to maintain, in this sense, non-slip ceramic tiles are recommended, especially for elderly that suffer from urinary incontinence. It can be also used the resistant laminated parquet with a high resistance class (32 or 33) [22] that withstands frequent washing and disinfection. Durable PVC floors, with a five-layer composition, resistant to frequent washing and disinfection [23] can also be used. If it still wanted to cover the floor, it is recommended a carpet for heavy traffic, resistant to repeated cleaning [24], that is fixed to the wall by a plinth and does not constitute a danger of obstruction. The chromatic contrast between floor and walls [25] is used as an age-friendly design principle;
- Gerontotechnology: Giving up carpets involves issues raised by a floor that can be cold, in this sense the use of underfloor heating is recommended. [26] Also, trip and fall monitoring sensors can be used. [27]

5.1.3. Doors

- Age-friendly architecture: In order to be used including by an older person in a
- wheelchair, the doors should have a minimum width of 80 cm (90 cm is recommended). [20] It is also recomanded to remove the thresholds and for the doors to have frame and round sill to avoid injuries;
- Gerontotechnology: Doors cand be activated by presence sensors or after computer vision recognition, portable buttons, keypads, smartphone apps via Bluetooth or WIFI, wireless card readers that open when you're in range of the door. [28]

5.1.4. Lighting

- Age-friendly architecture: During the day, generous natural lighting is necessary to fight against depression, in this sense it is recommended to give up thick walls and curtains and to use adjustable sun control devices such as blinds. In the evening, uniform and consistent artificial lighting is recommended [29], let's not forget that the elderly need a lighting level three times higher than the young adult. Intelligent lighting also assumes task lighting, smart lights with presence sensors and light trajectory tracing; [6]
- Gerontotechnology: An intelligent lighting assumes light on/off via voice control (when paired with a smart speaker), apps that allows older person to see which lights are on/off, in this regard timers or lighting groups can be set. [30]

5.1.5. Spatial configuration

- Age-friendly architecture: In elderly-friendly interior design, the general recommendations are towards a classic design with traditional furniture [31], however, they are not recipes because the elderly are different as any other person

of any age and then the profile of each beneficiary must be analyzed separately. Regardless of the design, it is recommended to free circulation paths of unnecessary pieces of furniture and kitchen-living-bathroom route must be highlighted as clearly as possible. [32] The most important aspects are related to the minimum dimensions of some spaces, because a wheelchair user needs free space with the size of a circle with a diameter of at least 1.5ml in order to be able to move freely; [20]

- Gerontotechnology: Intelligent technologies can increase comfort by developing the space with projections that recreate certain relaxing environments [33], perhaps giving the impression of more space, more light.

5.1.6. Furniture

- Age-friendly architecture: It is recommended to avoid furniture with edges, blunt surfaces and to place furniture items at accessible heights to avoid improvised climbing. It should be remembered that the bathroom is the most dangerous room in an apartment- 79% of injuries occur in people 65+ happen in bathroom [34] – so it is recommended to replace the bathtub with a shower at floor level, to install grab bars both in the bathroom and in the hallways;
- Gerontotechnology: Intelligent technologies can increase comfort by furniture that can be transformed, such as adjustable ergonomic chairs [35] that help the elderly user to stand up beds with adjustable height and inclination [36] and also with assistive fall prevention devices [37].

5.1.7. Landmarks for orientation

- Age-friendly architecture: It is recommended to encourage autonomy by avoiding disorientation with a possible different chromatic marking of the access to the bathroom and, if the elderly lives in the extended family, with a different marking by color or texture of the door of their own room. Clocks and calendars [38], which should be present in every room, are also handy orientation elements, good reminders for older persons with neurocognitive disorders;
- Gerontotechnology: During the night, for orientation, smart trajectory can be used, tracing solutions and bells with warning light [39], the toilet bowl can also be illuminated.

5.1.8. Color pallete

- Age-friendly architecture: As an elderly-friendly and dementia-friendly principle, it is recommended to use contrasting colors between walls, floor and furniture [6], for example a light-colored sofa on a colored wall, or the toilet bowl in a contrasting color to the wall, or just a colorful seat for the toilet bowl;
- Gerontotechnology: Colored lighting can be used that changes depending on the time of day or the situation, for example exposing the older person with neurocognitive disorders to a blue light before going to bed, prolongs deep sleep. [40]

5.1.9. Navigation outside the home

- Age-friendly architecture: An age-friendly outdoor space is an accessible space, without bumps or if they exist, bumbs are taken over with ramps, with rest areas, protected from the strong sun. An interesting exercise are the dementia-friendly therapeutic gardens that use loop circulation for the management of wandering [41], have orientation landmarks, reminder triggers such as vintage car [42], both activity and rest areas;
- Gerontotechnology: Shoes with ultrasonic, waterproof sensors attached to the toe of each shoe [43] can be use in order to preserve the safety of older person. Whenever it encounters obstacles, the sensors send vibrations or make some sounds to signal the wearer.

5.1.10. Socialization

- Age-friendly architecture: Maintaining social contacts is very important for active and healthy ageing. Socialization and direct interactions take place especially outside the home, in this sense, in the design of public spaces, areas with benches and chess tables attract the elderly [44], as do dedicates community centers for seniors [45].
- Gerontotechnology: The Covid-19 pandemic has further stimulated long distance communication, so even for the elderly, digital devices (phones, tablets, laptops) connected to the Internet contribute to well-being. [46] More advanced technologies are support avatar applications or even telepresence and social robots. [47]

5.2. Innovative elderly-friendly facilities in Bucharest, Romania: student projects and diplomas

The ab initio design of elderly people facilities-whether these are dwellings for independent elderly people or with varying degrees of dependence, nursing homes that provide institutionalized assistance-proves its advantages related to safety and comfort, increasing the quality of life, catalyzing independence and well-being. [48]

Together with the 5th year students from the Faculty of Architecture, within the “Ion Mincu” University of Architecture and Urbanism, in two consecutive generations, 2019-2020 and 2021-2022, the development of a project in the real site of the former Zefirul Factory, in the neighborhood Vatra Luminoasă, Bucharest, under the age-friendly umbrella concept. Starting from the results obtained with the first generation of students (2019-2020) which proved the architectural potential of the Vatra Luminoasă neighborhood in the paradigm of an age-friendly architecture [49], the exercise was repeated with the next generation of 5th year students (2021-2022) which also showed interesting, diverse, creative results.

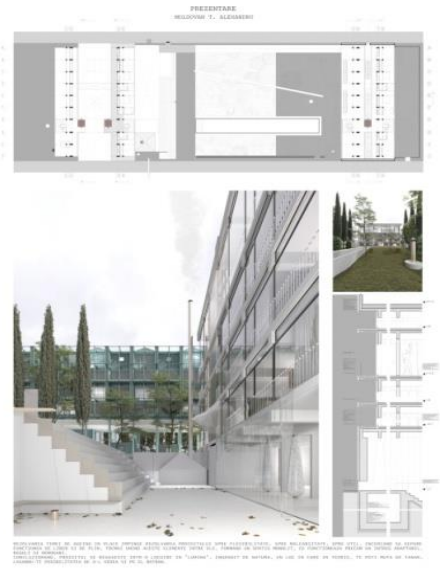
5.2.1. *Elderly Dwellings │"Street with Garden"│ Vatra Luminoasă*

University Year: 2019-2020
Authors: St. Arch. Răzvan Badea Șuțu &
St. Arch. Teona Dascălu
Tutors:
Prof. PhD. Arch. Dan Șerban
Lect. PhD. Arch. Mihaela Zamfir
Lect. PhD. Arch. Ana Maria Vesa (Dobre)
Arch. Simina Dron

Fig. 1 Elderly Dwellings │"Street with Garden"│ Vatra Luminoasă
Source: Group 52_2019-2020 Archive

"Small is beautiful"

5.2.2. Elderly Dwellings │"Strips"│ Vatra Luminoasă



University Year: 2019-2020
Author: St. Arch. Alexandru Moldovan
Tutors:
Prof. PhD. Arch. Dan Șerban
Lect. PhD. Maria Vesa (Dobre)
Arch. Simina Dron Arch. Mihaela Zamfir
Lect. PhD. Arch. Ana

Fig. 2 Elderly Dwellings │"Strips"│ Vatra Luminoasă
Source: Group 52_2019-2020 Archive

"Elderly friendly architecture, ageing in place"

5.2.3. Elderly Residential Center │"The 5th Garden"│ Vatra Luminoasă

University Year: 2021-2022
Author: St. Arch. Andreea Pribeanu
Tutors:
Prof. PhD. Arch. Dan Șerban
Assoc. Prof. Arch. Karoly Nemeș
Lect. PhD. Arch. Mihaela Zamfir
Lect. PhD Arch. Alexandru Crișan

Fig. 3 Elderly Residential Center │"The 5th Garden"│ Vatra Luminoasă
Source: Group 52_2021-2022 Archive

"Elderly-friendly architecture and nature"

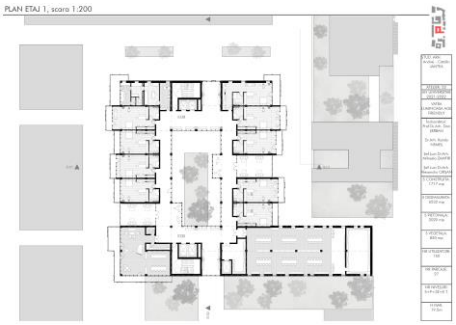
5.2.4. Elderly Nursing Home │"The 5th Garden" │ Vatra Luminoasă

University Year: 2021-2022
Author: St. Arch. Elena Preda
Tutors:
Prof. PhD. Arch. Dan Șerban
Assoc. Prof. Arch. Karoly Nemeș
Lect. PhD. Arch. Mihaela Zamfir
Lect. PhD Arch. Alexandru Crișan

Fig. 4 Elderly Nursing Home │"The 5th Garden"│ Vatra Luminoasă
Source: Group 52_2021-2022 Archive

"Frailty as a shaping need in age-friendly architecture"

5.2.5. Assisted Living Facilities for Elderly │"Generational Wealth Community Center"│ Vatra Luminoasă



University Year: 2021-2022
Author: St. Arch. Andrei Jantea
Tutors:
Prof. PhD. Arch. Dan Șerban
Assoc. Prof. Arch. Karoly Nemeș
Lect. PhD. Arch. Mihaela Zamfir
Lect. PhD Arch. Alexandru Crișan

Fig. 5 Assisted Living Facilities for Elderly │"Generational Wealth Community Center"│ Vatra Luminoasă
Source: Group 52_2021-2022 Archive

"Light as architectural tool in modeling age-friendly architecture"

Active and healthy ageing, in the community, requires, in addition to an adequate housing, social participation [50], interaction both among members of the same age group and between different generations. [51] Community centers can support the social role of each person, regardless of age.

The young are the first to give the pulse of society, of changes and implicitly of the needs that arise. The Covid-19 pandemic meant for more than a year, the limitation of direct interactions, face-to-face participation in education, work and relaxation activities. The desire to resume life before the pandemic as soon as possible, of joint activities, was felt in 2022 and in the choice of diploma subjects of the 6th year students from the Faculty of Architecture of the "Ion Mincu" University of Architecture and Urbanism, Bucharest, Romania. Community centers, from the experience of the main author of this article, Lect. PhD. Arch. Mihaela Zamfir, constituted a subject with a great potential. Even if community centers dedicated to the elderly in particular were not the first option in 2022, the strategic, sustainable approach, the idea that an active and healthy longevity is maintained with an active lifestyle, in the community, from a young age, is to be appreciated. Architecture forms social behaviors, supports relationships in the community throughout life. [52]

The seven diploma projects with themes of community architecture, guided for the July 2023 session by Lect. PhD. Arch. Mihaela Zamfir are:

5.2.6. CULTURE MINE. Socio-cultural community center │Petroșani, Romania│ Diploma project│ July 2023 session│ st. arch. Irina Corduneanu (fig. 6);

5.2.7. TAB Cultural incubator. Conversion of the Bucovăț Tannery | Bucovăț, Dolj | Diploma project | July 2023 session | st. arch. Cristina-Georgiana Fotescu (fig. 7);

5.2.8. ETHOS(m)ART. Socio-cultural art and science center for young people | Luigi Cazzavillan Park, Bucharest, Romania | Diploma project | July 2023 session | st. arch. Alina Alexandra Iancu (fig. 8);

5.2.9. WAVES. Community Center for Youth | Constanța, Romania | Diploma Project | July 2023 session | St. arch. Maria Ispas (fig. 9);

5.2.10. (in)KÜLTÜR. Socio-cultural center for the Turkish-Tatar community | Constanța, Romania | Diploma project | July 2023 session | st. arch. Melis Musa (fig. 10);

5.2.11. REintegrated. [HER]a Garden Multifunctional center of integrated services for combating and preventing domestic violence | Ferentari, Bucharest, Romania | Diploma project | session July 2023 | st. arch. Maria Antoaneta Smarandache (fig. 11);

5.2.12. CO-Z. Student center, co-living, co-learning | Parcul Carol, Bucharest, Romania | Diploma project | session July 2023 | st. arch. Florentina Mihaela Trandafir (fig. 12).

Fig. 6 CULTURE MINE. Socio-cultural community center | Petroșani, România | Diploma Project 2023 | UAUIM | Author: St. Arch. Irina Corduneanu | Tutor: Lect. PhD. Arch. Mihaela Zamfir
Source: Mihaela Zamfir educational archive

Fig. 7 TAB cultural incubator. Conversion of the Bucovăț Tannery │ Bucovăț, Dolj, România │Diploma Project 2023│ UAUIM│Author: St. Arch. Cristina Georgiana Fotescu │Tutor: Lect. PhD. Arch. Mihaela Zamfir

Source: Mihaela Zamfir educational archive

Fig. 8 ETHOS(m)ART. Socio-cultural art and science center for young people│Luigi Cazzavillan Park, Bucharest, Romania │Diploma Project 2023│ UAUIM│Author: St. Arch. Alina Alexandra Iancu │Tutor: Lect. PhD. Arch. Mihaela Zamfir

Source: Mihaela Zamfir educational archive

Fig. 9 WAVES. Community Center for Youth│Constanța, Romania │Diploma Project 2023│ UAUIM│
Author: St. Arch. Maria Ispas │Tutor: Lect. PhD. Arch. Mihaela Zamfir
Source: Mihaela Zamfir educational archive

Fig. 10 (in)KÜLTÜR. Socio-cultural center for the Turkish-Tatar community│
Constanța, Romania │ │Diploma Project 2023│ UAUIM│
Author: St. Arch. Melis Musa │Tutor: Lect. PhD. Arch. Mihaela Zamfir
Source: Mihaela Zamfir educational archive

Fig. 11 REintegrated. [HER]a Garden Multifunctional center of integrated services for combating and preventing domestic violence | Ferentari, Bucharest, Romania │ Constanța, Romania │ │Diploma Project 2023│ UAUIM│
Author: St. Arch. Maria Antoaneta Smarandache │Tutor: Lect. PhD. Arch. Mihaela Zamfir
Source: Mihaela Zamfir educational archive

Fig. 12 CO-Z. Student center, co-living, co-learning│Parcul Carol, Bucharest, Romania│ Diploma Project 2023│ UAUIM│
Author: St. Arch. Florentian Mihaela Trandafir│Tutor: Lect. PhD. Arch. Mihaela Zamfir
Source: Mihaela Zamfir educational archive

The students were encouraged to develop their diploma projects in the cities where they were born, in the communities they know best. Degree projects (2023) demonstrate sustainable strategic thinking at the community level, with an emphasis on architecture as a support for intergenerational relations. [49] The quality of dweeling is supported not only by the quality of residential buildings and apartments, it is also supported by the community facilities in the neighborhood. This aspect makes the difference between ageing in place and ageing in community.

6. Implications

The research results reveal the importance of interdisciplinary teamwork**.** The need for education of the Romanian population for active and healthy ageing is highlighted. This means: understanding the phenomenon of ageing and adopting a healthy and active lifestyle; information on Western models of good collective housing practices for seniors and elimination of prejudices; budgeting of apartments' adaptation expenses starting with the age of 55 or changing residence. The adaptation of housing for seniors, including accessorizing, must be supervised by the architect so that the result is optimal in terms of comfort and aesthetics. The need for architects to include the perspective of age in architecture in the design process, especially for dwellings, is highlighted.

We have to take into account that on average, people with Alzheimer's disease can live between 3 and 11 years from the time they are diagnosed, but there are people who live up to 20 years. [53] These aspects are important when we have to consider adapting an apartment in an existing multi-storey residential building: what are the adaptation costs of an apartment in a block built before the 90s, compared to the period in which the elderly will live in it; how much and how well the adaptations can be made so that the necessary conditions for a quality of life and a state of well-being are met. Certainly, from this moment on, new apartments should be designed in such a way that these have dimensions and areas in order be lived in comfortably and as independently as possible for the rest of their lives, to be apartments for life. It is certain that future collective housing design must include flexibility and the possibility of adapting to the requirements that change with age. Another solution are residential complexes of assisted living facilities type [54], which involves apartments designed specifically for the needs of the elderly and which involve moving at a certain point in life.

Future attitudes must take into account more generous aplication of Assisted Living Facilities concept for the new residential complexes.

7. Value

The work proves the importance of residential architecture but also of the public spaces and social-cultural facilities in supporting ageing in community, optimizing opportunities for autonomy, participation and security.

The adaptation of existing apartments in multi-storey buildings in Romania to the comfort and safety requirements of the elderly is technically possible, but it is necessary to be taken into account in advance, until the age of 60, because it requires budget investment, time and mood. More difficult are the necessary adaptations in the outdoor spaces of the

apartments, and here we highlight the situation of blocks with four levels, without an elevator, which require additional investments with which all residents must agree, namely the installation of a possible external elevator.

Because the Romanian society is ageing in the same trend as all European countries, it is necessary that the future residential complexes that are built to take into account greater flexibility in the subsequent adaptation of the apartments for the older age. It is also recommended for Romania to implement the assisted living facilities model and to build residential complexes for the elderly.

At the research level in higher education, there is creativity and experimentation in student projects and an openness towards the application of the age-friendly architecture concept. The residential architecture of the future is an architecture that intelligently and flexibly integrates the perspective of age in architecture, customarily and creatively assimilating the needs of users of all ages and integrating intelligent assistive technologies into the design. More than ever, the apartments of the future must be designed by the architect in collaboration with specialists from related fields, in interdisciplinary teams.

Acknowledgment: This research was funded through the Active and Assisted Living Programme, Project AAL-CP-2020-7-108-SI4SI-1, co-funded by the European Commission and the Romanian National IRD Funding Authority – UEFISCDI. The authors would like to express their appreciation for the fifth-year students from group 52, academic years 2019-2020 and 2021-2022, Faculty of Architecture, Ion Mincu University of Architecture and Urbanism, those who participated in the dementia-friendly architecture exercises, coordinated in the Vatra Luminoasă neighborhood, on the site of the former Zefirul Factory, completing outstanding projects. Special thanks to Prof. PhD. Arch. Dan Șerban who was open to the subject and supported this research by design approach, on the topic of age-friendly architecture.

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Digital divide, smart assistive technologies and ageing people

Ileana CIOBANU,
Discipline of Rehabilitation Medicine, "Elias" University Hospital, "Carol Davila" University of Medicine and Pharmacy, Bucharest, Romania
ileanacuk@yahoo.co.uk

Matei TEODORESCU,
Discipline of Rehabilitation Medicine, "Elias" University Hospital, "Carol Davila" University of Medicine and Pharmacy, Bucharest, Romania
mateiteodorescu@gmail.com

Andreea Georgiana MARIN,
Discipline of Rehabilitation Medicine, "Elias" University Hospital, "Carol Davila" University of Medicine and Pharmacy, Bucharest, Romania
andreea.budrica@gmail.com

Mihai Viorel ZAMFIR,
Physiology Division, Faculty of Medicine, "Carol Davila" University of Medicine and Pharmacy, Bucharest, Romania
mihai.zamfir@umfcd.ro

Francesco AGNOLONI,
f.agnoloni@medeaproject.eu

Mihaela ZAMFIR,
Synthesis of Architectural Design Department, Faculty of Architecture, "Ion Mincu" University of Architecture and Urbanism; MMZ- Individual Architecture Studio, Bucharest, Romania
mmg_architecturestudio@yahoo.com, mihaela.zamfir@uauim.ro

Rozeta DRAGHICI,
Ana Aslan National Institute of Gerontology and Geriatrics, Bucharest, Romania
rozetadraghici@gmail.com

Alina ILIESCU,
Discipline of Rehabilitation Medicine, "Elias" University Hospital, "Carol Davila" University of Medicine and Pharmacy, Bucharest, Romania
alina.iliescu@yahoo.com

Peiman Alipour SARVARI,
IT for Innovative Services Department, (ITIS-TSS), Luxembourg Institute of Science and Technology (LIST)
peiman.alipour@list.lu

Jensen JOYMANGUL,
IT for Innovative Services Department, (ITIS-TSS), Luxembourg Institute of Science and Technology (LIST)
jensen.joymangul@list.lu

Laszlo IRSAY,
University of Medicine and Pharmacy "Iuliu Hatieganu", Cluj-Napoca, Romania
irsaylaszlo@gmail.com

Mihai BERTEANU,
Discipline of Rehabilitation Medicine, "Elias" University Hospital, "Carol Davila" University of Medicine and Pharmacy, Bucharest, Romania
mberteanu@gmail.com

Abstract
Objective: To define the causes and potential solutions for the digital divide in the ageing population. Prior work: The digital divide between generations is somehow logical, because digital technologies evolved when today's elders were already retiring from professional activity. The pressure to use digital technologies comes later, when you need to monitor your functional and activity parameters, when you are isolated at home and have to talk to your family and your family doctor, when you need information in real time and the best source is the internet. Approach: Bibliographic research and case studies. Results: Digital assistive solutions progressed from assisting a function, increasing safety and the general level of activity, to improving physical, psychological condition and behaviour, then to solutions able to optimise task-oriented behaviour, then to enhancing social participation and now we talk about ecosystems and sustainability. The role of multidisciplinary teams implementing, in interdisciplinary approach, the principles of Physical and Rehabilitation Medicine and of the International Classification of Functioning, Disability and Health is crucial in developing such solutions. Implications: The stage we are now in is searching for the best solutions to find the friendliest interfaces, the easiest way to really implement smart in valuable feasible and sustainable services, but we are also searching ways to teach, train and coach the potential users of digital assistive solutions and for all other available ICT and sensor-based assistive technologies. Value: We go against the Cancel-Culture. In fact, we need to add two more domains to people's culture: the Active and Healthy Ageing Culture and the Digital Culture, and we need to make people aware of the importance of Ageing Well and of the fact that we are all relevant citizens of this imperfect society, where all lives matter.

Keywords: gerontotechnology, rehabilitation medicine, interdisciplinarity, age-friendly environment.

1. Introduction
In the context of world population growth, intense urbanisation, ecological and economy-related challenges, the implementation of Smart Cities seems the wisest solution. Smart Cities approach can help the metropole become living organisms, with its own real metabolism, a coordinating nervous system and immunity capabilities, able for self-sustenance and development [1].

Different solutions and integrated strategies are developed as we speak, granting the success of e-governance, e-education, assisted living, e-Health and digital health, cybersecurity and Information and Communication Technology (ICT)-based transportation [2]. But, the benefits of ICT, sensors and Artificial Intelligence (AI)-based technologies come with complications and with increased related costs.

One of the most important issues is related with the technologies themselves, with their usability, to be more precise. Such smart technologies require either skilful users, with enough ICT knowledge and abilities to manage all issues related to technology functioning and able to communicate with all complicated smart things in due time, or extremely friendly interfaces, designed to meet all their users needs and compensate all users' limitations – sensory, force, skill, coordination deficits, as well as emotional and cognitive limitations, in old users' case [3].

As smart technologies' development progress is exponential and learning to communicate with sensors and computers is a long and hard enterprise [4] as well as due to the fact that

human society needs also a lot of specialists in many other domains, with similar learning and experience long roads, the only way to manage usability is to increase technologies' interfaces user friendliness [5]. Due to the differences between perception, knowledge, areas of interest, strong and weak points of each category of users, developing older user-friendly interfaces is by itself a complicated endeavour. Designing and developing highly usable technologies require a special approach in the already classical user-centred development: participatory design, with the active involvement of all categories of the real future users.

The usability of digital assistive solutions is lower and lower as the potential users are more advanced in age. This is an important issue nowadays, when world population experiences an acute ageing trend [6]. Ageing population means increased levels of disability, frailty, higher burden on healthcare services and decrease of workforce available for care [7]. Smart technologies improves older people's quality of life, physical, emotional and social wellbeing [8]. Smart technologies may help older people live healthier independently for longer time at home, ageing in place, by empowering self-management of life and health condition and improving older users' efficiency in activities of daily living [9]. The whole healthcare systems are facing a change of paradigm and the new trend is the consumer-focused site of care, instead of centralised facilities for care, with already proven cost-efficiency [10, 11].

The digital divide between generations is somehow logical, because digital technologies evolved when today's elders were already retiring from professional activity. Today's elderly are part of the Baby-Boomers generation (born between 1946-1964), criticized in the media for their resistance to technological changes. The pressure to use digital technologies comes later, when you need to monitor your functional and activity parameters, when you are isolated at home and have to talk to your family and your family doctor, when you need information in real time and the best source is the internet. This pressure comes along with the societal need to reduce the burden upon the healthcare system and to decentralise at least a part of the healthcare services, the ones who better fit telehealth. Being healthy, active and living independently in your own home and ageing in place is a wish we all have, especially when we get older [12]. But for this, you have to reinvent yourself into a digital savvy person. Thus, digital divide, smart assistive technologies, smart cities and ageing people come together in discussion with concepts like Active and Healthy Ageing [13], Human Functioning [14] and Active and Assisted Living [15]. Built environments can be no only adapted to be age-friendly, but also designed to become smart environments for ageing well [16].

2. Objective

The objective of this paper is to define the causes and potential solutions for the intergenerational digital divide affecting the ageing population's capability of accepting and using smart assistive solutions.

3. Prior work

The digital divide between generations is somehow logical, because digital technologies evolved when today's elders were already retiring from professional activity. The pressure

to use digital technologies comes later, when you need to monitor your functional and activity parameters, when you are isolated at home and have to talk to your family and your family doctor, when you need information in real time and the best source is the internet. This research is based on concepts that come from the scope of several fields: rehabilitation medicine, geriatrics and gerontology, gerontopsychology, physical therapy and age-friendly architecture. These concepts have been applied in the last thirteen years in interdisciplinary research aimed at age-friendly environment [17, 18].

4. Approach

Bibliographic research in international databases and smart assistive technologies case studies from European Active and Assistive Living projects are used.

5. Results

Assistive technology is an umbrella term encompassing methods, devices, systems and internet of things-based solutions able to help users to perform successfully and efficiently tasks and activities of daily living [19]. These technologies (called also gerontotechnologies when designed to be used by older adults) involve sensor-based feedback, recommendations, alarms, reminders, monitoring and communication technologies. These should assist timely and as needed, being empowered by electronics and informatics to detect, monitor, report issues and anomalies, preventing hazards or assisting elaborated tasks [20]. Assistive technologies evolved from simple reminders to Smart Home Technologies. The aim of these technologies is to improve the quality of life of users, by helping them being independent in Activities of Daily Living (ADL) in a safe and efficient manner, helping users–ageing in place and empowering them to adopt behaviour changes in order to improve their lifestyle, for better health, mood, wellbeing, through optimised levels of activity and participation [21].

Digital assistive solutions for older people are aimed to meet the needs of ageing population in regards of independent living, a healthy level of activity and participation, while taking into account age related limitations, disabilities generated by comorbidities and frailty, as well as all kinds of environment-based facilitators and barriers.

Smart assistive technologies for older people progressed from assisting a function, increasing safety and the general level of activity, to improving physical, psychological condition and behaviour, then to solutions able to improve task-oriented behaviour, then to improve social participation and now we talk about ecosystems, about how all the Active and Assistive Living solutions can work together, how they can be implemented in real life systems and how they can be made sustainable. But, why to invent things nobody will use? How can we make those in need able and willing to use things which can bring them benefits?

5.1. Older people needs which can be assisted by smart technologies

A systematic review published in 2020 analysed results 26 systematic reviews on assistive technologies for older adults and from 537 studies and identified the main needs of older people which can benefit from assistance through technology [22]. These needs include compensation of deficits and limitations and assistance to ensure safety and to improve efficacy in activities of daily living (ADLs).

Deficits compensation in order to ensure functioning include: assistive technologies for sensory deficits (sight, hearing aids), for motor deficits and coordination (mobility and balance aids), cognitive support technologies (apps for language, memory, decision, space and time orientation, gamified cognitive training) and safety technologies for health-related issue (wearables for vital signs and movement and location monitoring for prevention and timely intervention support through technology).

Efficacy and safety in activities of daily living can be improved in the domains of self-efficacy in wellbeing (like apps stimulating and supporting behaviour changes to improve lifestyle), independent living (up to smart-home technologies), social connections and engagement. These cover indoor and outdoor activities, essential ADLs (smart kitchen, for example), professional activities and hobbies (also assistive tools for playing musical instruments), leisure activities (including assistive technologies for physical activity and sports) and communication (technologies to help connection with family and peers, as well as social robots). Researchers add to these categories also the need for medication management, mood recording and management, as well as the need for rehabilitation management (through apps as well as through telerehabilitation).

Smart solutions for the above needs include a large variety of low- and high-tech tools, stand-alone devices or IoT solutions, integrated in complex systems and services. These technologies can be wearables and dedicated apps – mHealth [23] or technologies embedded in smart environment [24].

5.2. Barriers in older adults' innovation adoption

Systematic reviews of literature found the main barriers in assistive technology (AT) adoption by older people: privacy doubts, trust, added value related questions, lack of ease of use, questionable suitability for daily use, lack of perceived need, fear of stigma, fear of dependence, lack of skills and training [25]. Other authors include here also lack of awareness and experience and decreased confidence in self-efficacy [26]. Reduced access to technologies, techno-complexity and techno-invasion related technostress and fear of not breaking the technologies are also barriers in innovation adoption by older people [27].

To increase the use of health and activity related technologies, one must understand and appropriate the relevance of health self-management for a good level of the quality of life (QoL). Old people have a general lower level of health literacy comparing with the general population [28], part of this issue being related to the access to health information and smart digital technologies, as a consequence of lack of knowledge and digital skills and low access to information sources, including internet, especially in south-eastern European countries [29, 30].

Technology reliability, very appreciated by older users, is not included in AT evaluation tools [31].

The Global Report on assistive technology published in 2022 emphasizes that most people in need of assistive technologies do not access it, due to lack of awareness, affordability, lack of services enabling the implementation of the AT, low quality of accessible AT,

supply channels related challenges. Living environment, the individual features of the disability and social-economic condition of the person come together with lack in policies supporting AT implementation [32].

Usability of smart assistive technologies and user behaviour are furthermore influenced by a series of personal factors: self-efficacy (which comes with experience, self-confidence, training and peer support), technology anxiety (related to previous frustrating experiences), trust in technology and in technology provider (including social and healthcare systems), privacy concerns, data protection concerns, perceived usefulness (related to health literacy as well as to digital literacy), social influence, functional and non-functional aspects of the technology and its interfaces [33] along with lack of technical and social support [34]. The above associate with negative general attitudes towards technology, including the basic functionalities of Smartphone and internet use (especially in south-east Europe). 2/5 of 65-74 years old population in Europe didn't use the internet in 2019, and only 7% of this population had above basic digital skills, using internet, internet banking, online shopping, paying taxes online, texting messages. Digital divide is lower in western Europe than in Eastern Europe. 75+ old people are the most exposed to social isolation, including due to lack of digital skills [35].

Social isolation itself and retirement from all social life and communication is a key factor for further distancing from the advances of technology and its use, the vicious cycle continuing with physical, emotional and cognitive decline [36]. Retirement from professional activity and losing connection with the accelerated progress in technology make the intergenerational gap in knowledge and skills increase even more.

All the above-mentioned factors are responsible for the intergenerational digital divide, all influencing and being influenced by the digital literacy level of the older potential smart-AT users and their user behaviour [37].

5.3. Facilitators of older adults' innovation adoption

Main positive determinants of innovation adoption by older users include: positive previous experiences, strong motivation due to the needs met, priority, perceived safety in regards of data and privacy, trust in provider and in the maturity and robustness of the technology, peer support, authority support, age-friendly design. All of the above are positively influenced by the level of digital literacy of the older user.

Assistive technologies with increased chances to be adopted by older users fall into two categories: technologies with extremely friendly interfaces, and technologies supported by services enabling and empowering older users to improve digital literacy and innovation adoption.

Some older adults do not see the association between assistive technology and their needs or don't priorities it, they must understand the value of these solutions in order to adopt and to use them [38]. Therefore, improving their level of health literacy, their knowledge of Active and Healthy Ageing benefits and positive psychology (to increase their self-esteem and to motivate them) would increase their efforts in adopting and learning new

technologies. Adopting a sanogenic lifestyle and preventing (or reducing) disability would not only decrease the burden on the healthcare system and on older people's families, but would also provide better mood, sense of coherence, activity and participation level of the older person, with improved quality of life for the whole community.

Smooth first encounters with friendly technologies can reduce the related technostress (including the techno-invasion and techno-complexity aspects) and improve adherence to digital health and smart technologies user behaviour [39]. Therefore, a well-designed methodology of introducing technologies to older people would improve the adoption of innovation by them. Providing potential users not only with comprehensive user manuals but also with related information and well-designed teaching programs improve the innovation adoption level.

The digital divide is decreasing while people benefiting from training in smart technologies in their formative years are getting older, but the differences in internet and digital technologies are still high between generations. In the European Union, 58% of older adults have internet service, compared to 74% of all households, only 40 % of older adults (55-74) use the internet, compared to 75% of the overall population. Romanian older adults participating in a survey stated that 97% responders use smartphone users, 77,5% use the smartphone only for audio communication, 10% use email, 2,4 of them post [40, 41].

Heuristics of complex systems designed for older users must be respected when designing technologies for this age category. Not only that the functionalities must be developed to meet real needs in steps acquirable by older people but the technologies must also meet the requirements related to non-functional aspects, like: compensating the user's limitations due to visual deficits, hearing deficits, motor and coordination deficits, perception, memory, executive functions and data processing deficits, cultural and generational specificity [42].

The user friendliness of the interface from the perspective of the older user include: buttons of at least 9.6 mm, simple and easy to do gestures (avoid up-down scroll or gestures involving more fingers), [43], good contrast, lack of shadows or Scharf effects, fonts of minimum 16px, to increase readability, common knowledge icons associated with short text, use non-competitional gamification to improve motivation and mood [44].

The heuristic principles for complex applications aim to ease the use of complex ICT for all users, no matter their age and digital skills, and include: visibility of system status (progress indicator, as a meaningful feedback), match between system and reality (in regards of logics and metaphors), user control and freedom (support to explore and recover from errors), consistency and standards (ease interaction by improving reaction time through routines in the organisation of the information on visual interfaces), error prevention functionalities (to smooth the experience and avoid frustration), enable recognition more than recall (assist memory), flexibility and efficiency of use, aesthetic and minimalistic design, help users recognize, diagnose, and recover from errors, help function and documentation [45].

Confidence in learning and self-efficacy in testing novelties improve willingness to learn and to adopt digital technologies [46, 47].

5.4. Case studies of smart assistive technologies from Active and Assisted Living Projects

Active and Assisted Living is a funding programme aiming to improve the quality of life of European older people and to increase industrial opportunities in the field of healthy ageing technology and innovation. The program provides funding for projects developed in multinational partnerships, with consortia including SMEs, research organisations and end-user organisations, in order to generate market-ready products and services for older people. The program ran more than 300 projects since 2008 and had its last call for proposal in 2023. AAL is co-financed by the European Commission (through Horizon 2020) and by the national funding agencies of 17 countries [48].

A side effect of participation in these projects is the development of interdisciplinarity, the generation and strengthening of international and trans-domain networks of smart assistive technology developers, industrial partners, healthcare and social experts, architects, old adults organisations, boosting the understanding of real needs of older users and developing solutions, concepts and new methodologies, some of these results being used to improve the interdisciplinary education of young specialists.

The paper presents shortly a few solutions developed by consortia including the authors, in AAL projects.

5.4.1. Solutions with very friendly user interfaces

These solutions allow older adults use advanced communication, information and assistive technologies surpassing the lack of digital literacy.

Here we find two approaches: solution recognises user and run the program and solution recognises user and initiate an interactive program.

SENSE-GARDEN aim was to create garden-like physical and virtual spaces, as environment for shared experiences used to improve mood and behaviour for older adults living with major neurocognitive disorders. The flow of personalised experiences, included passive immersion in beautiful sceneries to personalised memory lanes, space exploration associating cognition, emotion, space and time orientation with elements of physical exercise and gamified cognitive training accompanied by music, soundscapes and scents. The workflows are supported by media devices integrated in a IoT, all information being organised and offered to users in personalised sessions. The access to the personal workflows is done through RFID touchless ID recognition, when the older user wearing the bracelet is entering the therapy space or wants to change the type of experience by choosing another media device or computer screen by simply presenting the bracelet. Thus, the interaction between the user and the technical solution is very simple, the user can manage it no matter his level of digital literacy. The primary user is in control of the session. The intervention is designed in accord with individualised objectives and is conducted by the clinical psychologist or by a trained occupational therapist and the impact of the program on QoL, behaviour, mood and cognitive functioning of the primary users was

demonstrated in a series of cases [49]. During the COVID-19 pandemics, the same team developed a SENSE-GARDEN system version to be used at home, the intervention being integrated in a telerehabilitation session or used as stand-alone family-based social wellbeing intervention.

Architecture and interior design can facilitate the befriending of elderly users with smart technologies, by including them, from the beginning, in the design concept of the space – whether it is an apartment, a therapeutic salon as it was in the Sense Garden project or a space in a public building. Contemporary architecture is truly age-friendly when it includes, competitive, personalized and intelligent, assistive technologies.

CoachMyLife aimed at developing an ICT and computer-vision-based solution able to assist older users with subjective and objective minor cognitive disorders to manage independently their activities of daily living, by providing step by step guidance, when acknowledged by the user. The CoachMyLife team wanted to provide a local-based solution, to avoid any issues regarding personal data security and privacy. Therefore, computer vision was based was used not for explicit activity recognition per se (requiring big data processing capacity and access to and from external databases), but for implicit activity recognition (solution sensitive to the context). The system acknowledges the presence of the user in a certain space and a certain position. If that post is maintained longer than preset or learned as necessary for the task in that specific user, the solution initiates the interaction with the user, hailing the user and asking (text to speech) if the user is ok and if he/she wants to perform a certain activity. The communication is kept simple, the user answers to questions with simple yes or no. The system chooses the right path in accord with user's answers. If the user asks for help, the solution will assist with indicating each step in a preset workflow, in errorless learning manner, and will see if the user effected the steps of a certain activity one by one. The solution is still able to recognise two simple activities: eating (using a wearable with a position sensor) and drinking (using a dedicated mug, recognised by the computer vision capabilities). The solution also offers reminders and motivational quotes. After setting initially the system (by self or by a healthcare provider or a savvier family member), the solution requires simple interactions based on voice or a user-friendly visual interface, with very few functions. One very important strong point of the CoachMyLife solution is the fact that the solution initiates interactions and engages the user only when needed. No digital literacy required. A basic training will make the user proficient in using this solution at home. CoachMyLife technology has been validated in an extensive usability study run in Romania, Switzerland and Slovenia.

5.4.2. Solutions stimulating improvement of digital literacy of their users

These solutions help users increase their self-efficacy regarding the use of ICT and assistive technologies.

Here we find to approaches: solutions which empower user and demands improvement of skills and stimulate the search for information, and solutions which involve use of wearables and apps and involves users' coaching by specialised staff members of the organisation providing the service.

Smart Solution for Social Isolation – SI4SI aimed at providing older adults at risk of isolation a simple solution to improve social participation. Because social isolation has a lot of direct and indirect determinants, the solution designed is rather complex. It provides user a personal assistant app, showing vital signs, sleep quantity and quality and whatever data it receives and process from wearables and smart environment. This assistant was developed to help user improve his/her lifestyle and activity level in order to improve physical and psychological condition, self-confidence and energy, to be able to sustain a more active social life. Social participation is empowered by a second app, accessible from the assistant app, providing users with a safe and engaging channel of communication with selected social contacts (family members, peers with same interests, healthcare and social care providers, young volunteers willing to share and learn), as well as connect to social events recommended by the app. The navigation inside these apps is friendly but requires some skills one can get through exploration, try and error or following the steps indicated in comprehensive user guides. The solution is integrated in a service enabling a dedicated caregiver to monitor vital signs as well as anomalies appeared in physiological parameters and in activity routines, thus enabling timely intervention and constructive feedback to users and recommendations for more detailed investigations. The caregiver or social worker can also assess the quantity of social communication through the social app and address related issues.

These being said, the SI4SI solution user is in control, self-managing his own life and technology, but in a safe way, being monitored by a caregiver able also to help user overcome issues related to technology or health. The solution has been validated in a recent field usability study.

AGAPE aims to provide users with a very innovative service, trying to improve the digital literacy level of the older users through personalised coaching in regards of assistive technologies based on wearable sensors and digital interfaces. Users are made aware of the relevance of using smart things in order to self-manage active and healthy ageing. They are provided with wearables and apps and training and their interaction with technology is monitored.

AGAPE implements a comprehensive platform that facilitates Ambient Assisted Living (AAL). The platform has four applications, each specifically designed for four distinct kinds of end-users: older adults (AGAPE Assistant), informal carers (AGAPE Companion), AAL specialists (AGAPE Monitor), and wellbeing/health managers (AGAPE Eye). The AGAPE platform comprises four customised services: e-health literacy promotion, behavioural change service, lifestyle and health status monitoring, and social inclusion services.

Informative video and articles are supplied to enhance e-health literacy. Additionally, a coaching session is offered to older adults to facilitate the adoption of innovative technologies that can support Active and Assisted Living (AAL) by promoting behavioural changes. The lifestyle and health monitoring are achieved by the utilisation of several non-invasive devices. Finally, in order to foster social integration, a specialised messaging module that incorporates text, audio, and video communication is integrated into the platform. This module guarantees user-friendly functionality for elderly individuals.

All these services are provided either in-person or immediately through the AGAPE Assistant application and are closely supervised by an AAL expert using the AGAPE Monitor programme. The AGAPE Companion offers surveillance data on a particular elderly individual to their informal carer. Ultimately, the AGAPE Eye offered valuable perspectives on the broader AGAPE platform.

The Innovation Adoption strategy in AGAPE is designed to address and bridge the intergenerational digital divide by focusing on the unique needs of the ageing target group and their caregivers. Recognizing that older individuals may face challenges in adopting and using smart assistive solutions, the strategy employs a multi-faceted approach to enhance digital adoption within this demographic.

The quantitative branch of the strategy begins with a Digital Adoption questionnaire, allowing for a systematic evaluation of users' familiarity and willingness to embrace new technologies. This initial assessment serves as a foundation for creating a personalized service scenario, leveraging innovative devices such as wearables and smart technologies. By tailoring the service based on individual digital adoption levels, the strategy seeks to empower ageing individuals to comfortably integrate and utilize assistive solutions in their daily lives.

The behaviour-oriented aspect of the strategy further addresses the intergenerational digital divide by facilitating face-to-face interviews between the ageing population and professional coaches. These coaches act as guides, delving into the personal attitudes, preferences, and needs of the users. This personalized interaction not only helps in refining the service but also fosters a supportive environment, easing any reservations or hesitations related to technology adoption.

Moreover, the periodic follow-up meetings with the professional coach ensure ongoing support and allow for the adjustment of parameters as needed. This iterative process recognizes that digital adoption is a dynamic journey, and the strategy is committed to adapting to the evolving needs of the ageing population and their caregivers.

In summary, the Innovation Adoption strategy contributes to reducing the intergenerational digital divide by providing a user-centric, personalized approach. By combining quantitative assessments, innovative devices, and human-guided support, the strategy aims to empower ageing individuals and their caregivers, fostering a more inclusive and digitally connected community. AGAPE Project is ongoing.

6. Implications and value

Implementing AT in real life is not just a matter of design or older people willingness. There is a lot much more to do for this. The whole smart ecosystem must be prepared to empower older adults to perform this adventure [50]. Policies must be updated, to engage funding in AT co-design development, training and to decide upon the optimal way to provide AT to older adults [51]: to be recommended by the general practitioner, by the gerontologist or by the physical and rehabilitation doctor or the pharmacist, off the shelf, or offered to users in programs supported by the health insurance, in association with

training programs in community or in education institution – see the University of the third age [52], for example. Services (private but also public, state-run services) must be updated to enable support telerehabilitation and long-term care based on smart AT. Healthcare and social care staff must be trained to be able to manage these systems and the AT. Intergenerational relationships must be fostered and younger people must regain their respect and consideration for the older generations, their investment in the new ones and their wisdom and deeper understanding of what really matters in the world. This will reduce the distance between people and will increase reciprocity, including in matters of teaching and learning one from another.

Now we talk about a lot of communication channels and platforms able to integrate these solutions to offer users optimal experience and benefits, and we talk about the barriers and facilitators of innovation adoption at the level of all stakeholder categories, because technologically supported solutions, even the friendliest ones, need the user to acknowledge their need for them, and users must be able to understand the benefits as well as the way they can deal with these solutions.

The new technologies' usability level for primary user (older adult) as well as for secondary users (family and professional caregivers) is strongly influenced by the previous experience of the users with similar technologies as well as by cultural specificities, personal life priorities and personal attitudes [53]. Personal attitudes, interests and motivation are strongly influenced by the social support [54].

Older people with medical conditions appreciate technology which can provide them information (mainly the highly educated people) and means of easy communication with their medical case managers (especially low-medium education people). For high income educated older adults, wellbeing is a priority and technologies are more accessible and can help for health monitoring, prevention of complications, medication reminders [9].

COVID-19 pandemic brought mandatory isolation and showed us that we can adapt and accept new technologies, if the situation requires it. But not all of us. The ageing "digital immigrants", laggards in using internet and smart technologies, suffered the most and the digital divide grows deeper between them and the younger and proficient "digital natives" [55]. Social isolation "helped" the digital divide between old people and young people, even more, the older users lacking the support of their younger family members or social volunteers [29]. The elderly – as well as other age groups – spent more time at home and direct contact with the loved ones was reduced for safety reasons. Thus, the dwelling architecture received additional requests, requiring the inclusion of intelligent technologies to meet the new needs of comfort, health, maintaining communication and interactions.

Active and Healthy Ageing (AHA) concept of World Health Organisation (WHO) emphasizes the importance of "optimizing opportunities for health, participation and security" for improving the quality of life of people as they age. Health is viewed by WHO as the result of physical, mental and social wellbeing [56]. The determinants of AHA belong to multiple domains. These include diverse determinants such as: personal (biological and psychological factors), economic, health and social services, cultural and

historical, physical and built environment (including access to opportunities) and behavioural aspects. Education in youth, long-life learning and engagement in productive activities (physical and mental engagement as well) and social life decrease the risk of disability [56]. WHO's AHA takes into consideration the bio-psycho-social approach of the human being provided also by WHO, in the International Classification of Functioning, Disability and Health, which places activity as the central piece in the framework, activity ability and performance being influenced and influencing all the other components. Environmental factors contribute as barriers or facilitators to the activity and participation of the person [57].

We can improve old people's capabilities of using smart assistive technologies by influencing their personal factors (including their digital skills) or their environmental factors (including the technology itself) and empowering them to make changes in their own behaviour (including improving their lifestyle also by using specific assistive technologies). We can do this if we create the opportunity to use these technologies by increasing accessibility of these technologies, but also by improving health education, along with digital education, and by providing them community support, to increase motivation. We would also add here the importance of an age-friendly built environment that can facilitate the acceptance and friendship with smart technologies. Capability, opportunity and motivation are the three key factors supporting behaviour change, including lifestyle and interest and engagement in using smart assistive technologies [58].

So, the stage we are now in is searching for the best solutions to find the friendliest interfaces, the easiest way to really implement solutions in valuable feasible and sustainable services, but we are also searching ways to teach, train and coach the potential users of digital assistive solutions and for all other available ICT and sensor-based assistive technologies and related services. Because we move on fast forward, but we must leave nobody behind. This endeavour requires highly interdisciplinary team work and co-creation with real users.

The 2022 Global report on assistive technology comes with a series of recommendations aimed to inspire actions to support the improvement of access to AT as well as the usability of the AT: improve policies, ensure safety, efficiency and affordability of AT, improve the capabilities and capacity of the workforce involved in AT development, involve users in design, development, provision, monitoring and assessing AT use and impact, increase public awareness and reduce stigma associated to the use of the AT, improve evidence-based AT policies, invest in research, development, implementation and ecosystems, create enabling environments, include AT in humanitarian response to crisis, offer technical and economic assistance through international cooperation [32].

7. Conclusion

The users must be empowered to improve their digital literacy and so, their technostress level and digital technologies avoidance will be reduced. Technologies will require user-friendly interfaces and smooth user interactions with meaningful feedback, step-by step assistance based on errorless learning principles, a comfortable user experience and a lot of persuasive training and support from dedicated teams of younger experts. The role

of multidisciplinary teams is crucial in developing such solutions. The implementation of the principles of Physical and Rehabilitation Medicine, of the International Classification of Functioning, Disability and Health, Age-Friendly Architecture and of the concepts of User Centred Design, Participatory Design, in interdisciplinary approach, are mandatory to ensure the development of solutions with real value for older adults, families and professional social and healthcare providers as well.

We go against the Cancel-culture. In fact, we need to add two more domains to people's culture: the Active and Healthy Ageing culture and the Digital culture, and we need to make people aware of the importance of Ageing Well and of the fact that we are all relevant citizens of this imperfect society, where all lives matter.

Acknowledgments
This research was performed through the Active and Assisted Living Programme, Projects AAL-CP-2021-8-124-AGAPE, AAL-CP-2020-7-108-SI4SI-1, AAL-CP-2018-5-120-CoachMyLife-2, co-funded by the European Commission and the Romanian National IRD Funding Authority – UEFISCDI and by the National Funding Agencies for IRD in Italy, Slovenia, Switzerland, Luxemburg, Portugal.

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Regional innovative schemes of the educational capacity building for the smart specialization in the human settlements in the Republic of Moldova

Sergiu TUTUNARU,
Academy of Economic Studies of Moldova
tutunaru@ase.md

Anatolie BABIN,
MBA, Academy of Economic Studies of Moldova
anatolii.babin@ase.md

Ion COVALENCO,
Academy of Economic Studies of Moldova
covalenco@ase.md

Abstract
Objectives: This article aims to collect, analyze and summarize the best EU practices in developing digital skills and competencies of target groups of settlements in development regions in the context of smart specialization priorities, in relation to the specifics of the Republic of Moldova. It is also intended to develop recommendations for the successful implementation of the digital transformation of the Republic of Moldova into the European family of digital economy. The work highlights necessary activities to connect settlements to the ecosystems of the digital factory of open innovation and the digital academy of entrepreneurship that promote the development of digital skills. Prior work: The authors of the article are based on their published research in the field of smart settlements development, especially digitalization aspects, as well as best European practices. Approach: Bibliographic analysis, case studies, synthesis, conclusions. Results: Based on a comparative analysis, methods for teaching digital skills and competencies to target groups of development regions are proposed in the context of smart specialization priorities. The concepts of the European Institute of Innovation and Technology, the Open Innovation Factory and the Digital Academy of Entrepreneurship for the integration of regional educational ecosystems into the European Higher Education Area are also highlighted. The article not only contributes to the theoretical understanding of the concepts of adaptation of digital education in regions of development of smart settlements, but also provides the basis for the further development of a smart specialization strategy aimed at maximizing the social and economic positive results from its application while minimizing negative consequences. Implications: academics, researchers, practitioners. Value: The value of this work lies in identifying and structuring a regional innovative scheme for digital skills development compatible with best practice in the European Education Area related to specific of the Republic of Moldova.

Keywords: digital transformation, digital economy, educational renewal.

1. Introduction
Preparing the Moldavian population to successfully master the benefits of the digital economy is of great importance for our today. This is also due to the fact that Moldova is a candidate country for accession to the European Union. As part of its support to the enlargement of the EU and its neighbors, the European Commission's JRC [1] is carrying out smart specialization activities to identify their competitive advantages, opportunities and needs. Enhanced innovation strategies based on the smart specialization approach have the potential to drive technological renewal and broader innovation, providing the basis for creating unique competitive advantages for localities in the EU enlargement regions and neighboring countries.

In order to develop awareness-raising activities, training events and mapping of the economic, scientific and innovation potential already existing in the target regions of the Republic of Moldova, this article summarizes the best practices of the European Higher and Specialized Education Area. In order to design educational programs, it is necessary to discuss with representatives of business, academia and public authorities the potential competitive advantages of rural communities and small towns in the development regions.

The Education Framework for Urban and Rural Resilience Innovation can bring together regional universities and innovation centers in the EU and candidate countries to expand entrepreneurial ecosystems and help students, entrepreneurs and civil servants to find solutions to specific urban and rural problems in digital ages. Within the framework of accelerating the digital transformation of the development regions of the Republic of Moldova, examples of educational and awareness-raising activities are the European Institute of Innovation & Technology (EIT) Digital Open Innovation Factory [2] and the EIT Digital Entrepreneurial Academy [3].

The first model of the EIT will support pan-European teams of entrepreneurs in the launch or further development of digital technology projects and products. The work program EIT Digital Open Innovation Factory is guided by the five focus areas – Digital Tech, Digital Industry, Digital Cities, Digital Wellbeing and Digital Finance – of the EIT Digital Strategic Innovation Agenda 2022-2024 [4].

The second model is EIT Digital, which consists of three schools: a master's program, a professional school and a summer school, which together form the EIT Digital Entrepreneurial Academy. In order to participate in these initiatives, it is necessary to have an appropriate innovative educational infrastructure in the regions and groups of localities of the Republic of Moldova, which implies the realization of innovative educational activities.

2. Smart Specialization in human settlements

Smart Specialization Strategy (S3) is an approach that promotes regional development by identifying and focusing on a region's unique strengths, resources, and competitive advantages. Moldova has recognized the potential for smart specialization in the development of its human settlements, which include cities, towns, and rural areas. This involves areas such as urban planning, infrastructure development, digitalization, and sustainable living. To achieve this, educational capacity building is crucial.

Smart Specialization Strategy activities in the EU Strategy for the Danube Region [5] are facilitating interregional cooperation in the thematic priority pillars “Strengthening the Region”, “Connecting the Region”, “Building Prosperity” and “Protecting the Environment” aiming at balanced development, connectivity and enhanced competitiveness through innovative approaches promoting economic and social prosperity and growth in the region.

The Danube Region is a unique and particularly diverse area as it encompasses nine EU countries (Austria, two German regions: Baden-Württemberg and Bayern, Czech Republic, Slovak Republic, Slovenia, Croatia, Hungary, Romania and Bulgaria) and five non-EU

countries (Bosnia and Herzegovina, Montenegro, Moldova, Serbia and South-Western and Southern regions of Ukraine) of which some are accession countries and others are neighborhood countries all together composing a heterogeneous macro-region with some high and low performing countries in the fields of research and innovation.

Smart Specialization Strategy can make a valuable contribution to the better integration of the Danube region through the implementation of the EU Strategy for the Danube Region (EUSDR), in the sense that it can stimulate the constructive use of regional diversity by avoiding uniformity and duplication in regional investment goals as well as help develop critical mass to tackle major common challenges.

A local smart specialization strategy differs from a regional one by working closely with the local authority (i.e. the municipality) in order to engage community stakeholders in building preparedness to deal with, for example, resource-based industries that benefit from the abundance of natural resources in their area [6, 7]. In this context, preparedness is defined as the ability to plan for local development in a way that addresses territorial challenges and adopts a strategic approach to retaining benefits from resource-based industries operating in the area.

The primary objective of the Higher Education in Smart Specializations (HESS) [8] activities is to analyses how HEIs can be better integrated into S3 policy mixes and how the European, National (in the non-members countries) Structural and Investment Funds can be more effectively spent to achieve localization regional S3 objectives. The benchmarking activities also aims to explore how institutional capacity in regions of Europe's countries can be enhanced by strengthening the role of HEIs within the “quadruple helix” of government, academia, business and civil society or Living lab approaches adopted by the sectors of local economies. HESS can combine targeted territorial support activities, with cross-cutting and cross-border activities, to generate more widely appropriable lessons for EU territories and support to evidence-based policy.

3. The role of education for digital cities and villages

3.1. Innovation needs

By 2050, the global urban population will increase by 75% to 6.3 billion (i.e. two thirds of the world population) [9]. The challenge of developing and maintaining attractive, inclusive and safe urban environments needs to be met on multiple fronts. Stakeholders are local governments, city service providers, industry, and the citizens. Mobility as a service integrates public, private, peer-to-peer, conventional, clean, or autonomous transportation means. It will benefit from the increasing will of citizens to participate in the sharing economy.

Besides their traditional role, cities are increasingly organizing and exposing data, especially in real time. City data along with analytics and machine learning improves engagement and inclusiveness of the citizens and of the visitors. Augmented and virtual reality of the city is another facet of exposing or simulating city data from the past, present or future. A key factor for the attractiveness of a city is the safety of its citizens and visitor’s safety of the city and its general resilience to unplannable natural events.

3.2. Focus

In line with the innovation needs, the Digital Cities area will focus on: (I) urban mobility, including autonomous transportation, (II) citizen information, inclusiveness and engagement, (III) city safety and resilience with respect to environmental, economic, and demographic developments. We will develop breakthrough solutions with sustainable business models to cope with the challenges that city governments, citizens and businesses are facing in their roles as stakeholders of the urban environment. The high-level objective is for the governments to manage the cities more efficiently, make sure they are resilient, and include citizens in the life of the city.

3.3. Education needs

Education is an important element in smart city development. Strengths in education, advanced training and certification, universities, e-learning infrastructure, lifelong learning and innovation in education technologies are all part of what defines a smart city. Smart cities recognize the need for educational programmer producing graduates with modern knowledge, practical skills and collaborative attitudes. Moldova has various higher education institutions, such as universities and technical colleges, which play a pivotal role in smart specialization. These institutions provide knowledge and skills needed for various fields relevant to human settlements' development.

Working in complementarity with the pilot initiative to support the development of innovation and entrepreneurial capacity in higher education, the European Institute of Innovation & Technology (EIT) Regional Innovation Scheme (RIS) [10] contribute to increase the entrepreneurial and innovation capacity of the higher education sector in EIT RIS countries and regions. Universities and HEIs from RIS countries will join consortia and together with EIT's Knowledge and Innovation Communities (KIC) [11] partners will work on the action plan, designing the pathway how to increase their entrepreneurial and innovation capacity in short, medium and long term, benefiting from the EIT know-how [12]. Core elements of the action plan will be supported through the new EIT initiative on HEIs capacity building, however any supplementary and support activities are encouraged through the RIS segment to further amplify desired results and impact, either individually by institutions from RIS countries, or jointly with other KIC partners. It is expected that this will attract and facilitate the inclusion of a significantly higher number of Universities from the EIT RIS countries and regions into the EIT Label Master Programs [13].

3.4. Vocational Training

Vocational schools and training centers provide specialized skills to meet the demands of smart specialization. They offer programs in areas like construction, information technology, and sustainable agriculture.

Education can directly to support vocation of students, workers in different sectors of regional economy. In framework of the EIT, education, innovation, and business creation are always part of the same package. Many of EIT Community's programs [14] will connect shareholders to people who can both help to develop own sustainable solution ideas and teach peoples, how to run a successful business. Courses that bear EIT Label are all

guaranteed, that you are getting hands-on experience across Europe that directly prepares you for your chosen sector and connects you to the right people.

3.5. Lifelong Learning

Promoting lifelong learning through community centers and online courses ensures that the workforce in human settlements remains adaptable and updated in line with the latest innovations [15].

EIT alumni community is a lifelong professional network. The end of your time with Regional innovation hubs EIT as a learner won't be the end of your time with EIT Community. Both during and after your chosen EIT education program, you'll have easy access to a network that includes:

- Investors and Venture Capital firms;
- Businesses and non-profit associations;
- EU institutions and Member State officials;
- Universities and research centers;
- Building engines of innovation: EIT HEI Initiative.

EIT HEI Initiative helps higher education institutions get all the resources they need to teach innovation and entrepreneurship skills. EIT team provide:

- Expertise and coaching;
- Funding;
- Access to our innovation network;
- Help developing innovation action plans to meet institution needs;
- Transforming higher education institution into an incubator for sustainable growth and jobs for partner regions from Europe.

4. Regional Innovative Schemes

4.1. Collaboration with Industry

Manufacturing is the main driver of Europe's industrial innovation, its job creation, and its growth. But our manufacturing sector remains too fragmented and beholden to unsustainable economic models. That needs to end. EIT Manufacturing is working on all fronts to make sure manufacturing industries are keeping up. Through its Knowledge and Innovation Community model, it's empowering ambitious companies looking to make a positive difference on climate and communities. It is speeding up the take-up of sustainable innovations in manufacturing technology. It is most important of all, it's giving power back to the people with the skills to be the workforce of tomorrow, forging a new future on the factory floor. Whether you want to learn what it takes to run the factories of the future or have a bright idea for what those factories could look like, EIT Manufacturing is the place to be. It has no lesser ambition than to dramatically reduce industrial emissions while boosting Europe's growth simultaneously and it will need prepared people. The EIT Manufacturing model [16] can help in the following ways:

- Learn all about new industry skills and where innovation is most needed;
- Develop the skills and business acumen you need to confidently launch your venture;

- Find investors and businesses willing to advise you and support your endeavors;
- Get the support you need to get your new company off the ground in Europe;
- Develop a network in across the manufacturing sector that will last a lifetime.

Educational institutions collaborate closely with local industries and businesses. The EIT brings together organizations working in the field of education, research and innovation (the so-called "knowledge triangle") to form dynamic cross-border partnerships and create environments fostering innovation [17]. This allows for curriculum alignment with industry needs, ensuring graduates have the skills required for smart specialization projects. EIT's Regional Innovation Scheme enables the transfer of good practices and know-how using the EIT's unique approach to boosting innovation across the entire continent.

Through the EIT RIS, EIT Manufacturing can actively engage countries with modest or moderate levels of innovation, allowing wider participation in our activities and programs while helping to close innovation gaps. EIT Knowledge and Innovation Communities (KIC), such as EIT Manufacturing, engage local organizations to serve as RIS Hubs in EIT RIS countries and regions. The primary role of the RIS Hub is to ensure the visibility of the EIT Community and raise awareness of activities and cooperation opportunities for local actors representing education, business and research areas. RIS Hubs also liaise with the relevant national, regional and local authorities, and facilitate the sharing of EIT Innovation Community expertise with them.

4.2. Research and Development

Encouraging research and development activities in educational institutions fosters innovation in human settlements. Moldova has initiated various research, education [18] and infrastructure grants to fund projects in fields like urban planning and environmental sustainability [19].

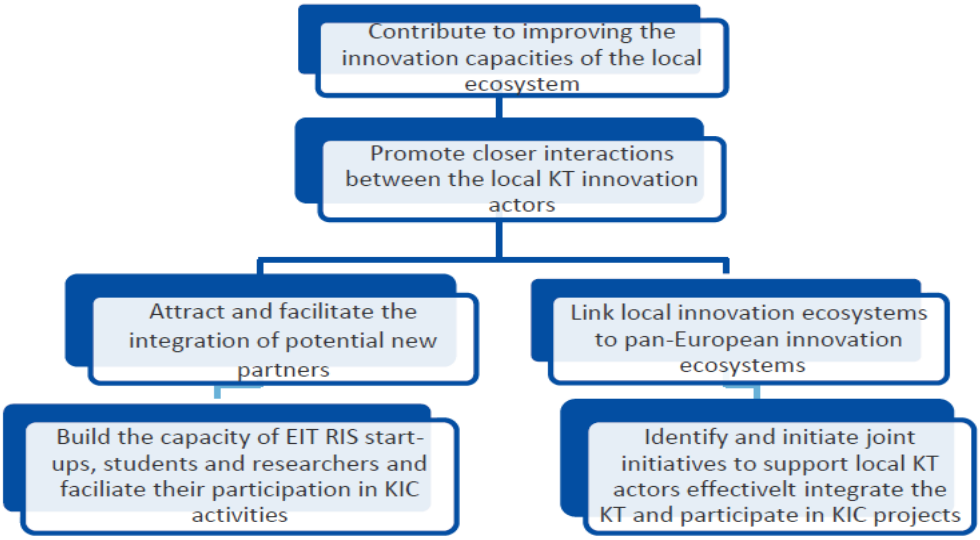

Fig. 1. Intervention logic EIT's KIC in line with the EIT RIS' objectives.
Source: EIT Digital

The schematic below [20] illustrates the intervention logic within which the EIT's Knowledge and Innovation Communities are expected to operate to create the desired impact, in line with the EIT RIS' objectives:

It is recommended that emphasis should be on supporting innovation projects with lead and participation of the entities from EIT RIS countries and regions, including, start-ups. The end result should be more commercializing partners from the EIT RIS countries and regions participate in the EIT Community. The EIT RIS scheme should support start-ups and innovators from the EIT RIS countries to effectively scale-up and elevate the outputs and outcomes of their innovation activities on the pan-European level. The EIT KIC may also wish to involve local start-ups in technology and know-how transfer, fully engage students benefiting from the EIT RIS (such as, by specific scholarships) in innovation projects and run pilots and tests of the outcomes of EIT KIC innovation projects and integrate researchers from the EIT RIS countries in EIT KIC innovation projects. The EIT RIS scheme could support transfer of knowledge and good practices in developing or facilitating growth of innovation ecosystems in the EIT RIS regions and countries and transferring or co-creating new innovation delivery mechanisms.

The EIT RIS could additionally be used to support researchers and innovators from the EIT RIS countries and regions to develop innovative and sustainable products, processes, technologies services and non-technological solutions that address a specific business opportunity or social objective. Some aspects of smart villages are reflected in [21].

4.3. EU Funding

Moldova has access to European Union funding programs to support educational capacity building. These funds are directed towards modernizing infrastructure, providing scholarships, and improving the quality of education.

The EIT's Knowledge and Innovation Communities (KIC) may choose to use their annual EIT RIS dedicated budget allocation to finance EIT RIS activities, as described in this Implementation Framework [22], co-funded up to 100%, as they consider it most appropriate, in line with their strategy and priorities to deliver tangible deliverables including widening participation in the KIC from EIT RIS countries and regions. In this context, the EIT RIS should also be mainstreamed within the KIC' core activities (that is participation in innovation, business creation and education actions) and used to exempt EIT RIS participants from co-funding rates and membership fees, thereby facilitating and attracting a high-level of participation to the EIT Community and boosting its pan-European spread. The KIC need to pre-fix the co-funding rate already at the call stage.

It is pertinent to note that beyond the 15% maximum budget dedicated to the EIT RIS, entities and partners from EIT RIS countries and regions still be fully involved in all activities in line with the co-funding rates delineated in the EIT SIA. Yet, the up to 100% co-funded activities is limited to the EIT RIS allocations which will be capped at a maximum 15% of the overall EIT funding for existing and new KIC. The EIT Governing Board will regularly monitor and evaluate the EIT RIS funding and may issue strategic guidance as appropriate.

4.4. EIT cross-border cooperation

EIT collaborative projects with neighboring countries and regions [23] enable the exchange of knowledge and expertise, enriching the educational environment.

The EIT nurtures entrepreneurial talent and supports new ideas, bringing together the "knowledge triangle" of leading companies, universities and research centers to form dynamic cross-border partnerships called Innovation Communities.

The EIT RIS will create synergies and complementarities with other EU, national, regional innovation initiatives and funding. There are opportunities for mutually reinforcing interaction with the EU's Cohesion Policy by addressing the links between the local and global aspects of innovation. KIC Colocation Centers are well positioned to capitalize on various funding schemes from their respective regions. The Co-location Centers offer platforms for cross-border collaboration playing a major role in strengthening the local-global connectivity of the KIC as a whole, including through close co-operation with regional authorities, in particular those involved in designing and delivering the Regional Innovation Strategies for Smart Specializations.

5. Challenges and future prospects

Analyzing the challenges and future prospects for developing human settlements in the Republic of Moldova, the following aspects stand out:

1. Funding: A major challenge is ensuring sustainable funding for educational capacity building. The Moldovan government needs to continue allocating resources to this critical sector.
2. Quality Assurance: Maintaining high educational standards and ensuring the relevance of programs to smart specialization goals require constant vigilance and quality assurance.
3. Digital Divide: Bridging the digital divide in rural areas is a critical task. Ensuring that even remote settlements have access to online learning and technology is vital.
4. Environmental Sustainability: Moldova must ensure that its smart specialization projects align with environmental sustainability goals, considering factors like energy efficiency and green infrastructure.

The future prospects for Moldova in the realm of educational capacity building for smart specialization in human settlements look promising. By addressing these challenges and continuing to innovate, Moldova can position itself as a regional leader in sustainable urban development and human settlements.

It is essential to note that the EU Strategy for the Danube Region is a macro-regional strategy designed to enhance the quality of life in the Danube region by covering twelve priority areas. It is a vital instrument for executing the EU Regional and Innovation Policy in the regions of the Republic of Moldova. Its purpose is to promote the growth of educational and research capabilities grounded on the invention of entrepreneurial potential within the confines of local smart specialization and regional innovation programs.

It should be emphasized that these activities jointly managed by the City of Vienna and the Center for European Perspective representing Slovenia. The Danube Civil Society Forum (DCSF) was established on July 1st, 2011 during the inaugural conference. Over 100 representatives attended from 14 Danube countries and diverse sectors including national, regional, and international NGOs, churches, minorities, academia, and EU institutions such as the EU Parliament, EU Commission, and EU Presidency (Hungary). Technical terms are explained when first introduced and the language is precisely chosen to maintain objectivity and formality with a clear and logical structure. Biases are avoided, and the spelling follows American English conventions. While the DCSF operated in close cooperation and consensus with the responsible EU institutions, the Danube Civil Society Forum [24] is a self-organized and independent NGO structure.

The Danube Civil Society Forum is the platform for civil society dialogue and networking in the Danube basin under the EU Strategy for the Danube Region. The Forum is registered under the Austrian law. It has 38 members; 36 regular members and 2 observers as of 1st August 2022. It functions as the interface for structured consultations between civil society and public and private authorities on the regional, national and EU level as well as to international and intergovernmental organizations active in the region. The DCSF is dedicated to support civil society organizations in the Danube basin. It aims to promote and enhance civil society participation and networking in the framework of the European Union Strategy for the Danube Region.

Within the framework of our research, the following three priority areas are of the greatest interest:

1. Priority Area (PA) № 7 “Knowledge society (research, education and ICT)” has the mission to develop the knowledge society through research, education and information technologies. It is coordinated by Slovakia and Serbia, with the involvement of a wide network of key players. The Priority Area 7 formulates the following objectives [25]:
    - To support education, research and ICT in the Danube Region by improvement of framework conditions for building a knowledge society;
    - To contribute to an increasing level and quality of network activities, strengthening the existing links and fostering new cooperation in the Danube Region;
    - To strengthen the realization of the European Research Area in the Danube Region;
    - To revert brain drain and foster brain circulation;
    - To further implement Smart Specialization Strategies in all Danube countries
2. The Danube Region Strategy Priority Area № 8 aims to support the competitiveness of enterprises in the Danube Region [26]. An Action is an important issue requiring intervention by the countries and stakeholders involved to meet the objective of the Priority Area. The main Actions of the PA 8 are:

- To foster cooperation and exchange of knowledge between SMEs, academia and the public sector in areas of competence in the Danube Region;
- To improve business support to strengthen the capacities of SMEs for cooperation and trade;
- To support enterprises through high performing training and qualification schemes;
- To prioritize the effective implementation of measures provided for under the Small Business Act for Europe;
- To improve the competitiveness of rural areas and in particular of the agricultural sector;
- To eliminate cross border barriers and bottlenecks to people and business -Seamless Europe for a livable Danube Region;
- To improve framework conditions for SMEs in areas where competitive infrastructure is missing.

3. Priority Area № 10 of the EU Strategy for the Danube Region aims at stepping up institutional capacity and cooperation as a precondition for shaping a sustainable, resilient and prosperous future [27]. In doing so, we address institutional capacity-building at local, regional and national level, involvement of civil society in public governance, increasing local development and better spending as well as increasing absorption rates of EU funds. It serves as an information and communication hub for local, regional, national and European stakeholders responsible for as well as working in the field of institutional capacity building, participative governance and spatial development. The activities of PA 10 aim at supporting policy and project development, stakeholder relations and capitalization in the Danube Region.

6. Conclusions

The Republic of Moldova, a small Eastern European country, has been making significant efforts to develop its economy and infrastructure, particularly in the context of European integration and smart specialization strategies. One of the key areas of focus is the development of human settlements and the enhancement of educational capacity to support smart specialization. Country and regional innovative schemes for educational capacity building are essential for achieving smart specialization in human settlements. The collaboration between educational institutions, industries, and international partners, coupled with a focus on research and development, holds the key to a prosperous future.

This infrastructure and human resources are usually provided by regional universities. Such innovation support, embedded in the European ecosystem, could be provided, as an example, by the IT4BA Innovation incubator [28] at the Academy of Economic Studies of Moldova (AESM) based on the JRC models of the EU Commission. AESM already has created the innovative educational ecosystem that brings together 8 resident ICT companies, teachers, researchers and dual degree students [29]. So, university innovation centers of this type and initiatives of Moldovan business innovation companies contribute

to the integration into pan-European teams of educational, research and business organizations that are the focus of EIT Digital.

Overcoming challenges and ensuring sustainability will be paramount in Moldova's journey towards smart specialization and a prosperous human settlements future.

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The role of NHIH in the digitalization of health, smart city condition

Cristina Teodora ȘICLOVAN,
NHIH, Bucharest, Romania
cepasa@casan.ro, tstef66@gmail.com

Abstract
The digitization of health is a priority of the European Union, Romania being involved in several projects, some of which are carried out by the National Health Insurance House (NHIH), in collaboration with partner institutions. The objectives of the ongoing projects are: "Modernization and optimization of the contracting and settlement of medical services", "Computer System for Modern Management of Access to Medical Services, Acts, Recommendations and Technologies – SIGMA SMART", "Development and expansion of the electronic file of health (EFH)", "Implementation of the electronic prescription", "Implementation of the electronic referral ticket", "Implementation of the electronic medical letter", "Development of the national telemedicine system", "Interoperability of health systems". All these projects regarding the use of digital technology in health are aimed at optimizing the patient's access to quality medical services, easing the work of medical personnel, reducing waiting times, ensuring the accuracy and security of data circulation in the national system and cross-border health system, generating reports and analyzes on the state of the health system, making the best diagnostic and therapeutic decisions for patient care and optimizing the use of funds in the social health insurance system. To carry out this work, I used the data available at the level of the National Health Insurance House (studies, plans), the press releases from the NHIH management and discussions with people involved in these projects. The implementation of digitization projects was based on feasibility studies, scientific data, based on the experience of the teams of specialists involved in the projects, in compliance with the standards and legal regulations in force and the recommendations of the European Commission. The work is a review of the ongoing projects at NHIH, the current problems facing the health system and is a basis for discussions for future debates, ideas, proposals and solutions in order to optimize the functioning of the health system.

Keywords: electronic health record, electronic prescription, medical services, digital technology, interoperability of health systems.

1. Introduction
The digitization of the health system has become a priority in the European Union, Romania being involved in several projects and initiatives regarding the implementation of digital solutions to improve efficiency, access to health services and the quality of patient care. [1]

The National Health Insurance House (NHIH) is one of the institutions that has an important role in the digitalization of health, because it manages the Single National Health Insurance Fund (FNUASS) from which the services provided in the health insurance system are settled and regulates the conditions of providing medical assistance, medicines and medical devices within this system. NHIH has several projects under implementation, being an important partner in the field of health digitization at the European level, projects aimed at the following objectives:

- Modernization and optimization of the contracting and settlement of medical services in all fields of medical assistance, by developing unitary procedures for all county health insurance companies, as well as for the Bucharest Health Insurance House and the Health Insurance House of Defense, Public Order, National Security and Judicial Authority. The goal is to standardize and clarify the

application of legislation throughout the country through new procedures that best respond to the needs of the insured people, given that, at the moment, there are inequities regarding access to medical services between the large university centers and areas with a shortage of specialists.

- The "Computer System for the Modern Management of Access to Medical Services, Acts, Recommendations and Technologies – SIGMA SMART" project, developed through a partnership agreement between NHIH, the Authority for Digitization of Romania and the Special Telecommunications Service which will allow the preparation of reports , analyzes and studies aimed at optimizing and strengthening the decision-making capacity of NHIH, by processing specific data collected in the Health Insurance Information Platform (HIIP or PIAS). Interrelating data from the various catalogs and areas of PIAS is not a simple matter, but requires insight and experience so that the reports generated are meaningful and can be useful to decision makers in order to develop evidence-based health policies. The total value of the project is 101.98 million lei, of which 85.64 million represents the non-refundable financing granted by the POCA Management Authority. Through the system that will be created within this project, the data extracted from PIAS will be integrated and organized in a unique reference format and will contribute to a better understanding of the needs of the insured, to reducing risks and increasing the efficiency of public spending in the system of health.
- The development and expansion of the electronic health file (EHF), an integrated computer system, which contains data and medical documents related to the medical history, diagnosis, treatment and monitoring of the health status of each insured person. The loading of medical data into the EHF was stopped in 2018 due to the obligation to comply with the EU regulation on the protection of personal data (GDPR), and after the harmonization of the normative acts in force with this requirement and the changes made in the Single Integrated Information System, the process was resumed in November 2021, and up to now more than 13 million electronic health records have been created. Every Romanian citizen will have an electronic health file, regardless of age and whether they are insured or not. In the DES there is a section called "summary for emergency situations" which contains vital data for the patient, essential for doctors in emergency situations, where the patient is unconscious or cannot tell the doctors about the diseases, allergies he has been diagnosed with or whether he is under drug treatment. This section includes, among others, the patient's chronic diseases, hematological diseases relevant for medical emergencies, transmissible diseases relevant for medical emergencies, current treatments, recent admissions. [2]

This information is accessible at any time, to any doctor in the public and private medical system, who is authenticated in the DES system and knows the patient's CNP (personal identification code). Pharmacies, medical laboratories, dentists and any other medical service provider in Romania, authenticated in the DES system, who knows the patient's CNP, can have access to this information from his health file. The rest of the medical information in the file can only be consulted in the presence of the patient or with his consent. Work is currently underway on interoperability between providers of medical

services, medicines and medical devices, so that they can access relevant medical data in real time, the investigations done on the patient and their results, the medication the patient is taking, other major health issues, so that providers can make informed medical decisions for the benefit of the patient and without the need for paper medical records.

- Implementation of the electronic prescription, i.e. a medical document issued by the prescriber, which contains information about the drugs and medical devices prescribed to the patient, which is transmitted electronically to the pharmacy and which is validated with the patient's health card.
- Implementation of the electronic referral ticket, which is a medical document issued by the family doctor or the specialist doctor and contains information about the specialized or paraclinical medical services recommended to the patient, which is transmitted electronically to the service provider and is validated with the health card of the patient.
- The implementation of the electronic medical letter, a medical document issued by the attending physician, contains information about the patient's diagnosis, treatment and progress, which is transmitted electronically to the family doctor or another specialist, to ensure the continuity of the patient's care.
- The development of the telemedicine system at the national level, i.e. a computer system that allows the provision of medical services at a distance, through information and communication technology, quick access to a second medical opinion, collaboration between health professionals in order to facilitate access to quality healthcare, especially for patients in isolated or disadvantaged areas. [406]

1.1. The planned interval for the implementation of health digitization activities

To carry out these digitization projects, NHIH benefits from European funding through the National Recovery and Resilience Plan (PNRR), which allocates 400 million euro for the digitization of the health system, until 2026. Calls for projects have been opened for the development of the digital system of NHIH and for the digitization of at least 200 hospitals. At the same time, with the help of the World Bank, the Ministry of Health will equip around 130 Emergency Reception Units in county, municipal and city hospitals with modern telemedicine solutions.

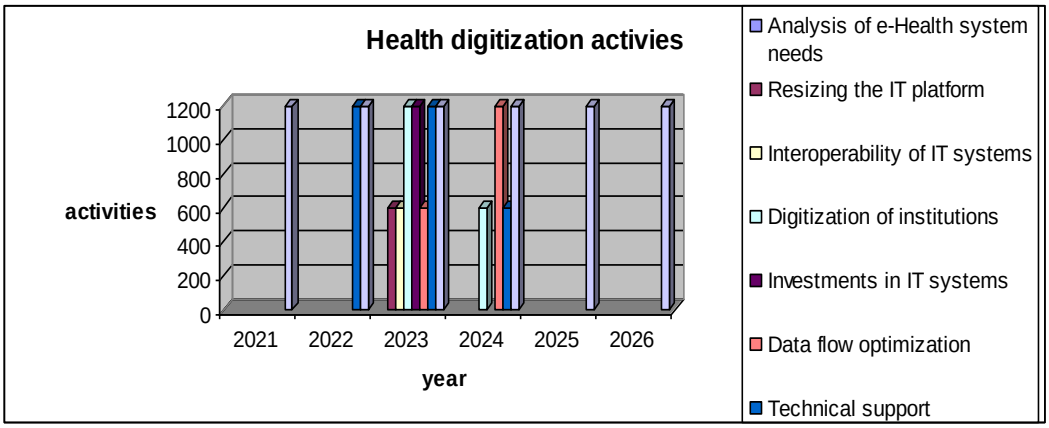

Fig. 1 Health digitization activities

A modern hospital operating in a smart city must be equipped with telemedicine and video collaboration, video surveillance, IT infrastructure and cyber security, connections with partner institutions and other integrated systems of a smart city. Each component has an essential role in creating a modern and efficient work environment and contributes to providing quality services to patients. By digitizing all levels of medical assistance, it is desired to obtain clear reports on services, devices and medical prescriptions settled, with the possibility of tracking the patient in the health care system, so that errors and losses in the system are eliminated.

1.2. Is digitization of health a viable solution for improving access to healthcare in Romania?

The standards required for the implementation of new technological solutions are increasingly high and complex, but let's not forget the reality around us: Romania faces considerable challenges in terms of ensuring access to healthcare. In total, approximately 11% of the population remains uninsured and has access to only a limited package of services. The percentage of the population with some form of health insurance has declined, with a significant gap between urban and rural areas. A large proportion of self-employed workers in agriculture and the Roma population in rural areas do not benefit from health insurance. In terms of reported unmet medical needs, significant differences persist between the lowest income groups (8%) and the highest income groups (2.3%). The percentage of the rural population insured decreased from 75.8% in 2014 to 63.5% in 2021, and the downward trend is maintained. [2]

In Romania, there are approximately 17 million insured people, of which over 10 million have health insurance, but do not pay, because they fall into the 19 categories of people exempted from paying the contribution to health insurance, according to the legislation in force. Romania is the country with the most categories of persons exempted from paying the contribution from the European Union. A simple calculation shows that each person who works in Romania pays, on average, health insurance both for himself and for two other people who do not pay anything. This imbalance determines the uncertainty of the future of the health system as it is currently organized. In the case of retirees, the level of unmet medical needs is twice as high as that of the general population. Rate of unmet healthcare needs, from due to the long distance to a medical facility, it is the third largest in the EU. Territorial imbalances in the provision of healthcare services are large and growing. There is a need to rethink the health system, digitize it and restrict the categories exempted from paying the health insurance contribution, as well as the introduction of private health insurance companies, the redefinition of service packages that can be settled by the public system and those settled from private health insurance.

1.3. Interoperability of health systems

Interoperability of health systems is another important step in the digitalization of health. To facilitate the exchange of information between digital health systems in different countries, it is essential to have common standards and interoperable interfaces. This ensures that patient data is properly read and interpreted by the various health IT systems. The European Union has adopted initiatives to establish common standards for interoperability in digital health. In this sense, National Health Insurance House has started

the configuration of the “e-Prescription” (electronic prescription) and “Patient Summary” (patient's medical file) services, in a cross-border context. The two components will allow European patients to use their prescription and medical documents in electronic format when they require treatment and medical services in the territory of another member state.

These aspects are essential to ensure continuity of care for the patient if he receives treatment in a different country than the one where he was initially treated or diagnosed. [407]

The main aspects regarding the interoperability of medical systems in the European Union include: interoperable electronic health records, common communication standards for data to be transmitted and interpreted correctly, data security to avoid unauthorized access or misuse of sensitive patient data, consent and patient privacy so that they can give or withdraw their consent to share their medical data between medical systems in different countries and common standards for identifying patients to avoid errors to ensure the accuracy of medical data. The lack of interoperability of medical systems in different countries is an obstacle to building the digital single market. In conclusion, the projects carried out by CNAS for the digitization of the health system are large-scale projects, with multiple components, and the difficulties that arise along the way are difficult to solve. It takes will, patience, ingenious ideas and teams of experienced professionals. [3]

1.4. NHIH proposals for solving problems in the health system.

NHIH analyzed the existing discrepancies in the health system and formulated some general strategies that can be applied to improve the integration of healthcare services:

1. Standardization and interoperability of systems. The implementation of common standards and interoperability protocol within health systems is essential because it will enable the efficient transfer of data between different components of the health system, such as hospitals, clinics, laboratories and pharmacies. [7]
2. Electronic Medical Records System (EMR). The use of electronic medical records can facilitate the sharing of medical information between different entities in the health care system. Providing quick and secure access to relevant patient information can improve care coordination. [3]
3. Telemedicine: The implementation of telemedicine technology can increase access to health care and facilitate communication between health professionals, especially in resource-constrained areas or in emergency situations. [8]
4. Collaboration between health professionals such as doctors, nurses, pharmacists and therapists can lead to better integration of services.
5. Continuing education and training: ensuring that health professionals are well trained in new technologies and are aware of each other's needs and responsibilities so that they can contribute to better integration of services.
6. Involving patients in managing their own medical records, making decisions and planning care can contribute to better coordination of medical services.
7. The implementation of clear policies and regulations that promote the exchange of information in a secure way and facilitate collaboration between the different components of the health system is essential.

8. Investments in technological infrastructure. Ensuring that the technical infrastructure required for effective service integration is available and up-to-date. Every health system is unique, and effective solutions may vary according to the local and regional context. A holistic approach involving both health professionals and stakeholders is required to achieve effective integration of healthcare service delivery.
9. Consultation of patient associations and organizations in order to optimize the normative acts that regulate the provision of medical services, medicines and medical devices. An example is the establishment at NHIH level, in October 2023, of a Task Force to fight cancer in Romania, made up of representatives of the institution, doctors involved in the fight against cancer, representatives of oncological patients, who, in the first stage, started mapping all to the existing medical services in the field of oncology, from preventive to curative ones. The second step will consist in designing, based on scientific data, the need for oncology services for the next 5 years, so that the reform of the medical services provided to the sick is in accordance with the real needs and financially sustainable.

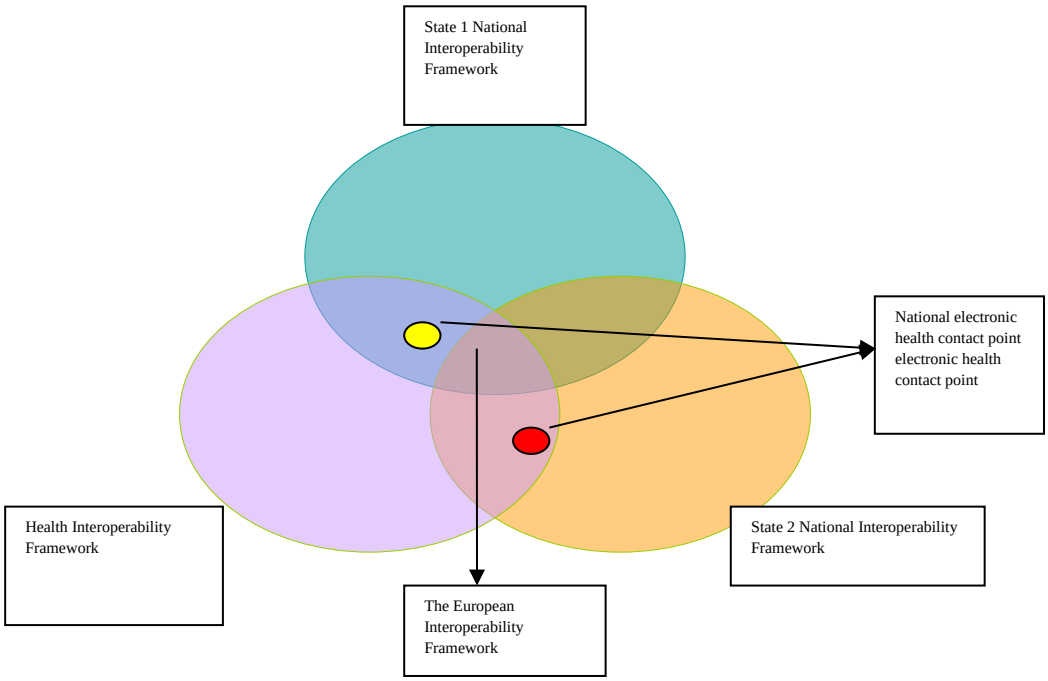

Fig. 2 The European Framework for Interoperability in the field of Health
Source: [4], p. 7

10. Preparing the health system in Romania to be interoperable with the health systems in the European Union, an important challenge that requires commensurate efforts. To promote interoperability in the field of digital health at the level of European countries, the European Union has developed initiatives such as the eHealth Network Project. Member States, including Romania, are involved in these efforts to create

an environment where health data can be shared securely and in compliance with data protection regulations. In order to achieve these objectives, the EU member states decided to develop in each member state a national electronic health contact point (Open NCP), which will exist at the level of each member state, according to the provisions of the draft European regulation regarding the electronic health data space (European Health Data Space – EHDS). [407]

All these efforts regarding the use of digital technology in health are aimed at focusing on the patient and his needs, increasing the availability of resources and their accessibility where they are most needed, making the best diagnostic and therapeutic decisions in patient care, optimizing the work of medical personnel, reducing work and waiting times, ensuring accuracy and security in centralizing and storing patient medical data, as well as using it to develop smart public policies, to intelligently allocate resources and to predict future trends in an informed and documented way.

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Rolul CNAS în digitalizarea sănătății, condiție smart city

Cristina Teodora ȘICLOVAN,
CNAS, București, România
cepasa@casan.ro, tstef66@gmail.com

Abstract
Digitalizarea sănătății este o prioritate a Uniunii Europene, România fiind implicată în mai multe proiecte, unele dintre acestea fiind derulate de Casa Națională de Asigurări de Sănătate, în colaborare cu instituțiile partenere. Obiectivele proiectelor aflate în derulare sunt: "Modernizarea și optimizarea modului de contractare și decontare a serviciilor medicale", "Sistem Informatic pentru Gestionarea Modernă a Accesului la Servicii Medicale, Acte, Recomandări și Tehnologii – SIGMA SMART", "Dezvoltarea și extinderea dosarului electronic de sănătate (DES)", "Implementarea rețetei electronice", "Implementarea biletului de trimitere electronic", "Implementarea scrisorii medicale electronice", "Dezvoltarea sistemului de telemedicină la nivel național", "Interoperabilitatea sistemelor de sănătate". Toate aceste proiecte privind utilizarea tehnologiei digitale în sănătate au ca scop optimizarea accesului pacientului la servicii medicale de calitate, ușurarea muncii personalului medico-sanitar, reducerea timpilor de așteptare, asigurarea acurateței și securității circulației datelor în sistemul de sănătate național și transfrontalier, generarea de rapoarte și analize privind starea sistemului de sănătate, luarea celor mai bune decizii diagnostice și terapeutice pentru îngrijirea pacienților și optimizarea utilizării fondurilor în sistemul asigurărilor sociale de sănătate. Pentru realizarea acestei lucrări am utilizat datele aflate la nivelul Casei Naționale de Asigurări de Sănătate (studii, planuri), comunicatele de presă din partea conducerii CNAS și discuții cu persoane implicate în aceste proiecte. Implementarea proiectelor de digitalizare s-a făcut pe baza unor studii de fezabilitate, a datelor științifice, pe baza experienței echipelor de specialiști implicate în proiecte, cu respectarea standardelor și reglementărilor legale în vigoare și a recomandărilor Comisiei Europene. Lucrarea este o trecere în revistă a proiectelor aflate în derulare la CNAS, a problemelor actuale cu care se confruntă sistemul de sănătate și este o bază de discuții pentru viitoare dezbateri, idei, propuneri și soluții în scopul optimizării funcționării sistemului de sănătate.

Cuvinte cheie: dosar electronic de sănătate, prescripție electronică, servicii medicale, tehnologie digitală, interoperabilitatea sistemelor de sănătate.

1. Introducere
Digitalizarea sistemului de sănătate a devenit o prioritate în Uniunea Europeană, România fiind implicată în mai multe proiecte și inițiative privind implementarea soluțiilor digitale pentru a îmbunătăți eficiența, accesul la servicii de sănătate și calitatea îngrijirii pacienților. [1]

Casa Națională de Asigurări de Sănătate (CNAS) este una dintre instituțiile care are un rol important în digitalizarea sănătății, deoarece gestionează Fondul Național Unic de Asigurări Sociale de Sănătate (FNUASS) din care se decontează serviciile furnizate în sistemul asigurărilor sociale de sănătate și reglementează condițiile de acordare a asistenței medicale, a medicamentelor și a dispozitivelor medicale în cadrul acestui sistem. CNAS are mai multe proiecte în curs de implementare, fiind un partener important în domeniul digitalizării sănătății la nivel european, proiecte care vizează următoarele obiective:

- Modernizarea și optimizarea modului de contractare și decontare a serviciilor medicale în toate domeniile de asistență medicală, prin elaborarea unor proceduri unitare pentru toate casele județene de asigurări de sănătate, cât și pentru Casa de Asigurări de Sănătate a Municipiului București și Casa Asigurărilor de Sănătate a Apărării, Ordinii Publice, Siguranței Naționale și Autorității Judecătorești. Se urmărește uniformizarea și claritatea aplicării legislației în întreaga țară prin proceduri noi care să răspundă cât mai bine nevoilor asiguraților, în condițiile în care, la ora actuală, există inechități privind accesul la servicii medicale între marile centre universitare și zonele cu deficit de specialiști.

- Proiectul "Sistem Informatic pentru Gestionarea Modernă a Accesului la Servicii Medicale, Acte, Recomandări și Tehnologii – SIGMA SMART", proiect derulat printr-un acord de parteneriat între CNAS, Autoritatea pentru Digitalizarea României și Serviciul de Telecomunicații Speciale care va permite elaborarea de rapoarte, analize și studii menite să optimizeze și să consolideze capacitatea decizională a CNAS, prin prelucrarea datelor specifice colectate în Platforma Informatică a Asigurărilor de Sănătate (PIAS). Interrelaționarea datelor din diversele cataloage și zone ale PIAS nu este un lucru simplu, ci necesită perspicacitate și experiență pentru ca rapoartele generate să aibă sens și să poată fi utile decidenților în vederea elaborării unor politici de sănătate bazate pe dovezi. Valoarea totală a proiectului este de 101,98 milioane lei, din care 85,64 milioane reprezintă finanțarea nerambursabilă acordată de Autoritatea de Management POCA. Prin sistemul care va fi creat în cadrul acestui proiect, datele extrase din PIAS vor fi integrate și organizate într-un format unic de referință și vor contribui la o mai bună înțelegere a nevoilor asiguraților, la reducerea riscurilor și creșterea eficienței cheltuielilor publice în sistemul de sănătate [2]
- Dezvoltarea și extinderea dosarului electronic de sănătate (DES)**,** un sistem informatic integrat, care conține date și documente medicale referitoare la istoricul medical, diagnosticul, tratamentul și monitorizarea stării de sănătate a fiecărui asigurat. Încărcarea datelor medicale în DES a fost oprită în 2018 din cauza obligativității respectării regulamentului UE privind protecția datelor cu caracter personal (GDPR), iar după armonizarea actelor normative în vigoare cu această cerință și modificările operate în SIUI, procesul a fost reluat în noiembrie 2021, iar până în prezent au fost constituite peste 13 milioane de dosare electronice de sănătate. Fiecare cetățean român va avea un dosarul electronic de sănătate, indiferent de vârstă și dacă este asigurat sau nu. În DES există o secțiune numită "sumar pentru situații de urgență" care conţine date vitale pentru pacient, esenţiale medicilor în situaţii de urgenţă, în care pacientul e inconştient sau nu poate spune medicilor bolile, alergiile cu care a fost diagnosticat şi nici dacă se află sub tratament medicamentos. În această secţiune sunt cuprinse, printre altele, bolile cronice ale pacientului, bolile hematologice relevante pentru urgenţe medicale, boli transmisibile relevante pentru urgenţe medicale, tratamentele curente, internări recente. [3]

Aceste informaţii sunt accesibile oricând, oricărui medic din sistemul medical public şi privat, care este autentificat în sistemul DES şi ştie CNP-ul pacientului. Farmaciile, laboratoarele medicale, medicii stomatologi şi orice alt furnizor de servicii medicale din România, autentificat în sistemul DES, care ştie CNP-ul pacientului, poate avea acces la aceste informaţii din dosarul său de sănătate. Restul informaţiilor medicale din dosar pot fi consultate doar în prezenţa pacientului sau cu acordul acestuia. Se lucrează, în prezent, la interoperabilitatea între furnizorii de servicii medicale, medicamente și dispozitive medicale, astfel încât aceștia să poată accesa în timp real date medicale relevante, investigațiile făcute pacientului și rezultatele acestora, medicația pe care o ia pacientul, alte probleme majore de sănătate, astfel încât furnizorii să poată lua decizii medicale în cunoștință de cauză spre beneficiul pacientului și fără a mai fi necesare documentele medicale pe suport de hârtie.

- Implementarea rețetei electronice, adică un document medical emis de medicul prescriptor, care conține informații despre medicamentele și dispozitivele medicale prescrise pacientului, care se transmite electronic către farmacie și care se validează cu cardul de sănătate al pacientului.
- Implementarea biletului de trimitere electronic, care este un document medical emis de medicul de familie sau de medicul specialist și conține informații despre serviciile medicale de specialitate sau paraclinice recomandate pacientului, care se transmite electronic către furnizorul de servicii și se validează cu cardul de sănătate al pacientului.
- Implementarea scrisorii medicale electronice, document medical emis de medicul curant, conține informații despre diagnosticul, tratamentul și evoluția pacientului, care se transmite electronic către medicul de familie sau către alt medic specialist, pentru a asigura continuitatea îngrijirii pacientului.
- Dezvoltarea sistemului de telemedicină la nivel național, adică un sistem informatic care permite furnizarea de servicii medicale la distanță, prin intermediul tehnologiei informației și comunicațiilor, acces rapid la o a doua opinie medicală, colaborare dintre profesioniștii din domeniul sănătății cu scopul de a facilita accesul la asistență medicală de calitate, în special pentru pacienții din zonele izolate sau defavorizate. [4]

1.1. Intervalul planificat pentru desfășurarea activităților de digitalizare a sănătății

Pentru a realiza aceste proiecte de digitalizare, CNAS beneficiază de finanțare europeană prin Planul Național de Redresare și Reziliență (PNRR), care alocă 400 de milioane de euro pentru digitalizarea sistemului de sănătate, până în 2026. Au fost deschise apelurile de proiecte pentru dezvoltarea sistemului digital al CNAS și pentru digitalizarea a minim 200 de spitale. Totodată, cu ajutorul Băncii Mondiale, Ministerul Sănătății va dota circa 130 de Unități de Primire Urgențe din spitale județene, municipale și orășenești cu soluții moderne de telemedicină. [5]

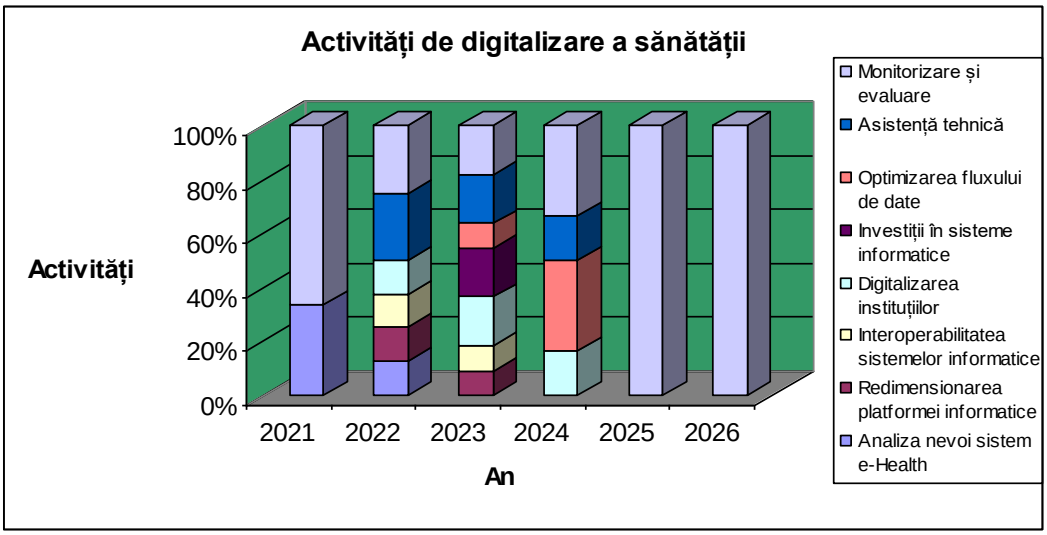

Fig.1 Activități de digitalizare a sănătății proiectate pe ani

Un spital modern care funcționează într-un smart city trebuie să fie dotat cu telemedicină și videocolaborare, videosupraveghere, infrastructură IT și securitate cibernetică, conexiuni cu instituțiile partenere și cu celelalte sisteme integrate ale unui oraș inteligent. Fiecare componentă are un rol esențial în crearea unui mediu de lucru modern și eficient și contribuie la oferirea unor servicii de calitate pacienților. Prin digitalizarea tuturor nivelurilor de asistență medicală, se dorește obținerea unor rapoarte clare privind serviciile, dispozitivele și prescripțiile medicale decontate, cu posibilitatea de urmărire a bolnavului în sistemul îngrijirilor de sănătate, astfel încât să fie înlăturate erorile și pierderile din sistem.

1.1. Digitalizarea sănătății este o soluție viabilă pentru îmbunătățirea accesului la asistență medicală în România?

Standardele solicitate pentru implementarea noilor soluțiilor tehnologice sunt tot mai înalte și complexe, dar să nu uităm realitatea din jurul nostru: România se confruntă cu provocări considerabile în ceea ce privește asigurarea accesului la asistență medicală. În total, aproximativ 11% din populație rămâne neasigurată și are acces doar la un pachet restrâns de servicii. Procentul de populație care beneficiază de o formă de asigurare de sănătate a scăzut, cu un decalaj semnificativ între mediul urban și cel rural. O mare parte a lucrătorilor care desfășoară o activitate independentă în agricultură și a populației rome din mediul rural nu beneficiază de o asigurare de sănătate. În ceea ce privește nevoile medicale nesatisfăcute raportate, persistă diferențe semnificative între grupurile cu cele mai mici venituri (8%) și grupurile cu cele mai mari venituri (2,3%). Procentajul populației rurale asigurate a scăzut de la 75,8% în 2014, la 63,5% în 2021, și tendința descendentă se păstrează.

În România sunt aproximativ 17 milioane de persoane asigurate, din care peste 10 milioane au asigurări de sănătate, dar nu plătesc, pentru că se încadrează în cele 19 categorii de persoane exceptate de la plata contribuției la asigurările de sănătate, conform legislației în vigoare. România este țara cu cele mai multe categorii de persoane exceptate de la plata contribuției din Uniunea Europeană. Un simplu calcul arată faptul că fiecare om care muncește în România plătește, în medie, asigurări de sănătate atât pentru el, cât și pentru alte două persoane care nu plătesc nimic. Acest dezechilibru determină incertitudinea viitorului sistemului de sănătate așa cum este organizat în prezent.

În cazul pensionarilor, nivelul nevoilor medicale nesatisfăcute este de două ori mai ridicat decât cel al populației generale. Rata nevoilor de asistență medicală nesatisfăcute, din cauza distanței mari până la o unitate medicală, este a treia ca mărime din UE. Dezechilibrele teritoriale în furnizarea serviciilor de asistență medicală sunt mari și se amplifică.

Este nevoie de regândirea sistemului de sănătate, de digitalizarea lui și de restrângerea categoriilor exceptate de la plata contribuției la asigurările de sănătate, precum și de introducerea caselor de asigurări de sănătate private, redefinirea pachetelor de servicii care pot fi decontate de sistemul public și a celor decontate din asigurările private de sănătate.

1.2. Interoperabilitatea sistemelor de sănătate

Aceasta este o altă etapă importantă în procesul de digitalizare a sănătății**.** Pentru a facilita schimbul de informații între sistemele de sănătate digitale din diferite țări, este esențial să

existe standarde comune și interfețe interoperabile. Acest lucru asigură ca datele despre pacient să fie citite și interpretate corespunzător de către diferitele sisteme informatice de sănătate. Uniunea Europeană a adoptat inițiative pentru a stabili standarde comune pentru interoperabilitate în domeniul sănătății digitale. În acest sens, CNAS a început configurarea serviciilor de "*e-Prescription*" (prescripţie electronică) şi "*Patient Summary*" (dosarul medical al pacientului), în context transfrontalier. Cele două componente vor permite pacienţilor europeni să utilizeze prescripţia şi documentele medicale proprii în format electronic atunci când necesită tratament şi servicii medicale pe teritoriul altui stat membru. Aceste aspecte sunt esențiale pentru a asigura o continuitate a îngrijirii pacientului în cazul în care acesta primește tratament într-o țară diferită de cea în care a fost inițial tratat sau diagnosticat. [6]Principalele aspecte privind interoperabilitatea sistemelor medicale din Uniunea Europeană includ: dosarele electronice de sănătate interoperabile, standarde comune de comunicare pentru ca datele să fie transmise și interpretate corect, securitatea datelor pentru evitarea accesului neautorizat sau utilizarea incorectă a datelor sensibile ale pacientului, consimțământul și confidențialitatea pacienților pentru ca aceștia să poată acorda sau retrage consimțământul privind partajarea datelor lor medicale între sisteme medicale din diferite țări și standarde comune pentru identificarea pacienților cu scopul de a evita erorile pentru a asigura corectitudinea datelor medicale. Lipsa interoperabilității sistemelor medicale din diferite țări este un obstacol în construirea pieței unice digitale. În concluzie, proiectele desfășurate de CNAS pentru digitalizarea sistemului de sănătate sunt proiecte de anvergură, cu multiple componente, iar dificultățile care survin pe parcurs sunt dificil de rezolvat. Este nevoie de voință, răbdare, idei ingenioase și echipe de profesioniști experimentați. [5]

1.3. Propuneri ale CNAS pentru rezolvarea problemelor din sistemul de sănătate

CNAS a analizat discrepanțele existente în sistemul de sănătate și a formulat câteva strategii generale care pot fi aplicate pentru a îmbunătăți integrarea serviciilor de asistență medicală:

1. Standardizarea și interoperabilitatea sistemelor. Implementarea standardelor comune și a protocolului de interoperabilitate în cadrul sistemelor de sănătate este esențială pentru că va permite transferul eficient al datelor între diferitele componente ale sistemului de sănătate, cum ar fi spitale, clinici, laboratoare și farmacii. [7].
2. Sistem de Dosare Medicale Electronice (EMR). Utilizarea dosarelor medicale electronice poate facilita partajarea informațiilor medicale între diferite entități din sistemul de sănătate. Asigurarea accesului rapid și securizat la informații relevante despre pacienți poate îmbunătăți coordonarea îngrijirii medicale. [5].
3. Telemedicina: implementarea tehnologiei de telemedicină poate spori accesul la îngrijirea medicală și poate facilita comunicarea între profesioniștii din sănătate, în special în zonele cu resurse limitate sau în situații de urgență. [8]
4. Colaborarea între profesioniștii din sănătate, cum ar fi medici, asistente medicale, farmaciști și terapeuți, poate duce la o integrare mai bună a serviciilor.

5. Educație și formare continuă: asigurarea ca profesioniștii din domeniul sănătății să fie bine instruiți în tehnologii noi și să fie conștienți de nevoile și responsabilitățile fiecăruia astfel încât să poată contribui la o mai bună integrare a serviciilor.
6. Implicarea pacienților în gestionarea propriilor dosare medicale, luarea deciziilor și planificarea îngrijirii poate contribui la o mai bună coordonare a serviciilor medicale.
7. Implementarea unor politici și reglementări clare care să promoveze schimbul de informații într-un mod securizat și să faciliteze colaborarea între diferitele componente ale sistemului de sănătate este esențială.
8. Investiții în infrastructură tehnologică. Asigurarea că infrastructura tehnică necesară pentru integrarea eficientă a serviciilor este disponibilă și actualizată. Fiecare sistem de sănătate este unic, iar soluțiile eficiente pot varia în funcție de contextul local și regional. O abordare holistică, care implică atât profesioniștii din sănătate, cât și părțile interesate, este necesară pentru a atinge o integrare eficace a furnizării serviciilor de asistență medicală.

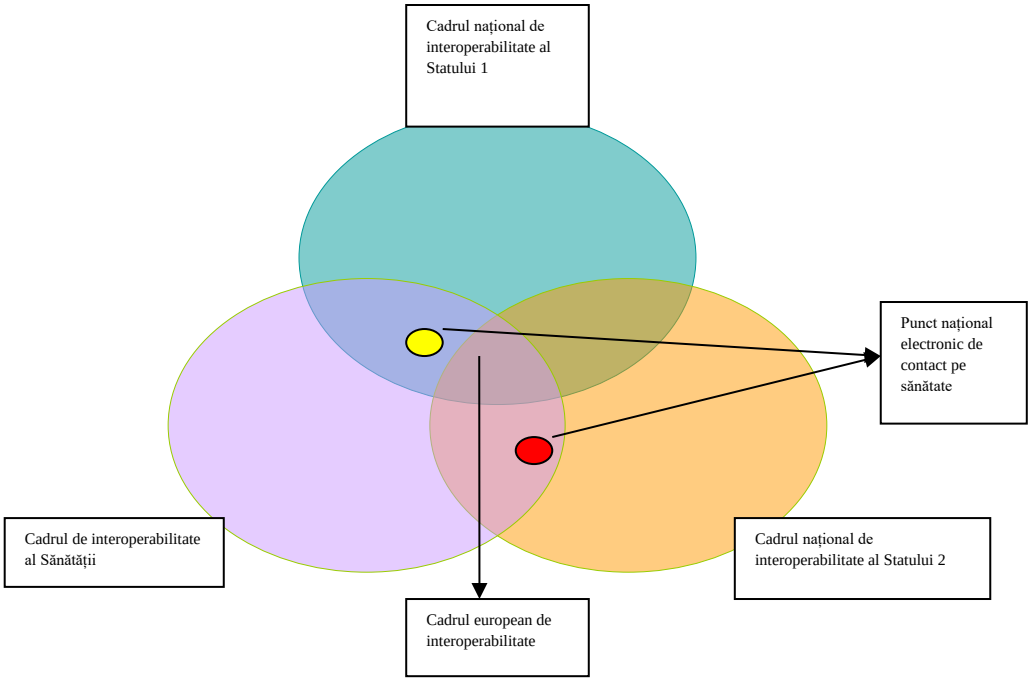

Fig. 2 Cadrul European de Interoperabilitate în domeniu Sănătății
Sursa: [4], p. 7

9. Consultarea asociațiilor și organizațiilor bolnavilor în vederea optimizării actelor normative care reglementează furnizarea de servicii medicale, medicamente și dispozitive medicale. Un exemplu este constituirea la nivelul CNAS, în octombrie 2023, a unui *Task Force* pentru combaterea cancerului în România, format din reprezentanți ai instituției, medici implicați în lupta cu cancerul, reprezentanți ai

bolnavilor oncologici, care, în prima etapă, au început cartografierea tuturor serviciilor medicale existente în domeniul oncologiei, de la cele preventive, până la cele curative. Pasul doi va consta în proiectarea, pe baza datelor științifice, a necesarului de servicii oncologice pentru următorii 5 ani, astfel încât reformarea serviciilor medicale acordate bolnavilor să fie conform nevoilor reale și sustenabilă financiar.

10. Pregătirea sistemului de sănătate din România pentru a fi interoperabil cu sistemele de sănătate din Uniunea Europeană, o provocare importantă care necesită eforturi pe măsură. Pentru promovarea interoperabilității în domeniul sănătății digitale la nivelul țărilor europene, Uniunea Europeană a dezvoltat inițiative precum proiectul *eHealth Network*. Statele membre, inclusiv România, sunt implicate în aceste eforturi pentru a crea un mediu în care datele de sănătate să poată fi partajate în condiții de securitate și conformitate cu reglementările privind protecția datelor. În vederea realizării acestor obiective, statele membre ale UE au decis dezvoltarea în fiecare stat membru a unui punct național electronic de contact pe sănătate (*Open NCP*), care va exista la nivelul fiecărui stat membru, conform prevederilor proiectului de regulament european referitor la Spațiul electronic al datelor privind sănătatea (*European Health Data Space – EHDS*). [4]

Toate aceste eforturi privind utilizarea tehnologiei digitale în sănătate au ca scop centrarea pe pacient și nevoile acestuia, crescând disponibilitatea resurselor și accesibilitatea lor acolo unde sunt mai necesare, luarea celei mai bune decizii diagnostice și terapeutice în îngrijirea pacienților, optimizarea muncii personalului medico-sanitar, reducerea timpilor de lucru și de așteptare, asigurarea acurateței și securității în centralizarea și stocarea datelor medicale ale pacienților, precum și folosirea lor pentru a dezvolta politici publice inteligente, pentru a aloca inteligent resursele și pentru a prezice tendințele viitoare în mod informat și documentat.

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Perspectives and implications in the use of artificial intelligence in healthcare

Narcis Dumitru BADEA,
General Directorate of Social Assistance, Bucharest, Romania
badeadumitrunarcis_90@yahoo.com

Abstract
Advances in applications and research in creative operations have led to the emergence of artificial intelligence, which has developed from a nascent application to a major influence in almost all areas of business, research, or manufacturing, including the medical field. Thus in the medical field the first application with particularly good results was in surgery, i.e. laparoscopy. Subsequently, minimally invasive operations in cardiology, orthopedics, urology, etc., as well as in minimally invasive operations on the unborn fetus, when certain congenital malformations were identified. It is expected that artificial intelligence will also be able to perform minimally invasive interventions on the Central Nervous System (CNS), especially for recovery from progressive neuronal degenerative conditions with multi-level damage (dopa and non-dopa). As a result artificial intelligence challenges specialists to create appropriate instrumentation, through new technologies and the creation of specialists in collateral fields (chemistry, welding, composite materials, microbiology, etc.), as well as new systems of micro-visualization without radioactive effects. This requires collaborations and cooperation between researchers in various fields and major investments in research laboratories and information of specialists. Artificial intelligence has also created opponents in terms of fears that it would replace some medical professionals and that some negative consequences of artificial intelligence applications in the medical field may not be predictable. Artificial intelligence is proving to be an evolutionary stage as a result of the emergence and development of technologies, types of management, the creation of niche researchers, with competitive aspects between laboratories and states and with state and private investment, especially as it also has applications in the military. Artificial intelligence-related discoveries are secret and top secret due to investments recoverable from licensing profits. Romania benefits from the National Strategy for Research, Innovation and Smart Specialization with funds from the PNRR, with the remark that national research institutions have lost specialists attracted by developed countries from the European Union, the USA, etc. In order to cope with the competition Romania should allocate substantial budgetary funds both in national research institutions and in the creation of co-invested specialists, as well as encourage private initiatives. Applications already practiced from the use of artificial intelligence in the medical field highlight the benefits for society as a whole with recognized positive results for the health of patients and by decreasingrecovery time and lowering the costs of hospitalizations and treatments. Romania as a member of the European Union and NATO has the advantages of cooperation and collaboration in the field of artificial intelligence, with similar institutions, as well as through participation in scientific sessions and specific topics. Romania as a member of the European Union and NATO has the advantages of cooperation and collaboration in the field of artificial intelligence, with similar institutions, as well as through participation in scientific sessions and specific topics. It is undeniable that artificial intelligence is proving to have an impact in most areas of social economics, manufacturing, healthcare and the military. The necessary investment and the applicable results of artificial intelligence create value and added value for society.

Keywords: non-invasive interventions, effective treatments, training of staff, investment.

1. Introduction
The implementation of digital technologies in health is widely recognized as an important condition for the effective functioning of health services as well as for ensuring citizen acceptance (C. Pisarenco, “PhD in law,” Constantin PISARENCO, Associate Professor).

Classical medicine, both as diagnosis and intervention for various treatments, has been and is being complemented by artificial intelligence technology, starting with the use of SMART phones, through which a patient can make instant contact with a medical

specialist, the use of Holters for measuring and recording heart rate, the use in angiography and scintigraphy as well as drones for transporting samples to be analyzed ordrugs to hard-to-reach areas.

In all cases of the use of artificial intelligence in medicine, as in other fields, thereis the unresolved issue of civil and criminal liability for malpractice cases, as there is no adequate legal regulation for the various situations.

Within the European Union, procedures are currently being debated to identify fraud created by the use of Artificial Intelligence when the faces and voices of scientifically recognized personalities are used to recommend the use of drugs and/or treatments that are not scientifically proven, at advantageous prices with disastrous consequences for the health of the population.

The newest development in the use of computers is Artificial Intelligence. It has found practical application in all fields of knowledge, implementable in social, civil, political and military life with, for the moment, immeasurable prospects.

Population health is an area where artificial intelligence is creating opportunities for ever-evolving involvement through intensive competitive, national and international research, for which major investments, including private ones, are being made.

Artificial intelligence in medicine also includes detailed research into the human genome, as DNA and chromosome structure, both as a prototype and customized for eachindividual, so that possible congenital, or evolving, diseases can be predicted based on environment, occupation, diet and habitat.

The applications of artificial intelligence in the medical field can be taken from imaging by various equipment that used radioactive or other less invasive or side-effect based technologies, then followed by analysis of blood and human tissues subject to interpretation by computer algorithms, then followed by robotic surgery equipment that can guide the placement of medical devices during procedures such as catheters and stents, reducing the risk of complications and improving patient outcomes and shortening hospital stays.

There are already plans to use artificial intelligence in neuropsychiatric conditions by implanting miniaturized chips into the central nervous system (CNS), classified as robotic-assisted surgical devices (RAS) by the FDA, which allow surgeons to perform operations using a console through surgical arms, cameras and other instruments.

In 2021, a draft law, the first of its kind, has been proposed in the EU Commission to regulate the risks associated with the use of artificial intelligence in order to harmonise AI regulation at national and EU state level in all areas except military technology.

It has been noted that artificial intelligence programs have been developed and implemented for diagnosing diseases, developing treatment protocols, monitoring patient condition, etc. The introduction of artificial intelligence may have mixed consequences in healthcare, especially in possible “medical errors”, e.g. IBM Watson Health AI [1].

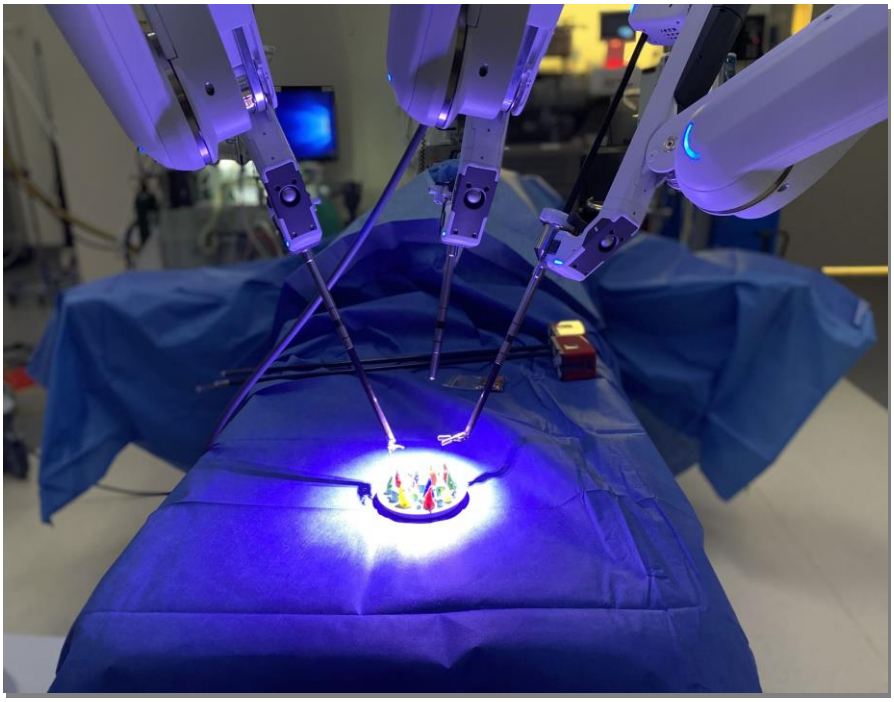

Fig.1. Minimally invasive surgery with the da Vinci Xi robot
Source:
https://www.anthc.org/news/anmc-purchases-da-vinci-xi-surgical-system-adding-critical-technology-to-the-or/

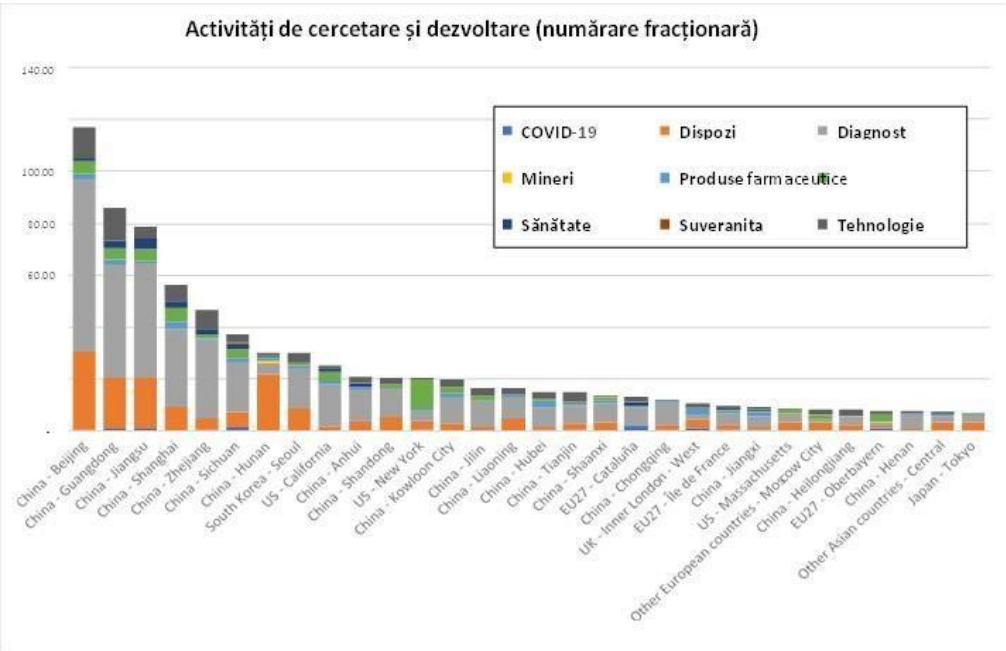

Fig.2. Research and development activities by region and by theme AI and health
Source: https://publications.jrc.ec.europa.eu/repository/ [2]

IBM has actively promoted Watson Health as a decision support tool for physicians, primarily to help the oncology branch determine the best treatment regimens. However, in 2018, it was reported that the Watson supercomputer was often making erroneous recommendations for cancer treatment, to the extent that medical professionals and the company's customers were identifying “referrals of dangerous and wrong treatment regimens/procedures” [3].

As a result, there are also opponents to some applications in the medical field, distrustful of the benefits of artificial intelligence, defenders of traditional medical treatments, interested either in keeping their jobs, or conservative towards modernity.

Artificial intelligence in the medical field requires collaborations with various specialties and specialists in the fields of biology, high technologies, microbiology, pharmacology, civil and military research institutions, etc., so that congresses in the field and communication sessions of common interest are organized periodically at national and international level.

According to expert estimates, the global healthcare artificial intelligence market was worth $8.2 billion in 2021, rising to $10.1 billion in 2022 at a compound annual growth rate (CAGR) of 23.5%, and is expected to grow to at least $49.1 billion by 2026 at a CAGR of 48.4%. [4].

The applications of artificial intelligence in the medical system also require specialization of staff at university level and regular training in line with new developments.

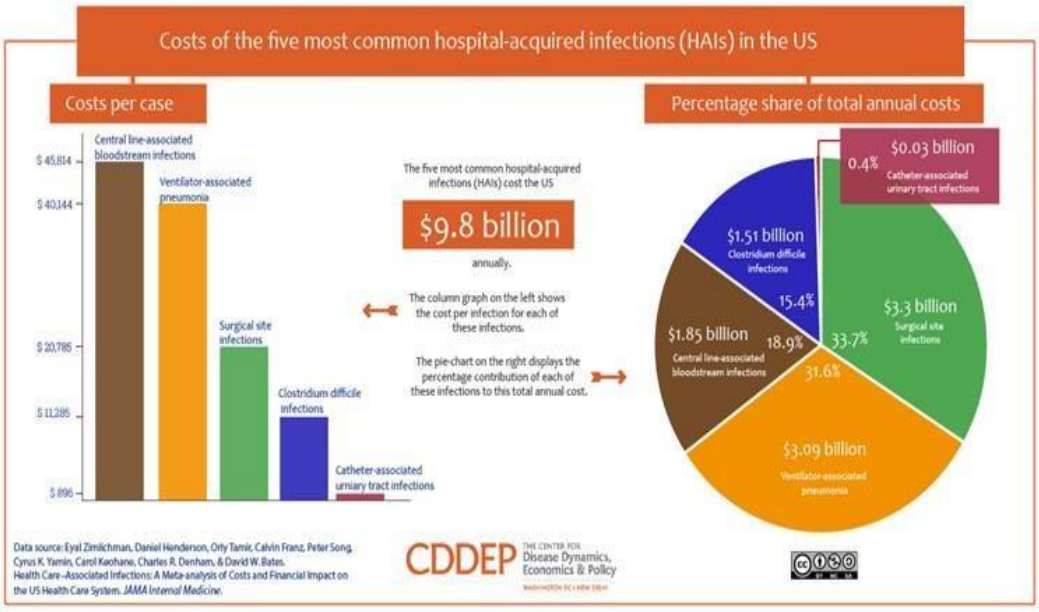

Fig. 3. Cost of the five most common hospitals using artificial intelligence [6]
Source: Centre for Disease Dynamics, Economics and Policy

Particular attention should be paid to controlling the instrumentation used by artificial intelligence to avoid malfunctions, errors as well as sterilization or reset operations, as sterilization is essential for hospitals. Hospital-acquired infections (HAIs) and surgical site infections (SSIs) in patients can increase length of hospital stay and create billions in additional costs each year, which is where robots providing cleaning services could help (according to CDDEP).

Purple Sun and Xenex are two companies offering cleaning robots, created throughartificial intelligence, that use UV light to reduce pathogens in some hospitals. A recent study found that UV light can eliminate nearly 98% of pathogens found in operating rooms. Xenex, which operates in more than 400 US hospitals, has developed a “germ zapping” robot that uses UV technology to clean hospitals and equipment, and New York-based PurpleSun recently partnered with Northwell Health to implement its UV sanitizing technology throughout Northwell's hospital system, but they will still have to consider factors such as regulations, pricing and the niche training of healthcare professionals – not to mention the emotional and ethical considerations in a field as sensitive as medicine.

Europe has lagged behind the US and China in terms of private investment in medicine-related AI. Without major efforts, the EU risks missing out on the opportunities offered by AI, facing a brain drain and being a consumer of solutions developed elsewhere. This is why the European strategy on AI in healthcare has set ambitious but realistic targets: more public and private investment in AI is needed in the EU to reach the target of €20 billion per year over the next decade. The EU strategy for AI in the healthcare sector corresponds to an annual investment of €7 billion achievable by the public sector (Member States and the Commission), on a relative par with investments made on other continents. For the next programming period 2021-2027, the Commission has proposed that the Union invest at least EUR 1 billion in AI for which the Horizon Europe and Digital Europe programme has been finalized [7].

Table 1. Romania's budget forecasts for research and application of artificial intelligence

No. Crt.	TOOLS FOR IMPLEMENTING SNCISI 2022-2027	ALLOCATED BUDGET
1.	National Recovery Plan and Resilience	approximately €259.43 million
2.	Operational Programme for Smart Growth, Digitalisation and Financial Instruments	approximately 1000 million euros
3.	Regional Operational Programme	approximately 2200 million euros
4.	National Research Development Innovation Plan IV	around €12000 million (*the estimated budget is based on a gradual annual increase in DC public expenditure of around 0.14% of GDP over the period 2022-2027 to reach the target of 1% in 2027)
5.	Romanian Academy Programs	approximately €400 million budgets (*cumulated during the implementation of the SNCISI)

6.	Operational Programme Transition Just	approximately 200 million euros
7.	Operational Programme Education and Employment	approximately 40 million euros
8.	Sectoral Plans of Ministries	approximately €120 million (*cumulative budget per the implementation period of the SNCISI)
9.	People's Academy Programmes of Science of Romania	approximately €12 million (*cumulative budget per the implementation period of the SNCISI)
10	Operational Programme Health	approximately 386 million euros

Source: https://s3platform.jrc.ec.europa.eu/map [5]

Romania's growing budget deficit has considerably reduced funding for research and applications of artificial intelligence in the medical field, so that many specialists have migrated to developed countries (USA, Canada) and the closure of research units in the field.

According to the figures published by the UN and WHO, the following tables show the ranking of the countries concerned, in terms of funds invested or attracted, in artificial intelligence in the medical field, influenced by the Russian-Ukrainian war and the war in the Middle East, as well as by the economic-financial crisis that has begun to manifest itself regionally and globally.

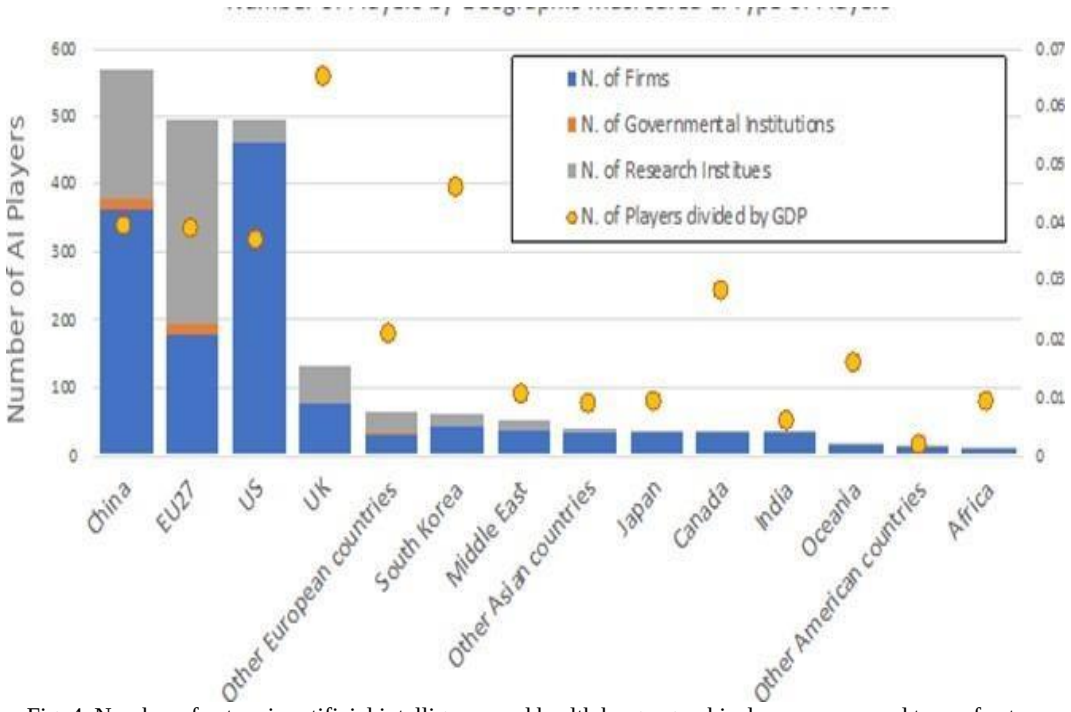

Fig. 4. Number of actors in artificial intelligence and health by geographical macro-area and type of actors
Source: https://publications.jrc.ec.europa.eu/repository/ [6]

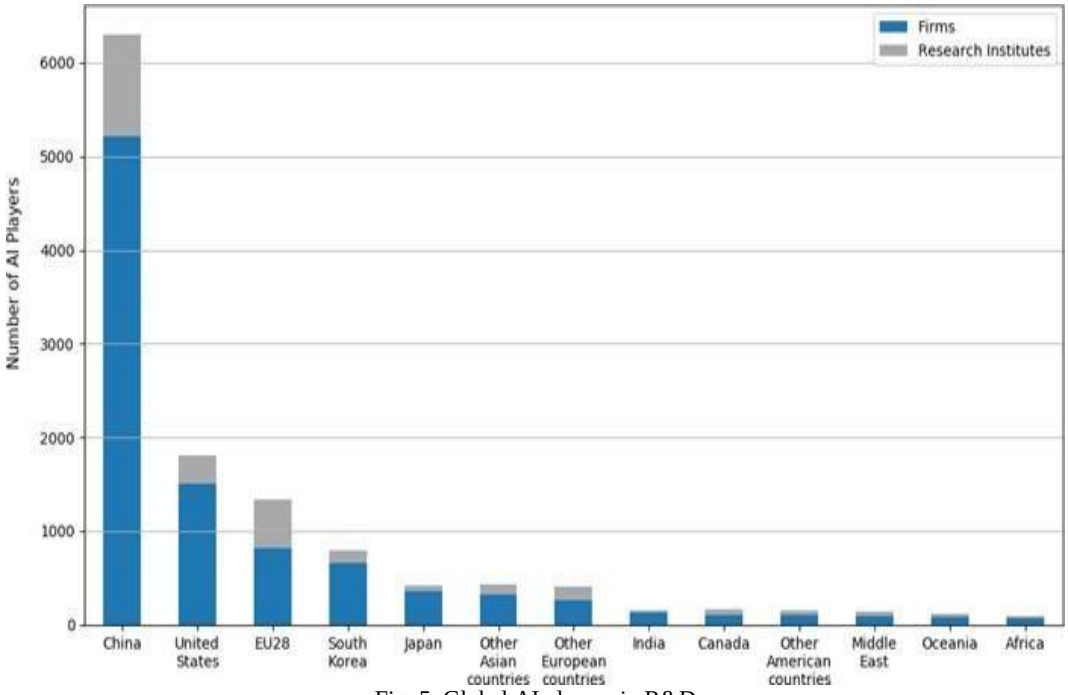

Fig. 5. Global AI players in R&D
Source: https://publications.jrc.ec.europa.eu/repository/

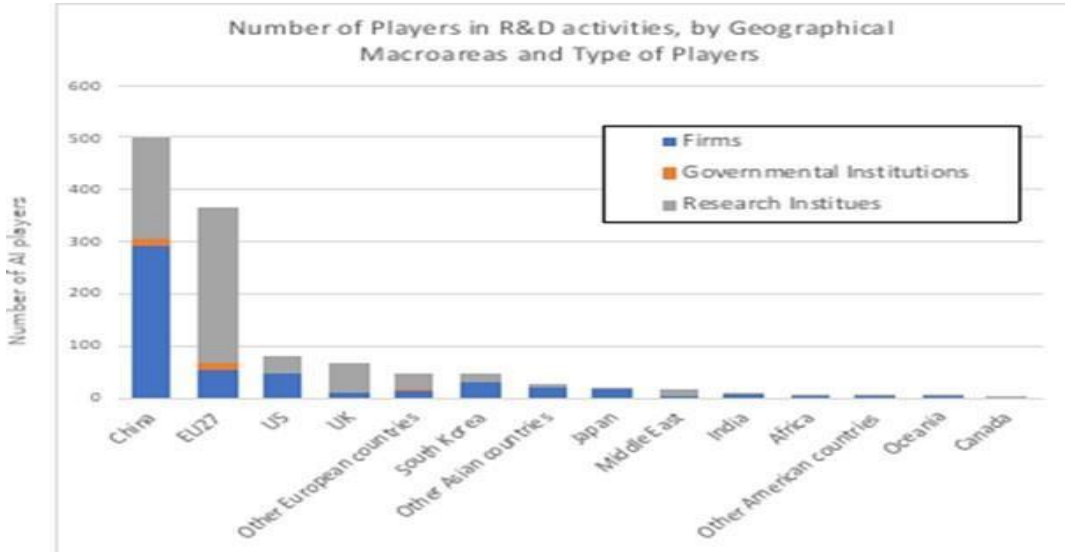

Fig. 6. AI and health players in research and development [7]
Source: https://publications.jrc.ec.europa.eu/repository/

In terms of the areas of involvement and activity of artificial intelligence in the field of medical diagnostics, the situation of countries that have developed application strategies is shown in the table below:

Table 2 Categories of applications in AI and health

Subject Health	Topics included (examples)
COVID-19	studies and activities related to pandemics and contact tracing applications
Sovereignty	cyber security, data governance, stakeholder engagement
HTA	health technology assessment
Prevention	wearable devices, hospital information systems, cardiac devices
Diagnostics	screening, diagnosis, image analysis, medical data analysis
Public health	big data analysis, social medicine
Devices	physical property modelling, device design and development
Pharmaceutical products	development of medicines and vaccines.

Figure 6 compares the profile of the three key macro domains based on the health sub-domains in Table 2, looking at the activities in which actors were involved.

An activity can be research and innovation processes, industrial production, trade and marketing, specific services related to artificial intelligence, business financing (venture capital funds or other types of investments). These activities may be explicitly stated, e.g. in the description of the company's activities in business registers, or they maybe derived from the analysis of the company's R&D activities, e.g. from texts of conference proceedings, research projects or patents. In addition, the number of activities includes:

- Industrial capacity: number of activities related to firms (production, trade, investment),
- Innovative potential (disaggregated): number of patents filed by individual applicants – which have a “potential” for development,
- Internal innovation network capacity: number of internal collaborations (in the same geographical area) for patent filing – shows the efficiency of the internal innovationnetwork,
- Research and development potential (disaggregated): number of single-author research publications at top AI conferences,
- R&D network capacity: number of internal collaborations (in the same geographical area) for publications in top conferences in the field of artificial intelligence efficiency of the internal research network,
- Global strategic network influence: number of external collaborations indifferent geographical areas measures the degree of centrality of individual macro-domains and their ability toinfluence the overall network of the AI and health ecosystem,
- Knowledge accumulation (with/without Horizon 2020 projects): access to information and knowledge for individual macro-areas through their own activities andthrough all types of collaborations [7].

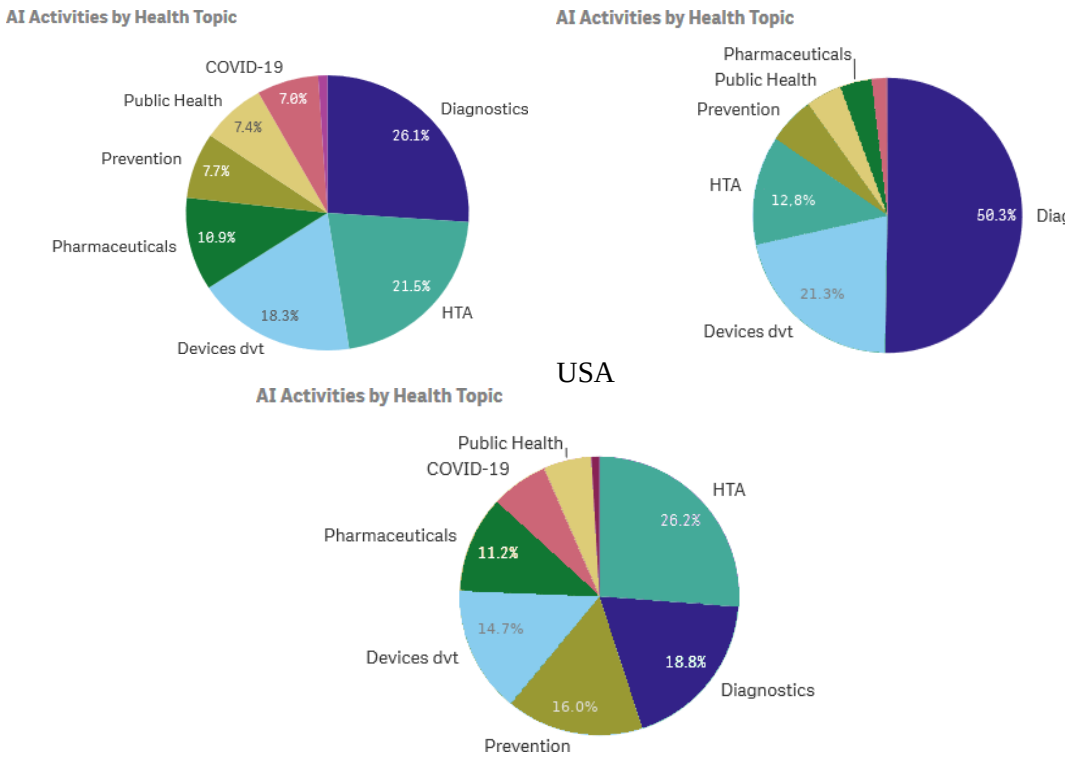

Figure 6: IA activity on health topics

Artificial intelligence is assimilated in the medical field with any device andequipment that replaces the hands of a specialist, so the use of lasers as scalpels in surgery, which also sutures instantly, is also an application of artificial intelligence. Romania has benefited from these practices with great delay and at great budgetary expense.

Digital solutions and artificial intelligence in healthcare are no longer ancillary IT systems; in terms of safety and efficiency, they are increasingly similar to drugs or medical devices. But while pharmaceutical corporations conduct and publish research, comply with standards and are subject to rigorous scrutiny, such practices are just beginning to emerge for artificial intelligence systems.

All developed countries have a strategy for implementing artificial intelligence in the medical field, which includes:

- Research centres
- Framework training
- Secrecy in military applications
- Collaboration with other institutions in different countries.
- Digitalization on health cards for each personIn current medicine, artificial intelligence has already proven its usefulness in the following conditions:
- Identifying and treating breast cancer
- Identifying and treating lymphatic cancer

- Identification and treatment of cholecystitis
- Identifying and treating osteoporosis
- Identifying and treating congenital diseases
- Identifying and treating pandemic diseases
- Identification and self-expanding aortic valve prosthesis, etc.

Each of these conditions listed above have a specific approach, analysis, diagnosis and intervention that are in the stage of experimentation, diagnosis, intervention and treatment, which have already proven to be much more effective and less costly compared to the practice of conventional medicine.

2. Conclusions

It follows from the above that the emergence and development of instrumentation and procedures from the evolution of artificial intelligence discoveries is and will be a breakthrough in the diagnosis and treatment of certain conditions, with particularly favourable consequences for the efficiency of medical care, with cost efficiencies and increased life expectancy.

In the field of population health, the practical applications of artificial intelligence represent a breakthrough incomparable to all previous discoveries and practices, starting with the discovery of virology and vaccines.

Each application of the progress of artificial intelligence, of interest to the medical field, is based on substantial investments from the state and private budget sector, the licensing of research results, the realization of profits on this basis, the horizontal and vertical development of interdisciplinary research relationships, all to the benefit of the welfare of society, all the more so as it can also be applied to agriculture and animal husbandry.

The emergence and development of artificial intelligence applications has required the emergence of new specializations in higher education, both in medical and technological fields. Thus most developed countries have had to develop strategies that take into account artificial intelligence and its applications in related fields. All the applications and effects of the emergence and evolution of research in the field ofartificial intelligence require significant financial efforts, even if the secrecy and competition of research institutes in developed countries reach the same breakthrough.

Communication sessions as well as congresses on the subject can help to eliminate identical research. However, it is not within the reach of all poor and developing countries to have access to the latest medical discoveries and applications of artificial intelligence, either due to lack of funds or lack of specialist staff.

Romania, either for lack of instruments or specialists, is forced to send patients to countries that have equipped applications and hospital units, with the related costs.

Proposals

Romania's governments over the last two decades have provided for a strategy of developing research institutes and training specialists sent to educational establishmentsin developed countries, but the growing budget deficit has blocked the projects of some research institutions in this field, so that many researchers have left Romania.

Government policy has come to be the determining factor in Romania in the case of the strategy of applying the use of artificial intelligence in the medical field in the medical system, by not making the necessary funds available, namely the establishment and proper equipping of regional hospitals, or of specialist departments in large existing hospitals through the lack of interest of specialists in foreign universities and hospitals, which is detrimental to the health of the population. Thus, Romania ranks 'top' in the European Union in terms of deaths due to various forms of cancer, children born with disabilities, the rural population without access to diagnostics, chronic lack of medicines, lack of modern regional medical units, lack of education and prevention methods, etc. As a result, for all these shortcomings, the political factor is responsible and must draw up appropriate legislation.

As a result, the Romanian population is still unable to benefit from the discoveries and latest applications of artificial intelligence in healthcare. Special attention should alsobe paid to the salaries of health professionals, so that the rural and small town populationshave access to specialist health professionals.

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Teoria grafurilor în optimizarea rețelelor de infrastructură urbană într-un oraș inteligent

Florentina PANĂ-MICU,
National University of Political Studies and Public Administration, Bucharest, Romania
florentina.micu@snspa.ro

Abstract
Crearea unor orașe inteligente reprezintă un deziderat din ce în ce mai larg dezbătut în societatea în care trăim, întrucât, beneficiind de tehnologii avansate, aceste orașe contribuie la creșterea calității vieții locuitorilor. În acest context, teoria grafurilor se dovedește a fi o unealtă deosebit de importantă în procesele de optimizare a rețelelor de infrastructură urbană. Obiectivul principal al cercetării este identificarea principalelor concepte din teoria grafurilor care pot fi aplicate în crearea de orașe inteligente cu scopul optimizării rețelelor de infrastructură urbană. Plecând de la acest obiectiv, cercetarea se va axa pe definirea principalelor concepte din teoria grafurilor precum: algoritmul lui Kruskal de determinare a unui arbore parțial de cost minim și algoritmul lui Dijkstra ce stabilește drumul de cost minim de la un nod de start la oricare altul dintr-un graf. Ulterior, articolul va cuprinde exemple prin care cu ajutorul teoriei grafurilor putem modela rețeaua de infrastructură urbană. Algoritmul lui Dijkstra are aplicabilitate în identificarea celor mai eficiente rute de transport și reducerea congestiei și a timpului de călătorie, precum și la optimizarea rețelei de conducte și a distribuției a apei. Pe de altă parte, algoritmul lui Kruskal vizează optimizarea unor arii ale orașului inteligent precum: gestionarea eficientă a resurselor, planificarea spațiilor verzi și conectivitatea durabilă. Așadar, în cadrul acestui articol vom explora potențialul pe care teoria grafurilor îl poate avea în optimizarea infrastructurii urbane a unui oraș inteligent și în creșterea eficienței și a sustenabilității acestui tip de oraș, întrucât alegerea optimă a conexiunilor și rețelelor poate contribui la crearea unui mediu urban care să răspundă nevoilor locuitorilor într-un mod durabil și eficent.

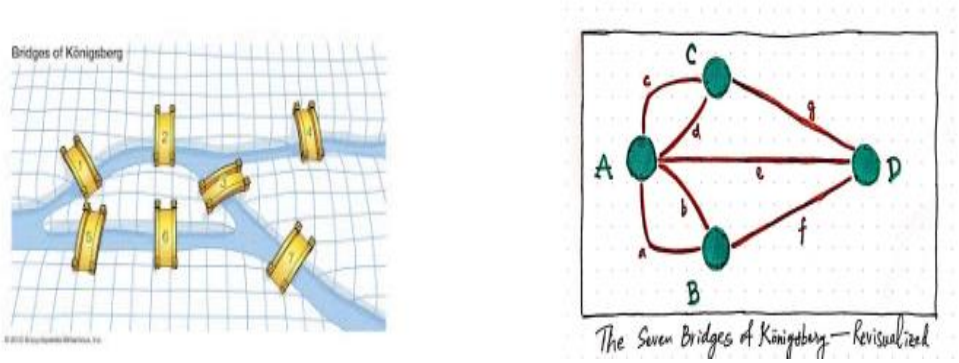
Cuvinte cheie: algoritmul lui Dijkstra, algoritmul lui Kruskal, arbore, graf, oraș inteligent.

1. Introducere
Aplicarea teoriei grafurilor în procesul de optimizare nu este una nouă, prima lucrare de teoria grafurilor fiind scrisă de Euler în anul 1736, cu scopul rezolvării "problemei celor 7 poduri" din Königsberg, prin identificarea unui traseu care să treacă o singură dată peste fiecare pod. [1]

Königsberg, oraş din Prusia Orientală (astăzi cunoscut sub numele de Kaliningrad în Rusia), este aşezat pe râul Pregel care înconjoară insula Kneiphof, după care se desparte în două braţe. Apa delimitează terenul în patru zone distincte. Malurile râului şi insula sunt legate prin şapte poduri, ca în fig.1. [2]

Problema pe care Leonard Euler încearcă să o rezolve constă în: "Este posibil să facem o plimbare prin oraş trecând pe fiecare din cele şapte poduri o singură dată şi să ne întoarcem de unde am plecat?".

Pentru a rezolva această problemă, Euler a dezvoltat concepte și notații care au stat la baza teoriei grafurilor. A introdus ideea de graf, reprezentând orașul și podurile sub formă de noduri și muchii, respectiv, și a demonstrat că soluția problemei depinde de conexiunile dintre aceste elemente marcând începutul teoriei grafurilor.



a) b)

Fig.1. Reprezentare grafică "problema celor șapte poduri din Königsberg"
Sursa: Alnassar, I. [3]

În prezent, teoria grafurilor are multiple aplicații practice în domenii precum: chimie, sociologie, tehnologia comunicațiilor, rețele de calculatoare, etc. De exemplu, un graf neorientat este compus din două mulțimi: o mulțime de vârfuri și o mulțime de muchii care pot reprezenta legăturile rutiere, legăturile dintre nodurile unei rețele de calculatoare sau ierarhiile dintr-o structură administrativă.

Plecând de la aceste considerente, cercetarea de față va pleca de la definirea conceptelor principale din teoria grafurilor cu rol în optimizarea infrastructurii urbane și va oferi un model de aplicare al algoritmului lui Kruskal si al algoritmului lui Dijkstra într-un oraș inteligent.

Importanța acestei cercetări derivă inclusiv de la definiția conceptului de "oraș inteligent" ca fiind acel tip de oraș care înglobează utilizarea infrastructurii tehnologice cu scopul îmbunătățirii eficienței serviciilor oferite și calității vieții locuitorilor. Un oraș inteligent înseamnă interconectivitate și acces facil la reurse, de aceea optimizarea joacă un rol foarte important în planificarea rețelelor de infrastructură urbană.

În acest context, optimizarea rețelelor de infrastructură urbană devine un element esențial în dezvoltarea unui oraș inteligent, iar teoria grafurilor o unealtă indispensabilă în proiectarea eficientă și durabilă a rețelelor de infrastructură urbană.

În acest articol, vom explora felul în care acești algoritmi matematici din teoria grafurilor (algoritmul lui Kruskal și algoritmul lui Dijkstra) pot fi integrați în procesul de planificare a rețelelor de infrastructură urbană.

Din punct de vedere metodologic, formulăm următoarea întrebare de cercetare: "Cum pot contribui algoritmii de optimizare din teoria grafurilor la o planificare și dezvoltare mai bună a infrastructurii urbane?".

Obiectivul general al cercetării este să identifice modalități în care algoritmii de optimizare din teoria grafurilor, cum ar fi algoritmul lui Kruskal și algoritmul lui Dijkstra, pot

îmbunătăți semnificativ dezvoltarea infrastructurii urbane și interconectivitatea într-un oraș inteligent.

2. Definirea conceptelor principale

Vom defini noțiunile elementare despre grafuri referindu-ne la grafurile neorientate pe care le vom numi pe scurt, grafuri.

Definiție: Un graf este o pereche (V(G), E(G)), unde V(G) este o mulțime finită și nevidă de elemente numite vârfuri**,** iar E(G) este o mulțime de perechi neordonate de elemente distincte din V(G), numite muchii. [1]

O muchie se notează {x, y} și vom spune că ea unește vârfurile x şi y.

Orice graf G poate fi desenat în plan reprezentând vârfurile sale prin puncte şi muchiile prin linii care unesc anumite perechi de vârfuri. Într-o astfel de reprezentare nu contează distanţele dintre vârfuri sau unghiurile dintre muchii.

Două vârfuri unite printr-o muchie se numesc adiacente.

De exemplu:

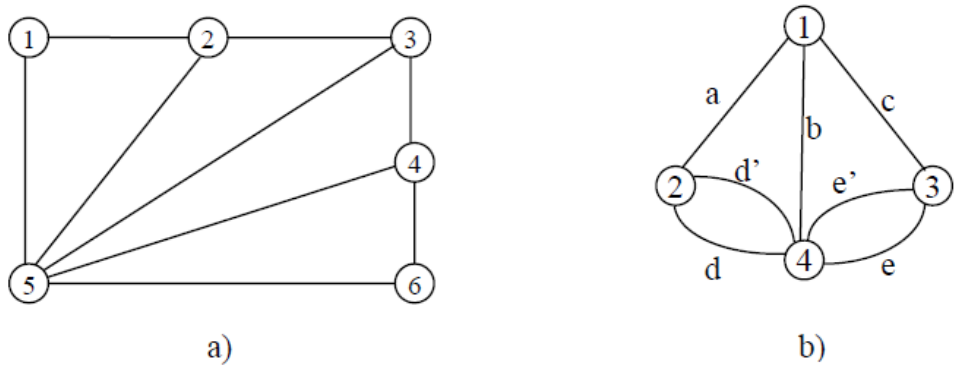


Fig. 2. Reprezentarea grafică a unui graf
Sursa: Nica, V.T. [4]

Cu alte cuvinte, punctele se numesc vârfuri (în imaginea a) vârfurile sunt reprezentate de numerele 1,2,3,3,5,6, iar în b) 1,2,3,4) , iar muchiile sunt liniile care unesc aceste vârfuri (în imaginea b) muchiile sunt reprezentate de a,b,c, d`, d, e, e`). Exprimare incoerentă!

Există situații cand nu este suficientă definirea sau reprezentarea printr-un graf neorientat, fiind necesar să fie dată o direcție muchiilor.

Un graf orientat G este o pereche (V, E) unde V este o mulţime finită şi nevidă de elemente numite vârfuri şi E este o mulţime de perechi ordonate de elemente distincte din V, numite arce.

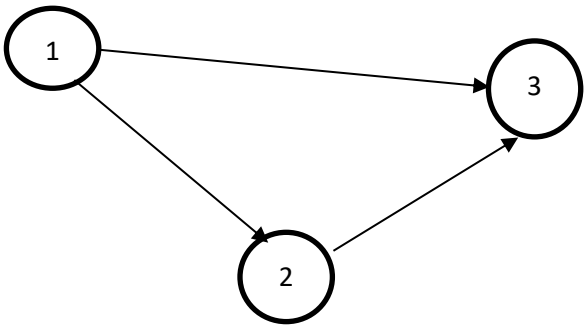


Fig.3. Reprezentarea grafică a unui graf orientat
Sursa: autorul

Graful pune în evidență conexiunile care există între anumite entități precum:

- Reţele de transport în care entităţile sunt localităţi, fabrici, depozite, iar legăturile sunt drumuri auto, feroviare, aeriene, navale;
- Reţele de comunicaţie audio, video, calculator prin care se conectează localităţi, locuinţe, instituţii, birouri;
- Reţele electrice;
- Reţele genealogice etc.

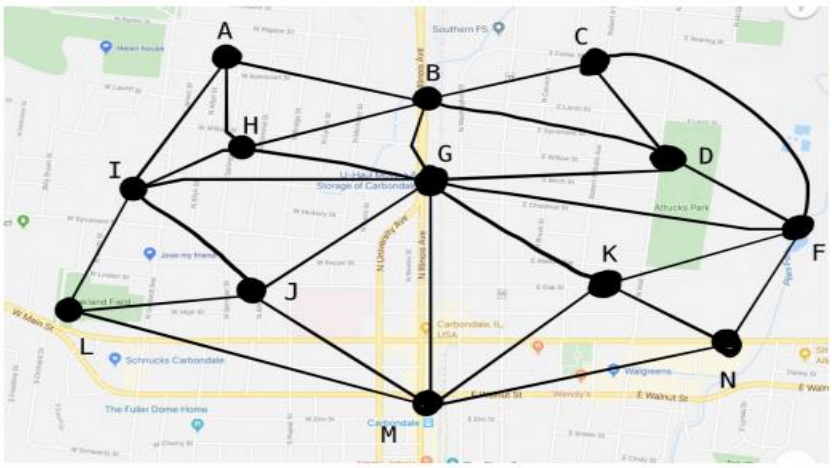


Fig. 4. Reprezentarea grafică a unui graf al stațiilor de transport public
Sursa: Alnassar, I. [3]

Definiții:

1. Un lanț într-un graf G este o succesiune finită de vârfuri ale lui G care se notează $\left[x_0, x_1, ..., x_r\right]$, cu proprietatea că oricare două vârfuri vecine sunt adiacente, adică $x_i x_{i+1} \in E(G)$, pentru orice $0 \le i \le r-1$.
2. Vârfurile x_0, x_r se numesc extremități, iar r reprezintă numărul de muchii al lanțului sau lungimea sa.

3. Graful G'=(V',E') se va numi subgraf al grafului G=(V,E) dacă V' ⊆ V , E' ⊆ E şi orice muchie din E'are aceleaşi extremităţi în G şi G'. [5]
4. Un ciclu într-un graf G este o succesiune finită de vârfuri ale lui G, notată $\left[x_0, x_1, \ldots\ldots, x_r\right]$, cu următoarele proprietăţi:

a) $x_i x_{i+1} \in E(G)$ pentru orice $0 \le i \le r-1$;

b) $x_0 = x_r$;

c) Toate muchiile $x_0 x_1, \ldots, x_{r-1} x_r$ sunt distincte.

5. Un graf G se numeşte conex dacă pentru orice pereche de vârfuri distincte x, y ale lui G, există un lanţ de extremităţi x şi y în G.
6. Un graf conex şi fără cicluri se numeşte arbore.

2.1. Problema arborelui parţial minim (algoritmul lui Kruskal)

Fie G un graf conex şi c o funcţie $c: E(G) \to (0, \infty)$ care asociază fiecărei muchii a grafului G un număr real pozitiv numit costul acelei muchii.

Costul unui graf parţial al lui G este egal prin definiţie cu suma costurilor asociate muchiilor lui H, ceea ce vom scrie: $c(H) = \sum_{u \in E(H)} c(u)$.

Un graf G pentru care a fost definită o funcție de cost se numește graf ponderat.
În aplicații, costul unei muchii poate fi:

- lungimea drumului dintre două localităţi;
- costul parcurgerii rutei reprezentate prin arcul corespunzător;
- durata parcurgerii rutei respective;
- cantitatea transportată pe ruta respectivă;
- capacitatea maximă a rutei respective.

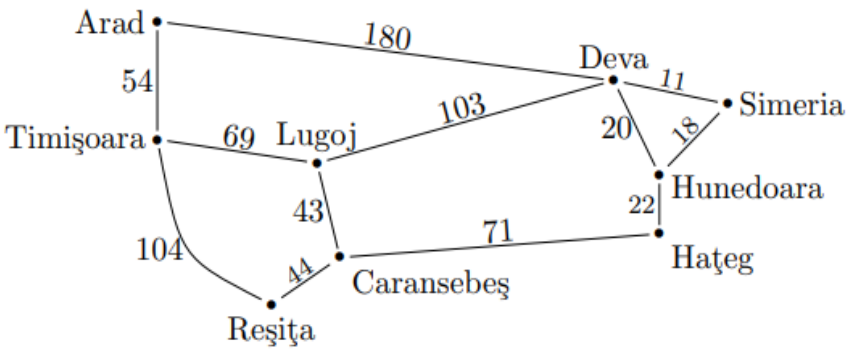


Fig. 5. Graful ponderat cu distanțele drumurilor dintre unele localități din România
Sursa: Marin, M. [6]

Algoritmul lui Joseph Kruskal, elaborat în 1956, permite determinarea unui arbore parțial de cost minim (APM) într-un graf ponderat.

Fie G un graf conex cu n≥2 vârfuri şi o funcţie de cost $c: E(G) \to (0, \infty)$.
Muchiile unui arbore parţial de cost minim sunt selectate una câte una, după cum urmează:

Pasul 1: Dintre muchiile nealese ale lui E(G) se selectează o muchie de cost minim cu condiţia să nu formeze cicluri cu muchiile deja alese.

Pasul 2: Au fost selectate n-1 muchii? Dacă da, ne oprim. Muchiile selectate sunt muchiile unui arbore parţial minim al lui G. Dacă nu, se repetă pasul 1.

2.2. Drumul de cost minim (algoritmul lui Dijkstra)

Algoritmul lui Edsger Dijkstra a fost inventat în anul 1959 pentru a determina drumul de cost minim de la un nod de start al unui graf la oricare altul.

Fie G un graf orientat cu n vârfuri 1, …, n, pentru care lungimea fiecărui arc (i,j) se notează cu $d_{ij} > 0$. Inițial, se fixează un vârf $t \in G$.

La sfârșitul algoritmului, l(i) va reprezenta distanța minima de la vârful t la vârful i, pentru orice $1 \le i \le n$.

Prin definiție, l(t)=0.

Dacă după aplicarea algoritmului pentru un vârf k se obține l(k)= ∞, înseamnă că nu există drumul de la vârful t la vârful k în graf.

Pașii algoritmului Dijkstra:

1. $T \leftarrow \varnothing$, $\overline{T} \leftarrow V(G)$,
2. $l(t) \leftarrow 0$ și $l(i) \leftarrow \infty,\ i \ne t$
3. Cât timp $|T| < n$ se execută:

a) Se selectează un vârf $i \in \overline{T}$ pentru care $l(i) = \min\{l(j) / j \in \overline{T}\}$

b) $T \leftarrow T \cup \{i\}$, $\overline{T} \leftarrow \overline{T} \setminus \{j\}$

c) Pentru fiecare arc (i,j) care are extremitatea inițială în i și extremitatea finală în $j \in \overline{T}$, $l(j) > l(i) + d_{ij}$, atunci $l(j) \leftarrow l(i) + d_{ij}$ și $pred(j) \leftarrow i$.

Unde:

- d este funcția distanță $d: E(G) \to (0, \infty)$ care asociază fiecărui arc din G lungimea sa $d(i, j) > 0$, notată cu d_{ij};
- pred reprezintă funcția predecesor, care pentru $(i, j) \in E, pred(j) = i$.

Algoritmul etichetează fiecare vârf i al grafului cu o etichetă notată l(i) care este un majorant al distanţei minime de la vârful t la vârful i , iar în final va fi egală chiar cu distanţa minimă de la t la i .

La fiecare pas intermediar algoritmul partiţionează vârfurile în două mulţimi: mulţimea T a vârfurilor cu etichete permanente şi complementara sa $\overline{T}$, a vârfurilor cu etichete temporare. Etichetele permanente ale vârfurilor din T reprezintă distanţele minime de la t la vârfurile respective, în timp ce etichetele etichetele temporare ale vârfurilor din T reprezintă nişte majorări ale distanţelor minime.

Algoritmul poate fi definit și pentru grafuri neorientate înlocuind arcul (i,j) cu muchia ij, cu o extremitate în vârful i selectat la acel pas și cealaltă extremitatea într-un vârf $j \in \overline{T}$.

Se specifică în text semnificația parametrilor și a variabilelor, însă nu este furnizată o legendă în format text 9 pct separată pentru fiecare dintre acestea (se regăsește într-un singur loc).

De asemenea, în cazul ecuațiilor, nu s-a numerotat consecutiv cu cifre arabe între paranteze, în partea dreaptă a paginii.

3. Aplicații ale teoriei grafurilor în optimizarea și planificarea infrastructurii urbane
Teoria grafurilor oferă un cadru matematic puternic pentru analiza și proiectarea infrastructurii urbane. Aplicațiile sale în planificarea infrastructurii urbane sunt diverse și acoperă o gamă largă de domenii, contribuind la eficiența, sustenabilitatea și funcționarea optimă a orașelor inteligente.

Așa cum am putut vedea în capitolul anterior, algoritmul lui Kruskal este un algoritm utilizat pentru a găsi arborele parțial de cost minim pentru un graf dat. Algoritmul funcționează începând cu toate vârfurile din graf și le conectează pentru a forma un arbore. Arborele este apoi redus prin eliminarea muchiilor care nu fac parte din arborele de cost minim.

Dintre aplicațiile practice ale algoritmului lui Kruskal enumerăm [5]:

- proiectarea rețelelor feroviare și rutiere (algoritmul lui Kruskal este folosit în proiectarea rețelelor feroviare și rutiere pentru a conecta mai multe orașe. Scopul este să se stabilească rutele de transport cele mai eficiente și economice între orașe, iar algoritmul lui Kruskal ajută la identificarea arborelui partial de cost minim, asigurând o conectivitate optimă și minimizând costul total);
- proiectarea canalelor de irigații în agricultură (în ingineria agricolă, algoritmul lui Kruskal poate fi folosit pentru proiectarea canalelor de irigații. Algoritmul ajută la identificarea rețelei de canale care acoperă eficient zona agricolă, asigurând o distribuție optimă a apei pentru irigarea culturilor. Această aplicație contribuie la optimizarea resurselor și la eficiența costurilor);
- proiectarea rețelelor de fibră optică (ajută la stabilirea conexiunilor cele mai eficiente între diferite puncte din rețea, asigurând că datele pot fi transmise eficient

prin rețeaua de fibră optică. Acest aspect este crucial pentru optimizarea performanței sistemelor de comunicații);
- optimizarea rețelelor de distribuție a apei.

În lucrarea "Applied Graph Theory to Real Smart City Logistic Problems", Gutierrez et al ne relevă faptul că „ una dintre cele mai convenabile modalități de lucru cu trasee rutiere și rutare este tratarea rețelei de drumuri ca pe un graf" și de asemenea că „ teoria grafurilor este unul dintre pilonii pentru soluții inovatoare în Logistica Inteligentă…". [7]

Autorii aplică algoritmul lui Kruskal în calcularea rutelor de conducere în regiunea de Nord Jutland, Danemarca, acoperind 100% din drumurile din zonă.

Algoritmul descris de autori în lucrarea menționată cuprinde următorii pași:
1. Calculul arborelui de parțial de cost minim tradițional, având ca rădăcină cel mai apropiat vârf față de un garaj unde sunt parcate mașinile
2. Modificarea arborelui de parțial de cost minim pentru a include și muchiile care nu aparțin arborelui de parțial de cost minim inițial, numite muchii fantomă și vârfuri
3. Aplicarea algoritmului de navigare în graf peste arborele de parțial de cost minim modificat pentru a sorta vârfurile în ordinea vizitării și a crea astfel ruta (ca o secvență de puncte de interes).

Pe de altă parte, algoritmul lui Dijkstra de determinare a drumului de cost minim într-un graf are mai multe aplicații practice, dintre care [8]:
- Google Maps: găsirea distanței în Google Maps de la un oraș la altul sau de la locația curentă la cea mai apropiată locație dorită. Algoritmul lui Dijkstra este folosit pentru a găsi distanța minimă între două locații de-a lungul traseului.
- Aplicații în rețele de socializare: în mai multe rețele de socializare, aplicația sugerează lista de prieteni pe care un anumit utilizator i-ar putea cunoaște. Algoritmul standard Dijkstra poate fi aplicat folosind calea cea mai scurtă între utilizatori măsurată prin conexiunile între ei.
- Open Shortest Path First (OSPF): Open Shortest Path First (OSPF) este un protocol de rutare bazat pe stare de legătură folosit pentru a găsi cea mai bună cale între routerul sursă și destinație. Algoritmul oferă calea cu cel mai mic cost de la routerul sursă la alte routere din rețea.

În contextul optimizării planificării rețelelor de infrastructură urbană într-un oraș inteligent, algoritmul lui Dijkstra poate fi utilizat pentru a rezolva probleme precum:
- Gestionarea traficului prin optimizarea semafoarelor și a rutelor pentru a minimiza congestia și a îmbunătăți fluxul de trafic în timp real;
- Planificarea transportului public prin identificarea traseelor optime pentru autobuze, tramvaie sau metrouri pentru a asigura acoperirea eficientă a orașului și pentru a reduce timpii de așteptare pentru călători;
- Optimizarea rețelelor de apă și canalizare prin identificarea căilor optime pentru conductele de apă și canalizare pentru a asigura distribuția eficientă a resurselor de apă;

- Rutarea inteligentă a vehiculelor electrice prin identificarea optimă a locurilor de încărcare pentru a contribui astfel la încurajarea utilizării transportului electric.

Algoritmul lui Dijkstra este folosit de mai mulți autori în identificarea în găsirea rutei optime în traficul urban.

În lucrarea, "Pathfinding through urban traffic using Dijkstra's Algorithm", autoarea Tubagus Andhika Nugraha descoperă rezultate plauzibile în identificarea unei rute optime de transport pentru locuitorii din Jakarta folosind algoritmul lui Dijkstra. [9]

Autoarea pleacă în cercetarea sa de la harta orașului și transformă elementele hărții în obiecte discrete astfel încât harta să poată fi reprezentată sub forma unui graf. Ulterior adaugă ponderi grafului reprezentat de harta orașului, prin colectarea de date cu privire la distanța drumurilor, precum și datele despre trafic, măsurate prin viteza medie a mașinilor. Concluzia la care ajunge autoarea la finalul cercetării este că Dijkstra este cel mai eficient algoritm pentru găsirea celor mai scurte drumuri în grafuri cu ponderi non-negative.

O altă lucrare, "Implementation and Analysis of Dijkstra's Shortest Path Algorithm in the Context of Romanian Cities", ne prezintă o problemă de identificare a celui mai scurt si eficient drum dintre Arad și București. Algoritmul examinează orașele și căile lor de conectare, actualizând distanțele cele mai scurte către orașele învecinate pe măsură ce avansează.

Astfel, de la început, "Arad" are o distanță de 0, iar toate celelalte orașe au o distanță setată la infinit (inf), simbolizând că încă nu știm distanța cea mai scurtă pentru a ajunge la ele.

Algoritmul lui Dijkstra acționează sistematic astfel:

1. Alege un oraș.
2. Verifică orașele învecinate.
3. Actualizează distanțele lor dacă găsește o cale mai scurtă.
4. Se mută la următorul oraș și repetă procesul. [10]

Algoritmul lui Kruskal și algoritmul lui Dijkstra sunt complementare, în timp ce algoritmul lui Kruskal se concentrează pe găsirea unui arbore de parțial de cost minim într-un graf neorientat ponderat, algoritmul lui Dijkstra se concentrează pe găsirea celei mai scurte căi între un nod de start și toate celelalte noduri într-un graf orientat ponderat.

Integrarea ambilor algoritmi în optimizarea rețelelor de infrastructură urbană poate aduce contribuții semnificative în ceea ce privește gestionarea resurselor și îmbunătățirea conectivității într-un oraș inteligent.

De asemenea, în contextul Internet of Things (IoT), algoritmii precum Kruskal și Dijkstra pot avea diverse aplicații în optimizare, precum:

- rutare eficientă a datelor în rețele IoT: algoritmul lui Dijkstra poate fi utilizat pentru a găsi cea mai scurtă cale între dispozitivele IoT, facilitând transmiterea eficientă a datelor între acestea;

- ghidarea dispozitivelor mobile: algoritmul lui Dijkstra poate ghida aceste dispozitive pe rutele optime pentru a îndeplini sarcinile sau pentru a evita obstacole;
- gestionarea consumului de energie: algoritmul Dijkstra poate fi utilizat pentru a găsi rute care să minimizeze consumul de energie, prelungind durata de viață a dispozitivelor;
- conectivitatea senzorilor în rețele IoT: algoritmul lui Kruskal poate fi aplicat pentru a conecta senzorii sau dispozitivele IoT într-o rețea eficientă, asigurându-se că acestea sunt conectate într-un mod care optimizează comunicarea și acoperirea zonelor;
- optimizarea structurii rețelei: algoritmul Kruskal poate contribui la optimizarea fizică a rețelelor IoT, conectând dispozitivele într-un mod care minimizează costurile de instalare și întreținere;

4. Concluzii

Așa cum am putut vedea, teoria grafurilor a evoluat de-a lungul timpului de la încercarea de a soluționa probleme precum "problema podurilor din Königsberg" către oferirea de soluții de optimizare pentru diferite probleme de infrastructură urbană în proiectarea arhitecturii unui oraș inteligent.

Un oraș inteligent nu este doar un oraș în care tehnologia este încorporată și folosită la cel mai înalt nivel ci și un oraș în care interoconectivitatea contează în gestionarea resurselor și accesul facil la toate serviciiile oferite.

Pentru a transforma o rețea urbană într-o rețea "inteligentă" înseamnă gestionarea unei sinergii complexe a mai multor rețele, dispozitive, semafoare și contoare inteligente de apă și energie, împreună cu oameni.

Utilizarea algoritmilor de optimizare din teoria grafurilor poate aduce contribuții semnificative în ceea ce privește gestionarea resurselor și îmbunătățirea conectivității într-un oraș inteligent.

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The role of digitization in the architecture of the judicial system in Romania, between sustainability and innovation

Valentin – Stelian BĂDESCU,
Lawyer in the Bucharest Bar and an associate scientific researcher of the Institute of Legal Research of the Romanian Academy.
valentinbadescu@yahoo.com

Ruxandra Ioana BĂDESCU,
Economist, doctoral student of the Doctoral School of Business Administration within the Academy of Economic Studies in Bucharest.
ruxbadescu@gmail.com

Abstract
Since we are at a turning point, i.e. the moment when traditional justice is being replaced easily, easily by digital justice, we considered it opportune to analyze the way in which the judicial system is being reformed, the implications that new technologies have on law, as well as the need adapting it to all the changes imposed by the evolution of society. This article does not aim to present a generalized and rigid picture, but represents our vision of how digitization is reflected in everyday life, as well as the challenges we have to face in this context. We are not too optimistic to say that we are lucky to live in an age of technology, where artificial intelligence intertwines with human reason, forming a duo destined to make our lives easier. Today, people are surrounded by technology, giving rise to a synergy that was hard to imagine at the beginning of this millennium. Technology, which a few decades ago was only present in science fiction films, has today reached everyone's reach, becoming an integral part of the everyday life of most people.

Keywords: digitization, judicial system, innovation, sustainability, advantages, risks.

1. Argument – warning: legal perspectives on technology are worrying, law at the confluence of two worlds: where to?

I woke up as I do every morning, a little after six o'clock. I was determined to write my article for the 11th Smart Cities International Conference (SCIC), December 7-8, 2023, organized by the Faculty of Public Administration, Smart-EDU Hub of the National University of Political Studies and Public Administration, but I didn't know which topic to choose since the distinguished organizers offered us almost ten panels. I start to get out of bed and my eyes fall on the bedside table where the pile of books to read has risen slightly. I don't like it when this happens because it means I'm going through a hectic period where I don't have much time left for reading. That is, exactly the madness that I have been experiencing lately. And just like that, I started browsing through a recent and substantial volume. This is a shocking book: “The Real Anthony Fauci, Bill Gates, Big Pharma and the Global War on Democracy” written by Robert F. Kennedy Jr., a book designed to show you the world for what it is: vile to the core. You just read and you can't believe what you read. You pinch yourself to make sure you're not dreaming. You even end up wanting to find proof that the author is fabulating. It just turns your whole worldview on its head. You can't believe there are such vile people. And what you find is not only that they exist, but that they are only the tip of a terrible evil system. And furthermore, why are absolutely all his actions blindly copied all over the world? [1]

For most of us, Fauci – this sinister figure – seems out of the picture now. This is because we were not connected to the realities there. It is to Robert Kennedy's credit that he has a

terrible memory and terrifying information. Every word in his book is effectively overwhelmed by evidence. What Fauci is doing now is nothing but the same criminal line he has been practicing since his youth. And his association with dubious characters, such as Bill Gates, is nothing more than a demonstration that the “law of attraction” between like-minded people works flawlessly. Did you know, for example, that Fauci has financial interests in Moderna? No, no one else knew that. Did you know that the CDC spent $79 million in public money to develop Redemsivir? Gilead is the company that holds the patent for Remdesivir, and coincidentally, the Bill & Melinda Gates Foundation (BMGF) purchased over $65 million worth of stock in this company before the company's stock market explosion. Can you imagine, however, the level of perplexity of these scoundrels when serious doctors and scientists came up with generic treatments for the so-called killer virus? They, the conspirators, had been planning the coup since 2009 to earn money ruthlessly. How do you feel when some idealists threaten to screw up your plan? What does it mean to treat with hydroxychloroquine when they had prepared for the “miracle treatment” a price more than 1000 times higher than the generics? Thus, a whole well-financed machine goes into action. Kennedy explains the nefarious way Fauci's criminal network was able to eliminate cheap treatments by falsifying scientific reports. For example, in the medical world it is already an axiom that hydroxychloroquine is toxic. Why? Simple: medical tests regarding its effectiveness have been criminally falsified. The patients on whom the “studies” were done were administered lethal doses of hydroxychloroquine. While the standard treatment prescribed doses of a maximum of 400 mg/day, Fauci's gang used in the so-called scientific studies doses of 1200 mg/day on day 1 and doses of 800 mg/day on the following days. No wonder patients died. In fact, they were deliberately killed to remove a cheap treatment. And this is murder!

As for deaths from the vaccine, to minimize the number, the CDC changed the methodology for counting deaths. Thus, death caused by the vaccine is considered to be only the death that occurred a maximum of two weeks after the administration of the second dose! To top it off, many of those who died from the vaccine swelled the ranks of the... COVID deaths from a “deficiency in reporting”. A few years ago, Bill Gates was explaining how he made more money from vaccines than from IT. That statement has disappeared from everywhere. It was simply deleted. Before I end, I recommend all those who love the truth to skim through Robert Kennedy Jr.'s book. Despite the fact that it is a tough book, it is a wealth of information that reveals the world in which we live. Good to know so we can see what's next. The Fauci case has a correspondent, of course, also in Romania, where the totally independent media or the opposing voices of the lying and criminal official narrative, have been placed on true blacklists by the local faucs and scumbags, with the aim of being eliminated from the public space. Government or other bribed media trusts para-governmental propaganda means, such as the Ro Vaccinare propaganda page, a so-called NGO Eurocommunication or even a “laboratory” that operates by infiltrating under the roof of the Romanian Academy, were part of the huge manipulation and disinformation machine and could now have of paying huge compensations for the public damages caused to those who revealed the truth about the Covid Affair. In this regard, we remind you of the Eurocomunicare scam, the NGO led by former “Era Socialista” employee Paul Dobrescu and some big mouth Alina Bârgăoanu, who obtained two million euros from the General Secretariat of the Government by direct entrustment for the “strategy of communication” of the Government regarding the failed

Covid vaccination campaign. Millions used to organize online conference calls, bribe propagandists and pandemic actors, commission fake polls and draw up fake blacklists of independent publications and personalities accused of “fake news”. Lawyers must do their job against mercenaries of the allogenous occult, traitors to nation and country. As for the author of these lines, I have no intention of stopping. The problem is that, if in a first phase I will most likely be able to bypass the censorship, in a later phase I probably won't be able to do it anymore. We will see then what can be done. Remember, however, that the worst stage of history begins in which, as a result of current technologies, absolutely all the sick ideals of the tyrants of the past can be implemented without the risk of failure. Any abuse, any injustice, any madness can now become a reality, and people will have only one option: to obey. Unfortunately for us, we are once again in the unfortunate boat of history, once again being denied the possibility of at least delaying the madness of the psychopaths who rule the world. How natural, how natural! I actually trembled because I understood the madness we are doing to ourselves. Everything is so simple, and we complicate it out of the desire to “clarify the simplicity”, ending up in a labyrinth from which we no longer understand anything. Without a doubt, “The Real Anthony Fauci, Bill Gates, Big Pharma and the Global War on Democracy” has the merit of making our escape from the labyrinth we are wandering through easier, connecting us to a spirituality forgotten today. I simply felt deeply struck by the truths I have read so far, and this makes the discovery of some stories even more surprising, like some unexpected illuminations in the fog we are wandering through. I end here the introduction of the study, encouraging you to discover the right path! Not before arguing why I chose this title and why exactly Antonio Fauci. Simply because technology and the legal system have entered a dangerous zone, and the legal outlook on technology is worrisome. Law is at the confluence of two worlds: sustainability and innovation where?

2. Accelerating innovation and its impact on the sustainability of the judicial system

The insiders know that law represents a set of rules of conduct, which, in a society, regulate relationships between people (objective law). The term equally designates the prerogative, power or faculty recognized by civil law (subjective law). Thus, the present study is not only a set of reflections, some containing criticism, but also personal contributions of the authors produced by the transition – perhaps quite sudden – brought by digitization to traditional principles and practice, trying to make a contribution both in the theoretical sphere, but also in the practice of the subject addressed. A unitary approach leading to the guarantee of good justice and good governance, these being state obligations that must be received in a democratic society because justice and governance represent the most important public services under the spectrum of the dematerialization of traditional activities, through the effect of digitalization which can affect their sustainability. According to Wikipedia, sustainability is the ability to constantly exist. In the 21st century it generally refers to the ability of the biosphere and human civilization to coexist. It is also defined as the process of maintaining change in a balanced environment of homeostasis, where the exploitation of resources, the direction of investment, the direction of technological development and institutional change are all in harmony and enhance both current and future potential meet the needs and human aspirations [2], and Dex on line, states that it is a characteristic of an activity to be able to be carried out over a long period of time [3]. Since we are at a turning point, i.e. the moment when traditional justice is being replaced easily, easily by digital justice, we considered it opportune to analyze the way in which the judicial system is being

reformed, the implications that new technologies have on law, as well as the need adapting it to all the changes imposed by the evolution/involution of society. This article does not aim to present a generalized and rigid picture, but represents our vision of how digitization is reflected in everyday life, as well as the challenges we have to face in this context. I am not too optimistic that we can say that we are lucky to live in an age of technology, where artificial intelligence intertwines with human reason, forming a duo destined to make our lives easier. Today, people are surrounded by technology, giving rise to a synergy that was hard to imagine at the beginning of this millennium. Technology, which a few decades ago was only present in science fiction films, has today reached everyone's reach, becoming an integral part of the everyday life of most people.

Its emergence and rapid development led to the progress of society on multiple levels, but it also came with challenges and anxieties that began to sprout in our souls. As the process of technologization has expanded in countless directions, capturing every bit of our lives, people have had to adapt to new trends and evolve with new technologies. We have reached the point where the Internet and smart devices have taken on the role of being our best friends and helping us to solve the problems we face in our daily life more easily. We find digitization in everything that surrounds us, in all the fields and activities in which we take part. Thus, it was inevitable that the impact of new technologies would not spill over into the judicial system, bringing with it a series of benefits and challenges that all participants in the act of justice must face, including us, the lawyers. In what follows, I have proposed to initiate a journey in which the stations will be represented by the most important changes that reflect the impact of new technologies on the Romanian judicial system, analyzing at the same time how the legal system must keep up with them. [4]

To fully understand the implications of innovation, i.e. new technologies and the transformations they produce for the entire society, we must first understand what artificial intelligence means. “Artificial intelligence is one of the most profound concepts we work on as humanity, it's deeper than fire or electricity,” said Sundar Pichai – CEO of Alphabet at the 2020 annual meeting of the World Economic Forum in Davos, Switzerland . “I believe we are working on one of the most world-changing technologies our industry has ever seen. Our biggest investment is in the development of artificial intelligence and its integration into each of our products”, said Mark Zuckerberg – CEO of Meta, on the company blog (2023). As everyone already knows, Silicon Valley is considered the center of the world when it comes to developing the technologies of the future. Artificial intelligence has occupied a particularly important place in the research and development strategies of the most influential companies out there, and obviously not only. Top executives like the ones quoted, and many others, as we'll see throughout the article, have said that artificial intelligence forms the core of the operations of the companies they lead—it's the driving force behind their research and development strategies. As early as 2016, it was claimed that “we will soon move from a mobile-based world to an AI-based world”. The question that arises in this context is: what has generated the change and what is the nature of this continuous transformation? [5]

A possible answer would be astonishing: lived reality, what we used to see in science fiction movies is happening today with them, with us and everywhere. The man did not change,

but he found a friend with unsuspected powers. We pride ourselves on this harmless friend for the time being, hoping that he will not forget his demiurge, given that this “machine” undeniably surpasses us in calculation speeds, reactions and prognostications. What is happening and why has Artificial Intelligence become today an unprecedented technological landmark of paradigmatic change in all areas of life? AI is the epochal equivalent of the discovery of the steam engine, perhaps even more, a field in a major and irreversible evolution for mankind. This engine runs on intelligent algorithms that are there to learn by themselves, and that will eventually develop towards the boundaries of science fiction imagination. It is known that AI can analyze huge amounts of data and make decisions in fractions of seconds, which makes it even more valuable, sometimes unpredictable in fields such as medicine, finance, transportation and more. In medicine, for example, there are important indicators. AI x-rays and interprets with precision unimaginable to the human eye, using screening on any part of the human body, at any depth, identifying diseases that cannot be detected early on by any CT, MRI, etc. Simply put, AI research in medicine has been unexpectedly helping to diagnose, treat, as well as significantly reduce costs associated with the healthcare system, effortlessly, in a second, cheaply, and all can be prescribed on the screen a phone. From the first contacts with this field, we wondered why it would be important to understand such an area from the perspective of the development of the legal system. First, AI can be a great tool for those interested in analyzing the social behavior of individuals and social issues in general. For example, AI can be used to analyze data on discrimination, social inequality or poverty, help identify and understand the causes of these problems, and generate effective mathematical solutions. Also, AI can be used to monitor and evaluate the effectiveness of social interventions, which seems like another huge advantage, when using the right algorithms it learns to become self-taught, generating and regenerating better and better solutions. Knowledge and understanding of AI technologies helps the specialist develop the necessary skills to use intelligent tools in sociological research and practice, as well as in social work, providing additional career opportunities. In terms of data analysis, AI makes a difference when it comes to Big Data, regardless of size, impossible to quantify otherwise. Auto-generating an automated map of the data allows, subsequently, to quickly identify and understand the causes of the phenomena addressed and, obviously, a step with little effort to consolidate the best solutions. Another quality of this technology lies in possibility to make predictions, a way to identify the best decisions and develop prevention policies based on them. Complex processes of monitoring and evaluating public policies can be greatly facilitated when we use the path of AI tools. Another advantage is the speed of work, identifying the right patterns and measurable trends in big data about social behavior and social problems, providing valuable insights for researchers and practitioners. Last but not least, data personalization through AI can be successfully used in social interventions for people's individual needs, supporting the effectiveness of all research processes. All these advantages contribute to improving quality of life research by systematically identifying and visually understanding social problems, as well as by forecasting and developing effective interventions, and the list goes on. The important thing is to perceive the AI universe as a tool that makes our work easier on the one hand, and on the other hand gives us the chance to easily control the Big Data universe.

AI is already changing people's lives in society. From the perspective of the common man, we would only dwell on a few aspects, for example, in the case of work, AI can automate

a vast area of activities that are done manually, providing speed, quality, precision and efficiency in many industrial fields, but obviously , it can also have a negative impact on jobs, and here we don't have clear answers yet. Services can use a number of enhanced and personalized processes, such as health services, education, transportation, economy, etc. For example, in the medical field, in the case of diagnosis, AI can help doctors generate personalized treatment decisions. AI can monitor patients remotely, such as through computerized systems or by analyzing real-time data, monitoring the first signs of healing or worsening disease. We can see how a simple mask with specific sensors offers the possibility to accurately read the bio-chemical data produced by a patient's breath, keeping the doctor informed of any evolution of health indicators. Of course, not everything is perfect because depending on the quality of the programmed algorithms depends on the accuracy of these supercomputers to provide the right feedback or give errors. Everything revolves around the infinite possibilities of machine-learning and deep-learning programs, and from a communication perspective, AI can improve the way people communicate with each other, such as through virtual assistants or automated translations. [6]

In another key interpretation, that of security, AI can be an advantage or a great pitfall for security systems. Doors are opened by analyzing behavioral data or facial recognition. In the transportation industry, AI can be used to optimize delivery routes and improve logistics efficiency. In the field of energy, AI can be used to manage and optimize energy consumption saving money, and AI is already being used to monitor and prevent climate phenomena and prepare communities for emergencies. However, AI can also have negative effects, such as increasing inequality, discrimination, or increasing privacy and security concerns. Therefore, it is important to take steps to manage these unwanted effects and ensure a symbiosis between human and AI with as little damage as possible. In a stage conclusion, AI is a technology of the future that we already have with significant potential for everything from research, to innovation, to issues as diverse as business efficiency, improving health, and understanding human behavior and social interactions. In addition to all these benefits, researchers can learn and use algorithms, analyzing important data from social networks, such as posts on Facebook or Twitter in order to quickly and comprehensively understand how people react to certain events or how certain news or ideas spread. Let's not forget surveys and questionnaires that can be applied with the help of bots programmed to perform certain functions, saving time and money. Governments and most businesses today can learn quickly and at low cost how to adapt their products and services to consumer needs and trends. However, it is important to remember that AI is not a magic solution to all problems and that a responsible approach is required. AI opens a door for everyone. Next to us, someone is too fast and smart, and we might be lazy, but one day it can destroy or save us, we decide how we use it. [7] Let's choose the optimistic option and, in that hypothesis, analyze the digitalization of justice from the perspective of the demands of the law and the political desires.

3. Digitization of justice – between the requirements of the law and the desires of politicians or about telematic justice and computer justice

3.1. Some terminological clarifications

The existence, already, of some doctrinal concerns regarding the issue of the modernization of the judicial act and the use of new technologies in the judicial process makes it easier

for us to clarify some terms and expressions that appeared in the various studies and interventions of legal specialists in the online environment, positioning in favor of innovation in such a conservative field as that of justice, by introducing information and communication technologies. Innovation and recourse to these new technologies are necessary and natural, being closely related to the evolution of the social environment, the increased technologization of all social sectors and the rapid development of Artificial Intelligence. The introduction of the new, although it is obviously and instinctively met with reluctance, can neither be stopped nor temporarily limited (accepting the use of these technologies only in exceptional periods), because sooner or later we will inevitably realize its undeniable advantages.

The issue of AI, information and communication technologies and their benefits for the justice system could not be addressed in a complete manner without bringing ab initio into discussion, new concepts, such as telematic justice [8], computer justice, E-justice, more and more circulated and applied at the level of every modern state. These new concepts have as a binder a modern philosophy of justice, which puts the citizen and the quality of the justice act at the center of its concerns. [9] Since we have found that in the online environment various terms and various expressions are sometimes used as synonyms – telematic justice, IT justice, electronic justice, digitized justice – we believe that a clarification of their meaning is essential to avoid confusion and establish clear categories of analysis.

3.2. Telematic justice

Telematics is that scientific and technological discipline that analyzes and implements services and applications that use both computer and telecommunication systems, as a result of the union of both disciplines [10]. The term “telematics” is a compound term and comes from the fusion of the terms “telecommunications” ("tele” – prefix from the Greek lb. meaning “far”, or “remote") and “informatics” (discipline that refers to the practice of processing information). The term “telematics” was first used by Simon Nora and Alain Minc in 1978 in the paper “The Computerization of the Society" [11]. Any type of communication via the Internet or via the global positioning system (e.g. sending an e-mail to another country) is considered a telematics application, which ensures the transmission long distance information. This term is used for a wide variety of commercial and non-commercial purposes and, very recently, in the judicial field.

The judiciary is the third pillar of the rule of law, being subordinated to principles such as equity, impartiality and independence. The nature and importance of the judicial system calls for special attention from public and private actors when the question arises of making structural and procedural changes, such as those determined by the introduction of new technologies in justice and the judicial system. Faced with numerous problems – rising legal costs, increased trial duration, difficult management of an ever-increasing number of cases – the judicial system has the choice between the following three main strategies:

a) To increase the administrative staff and the number of judges. By doing so, they increase the costs of the legal act by increasing the salary costs with the related staff, providing the necessary infrastructure (offices, computers, etc.)

b) To change the rules and procedures related to the realization of the act of justice. Such a strategy requires time and also additional costs, since the adoption of new legal provisions in the field or the modification of existing ones requires the completion of some preliminary stages that will culminate in the adoption and publication in the Official Gazette of Romania of the respective normative acts, the legislative process being cumbersome, "chronophagous" and not without errors [12].
c) To make investments in information and communication technology (ICT).

The use of ICT is considered one of the key elements that could significantly improve the administration of justice. The rapid development of technology opens up new opportunities that were unthinkable a few years ago. Around the world, several statutory reforms have been introduced that allow the use and exchange of electronic data and documents within national judicial systems, as well as between them and supranational courts. The availability of web services, the possibility of consulting legislation and jurisprudence online, the use of electronic archiving, the electronic exchange of legal documents, are just a few examples that stimulate the judicial system to rethink and fundamentally change its organization and activity. ICT can be used to increase efficiency, access, timeliness, transparency and accountability, helping the judiciary to deliver quality services at low cost. "The use of the Internet can offer the chance to open the judicial system to the public, providing both general and specific information about its activities, thus also increasing legitimacy" [13].

Telematic justice is a contemporary construct that is based on a technological architecture that allows the remote execution (online) of some operations such as archiving documents, sending communications and notifications, consulting the status of proceedings using the online register, consulting files and jurisprudence and even making of remote judicial processes and procedures through online means of communication, operations that previously could only be carried out by physically visiting the headquarters of the judicial authorities involved. Telematic justice is not to be confused with electronic justice, electronic justice representing the proximate genre, because all other categories – telematic, computerized and digitized justice – presuppose the existence of an included electronic component [14].

Telematic justice is not to be confused with the concept of E-Justice, created by the European Commission. The development of E-Justice is seen at European level as a key element in the modernization of national judicial systems, and a standard in the realization of the national and European justice act. E-Justice is actually electronic justice that includes both easy and fast access to information of a legal nature, as well as the rapid transmission of documents and procedures, i.e. both telematic and IT justice, digitalization being the common element. Thus, since the creation of a judicial portal in civil and commercial matters in 2003, the Commission has supported the implementation of an atlas of justice in criminal and civil cases to enable practitioners to determine the appropriate judicial authorities in different parts of the EU. The Commission considers that the first objective of E-Justice is to increase the effectiveness of justice throughout Europe for its citizens and that the development of an electronic signature (E-signature) and an electronic identity

(E-identity) is a priority, which are extremely interesting from the point of view of the challenges to which the judicial system is subjected. Therefore, telematic justice is the concrete way by which the E-Justice standard is achieved. E-Justice is a European concept, while telematic justice represents a new way of organizing and carrying out justice worldwide.

3.3. Computer justice

Computer justice uses Artificial Intelligence (AI) as a decision-making factor in the act of justice and involves the use of AI algorithms at various stages of the judicial process. One of the applications of computer justice is the use of IT tools for criminal risk assessment (e.g. COMPAS – Correctional Offender Management Profiling for Alternative Sanctions, IORNS – Inventory of Offender Risk, Needs, and Strengths, OST – Offender Screening Tool, STRONG – Static Risk and Offender Needs Guide, etc.) of recidivism or violent behavior in order to provide logistical support to the judge who has to decide on preventive measures, the individualization of the punishment, the individualization of the execution of the punishment or conditional release in the case of accused/convicted persons [15]. These tools provide essential information to the judge by processing a significant amount of statistical data and classifying the defendant/convict into certain behavioral typologies. Although they also have shortcomings, being criticized for perpetuating discriminatory patterns (e.g. people of color have a statistically higher risk of recidivism than Caucasians) these electronic criminal risk assessment tools are widely used in the United States, Canada, Great Britain, France and in other countries, as they increase the degree of objectivity of the decision-making act. At the same time, computer justice also involves the use of artificial intelligence algorithms, as electronic judges or, as they were called in the media – "robot judges", it is true, only on an experimental level at the moment and only for small civil cases importance.

3.4. Digitized justice

Telematic justice is not to be confused with digital justice either, because digital justice is a component of telematic justice, but also of computer justice. Digitized justice involves the use of artificial intelligence algorithms in the organization, management and implementation of justice operations, by transforming analog information into numerically coded information. Digitized justice includes both the communication between the actors involved in the act of justice via email/internet, as well as the storage of the resulting data and their processing in order to obtain relevant indexes that will then be used within the computer justice system (e.g. storage of court decisions and ordering according to of different categories – the court, territorial jurisdiction, material jurisdiction, pronounced solution, etc.). Although at first sight there is no difference between the terms informatics and digital/digitized, their association with certain categories can change their meaning. According to dexonline, to digitize is to convert analog signals into digital signals. Therefore, there is a difference between computer justice and digitized justice, computer meaning mathematically transposed information and, in common language, it is synonymous with IT (information technology – Information technology). [16] An IT justice or computer justice involves the use of information technology to achieve its goals. Digital justice is software-based and client-oriented. The digital transformation of justice is a strategic transformation in which litigants' preferences and behavior determine the

technological decisions of decision-makers regarding the organization of justice. The IT transformation of justice would entail "a complete overhaul of the organization's information systems (IT). IT transformation can involve changes in network architecture, hardware, software and the way data is stored and accessed". Differences can therefore be identified between the IT transformation and the digital transformation of justice:

- IT transformation focuses on IT priorities, while digital transformation focuses on the priorities of litigants and agents involved in the delivery of justice.
- the IT transformation has a clear, well-defined end result (e.g. the introduction of software for the systematization of judicial solutions). Digital transformation is an ongoing process of better addressing changes over time and therefore does not have an end result [17]. In other words, digital transformation or digitization implies the continuous adoption of new, increasingly advanced digital technologies to improve procedures. Digitized justice involves the modernization or adoption of new technological systems, platforms and software solutions to meet the needs of the agents involved in the execution of the act of justice and the litigants, generating tangential benefits for the system, including more corrections, faster solutions, shorter response times , improved user experience, etc. [18].

4. Digital responsibility, myth and truth

4.1. Specific matters

In order for new technologies to be favorably received by those on whom they have a daily impact (users of public services, consumers, patients, litigants, etc.), it has become necessary to develop a general law of algorithms, so that their function be exercised in accordance with the law. In other words, to build a robust and predictable AI norm that ensures imperative societal control over algorithms, we need to put law back at the center of the normative process. We have fundamental rights at the forefront of the hierarchy of norms of many states and international texts (that of human dignity, equality and non-discrimination, the right to private life, the right to the protection of personal data, the right to a fair trial and the presumption of innocence, etc.) , which are neither negotiable nor optional, unlike ethical goals or ideals. Therefore, it is time to give priority to the law, and the content of legal norms must be thought in the sense of a responsible and inclusive AI. Since it is necessary to regulate AI by law, an interdisciplinary approach is required, involving lawyers, mathematicians and computer scientists, to make it possible to integrate the particularities of AI into law. The highly complex methods of AI generate social risks, forcing the jurist to understand the technique when developing the rule and then when applying it [19], and the social acceptance of the use of algorithms is closely related to the attribution and distribution of responsibilities in case of damages . In the presence of self-learning AI systems, one of the main difficulties is defining a responsible framework relative to foreseeable social risks. Artificial intelligence is the culmination of a complex chain of activities, requiring the intervention of several categories of producers and operators; this means that tasks must be clearly distributed and tracked: the designer must know his legal and ethical constraints, transcribe related instructions into algorithmic code. It is therefore necessary to have appropriate legal regimes for the links of a whole chain of responsibility:

- the responsibility of the designer for damages caused by incorrect initial programming;
- responsibility for insufficient vigilance during the operation of the algorithmic tool;

- the user's responsibility for damages caused by manipulating the algorithmic tool;
- responsibility for damages caused by the functional autonomy with which the algorithm was endowed at the time of manufacture, which it developed during learning and throughout its operation, etc.

It is up to the law to alleviate the difficulties of tracing the chain of causation and to facilitate the designation of the debtor of the obligation to repair the damage, in order to avoid a dilution of responsibilities. Until recently, the classical rules of civil liability were able to meet the needs of the evolving society. Digital legal liability – combined with the revolution in mathematics and technologies, which directly affects transport, education, health, justice – is already implemented by resorting to the classic rules of civil liability (tort, non-contractual, contractual), administrative, criminal, disciplinary. However, the upheavals generated by digital technology in human activities (robotics, telemedicine, predictive justice, education, autonomous aircraft, drones, nanotechnologies, etc.), are such that the classic law of liability may fall into obsolescence. In the fields of privacy, protection of intellectual property (software, applications), loss or destruction of data, computer failures that paralyze large companies, cybercrime, complex issues arise in terms of civil, criminal and administrative liability, against the background of an unprecedented increase in damages digital of all kinds.

According to the classic distinction, liability can be contractual or tortious, depending on whether or not the AI system is designed/used within a contract. Tort liability regimes seem to suit AI systems by considering AI to be an incorporeal 'thing'. It is appreciated that, in particular, liability for defective products can be used as a basis, with some adaptations of the concepts of “product” or “defect”. However, the unpredictability and autonomy of some systems do not fit well with liability regimes for the “fact” of things, and human-machine interaction causes permanent adaptations of systems. The “thing” in question is more active and autonomous than in the cases traditionally covered by these liability regimes [20]. Hence, the relevance of an analogy with indirect liability for the act of others (for children and animals); but such an analogy is difficult to hold, in the absence of the living nature of systems. [21] Of course, liability for damage caused by things, especially in the case of defective products, can still be invoked, for a transitional period. It remains to be seen whether these rules will ensure, in the long term, a satisfactory legal balance, when the victim-claimant will encounter major difficulties in accessing various digital techniques to prove their causation with the damages suffered. Likewise, in the course of digital justice (predictive justice that anticipates and presents to lawyers the likelihood of judicial decisions, software that helps magistrates decide on the parole of convicts, etc.), new types of responsibilities could be envisaged, associated with damages specific to digital technology and new types of evidence, both in terms of court officials using these new techniques and in terms of the emergence of new “actors” (start-ups, IT specialists, robots which partially replace lawyers and magistrates). For example, in the matter of evidence, the digital traceability of all actions taken by the parties to a contract, influences the distribution of responsibilities in the case of interdependent activities that led to the harmful action, etc. [22] And all this under the conditions of responsibility whose ex ante and ex post connotations we try to discern further.

4.2. Ex ante liability

In order to generate social trust in AI, accountability must exist ex ante ("conditions of admissibility") and ex post (after AI harm occurs) and in order to guarantee an accountable and inclusive framework for AI, ex ante accountability must be considered ante, that is, the application of the rules starting with the design of the systems, with the aim of minimizing or even avoiding the occurrence of damages. At the European level, in particular, two approaches regarding accountability have been outlined: a first approach focuses on the explainability and transparency of the decisions taken, by granting a right to an explanation, while a second one evaluates the socio-economic impact of the system to verify loyalty, explainability, audibility, accountability and accuracy. It is certain that many voices are raised in international doctrine to demand more transparency, explainability and loyalty (non-discrimination) of AI systems. [23]

From this perspective, the European Union grants natural persons the right not to be subject to a decision based solely on automatic processing, including profiling, which produces legal effects concerning the data subject or similarly affects him to a significant extent. Exceptions are provided [art. 22 para. (2)], accompanied by guarantees, related to the right to obtain human intervention, to express one's point of view, to challenge the decision (art. 22 para. 3) and to receive individual explanations. The data controller must also ensure control over the algorithmic processing and its developments, in order to be able to explain, in detail and in an intelligible form to the data subject, how the data processing has been carried out with regard to him. [24] Therefore, it is not possible to use algorithms capable of self-reviewing the rules they apply without the verification and validation of a human controller. In France, no decision with legal effects can have applicability without the participation of the human being in its process; however, in certain areas, fully automated decisions issued by a public administration are accepted (for example, for the calculation of taxes). As we can see, European legislators focus on the right to transparency and the explanation of algorithmic decisions. However, such rights take into account only part of the social risks and not sufficiently protects against systemic discrimination, in particular because the explanation is subsequent to the decision and therefore intervenes ex post. [25]

4.3. Ex post accountability – acceptable, justified and 'humanised'

The second approach to ex ante responsibility promotes an algorithmic impact study that consists in evaluating, before the production of any automated decision-making system, its possible social impact and in determining the levels of exigency to minimize the risks, to ensure that there are no unforeseen biases in the data and other factors that could unfairly influence the results. The assessment should be reviewed regularly, and after the decision is made, the administration should provide a meaningful explanation to those affected as to how the decision was made and why it was made. Canadian citizens must have every opportunity to challenge the decision-making process. The administration must publish the source code, subject to classified data, as well as information about the effectiveness of the systems in achieving the objectives.

In this sense, researchers have identified several causes that will make it difficult to establish a liability system adequate to the disturbances generated by contemporary digital activity. Undoubtedly, the growing influence of GAFAMI (Google, Apple, Facebook,

Amazon, Microsoft, IBM) and BATX (Baidu, Alibaba, Tencent, Xiaomi), the players at the origin of this revolution, must be taken into account. This influence is likely to call into question the sovereignty of the state, the terms of normative regulation and judicial activity, tending to create a digital sovereignty. Large digital companies tend to create their own regulations – codes of conduct and codes of ethics; thus, the fear of establishing a parallel justice was born, especially since GAFAMI has countless technical means capable of programming new types of dispute resolution [26]. The evolution of digital responsibility tends to respond to immediate and eminently technical needs, at the expense of a human approach. However, technological changes must not harm the person, because technicality, no matter how objective and precise it may be, can become inhuman. In other words, the major risk that arises during the contemporary implementation of digital responsibility is its dehumanization.

The classical rules of responsibility, still applicable, will gradually be replaced by a special digital responsibility, which will develop progressively. We are therefore challenged to create an original construction of digital responsibility in the 21st century that is acceptable, justifiable and 'humanised'. To have legitimacy, any use of artificial intelligence and its associated techniques must be accompanied by a human guarantee, combined with a wider social responsibility. In this regard, the Montreal Declaration for a Responsible Development of AI stated, already from 2018, that if "a harm has been caused by an AI [artificial intelligence system] and the AI has been proven to be reliable and subject to normal use, it is not reasonable to blame the people involved in its development or use". [27] Compensation for damages caused by an algorithmic risk would fall under the concept of a "national solidarity", anchored on societal and collective foundations, rather than implying an unjustified individualistic responsibility of man. So it seems necessary to react with a broader social responsibility, leaving room for ethical reflection at different levels. For this, it is important that all interested parties can debate and be able to pronounce on the use of AI: citizens, economic actors (start-ups, digital giants), academics, public institutions (judicial, fiscal, social), encouraging reflection collective on the purposes of technology digital and related digital responsibilities. There are various procedures: either a group of experts prepares a project that they send to the interested parties, or the interested parties are consulted upstream, participating in debates, answering questionnaires, so that later the answers are processed by experts. Then, organizations empowered by public authorities and made up of representatives of all interested parties run a certification procedure, with the aim of attesting that the artificial intelligence is "trustworthy". The new mechanisms of legal responsibility and the hypothesis of responsible AI will have to be thought of and realized on an international, global scale, no longer on a European level, given the internationalization of digital players, clouds, platforms managed mainly by digital giants such as GAFAMI and BATX. [28]

5. Instead of conclusions, about the advantages and disadvantages of the digitization of the Romanian judicial system

We are currently in a spring of artificial intelligence and only time will tell if this will lead to the realization of generalized intelligence. However, what is generally accepted and indisputable is the fact that the digitization of the Romanian judicial system represents the most important progress in artificial intelligence research in our country. This technology

will increase the efficiency, intelligence and responsiveness of every application, and the business environment movements around IT/AI startups seem to be the spearhead of all these initiatives. [29] Therefore, we can say that we have entered a new era, being justified in believing that technological changes will produce important changes in the judiciary in Romania. Considering the turning point where we are, namely the moment when traditional justice is being replaced easily, easily by digital justice, we considered it appropriate to present the advantages and disadvantages of the digitalization of the Romanian judicial system, and the analysis of this will be done in a future study independently. So, in a brief enunciative and non-exhaustive list, the advantages of E-Justice are:

1. Promotion of national and European synergies.
2. Access to justice for natural and legal persons in Europe, showing particular interest in:
    - Access to information: ignorance of the legislation of other member states is one of the major factors preventing people from asserting their rights in another EU state, by providing information to European citizens in their own language about judicial systems and procedures across the European Union .
    - Identification of the competent court. This reduces delays and minimizes the risk of cases being dismissed for material and territorial lack of jurisdiction, especially in cases with a cross-border component.
    - Access to the court with the help of the website that provides answers to the many and varied problems that a person involved in a judicial procedure may face: in which Member State the matter should be referred, the way to refer the court, the applicable law, the costs procedure (fees), enforcement of the court decision, etc.
    - Specific family law procedures: the harmonization of national laws and legal procedures makes it easier for European citizens to exercise their rights, even if they have lived in different EU countries, as well as financial claims procedures, in cases where there is a cross-border dimension to claims the payment.
3. More effective judicial cooperation, by creating electronic tools that should accompany the implementation of judicial cooperation instruments within the European Union.
4. Facilitating the use of videoconferencing. Although many acts adopted at European level allow the use of videoconferencing in judicial proceedings, the technology has not been fully exploited, for cultural, linguistic or technical reasons, despite the obvious advantages that the use of this means has in terms of costs, travel and flexibility.
5. Continuation of record interconnection. With the increased mobility of people and businesses across national borders, it is necessary to facilitate the access of suppliers, creditors, corporate partners and consumers to reliable information in order to increase transparency and legal certainty in all EU countries.
6. Enforcement of court decisions. Depending on existing national regulations, there are several tools that can be used to enforce court decisions. For example, the European Enforcement Order is a procedure that can be used for uncontested claims to facilitate cross-border recognition and enforcement of judgments.

7. Translation Assistance. The development of a true European judicial area is a major challenge. Legal proceedings are conducted almost exclusively in the national language, and the use of a foreign language is permitted only as an exception. [30] Despite the enthusiasm that we do not try to disguise, an objective approach to a research subject also requires the presentation of its negative aspects, more or less pregnant. Thus, despite the obvious advantages, the judicial system's embrace of the concepts of telematic and digitized justice exposes them to a set of risk factors associated with the development and implementation of means and tools that work on the basis of information technology [31], such as It would be:
    - Deficiencies in the initial design phase and ongoing control of AI development. If the initial digital architecture of the system is poorly planned due to misperception or misinterpretation of requirements, the entire project can be at risk. The analysis of this risk factor reveals that the type of design/development team: internal or outsourced can also be of great importance. Then, the maintenance/maintenance model of the IT system used is also very important.
    - Adequate training/training of users, general IT vision, technical skills of users are also risk factors regarding the effective digitalization of the judicial system. The solution for minimizing these risk factors is the trainings carried out by the design team with the users: judges, prosecutors and administrative staff and the use of a simplified computer language. At the same time, to meet the needs and expectations of users, the IT system design/development team includes a so-called “translator” for complex legal questions (for IT teams) and a “translator” for IT questions (for legal users).
    - The introduction of information systems or, better said, the digitization of a structure or a (judicial) system, will determine the change of the system/structure itself. People in the judiciary must be aware of these changes and especially of their inevitability. To avoid shocks related to the use of new IT systems, potential users should constantly attend training sessions. With given that AI evolves and users tend to forget some of the previously learned skills, training/training should be conducted continuously, regularly (eg quarterly, annually, etc.), or when needed (eg when the interface changes or new software is introduced).

All these negative aspects can seem scary and cause dissatisfaction among users, especially for users whose technical skills and abilities were formed in the more distant past. Young users have always been the most enthusiastic supporters of change of any kind, as a rule. Continuous preparation, participation in training programs require time, and sometimes financial resources, however, a strategy for the digitalization of the justice system, effectively thought out in the medium and long term, could offer solutions to remove these shortcomings. One could consider, for example, a specialization of judges or administrative staff, introduce IT training courses at their specific vocational training institutes, or offer financial or non-financial rewards to people in the system who want to modernize the justice act. There are only a few suggestions that, after a brief reflection, I found appropriate to make. Obviously a group of specialists could identify many more, it just takes the will.

As a distinguished colleague pointed out, “regardless of whether we accept it or not, the innovations of progress will reach, encompass and even surpass including the execution of the act of justice, what we have to do is only to integrate faster or slower" [32]. Therefore, these intelligent systems called AI that have developed and will develop in the future with surprising speed, in all fields of activity, already have and will have a very large impact on social life.

Its development can help mankind to make society work administratively better, to diagnose and cure diseases, to increase life expectancy, to help people with disabilities, to understand everything better and faster, even to make new discoveries that they can apply more quickly thus taking humanity to another level of consciousness. We also believe that the warnings of specialists regarding the strength that AI can have and the dangers to which humanity can be exposed should not be ignored. To be constantly alert it is necessary that initial and continuous education, research be considered a priority in order to be able to keep up with the new technology which, let's not forget, can learn by itself at a speed far superior to the human being. Therefore, combining professional life with personal life is important for the harmonious development of the individual and implicitly of society in the context of the very rapid development of new technologies. Respect for private life, its protection, creates a balance in society, therefore, permanent attention must be paid to the legislative field and its continuous improvement in parallel with the very rapid development of technology. [33] Although we cannot talk about a general modernization, we believe that this digital reform will expand, in the short or medium term, to all courts in Romania.

Finally, in order not to place ourselves against the technological current, which will undoubtedly capture the legal world, we must change the rigid view that is widespread and embrace artificial intelligence and all the benefits that come with it. Although change can be seen as a great challenge, I believe that the future of the legal system will be reflected in a perfect synergy between artificial intelligence and human intelligence, and the durability and success of each will be directly related to how we manage to we adapt to these changes.

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Rolul digitalizării în arhitectura sistemului judiciar din România, între sustenabilitate și inovație

Valentin – Stelian BĂDESCU,
Avocat în Baroul Bucureşti şi cercetător ştiinţific asociat al Institutului de Cercetări Juridice al Academiei Române
valentinbadescu@yahoo.com

Ruxandra Ioana BĂDESCU,
Economist, doctorand al Şcolii Doctorale Administrarea Afacerilor din cadrul Academiei de Studii Economice din Bucureşti
ruxbadescu@gmail.com

Abstract
Întrucât ne aflăm într-un punct de cotitură, respectiv momentul în care justiția tradițională este înlocuită ușor, ușor de justiția digitală, am considerat oportună analizarea modului în care se reformează sistemul judiciar, implicațiile pe care noile tehnologii le au asupra dreptului, precum și nevoia de adaptare a acestuia la toate schimbările impuse de evoluția societății. Prezentul articol nu urmărește expunerea unei imagini generalizate și rigide, ci reprezintă viziunea noastră asupra modului în care digitalizarea se oglindește în viața de zi cu zi, precum și provocările cărora trebuie să le facem față în acest context. Nu suntem prea optimiști să putem afirma că suntem norocoși să trăim într-o eră a tehnologiei, unde inteligența artificială se împletește cu rațiunea umană, formând un duo destinat să ne ușureze viața. În prezent, oamenii sunt înconjurați de tehnologie, dând naștere unei sinergii ce era greu de imaginat la începutul acestui mileniu. Tehnologia, care acum câteva decenii era prezentă doar în peliculele science-fiction, a ajuns astăzi la îndemâna oricui, devenind parte integrantă din viața de zi cu zi a majorității oamenilor.

Cuvinte cheie: digitalizare, sistem judiciar, inovație, sustenabilitate, avantaje, riscuri.

1. Argument – avertisment: perspectivele juridice asupra tehnologiei sunt îngrijorătoare, dreptul aflat la confluența a două lumi: încotro?

M-am trezit aşa cum o fac în fiecare dimineaţă, puţin după ora şase. Eram hotărât să-mi scriu articolul pentru cea de-a XI-a ediție a Conferinței Internațională Smart Cities (SCIC), 7-8 decembrie, 2023, organizată de Facultatea de Administrație Publică, Smart-EDU Hub din cadrul Universității Naționale de Studii Politice și Administrație Publică, doar că nu ştiam ce subiect să aleg întrucât distinșii organizatori ne-au oferit aproape zece paneluri. Dau să mă ridic din pat şi-mi cad ochii pe noptieră unde s-a cam ridicat binişor grămăjoara cu cărţi de citit. Nu-mi place când se întâmplă asta deoarece înseamnă că trec printr-o perioadă agitată în care nu prea îmi mai rămâne timp de lectură. Adică exact nebunia pe care-o trăiesc eu în ultima perioadă. Şi uite-aşa, m-am apucat să răsfoiesc un recent și consistent volum. Este vorba despre o carte șocantă: "*Adevăratul Anthony Fauci, Bill Gates, Big Pharma și Războiul Global împotriva democratiei*" scrisă de Robert F. Kennedy Jr., o carte menită a-ți arăta lumea așa cum e: ticăloasă până-n măduva oaselor. Pur și simplu citești și nu-ți vine să crezi ceea ce citești. Te ciupești pentru a verifica dacă nu cumva visezi. Ajungi chiar să îți dorești să găsești o dovadă că autorul fabulează. Pur și simplu îți dă toată viziunea ta despre lume peste cap. Nu poți să crezi că există oameni atât de ticăloși. Iar ceea ce constați este nu doar că aceștia există, ci că ei sunt doar vârful unui teribil sistem ticălos. Și, mai mult, de ce absolut toate acțiunile lui sunt copiate orbește peste tot în lume? [1] Pentru cei mai mulți dintre noi, Fauci – acest personaj sinistru – pare ieșit în față acum. Asta pentru că nu eram conectați la realitățile de acolo. Meritul lui Robert

Kennedy este acela că are o memorie teribilă și informații terifiante. Fiecare cuvânt din cartea sa este efectiv copleșit de dovezi. Ceea ce face Fauci acum nu-i nimic altceva decât aceeași linie criminală pe care o practică încă din tinerețe. Iar asocierea sa cu personaje dubioase, precum Bill Gates, nu-i altceva decât o demonstrație că "legea atracției" dintre oamenii de aceeași factură funcționează impecabil. Știați, spre exemplu, că Fauci are interese financiare în Moderna? Nu, mai nimeni n-a știut asta. Știați că pentru dezvoltarea Redemsivir CDC a cheltuit 79 milioane $, bani publici? Gilead e compania care deține patentul pentru Remdesivir și, întâmplător, în această companie Bill&Melinda Gates Foundation (BMGF) a achiziționat acțiuni în valoare de peste 65 milioane $, înainte de explozia la bursă a companiei.

Vă imaginați, totuși, cam care a fost nivelul de perplexitate al acestor ticăloși în momentul în care medici și oameni de știință serioși au venit cu tratamente generice pentru așa-zisul virus ucigaș? Ei, conspiratorii, plănuiau lovitura încă din 2009 pentru a câștiga bani cu nemiluita. Cum te simți când niște idealiști amenință să-ți dea planul peste cap? Cum adică să tratezi cu hidroxiclorochină în condițiile în care ei pregătiseră pentru "tratamentul minune" un preț de peste 1000 de ori mai mare decât al genericelor? Astfel, o întreagă mașinărie bine finanțată intră în acțiune. Kennedy explică modul ticălos în care rețeaua criminală a lui Fauci a reușit să elimine tratamentele ieftine prin intermediul falsificării rapoartelor științifice. Spre exemplu, în lumea medicală este deja o axiomă faptul că hidroxiclorochina este toxică. De ce? Simplu: testele medicale în ceea ce privește eficiența sa au fost falsificate la modul criminal. Pacienților pe care s-a făcut "studiile" le-au fost administrate doze letale de hidroxiclorochină. În condițiile în care tratamentul standard prevedea doze de maxim 400 mg/zi, gașca lui Fauci a utilizat în studiile așa-zis științifice doze de 1200 mg/zi în ziua 1 și doze de 800 mg/zi în zilele următoare. Nu-i de mirare că pacienții au murit. De fapt, au fost deliberat uciși pentru a se elimina un tratament ieftin. Iar asta e crimă!

În ceea ce privește morțile cauzate de vaccin, pentru a minimiza cifra, CDC a modificat metodologia de contorizare a deceselor. Astfel, se consideră moarte cauzată de vaccin doar decesul survenit la maximum două săptămâni după administrarea celei de a doua doze! Culmea, mulți dintre cei care au murit din cauza vaccinului au îngroșat rândul morților de... COVID dintr-o "deficiență de raportare". În urmă cu ceva ani, Bill Gates explica doct cum a făcut mai mulți bani din vaccinuri decât din IT. Respectiva declarație a dispărut de peste tot. Pur și simplu a fost ștearsă. Înainte de a încheia, le recomand tuturor celor care iubesc adevărul să răsfoiască puțin cartea lui Robert Kennedy Jr. În ciuda faptului că e o carte dură, e doldora de informații care ne dezvăluie, fără perdea, lumea în care trăim. E bine să știm ca să vedem ce urmează. Cazul Fauci are corespondent, firește, și în România, unde media total independente sau vocile contastatare ale narațiunii oficiale mincinoase și criminale, au fost plasate pe adevărate liste negre de faucii și arafații locali, cu scopul de a fi eliminate din spațiul public. Trusturi media mituite de Guvern sau alte mijloace de propagandă para-guvernamentale, ca pagina de propagandă Ro Vaccinare, un așa-zis ONG Eurocomunicare sau chiar un "laborator" care activează prin inflitrare sub acoperișul Academiei Române, au făcut parte din uriașa mașinărie de manipulare și dezinformare și ar putea avea acum de plată despăgubiri imense pentru daunele publice provocate celor care au dezvăluit adevărul despre Afacerea Covid. Reamintim în acest sens escrocheria

Eurocomunicare, ONG-ul condus de fostul angajat de la "Era Socialistă" Paul Dobrescu și o oarecare gură mare Alina Bârgăoanu, care a obținut prin încredințare directă două milioane de euro de la Secretariatul General al Guvernului pentru "strategia de comunicare" a Guvernului privind campania eșuată a vaccinării Covid. Milioane folosite pentru a organiza teleconferințe online, a mitui propagandiști și actori ai pandemiei, a comanda sondaje false și a întocmi false liste negre cu publicații și personalități independente, acuzate de "fake news". Avocații trebuie să-și facă meseria împotriva mercenarilor ocultei alogene, trădătoare de neam și țară. Cât despre autorul acestor rânduri, nu am intenţia de a mă opri. Problema este că, dacă într-o primă fază cel mai probabil voi reuşi să ocolesc cenzura, într-o fază ulterioară probabil n-o voi mai putea face. O să vedem atunci ce se poate face. Reţineţi însă că începe cea mai urâtă etapă a istoriei în care, ca efect al tehnologiilo actuale, absolut toate idealurile bolnave ale tiranilor trecutului pot fi puse în aplicare fără riscul de a eşua. Orice abuz, orice injustiţie, orice nebunie poate deveni acum realitate, iar oamenii nu vor avea decât o singură opţiune: să se supună. Din păcate pentru noi, suntem iar în barca nefastă a istoriei, refuzându-ni-se din nou posibilitatea cel puţin de a întârzia nebunia psihopaților care conduc lumea. Cât firesc, câtă naturaleţe! Efectiv m-am cutremurat deoarece am înţeles nebunia pe care ne-o facem singuri. E totul atât de simplu, iar noi complicăm din dorinţa de a "clarifica simplitatea", sfârşind într-un labirint din care nu mai înţelegem nimic. Fără doar şi poate, "*Adevăratul Anthony Fauci, Bill Gates, Big Pharma și Războiul Global împotriva democratiei*" are meritul de a face mai uşoară evadarea noastră din labirintul prin care orbecăim, conectându-ne la o spiritualitate uitată în ziua de azi. Pur şi simplu m-am simţit lovit profund de adevărurile pe care le-am citit până acum, iar asta face mai mare surpriza descoperirii unor povestiri, ca nişte iluminări neaşteptate în negura prin care orbecăim. Pun punct aici introducerii studiului, încurajându-vă să descoperiţi drumul drept! Nu înainte de a argumenta de ce am ales acest titlu și de ce tocmai Antonio Fauci. Pur și simplu pentru că tehnologia și sistemul juridic au intrat într-o zonă periculoasă, iar perspectivele juridice asupra tehnologiei sunt îngrijorătoare. Dreptul se află la confluența a două lumi: sustenabilitate și inovație încotro?

2. Accelerarea inovației și impactul acesteia asupra sustenabilității sistemului judiciar

Cei inițiați cunosc faptul că dreptul reprezintă un ansamblu de reguli de conduită, care, într-o societate, reglementează raporturile dintre persoane (dreptul obiectiv). Termenul desemnează în egală măsură prerogativa, puterea sau facultatea recunoscută persoanelor de legea civilă (dreptul subiectiv). Astfel, prezentul studiu nu reprezintă numai un ansamblu de reflecții, unele conținând critici, dar și contribuții personale ale autorilor produse de tranziția – poate destul de bruscă – adusă de digitalizare principiilor și practicii tradiționale încercând să aducem o contribuție atât în sfera teoretică, dar și în cea practică a subiectului abordat. O abordare unitară care să conducă la garanția unei bune justiții și la o bună guvernare, acestea fiind obligații statale care trebuie sa primeze intr-o societate democratică deoarece justiția și guvernarea reprezinta serviciile publice cele mai importante aflate sub spectrul dematerializarii activitaților tradiționale, prin efectul digitalizarii ce poate afecta sustenabilitatea acestora. Potrivit Wikipedia, sustenabilitatea este capacitatea de a exista constant. În secolul al XXI-lea se referă în general la capacitatea biosferei și a civilizației umane de a coexista. Este, de asemenea, definit ca procesul de menținere a schimbărilor într-un mediu echilibrat de homeostază, în care exploatarea resurselor, direcția investițiilor, orientarea dezvoltării tehnologice și schimbarea instituțională sunt toate în armonie și

sporesc atât potențialul actual, cât și cel viitor satisface nevoile și aspirațiile umane [2], iar Dex on line, precizează că este o caracteristică a unei activități de a putea fi desfășurată pe o perioadă lungă de timp [3].

Întrucât ne aflăm într-un punct de cotitură, respectiv momentul în care justiția tradițională este înlocuită ușor, ușor de justiția digitală, am considerat oportună analizarea modului în care se reformează sistemul judiciar, implicațiile pe care noile tehnologii le au asupra dreptului, precum și nevoia de adaptare a acestuia la toate schimbările impuse de evoluția/involuția societății. Prezentul articol nu urmărește expunerea unei imagini generalizate și rigide, ci reprezintă viziunea noastră asupra modului în care digitalizarea se oglindește în viața de zi cu zi, precum și provocările cărora trebuie să le facem față în acest context. Nu sunt prea optimist să putem afirma că suntem norocoși să trăim într-o eră a tehnologiei, unde inteligența artificială se împletește cu rațiunea umană, formând un duo destinat să ne ușureze viața. În prezent, oamenii sunt înconjurați de tehnologie, dând naștere unei sinergii ce era greu de imaginat la începutul acestui mileniu. Tehnologia, care acum câteva decenii era prezentă doar în peliculele *science-fiction,* a ajuns astăzi la îndemâna oricui, devenind parte integrantă din viața de zi cu zi a majorității oamenilor.

Apariția și dezvoltarea fulminantă a acesteia a condus la un progres al societății pe planuri multiple, dar a venit la pachet și cu provocări și neliniști care au început să încolțească în sufletele noastre. Întrucât procesul de tehnologizare s-a extins în nenumărate direcții, acaparând fiecare bucățică din viețile noastre, oamenii au fost nevoiți să se adapteze noilor tendințe și să evolueze odată cu noile tehnologii. Am ajuns în punctul în care internetul și aparatura inteligentă și-au însușit rolul de a ne fi camarazi de nădejde și de a ne ajuta să rezolvăm mai ușor problemele ivite în viața cotidiană. Regăsim digitalizarea în tot ceea ce ne înconjoară, în toate domeniile și activitățile la care luăm parte. Astfel, era inevitabil ca impactul noilor tehnologii să nu se răsfrângă și asupra sistemului judiciar, venind cu o serie de beneficii și provocări cărora trebuie să le facă față toți participanții actului de justiție, inclusiv noi, avocații. În cele ce urmează, mi-am propus să inițiez o călătorie în care stațiile vor fi reprezentate de cele mai importante schimbări care oglindesc impactul noilor tehnologii asupra sistemului judiciar românesc, analizând deopotrivă și modul în care sistemul juridic trebuie să țină pasul cu acestea [4].

Pentru a înțelege pe deplin implicațiile inovației, respectiv a noilor tehnologii și a transformărilor pe care le produc întregii societăți, trebuie mai întâi să înțelegem ce înseamnă inteligența artificială. “Inteligența artificială este unul dintre cele mai profunde concepte la care lucrăm ca umanitate, este mai profundă decât focul sau electricitatea”, a spus Sundar Pichai – *CEO*-ul *Alphabet,* în cadrul întâlnirii anuale din 2020 a Forumului Economic Mondial de la *Davos*, Elveția. “Cred că lucrăm la una dintre tehnologiile cu cea mai mare putere de transformare a lumii pe care le-a văzut vreodată industria noastră. Cea mai mare investiție a noastră este în dezvoltarea inteligenței artificiale și în integrarea acesteia în fiecare dintre produsele noastre”, a declarat Mark Zuckerberg – *CEO*-ul *Meta,* pe blogul companiei (2023). Așa cum toată lumea știe deja, *Silicon Valley* este considerat centrul lumii în ceea ce privește dezvoltarea tehnologiilor viitorului. Inteligența artificială a ocupat un loc deosebit de important în strategiile de cercetare și dezvoltare ale celor mai influente companii de acolo și, evident, nu numai. Manageri de top, precum cei citați, dar

și mulți alții, așa cum vom vedea pe parcursul articolului, au declarat că inteligența artificială formează nucleul operațiunilor companiilor pe care le conduc – aceasta fiind forța motrice din spatele strategiilor lor de cercetare și dezvoltare. Încă din 2016, se afirma că "în curând vom trece de la o lume bazată pe tehnolgiile *mobile* la una bazată pe cele *AI*". Întrebarea care apare în acest context este: ce a generat schimbarea și care este natura acestei transformări continue? [5]

Un posibil răspuns ar fi uluitor : realitatea trăită, ceea ce vedeam în filmele science fiction se întâmplă astăzi la ei, la noi și peste tot. Omul nu s-a schimbat, dar și-a găsit un prieten cu puteri nebănuite. Ne mândrim cu acest prieten inofensiv momentan, sperând că nu-și va uita demiurgul, în condițiile în care această "mașină" ne întrece incontestabil la vitezele de calcul, la reacții și pronisticuri. Ce se întâmplă și de ce Inteligența Artificială a devenit astăzi un reper tehnologic fără precedent de schimbare paradigmatică în toate domeniile vieții? IA este echivalentul epocal al descoperirii motorului cu aburi, poate și mai mult, un domeniu într-o evoluție majoră și ireversibilă pentru omenire. Motorul acesta merge cu algoritmi inteligenți care acolo ca să învețe singur, și care cu timpul se va dezvolta spre granițile imaginației science fiction. Este știut că IA poate analiza cantități uriașe de date și poate lua decizii în fracțiuni de secunde, ceea ce o face încă și mai valoroasă, uneori impredictibilă în domenii precum medicina, finanțele, transportul și multe altele. În medicină, spre exemplu, există indicatori importanți. IA radiografiază și interpretează la precizii de neimaginat pentru ochiul uman, folosind screening-ul pe orice parte din corpul uman, la orice profunzime, identificând boli care nu pot fi dedectate incipient de niciun CT, RMN etc. Mai simplu spus, cercetarea în domeniul IA în medicină ajută nesperat de mult la diagnostic, la tratament, precum și la reducerea semnificativă a costurilor asociate sistemului de sănătate, fără niciun efort, într-o secundă, ieftin, iar totul poate fi receptat pe ecranul unui telefon. Încă din primele contacte cu acest domeniu ne-am întrebat de ce ar fi important să înțelegem o astfel de arie din perspecitva dezvoltării sistemului juridic. În primul rând, IA poate fi un instrument excelent pentru cei interesați să analizeze comportamentul social al indivizilor și problemele sociale, în general. De exemplu, IA poate fi utilizată pentru a analiza date despre discriminare, inegalitate socială sau sărăcie, poate ajuta la identificarea și înțelegerea cauzelor acestor probleme și la generarea unor soluții matematice eficiente. De asemenea, IA poate fi utilizată pentru a monitoriza și evalua eficacitatea intervențiilor sociale, ceea ce pare un alt uriaș avantaj, atunci când prin folosirea unor algoritmi potriviți învață să devină autodidact, să genereze și să regenereze soluții din ce în ce mai bune. Cunoașterea și înțelegerea tehnologiilor IA îl ajută pe specialist la dezvoltarea abilităților necesare pentru a utiliza instrumente inteligente în cercetarea și practica sociologică, la fel în cazul asistenței sociale, oferind oportunități suplimentare în carieră. În ceea ce privește analiza datelor, IA face diferența atunci când vine vorba de datele Big Data, indiferent de dimensiuni, imposibil altfel de cunatificat. A autogenera o hartă automatizată a datelor permite, ulterior, identificarea rapidă și înțelegerea cauzelor fenomenelor abordate și evident, un pas cu puțin efort pentru a consolida cele mai bune soluții. O altă calitate a acestei tehnologii se află în posibilitatea de a realiza predicții, un mod de a identifica cele mai bune decizii și de a dezvolta în urma lor politicile de prevenire. Procese complexe de monitorizare și evaluare a politicilor publice pot fi ușurate enorm atunci când folosim calea instrumentelor IA. Alt avantaj este viteza de lucru, de identificare a modelelor potrivite și a tendințelor măsurabile în

macrodate despre comportamentul social și problemele sociale, oferind insight-uri valoroase pentru cercetători și practicieni. Nu în ultimul rând, personalizarea datelor prin IA poate fi utilizată cu succes în intervențiile sociale pentru nevoile individuale ale oamenilor, sprijinind eficacitatea tuturor proceselor de cercetare. Toate aceste avantaje contribuie la îmbunătățirea cercetării în calitatea vieții prin identificarea sistematică și înțelegerea vizuală a problemelor sociale, precum și prin prognoza și dezvoltarea intervențiilor eficiente, iar lista poate continua. Important este să percepem universul IA ca pe un instrument care ne ușurează munca pe de o parte, iar pe de altă parte ne oferă șansa să controlăm ușor universul Big Data.

IA schimbă deja viețile oamenilor în societate. Din perspectiva omului obișnuit, ne-am opri doar la câteva aspecte, de pildă, în cazul muncii, IA poate automatiza o arie vastă din activitățile care sunt realizate manual, oferind viteză, calitate, precizie și eficiență în multe domenii industriale, dar, evident, poate avea și un impact negativ asupra locurilor de muncă, iar aici nu avem încă răspunsuri clare. Serviciile pot utiliza o serie de procese îmbunătățite și personalizate, cum ar fi servicii de sănătate, educație, transport, economie etc. De exemplu, în domeniul medical, în cazul diagnosticării, IA poate ajuta medicii să genereze decizii de tratament personalizat. IA poate monitoriza pacienții de la distanță, cum ar fi prin intermediul sistemelor computerizate sau prin analizarea datelor în timp real, monitorizând primele semne de vindecare sau de agravare a bolii. Putem vedea cum o simplă mască cu senzori specifici oferă posibilitatea de a citi cu exactitate datele bio-chimice produse de respirația unui pacient, punând medicul la curent cu orice evoluție a indicatorilor de sănătate. Desigur, nu totul este perfect pentru că în funcție de calitatea algoritmilor programați depinde acuratețea acestor super-computere de a oferi feed-back-ul potrivit sau de a da erori. Totul se rotește în inifinitul posibilităților programelor de dezvoltate de tip machine-learning și deep-learning, iar din perspectiva comunicării IA poate îmbunătăți modul în care oamenii comunică unii cu alții, cum ar fi prin intermediul asistenților virtuali sau al traducerilor automatizate [6].

Într-o altă cheie de interpretare, cea a siguranței, IA poate fi un avantaj sau o mare capcană pentru sistemele de securitate. Ușile se deschid prin analiza datelor de comportament sau prin recunoașterea facială. În industria transporturilor, IA poate fi utilizată pentru a optimiza rutele de livrare și a îmbunătăți eficiența logistică. În domeniul energiei, IA poate fi utilizată pentru a gestiona și optimiza consumul de energie salvând bani, de asemenea, IA este deja utilizată pentru a monitoriza și preveni fenomenele climatice și a pregăti comunitățile pentru situații de urgență. Cu toate acestea, IA poate avea și efecte negative, cum ar fi creșterea inegalității, a discriminării sau creșterea preocupărilor legate de confidențialitate și securitate. Prin urmare, este important să se ia măsuri pentru a gestiona aceste efecte nedorite și pentru a asigura o simbioză între om și IA cu cât mai puține daune. Într-o concluzie de etapă, IA este o tehnologie a viitorului pe care deja o avem cu potențial semnificativ pentru orice domeniu de la cercetare, la inovare, la probleme diverse cum ar fi eficiența în afaceri, îmbunătățirea sănătății, și înțelegerea comportamentului uman și a interacțiunilor sociale. În plus față de toate aceste beneficii, cercetătorii pot învăța și utiliza algoritmi, analizând date importante din rețelele sociale, cum ar fi postările de pe Facebook sau Twitter în scopul de a înțelege rapid și panoramic cum oamenii reacționează la anumite evenimente sau cum se răspândesc anumite știri sau idei. Să nu uităm de sondaje și

chestionare care se pot aplica cu ajutorul unor boți programați să execute anumite funcții, salvând timp și bani. Guvernele și majoritatea întreprinderilor pot afla astăzi rapid și costuri mici despre cum să-și adapteze produsele și serviciile potrivite nevoilor și tendințelor consumatorilor. Cu toate acestea, este important să ne amintim că IA nu este o soluție magică pentru toate problemele și că este necesară o abordare responsabilă. IA deschide tuturor o ușă. Lângă noi, cineva este prea rapid și deștept, iar noi ne-am putea lenevi, însă într-o zi ne poate distruge sau salva, noi decidem cum o folosim [6]Să alegem varianta optimistă și, în aleastă ipoteză, să analizăm digitalizarea justiției din perspectiva exigențelor dreptului și dezideratele politicului.

3. Digitalizarea justiției – între exigențele dreptului și dezideratele politicului sau despre justiția telematică și justiția informatică

3.1. Unele clarificări terminologice

Existența, deja, a unor preocupări doctrinare în ceea ce privește problematica modernizării actului de justiție și a utilizării noilor tehnologii în procesul judiciar ne înlesnește cclarificarea unor termeni și expresii care au apărut în diversele studii și intervenții ale specialiștilor în drept în mediul online, poziționându-se în favoarea inovării într-un domeniu atât de conservator precum cel al justiției, prin introducerea tehnologiilor informației și ale comunicării. Inovația și recurgerea la aceste noi tehnologii sunt necesare și firești, fiind strâns legate de evoluția mediului social, tehnologizarea accentuată a tuturor sectoarelor sociale și dezvoltarea fulminantă a Inteligenței Artificiale. Introducerea noului, deși este evident și instinctual întâmpinată cu reticență, nu poate fi nici oprită, nici limitată temporar (acceptându-se utilizarea acestor tehnologii doar în perioade excepționale), deoarece, mai devreme sau mai târziu, vom realiza inevitabil avantajele sale incontestabile. Problematica AI, a tehnologiilor informației și comunicării și a beneficiilor acestora pentru sistemul de justiție nu ar putea fi abordată de o manieră completă fără a aduce *ab initio* în discuție, concepte noi, precum justiția telematică [7], justiția informatică, E-justice, din ce în ce mai vehiculate și mai aplicate la nivelul fiecărui stat modern. Aceste noi concepte au ca liant o filosofie modernă a justiției, care pune în centrul preocupărilor sale cetățeanul și calitatea actului de justiție [8]. Întrucât am constat că în mediul online sunt folosiți diverși termeni și diverse expresii uneori ca sinonime – justiție telematică, justiție informatică, justiție electronică, justiție digitalizată – suntem de părere că o clarificare a sensului acestora este esențială pentru a evita confuziile și a stabili categorii clare de analiză.

3.2. Justiția telematică

Telematica este acea disciplină științifică și tehnologică care analizează și implementează serviciile și aplicațiile care folosesc atât sistemele informatice, cât și sistemele de telecomunicație, ca rezultat al uniunii ambelor discipline [8]. Termenul "telematică" este un termen compus și provine din fuziunea termenilor "telecomunicații" („tele" – prefix provenit din lb. greacă însemnând "departe", sau "la distanță") și "informatică" (disciplină care se referă la practica procesării informațiilor). Termenul "telematică" a fost utilizat pentru prima dată de Simon Nora și Alain Minc în 1978 în lucrarea "*The Computerization of the Society"* [9]. Este considerată aplicație telematică orice tip de comunicare prin intermediul internetului sau prin intermediul sistemului de poziționare globală (ex.: trimiterea unui e-mail într-o altă țară), care asigură transmiterea informațiilor pe distanțe

lungi. Acest termen este utilizat pentru o varietate largă de scopuri comerciale și non-comerciale și, foarte recent în domeniul judiciar.

Puterea judecătorească este cel de-al treilea pilon al statului de drept, fiind subsumată unor principii precum echitatea, imparțialitatea și independența. Natura și importanța sistemului judiciar reclamă o atenție deosebită din partea actorilor publici și privați în momentul în care se pune problema realizării unor modificări structurale și procedurale, precum cele determinate de introducerea noilor tehnologii în justiție și sistemul judiciar. Confruntat cu numeroase probleme – creșterea costurilor actului de justiție, durata crescută a procesului, gestionarea dificilă a unui număr în continuă creștere de cazuri – sistemul judiciar are posibilitatea de a alege între următoarele trei strategii principale:

a) Să sporească personalul administrativ și numărul judecătorilor. Procedând astfel, cresc costurile actului de justiție prin creșterea costurilor salariale cu personalul aferent, asigurarea infrastructurii necesare (birouri, calculatoare etc.)
b) Să schimbe normele și procedurile referitoare la realizarea actului de justiție. Asemenea strategie presupune timp și, de asemenea costuri suplimentare, de vreme ce adoptarea de noi prevederi legale în domeniu ori modificarea celor existente reclamă parcurgerea unor etape prealabile care vor culmina cu adoptarea și publicarea în Monitorul Oficial al României al respectivelor acte normative, procesul legislativ fiind greoi, "cronofag" și nu lipsit de erori [10].
c) Să realizeze investiții în tehnologia informației și comunicării (TIC).

Utilizarea TIC este considerată unul dintre elementele cheie care ar putea îmbunătăți semnificativ administrarea justiției. Dezvoltarea rapidă a tehnologiei deschide noi oportunități care erau de neconceput acum câțiva ani. În întreaga lume, au fost introduse mai multe reforme statutare care permit utilizarea și schimbul de date și documente electronice în sistemele judiciare naționale, dar și între acestea și instanțele supranaționale. Disponibilitatea serviciilor web, posibilitatea de a consulta legislația și jurisprudența on-line, utilizarea de arhivare electronică, schimbul electronic de documente juridice, sunt doar câteva exemple care stimulează sistemul judiciar să-și regândească și să își modifice fundamental organizarea și activitatea. TIC poate fi utilizat pentru a spori eficiența, accesul, actualitatea, transparența și responsabilitatea, ajutând sistemul judiciar să furnizeze servicii de calitate la un cost redus. "*Utilizarea internetului poate oferi șansa de a deschide sistemul judiciar publicului, oferind atât informații generale, cât și specifice cu privire la activitățile sale, crescând astfel și legitimitatea"* [11].

Justiția telematică este un construct contemporan care se fundamentează pe o arhitectură tehnologică ce permite executarea de la distanță (online) a unor operațiuni precum arhivarea documentelor, transmiterea de comunicări și notificări, consultarea stării procedurilor folosind registrul online, consultarea dosarelor și a jurisprudenței și chiar realizarea de procese și proceduri judiciare la distanță prin intermediul mijloacelor de comunicare online, operațiuni care anterior nu puteau fi realizate decât vizitând fizic sediul autorităților judiciare implicate. *Justiția telematică* nu se confundă cu *justiția electronică*, justiția electronică reprezentând genul proxim, deoarece toate celelalte categorii – justiția telematică, informatică și digitalizată – presupun existența unei componente electronice incluse [8].

Justiția telematică nu se confundă nici cu conceptul de *E-Justice*, creație a Comisiei Europene. Dezvoltarea E-Justice este privită la nivel european ca un element cheie în modernizarea sistemelor judiciare naționale, și un standard în realizarea actului de justiție național și european. E-Justice este de fapt justiția electronică ce include atât acces facil și rapid la informații cu caracter juridic, cât și transmiterea rapidă de documente și proceduri, adică atât justiție telematică cât și informatică, digitalizarea fiind elementul comun. Astfel, de la crearea unui portal judiciar în materie civilă și comercială în anul 2003, Comisia a sprijinit punerea în aplicare a unui atlas de justiție în cazurile penale și civile care să le permită practicienilor să determine autoritățile judiciare adecvate din diferite părți ale UE. Comisia consideră că primul obiectiv al E-Justice este de a spori eficacitatea justiției în întreaga Europă pentru cetățenii săi și că este prioritară dezvoltarea unei semnături electronice (E-signature) și a unei identități electronice (E-identity), care sunt extrem de interesante din punct de vedere al provocărilor la care este supus sistemul judiciar. Prin urmare, justiția telematică este modalitatea concretă prin care se realizează standardul E-Justice. E-Justice este un concept european, în vreme ce justiția telematică reprezintă o nouă modalitate de organizare și realizare a actului de justiție la nivel mondial.

3.3. Justiția informatică

Justiția informatică utilizează Inteligența Artificială (AI) ca factor decizional în actul de justiție și presupune utilizarea de algoritmi AI în diferite etape ale procesului judiciar. Una din aplicațiile justiției informatice o reprezintă utilizarea instrumentelor informatice de evaluare a riscului penal (ex. COMPAS – *Correctional Offender Management Profiling for Alternative Sanctions,* IORNS – *Inventory of Offender Risk, Needs, and Strengths,* OST – *Offender Screening Tool,* STRONG – *Static Risk and Offender Needs Guide etc.*) de recidivă sau comportament violent pentru a oferi suport logistic judecătorului care trebuie să decidă luarea unor măsuri preventive, individualizarea pedepsei, individualizarea executării pedepsei ori liberarea condiționată în cazul persoanelor inculpate/condamnate [12]. Aceste instrumente oferă informații esențiale judecătorului prin procesarea unei cantități importante de date statistice și încadrarea inculpatului/condamnatului în anumite tipologii comportamentale. Deși prezintă și neajunsuri, fiind criticate că perpetuează tipare discriminatorii (ex. persoanele de culoare au statistic un risc mai mare de recidivă decât caucazienii) aceste instrumente electronice de evaluare a riscului penal sunt utilizate la scară largă în Statele Unite, Canada, Marea Britanie, Franța și în alte state, întrucât cresc gradul de obiectivitate al actului decizional.

Totodată, justiția informatică mai presupune și utilizarea algoritmilor de inteligență artificială, ca judecători electronici sau, așa cum au fost numiți în mass-media – "judecători roboți", este adevărat, doar la nivel experimental în acest moment și doar pentru cauze civile de mică importanță.

3.4. Justiția digitalizată

Justiția telematică nu se confundă nici cu *justiția digitalizată*, deoarece justiția digitalizată este o componentă a justiției telematice, dar și a celei informatice. Justiția digitalizată presupune utilizarea algoritmilor de inteligență artificială în realizarea operațiunilor de organizare, management și realizare a actului de justiție, prin transformarea informațiilor analoge în informații codate numeric. Justiția digitalizată include atât comunicarea dintre actorii implicați în actul de justiție prin email/internet, cât și stocarea datelor rezultate și

procesarea acestora în vederea obținerii de indici relevanți ce vor fi utilizați apoi în cadrul justiției informatice (ex. stocare decizii judecătorești și ordonare în funcție de diferite categorii – instanța, competență teritorială, competență materială, soluție pronunțată etc.). Deși la prima vedere nu există nicio diferență între termenii *informatic* și *digital/digitalizat*, asocierea lor cu anumite categorii poate să determine schimbarea sensului acestora. Potrivit dexonline, a digitaliza înseamnă a transforma semnalele analogice în semnale digitale. Prin urmare, există o diferență între justiția informatică și justiția digitalizată, informatic înseamnând informație transpusă matematic și, în limbaj uzual este sinonim cu *IT* (tehnologia informației – *Information technology*) [8].

O justiție IT sau o justiție informatică presupune utilizarea tehnologiei informației pentru realizarea scopurilor sale. Justiția digitală este bazată pe software și orientată către client. Transformarea digitală a justiției este o transformare strategică în care preferințele și comportamentul justițiabililor determină deciziile tehnologice ale factorilor decidenți în ceea ce privește organizarea justiției. Transformarea IT (informatică) a justiției ar presupune "o revizuire completă a sistemelor informatice (IT) ale organizației. Transformarea IT poate implica modificări în arhitectura rețelei, hardware, software și modul în care datele sunt stocate și accesate". Pot fi identificate așadar diferențe între transformarea IT (informatică) și transformarea digitală a justiției:

- transformarea IT se concentrează pe prioritățile IT, în timp ce transformarea digitală se concentrează pe prioritățile justițiabililor și ale agenților implicați în realizarea actului de justiție.
- transformarea IT are un rezultat final clar, bine definit (ex. introducerea unui software pentru sistematizarea soluțiilor judecătorești). Transformarea digitală este un proces continuu de abordare mai bună a schimbărilor în timp și, prin urmare, nu are un rezultat final [13]. Cu alte cuvinte transformarea digitală sau digitalizarea presupune adoptarea continuă a unor noi tehnologii digitale, tot mai avansate, pentru îmbunătățirea procedurilor. Justiția digitalizată presupune modernizarea sau adoptarea de noi sisteme tehnologice, platforme și soluții software pentru a răspunde nevoilor agenților implicați în realizarea actului de justiție și ale justițiabililor, generând beneficii tangențiale pentru sistem, incluzând mai multe corecții, rezolvări mai rapide, timpi de răspuns mai reduși, experiență îmbunătățită a utilizatorului etc. [14].

4. Responsabilitatea digitală, mit și adevăr

4.1. Chestiuni precizatoare

Pentru ca noile tehnologii să fie primite în mod favorabil de către cei asupra cărora au zilnic impact (utilizatori ai serviciilor publice, consumatori, pacienți, justițiabili etc.), a devenit necesar să se dezvolte un drept general al algoritmilor, astfel încât funcția lor să fie exercitată în conformitate cu legea. Cu alte cuvinte, pentru a construi o normă solidă și previzibilă a IA, care să asigure un control imperativ al societății asupra algoritmilor, trebuie să repunem dreptul în centrul procesului normativ. Avem drepturi fundamentale aflate pe frontispiciul ierarhiei normelor multor state și al textelor internaționale (cel al demnității umane, al egalității și nediscriminării, dreptul la viață privată, dreptul la protecția datelor cu caracter personal, dreptul la un proces echitabil și prezumția de nevinovăție etc.), care nu sunt negociabile și nici opționale, spre deosebire de obiectivele sau idealurile etice.

Prin urmare, este timpul să dăm prioritate dreptului, iar conținutul normelor legale trebuie gândit în sensul unei IA responsabile și inclusive. Din moment ce este necesar să se reglementeze IA prin lege, se impune o abordare interdisciplinară, implicând juriști, matematicieni și informaticieni, pentru a face posibilă integrarea în lege a particularităților IA. Metodele extrem de complexe ale IA generează riscuri sociale, obligându-l pe jurist să înțeleagă tehnica atunci când elaborează norma și apoi, când o aplică [15], iar acceptarea socială a utilizării algoritmilor este strâns legată de atribuirea și distribuirea responsabilităților în caz de daune. În prezența sistemelor de auto-învățare ale IA, una dintre principalele dificultăți este definirea unui cadru responsabil raportat la riscurile sociale previzibile. Inteligența artificială este punctul culminant al unui lanț complex de activități, necesitând intervenția mai multor categorii de producători și operatori; aceasta înseamnă că sarcinile trebuie să fie distribuite și urmărite în mod clar: proiectantul trebuie să cunoască constrângerile sale juridice și etice, să transcrie instrucțiunile aferente în codul algoritmic. Prin urmare, este necesar să avem regimuri juridice adecvate pentru verigile unui întreg lanț de responsabilitate:

- răspunderea proiectantului pentru daunele cauzate de programarea inițială incorectă;
- răspunderea pentru vigilența insuficientă în timpul funcționării instrumentului algoritmic;
- răspunderea utilizatorului pentru daune cauzate prin manipularea instrumentului algoritmic;
- răspunderea pentru daunele cauzate de autonomia funcțională cu care algoritmul a fost înzestrat din fabricație, pe care a dezvoltat-o în timpul învățării și pe tot parcursul funcționării sale etc.

Revine legii să atenueze dificultățile de urmărire a lanțului cauzalităților și să faciliteze desemnarea debitorului obligației de reparare a prejudiciului, pentru a evita o diluare a responsabilităților. Până de curând, regulile clasice ale răspunderii civile au fost capabile să răspundă nevoilor societății în evoluție. Răspunderea juridică digitală – combinată cu revoluția în matematică și în tehnologii, care afectează direct transportul, educația, sănătatea, justiția – este deja implementată prin recurgerea la regulile clasice ale răspunderii civile (delictuală, extracontractuală, contractuală), administrative, penale, disciplinare. Cu toate acestea, răsturnările generate de tehnologia digitală în activitățile umane (robotică, telemedicină, justiție predictivă, educație, avioane autonome, drone, nanotehnologii etc.), sunt de așa natură încât legea clasică a răspunderii poate cădea în desuetudine. În domeniile confidențialității, protecției proprietății intelectuale (software, aplicații), pierderii sau distrugerii datelor, eșecurilor computerului care paralizează companiile mari, criminalității informatice, se nasc probleme complexe în ceea ce privește răspunderea civilă, penală și administrativă, pe fondul creșterii fără precedent a pagubelor digitale de tot felul.

Potrivit distincției clasice, răspunderea poate fi contractuală sau delictuală, după cum sistemul de IA este sau nu proiectat/utilizat în cadrul unui contract. Regimurile răspunderii delictuale par să se potrivească sistemelor de IA, considerând că IA este un “lucru” necorporal. Se apreciază că, în special, răspunderea pentru produsele defecte poate fi utilizată ca bază, cu unele adaptări ale conceptelor de “produs” sau “defect”. Cu toate

acestea, imprevizibilitatea și autonomia unor sisteme nu se potrivesc bine cu regimurile de răspundere pentru "fapta" lucrurilor, iar interacțiunea om-mașină determină adaptări permanente ale sistemelor. "Lucrul" în cauză este mai activ și mai autonom decât în ipotezele acoperite în mod tradițional de aceste regimuri de răspundere [16]. De aici, s-a pus în discuție relevanța unei analogii cu răspunderea indirectă pentru fapta altora (pentru copii și animale); dar o astfel de analogie este dificil de reținut, în absența naturii vii a sistemelor [17]. Desigur, răspunderea pentru prejudiciul cauzat de lucruri, mai ales în cazul produselor defecte, poate fi invocată în continuare, pentru o perioadă de tranziție. Rămâne de văzut dacă aceste reguli vor asigura, pe termen lung, un echilibru juridic satisfăcător, atunci când victima-reclamant va întâmpina dificultăți majore în accesarea diferitelor tehnici digitale pentru a demonstra cauzalitatea acestora cu daunele suferite. La fel, în timpul desfășurării justiției digitale (justiția predictivă care anticipează și prezintă avocaților probabilitatea deciziilor judiciare, software-uri care ajută magistrații să decidă cu privire la eliberarea condiționată a condamnaților etc.), ar putea fi avute în vedere noi tipuri de responsabilități, asociate cu daune specifice tehnologiei digitale și cu noi tipuri de probe, atât în ceea ce privește funcționarii din instanță care folosesc aceste noi tehnici, cât și în ceea ce privește apariția unor noi "actori" (*start-up-uri*, specialiști IT, roboții care înlocuiesc parțial avocații și magistrații). De exemplu, în materia probelor, trasabilitatea digitală a tuturor acțiunilor întreprinse de părțile unui contract, influențează repartizarea responsabilităților în cazul unor activități interdependente care au condus la acțiunea vătămătoare etc. [15]. Și toate acestea în condițiile responsabilității ale cărei conotații *ex ante* și *ex post* încercăm să le decelăm mai departe.

4.2. Responsabilitatea ex ante

Pentru a genera încredere socială în IA, responsabilitatea trebuie să existe *ex ante* („condiții de admisibilitate") și *ex post* (după apariția daunelor generate de IA) și în scopul garantării unui cadru responsabil și incluziv pentru IA, trebuie luată în considerare responsabilitatea *ex ante*, adică aplicarea regulilor începând cu *proiectarea sistemelor,* cu scopul de a minimiza sau chiar evita apariția daunelor. La nivel european, mai ales, s-au conturat două abordări privind responsabilitatea: o primă abordare se concentrează pe explicabilitatea și transparența deciziilor luate, prin acordarea unui *drept la explicație,* în timp ce o a doua evaluează impactul socio-economic al sistemului pentru a verifica loialitatea, explicabilitatea, audibilitatea, responsabilitatea și acuratețea. Cert este că multe voci sunt ridicate în doctrina internațională pentru a cere mai multă transparență, explicabilitate și loialitate (nediscriminare) a sistemelor de IA [18].

Din această perspectivă, Uniunea Europeană acordă persoanelor fizice dreptul de a nu face obiectul unei decizii bazate exclusiv pe prelucrarea automată, inclusiv crearea de profiluri, care produce efecte juridice care privesc persoana vizată sau o afectează în mod similar într-o măsură semnificativă. Sunt prevăzute excepții [art. 22 alin. (2)], însoțite de garanții, legate de dreptul de a obține intervenția umană, de a-și exprima punctul de vedere, de a contesta decizia (art. 22 alin.3) și de a primi explicații individuale. Operatorul de date trebuie să asigure, de asemenea, controlul asupra procesării algoritmice și evoluțiilor sale, pentru *a putea explica, în detaliu și într-o formă inteligibilă* persoanei vizate, modul în care a fost efectuată prelucrarea datelor în ceea ce o privește [19]. Prin urmare, nu este posibil să se utilizeze algoritmi capabili să revizuiască singuri regulile pe care le aplică, fără

verificarea și validarea din partea unui controlor uman. În Franța, nici o decizie cu efecte juridice nu poate avea aplicabilitate fără participarea ființei umane în procesul său; însă, în anumite domenii, sunt acceptate decizii complet automatizate emise de o administrație publică (de exemplu, pentru calcularea impozitelor). După cum putem vedea, legiuitorii europeni se concentrează pe dreptul la transparență și pe explicarea deciziilor algoritmice. Cu toate acestea, astfel de drepturi iau în considerare doar o parte a riscurilor sociale și *nu protejează suficient împotriva discriminării sistemice,* în special pentru că explicația este ulterioară deciziei și, prin urmare, intervine *ex post* [20].

4.3. Responsabilitatea ex post – acceptabilă, justificată și "umanizată"

A doua abordare a responsabilității *ex ante* promovează un studiu de impact algoritmic care constă în *evaluarea, înainte de producerea oricărui sistem automatizat de luare a deciziilor,* a posibilului impact social al acestuia și în determinarea nivelurilor de exigență pentru a minimiza riscurile, pentru a se asigura că nu există părtiniri neprevăzute în date și alți factori care ar putea influența în mod nedrept rezultatele. Evaluarea ar trebui revizuită în mod regulat, iar după luarea deciziei, administrația ar trebui să ofere o explicație semnificativă celor afectați cu privire la modul în care a fost luată decizia și de ce a fost luată. Cetățenii canadieni trebuie să aibă toate posibilitățile de a contesta procesul de luare a deciziilor. Administrația trebuie să publice codul sursă, sub rezerva datelor clasificate, precum și informații despre eficacitatea sistemelor în atingerea obiectivelor.

În acest sens, cercetătorii au identificat mai multe cauze care vor îngreuna stabilirea unui sistem de răspundere adecvat tulburărilor generate de activitatea digitală contemporană. Fără îndoială că trebuie luată în considerare influența crescândă a GAFAMI (Google, Apple, Facebook, Amazon, Microsoft, IBM) și BATX (Baidu, Alibaba, Tencent, Xiaomi), jucătorii aflați la originea acestei revoluții. Această influență este susceptibilă să pună sub semnul întrebării suveranitatea statului, termenii reglementării normative și activității judiciare, tinzând la crearea unei suveranități digitale. Marile companii digitale tind să-și creeze propriile reglementări – coduri de conduită și coduri etice; astfel, s-a născut temerea stabilirii unei *justiții paralele,* mai ales că GAFAMI dispune de nenumărate mijloace tehnice capabile să programeze noi tipuri de soluționare a litigiilor [21]. Evoluția responsabilității digitale tinde să răspundă nevoilor imediate și eminamente tehnice, în detrimentul unei abordări umane. Însă, schimbările tehnologice nu trebuie să dăuneze persoanei, deoarece tehnicitatea, oricât de obiectivă și precisă ar fi, poate deveni inumană. Cu alte cuvinte, riscul major care apare în timpul implementării contemporane a responsabilității digitale este dezumanizarea sa.

Regulile clasice de responsabilitate, aplicabile încă, vor fi înlocuite treptat de o responsabilitate digitală specială, care se va dezvolta progresiv. Prin urmare, suntem provocați să realizăm o construcție originală a responsabilității digitale în secolul XXI, care să fie acceptabilă, justificată și "umanizată". Pentru a avea legitimitate, orice utilizare a inteligenței artificiale și a tehnicilor asociate acesteia trebuie să fie însoțită de o garanție umană, combinat cu o responsabilitate socială mai largă. Sub acest aspect, în *Declarația de la Montreal pentru o dezvoltare responsabilă a IA* se afirma, deja din 2018, că, în cazul în care "un prejudiciu a fost cauzat de un SIA [sistem de inteligență artificială] și SIA s-a dovedit a fi fiabil și supus utilizării normale, nu este rezonabil să acuzăm persoanele

implicate în dezvoltarea sau utilizarea acesteia" [22].Compensația pentru daunele cauzate de un risc algoritmic ar intra sub conceptul unei "solidarității naționale", ancorată pe fundamente societale și colective, mai degrabă decât să implice o răspundere individualistă nejustificată a omului. Așadar, pare necesar să reacționăm cu o responsabilitate socială mai largă, lăsând spațiu pentru reflecție etică, la diferite niveluri. Pentru aceasta, este important ca toate părțile interesate să poată dezbate și să se poată pronunța asupra utilizării IA: cetățeni, actori economici (*start-up-uri,* giganți digitali), universitari, instituții publice (judiciare, fiscale, sociale), încurajând reflecția colectivă asupra scopurilor tehnologiei digitale și asupra responsabilităților digitale conexe. Există diverse proceduri: fie un grup de experți elaborează un proiect pe care îl trimit părților interesate, fie părțile interesate sunt consultate în amonte, participând la dezbateri, răspunzând la chestionare, pentru ca ulterior răspunsurile să fie prelucrate de experți. Apoi, organizații abilitate de autoritățile publice și formate din reprezentanți ai tuturor părților interesate derulează o procedură de *certificare,* cu scopul de a atesta că inteligența artificială este "demnă de încredere". Noile mecanisme de responsabilitate legală și ipoteza IA responsabilă vor trebui gândite și realizate la scară internațională, mondială, nu mai la nivel european, dată fiind internaționalizarea jucătorilor digitali, a *cloud-urilor,* a platformelor gestionate în principal de giganții digitali precum GAFAMI și BATX [15].

5. În loc de concluzii, despre avantajele și dezavantajele digitalizării sistemului judiciar românesc

În prezent, ne aflăm într-o primăvară a inteligenței artificiale și numai timpul ne va arăta dacă aceasta va duce la realizarea unei inteligențe generalizate. Cu toate acestea, ceea ce este în general acceptat și de necontestat este faptul că digitalizărea sistemului judiciar românesc reprezintă cel mai important progres în cercetarea din domeniul inteligenței artificiale în patria noastră. Această tehnologie va spori eficiența, inteligența și capacitatea de reacție a fiecărei aplicații, iar mișcările mediului de *business* din jurul *startup*-urilor din domeniul *IT/AI* par a fi vârful de lance al tuturor acestor inițiative [5]. Prin urmare putem spune că am pășit într-o nouă eră fiind îndreptățiți să credem că că schimbările tehnologice vor produce mutații importante și în justiția din România. Având în vedere punctul de cotitură în care ne aflăm, respectiv momentul în care justiția tradițională este înlocuită ușor, ușor de justiția digitală, am considerat oportună prezentarea avantajelor și dezavantajelor digitalizării sistemului judiciar românesc, urmând ca analiza acesora să fie făcută într-un viitor studiu de sine stătător. Așadar, într-o scurtă enumareare enunțiativă și nu exhaustivă avantajele E-Justice sunt:

1. *Promovarea sinergiilor naționale și europene.*
2. *Accesul persoanelor fizice și juridice la justiție în Europa,* manifestând interes deosebit față de:
    - Accesul la informație: necunoașterea legislației altor state membre este unul dintre factorii majori care împiedică oamenii să își afirme drepturile într-un alt stat din cadrul UE, prin furnizarea de informații cetățenilor europeni în propria lor limbă privind sistemele și procedurile judiciare din întreaga Uniune Europeană.
    - Identificarea instanței competente. Acest lucru reduce întârzierile și minimalizează riscul de respingere a cauzelor pentru necompetență

materială și teritorială, în special în cazul speţelor cu componentă transfrontalieră.

- Accesul la instanţă cu ajutorul site-ul web care oferă răspunsuri la numeroasele și variatele probleme cu care se poate confrunta o persoană implicată într-o procedură judiciară: în ce stat membru trebuie sesizată problema, modul de sesizare a instanţei, legea aplicabilă, costurile procedurii (taxe), punerea în executare a hotărârii instanţei etc.
- Proceduri specifice de dreptul familiei: armonizarea legislaţiilor naţionale și a procedurilor legale facilitează cetăţenii europeni să își exercite drepturile, chiar dacă au locuit în diferite ţări din UE, precum și proceduri privind creanţe financiare, în cazurile în care există o dimensiune transfrontalieră pentru cererile de plată.

3. *Cooperarea judiciară mai eficientă,* prin crearea de instrumente electronice care ar trebui să însoţească punerea în aplicare a instrumentelor de cooperare judiciară în cadrul Uniunii Europene.
4. *Facilitarea utilizării videoconferinţei.* Deși multe acte adoptate la nivel european permit utilizarea videoconferinţei în procedurile judecătorești, tehnologia nu a fost complet exploatată, din motive culturale, lingvistice sau tehnice, în ciuda avantajelor evidente pe care utilizarea acestui mijloc le are raportat la costuri, deplasări și flexibilitate.
5. *Continuarea interconectării cazierului.* Odată cu mobilitatea sporită a persoanelor și a afacerilor peste graniţele naţionale, este necesar să se faciliteze accesul furnizorilor, creditorilor, partenerilor corporativi și consumatorilor la informaţii fiabile pentru a spori transparenţa și securitatea juridică în toate ţările UE.
6. *Punerea în executare a hotărârilor judecătorești.* În funcţie de reglementările naţionale existente, există mai multe instrumente care pot fi utilizate pentru a se pune în executare hotărâri judecătorești. De exemplu, titlul executoriu european este o procedură care poate fi folosită pentru cererile necontestate pentru a facilita recunoașterea transfrontalieră și executarea hotărârilor judecătorești.
7. *Asistenţă pentru traducere.* Dezvoltarea unei adevărate zone judiciare europene este o provocare majoră. Procesele juridice se desfășoară aproape exclusiv în limba naţională, iar utilizarea unei limbi străine este permisă doar cu titlu de excepţie [23]. În ciuda entuziasmului pe care nu încercăm să îl disimulăm, o abordare obiectivă a unui subiect de cercetare impune și prezentarea aspectelor negative, mai mult sau mai puţin pregnante ale acestuia. Astfel, în ciuda avantajelor evidente, îmbrăţișarea de către sistemul judiciar a conceptelor de justiţie telematică și digitalizată, îl expune pe acestea unui set de factori de risc asociaţi cu dezvoltarea și implementarea unor mijloace și instrumente ce funcţionează în baza tehnologiei informaţiei [24], cum ar fi:
    - Deficienţe în faza de proiectare iniţială și controlul continuu al dezvoltării AI. Dacă arhitectura digitală iniţială a sistemului este planificată defectuos din cauza perceperii sau interpretării greșite ale cerinţelor, întregul proiect poate fi în pericol. Analiza acestui factor de risc relevă faptul că o importanţă foarte mare o poate avea și tipul echipei de

proiectare/dezvoltare: intern sau externalizat. Apoi, este foarte important și modelul de întreținere/mentenanță a sistemului informatic utilizat.

- Pregătirea corespunzătoare/instructajul utilizatorilor, viziunea informatică generală, abilitățile tehnice ale utilizatorilor sunt de asemenea, factori de risc privind digitalizarea eficientă a sistemului judiciar. Soluția pentru minimalizarea acestor factori de risc o reprezintă trainingurile realizate de echipa de proiectare cu utilizatorii: judecători, procurori și personalul administrativ și utilizarea unui limbaj informatic simplificat. Totodată, pentru a răspunde nevoilor și așteptărilor utilizatorilor, în echipa de proiectare/dezvoltare a sistemului informatic este inclus un așa-numit "traducător" pentru întrebări juridice complexe (pentru echipele IT) și un "traducător" pentru întrebările legate de sistemul informatic (pentru utilizatorii juriști).
- Introducerea sistemelor informatice sau, mai bine zis, digitalizarea unei structuri sau a unui sistem (judiciar), va determina schimbarea sistemului/structurii înseși. Oamenii din sistemul judiciar trebuie să fie conștienți de aceste schimbări și mai ales de inevitabilitatea lor. Pentru a evita șocurile legate de utilizarea noilor sisteme informatice, potențialii utilizatori ar trebui să participe constant la sesiuni de formare/instruire. Având în vedere că AI evoluează, iar utilizatorii tind să uite unele dintre abilitățile învățate anterior, pregătirea/instruirea ar trebui să fie desfășurate continuu, cu regularitate (ex. cu frecvență trimestrială, anuală etc.), sau atunci când este nevoie (ex. când se schimbă interfața sau se introduce un software nou).

Toate aceste aspecte negative pot părea înfricoșătoare și pot genera nemulțumire printre utilizatori, în special pentru utilizatorii ale căror competențe și deprinderi tehnice s-au format într-un trecut mai îndepărtat. Întotdeauna utilizatorii tineri au fost cei mai entuziaști susținători ai schimbării de orice fel, ca regulă. Pregătirea continuă, participarea la programe de training necesită timp, și uneori resurse financiare, însă, o strategie de digitalizare a sistemului de justiție, gândită eficient pe termen mediu și lung, ar putea oferi soluții pentru înlăturarea acestor neajunsuri. S-ar putea gândi, spre exemplu, o specializare a judecătorilor sau a personalului administrativ, s-ar putea introduce cursuri de formare IT la institutele de pregătire profesională specifice ale acestora sau s-ar putea oferi recompense financiare sau non-financiare persoanelor din sistem care doresc să modernizeze actul de justiție. Sunt numai câteva sugestii pe care, la o scurtă reflecție, le-am găsit oportun a fi făcute. Evident că un grup de specialiști ar putea identifica mult mai multe, este nevoie doar de voință. Așa cum arăta un distins coleg, "*indiferent dacă acceptăm sau nu, inovațiile progresului vor atinge, cuprinde și chiar întrece inclusiv înfăptuirea actului de justiție, ceea ce avem de făcut fiind doar să ne integrăm mai repede sau mai lent"* [25]. Prin urmare, aceste sisteme inteligente denumite IA care s-au dezvoltat și se vor dezvolta în viitor cu o rapiditate surprinzătoare, în toate domeniile de activitate, au deja și vor avea un impact foarte mare asupra vieții sociale.

Dezvoltarea ei poate fi de ajutor omenirii pentru a face ca societatea să funcționeze la nivel administrativ mai bine, să diagnosticheze și să vindece boli, să crească speranța de viață,

să ajute persoanele cu dizabilități, să înțeleagă mai bine și mai repede totul, ba chiar să facă noi descoperiri pe care să le poată aplica mai repede ducând astfel omenirea pe un alt nivel de conștiință. De asemenea, considerăm că nu trebuie ignorate avertismentele specialiștilor în ce privește forța pe care o poate avea IA și care sunt pericolele la care umanitatea se poate expune. Pentru a fi permanent atenți este necesar ca educația inițială și continuă, cercetarea să fie considerate o prioritate pentru a putea ține pasul cu noua tehnologie care, să nu uităm, poate învăța singură cu o viteză mult superioară ființei umane. Așadar, îmbinarea vieții profesionale cu viața personală este importantă pentru dezvoltarea armonioasă a individului și implicit a societății în contextul dezvoltării foarte rapide a noilor tehnologii. Respectarea vieții private, protecția ei, crează un echilibru în societate, așa că, trebuie acordată o permanentă atenție domeniului legislativ și îmbunătățirea lui continuu în paralel cu dezvoltarea foarte rapidă a tehnologiei [23]. Deși nu putem vorbi despre o modernizare generală, considerăm că această reforma digitală se va extinde, în termen scurt sau mediu, în toate instanțele din România. În fine, pentru a nu ne plasa împotriva curentului tehnologic, care indubitabil va acapara lumea juridică, trebuie să schimbăm viziunea rigidă care este larg răspândită și să îmbrățișăm inteligența artificială și toate beneficiile cu care vine la pachet. Deși schimbarea poate fi privită drept o mare provocare, consider că viitorul sistemului juridic se va reflecta într-o sinergie perfectă între inteligența artificială și inteligența umană, iar dăinuirea în timp și succesul fiecăruia vor fi în legătură directă cu modul în care vom reuși să ne adaptăm acestor schimbări.

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Integrated European – level measures regarding artificial intelligence in relation to human rights

Georgiana Mădălina MIHĂILĂ,
PhD. student, National University of Political Studies and Public Administration (SNSPA), Public Administration Faculty, Bucharest, Romania
georgiana.mihaila@administratiepublica.eu

Abstract
This paper explores the integrated measures adopted at the European level to regulate the use of artificial intelligence (AI) in order to ensure that human rights are respected and protected. The influence of artificial intelligence in various domains, from the economy to social life, has grown considerably. With this in mind, the European Union (EU) has developed a legislative and regulatory framework to enable the use of these advanced technologies without prejudice to human dignity, fundamental freedoms and human rights. This includes the implementation of a risk-based approach, which classifies AI applications according to their potential impact on individual rights and freedoms. In addition, the EU promotes training and education on the ethical use of AI. Improving the digital skills needed in Europe is essential so that citizens can benefit from new technologies to their advantage and avoid their potential pitfalls. The research underlines the importance of a formal framework leading to an AI-based ecosystem that promotes innovation, but at the same time respects fundamental human values and rights. Artificial intelligence can significantly improve the quality of life of citizens, but associated risks and good risk prevention measures must be considered. The prudent use of new technologies is an issue of concern to countries around the world, which is why international cooperation initiatives are essential to harmonise global standards and promote responsible AI governance. The European Union aims to develop citizens who are able to navigate and positively influence technological development without being affected by their fundamental rights, which has a significant long-term impact in a society that wants to be anchored to new realities but also maintain social equity.

Keywords: protecting citizens in the context of new technologies, AI risks, education and digital skills.

1. Introduction and conceptual delimitations

Societies are evolving at a rapid pace and these changes must support the people who form them, without harming them, especially in terms of rights and freedoms. In the context of the development of new technologies, the presence of artificial intelligence is increasingly present in people's everyday lives.

The concept of artificial intelligence (AI) refers to systems that "exhibit intelligent behaviour by analysing their environment and taking action, somewhat autonomously, to achieve specific goals" [1]. Its presence in our lives has grown over time, influencing private, social and political life. [2] Although it is a fundamental element of the ideas of reforming communities and its potential is well known, the use of artificial intelligence presents a number of risks, as well as effects that can be classified as negative. From this perspective, we would mention the impact that artificial intelligence could have on fundamental rights such as privacy, dignity, freedom of expression, movement, security and data protection. [3]

The use of artificial intelligence is intended to improve the lives of citizens, including through the provision of quality healthcare, safer transport, products and services tailored to their needs, increased accessibility of information and resources for education and training. In the private sector, artificial intelligence can underpin both the development of

new products and services and improve the management of work and related resources. There are also major contributions in crucial areas of current interest at European level, such as the green and circular economy, agriculture, tourism, medicine, etc. Involving AI in improving public services could also lead to cost reduction and increased performance, with benefits both for the human resource that makes up public administrations and for citizens. AI can be used to revolutionise areas such as “public transport, education, energy and waste management, and can improve the sustainability of products”. [4]

Unfortunately, however, the under- or over-use of artificial intelligence can be a danger, leading either to problematic implementation and failure to meet objectives, or to the generation of new problems, which underlines the need for balance in their use and a good understanding of them. Liability for the damage that AI could cause is also one of the controversial issues in this area, also affecting citizens' trust in new technologies. At the same time, opinions on the effects of AI on democracy are controversial, and can be both positive in terms of increased engagement, information and transparency, and negative in terms of the algorithms of social media platforms that automatically sort the information that reaches the user. [4]

On the labour side, AI has created dissension because it could lead to the elimination of a significant number of jobs, even if at the same time it will allow the creation of new jobs and the improvement of existing ones. Education could not be bypassed by AI, and the use of artificial intelligence could play a key role in preventing unemployment and qualifying people. [4]

The relationship between new technologies, including artificial intelligence, and human rights has not been uniformly established in the literature and among practitioners, as it is complex and can be influenced by a multitude of factors. It is precisely the novelty of this topic that poses challenges to its study, as it is a topic of interest with long-term impact. [5] The presence of AI in all daily activities is arousing interest and encouraging research, being part of the new reality for which the world needs to be prepared through knowledge.

2. Artificial intelligence at EU level

In order both to allow artificial intelligence to be used to its full potential and to prevent possible negative effects and human rights infringements, regulation is necessary. The lack of a legal framework that provides clarity on the concept and includes rules on the limits of data use could lead to poor use of AI and a human rights imbalance. The regulatory framework should also take into account how the impact of AI is monitored, the liability for breaches and possible sanctions. [6]

In view of these considerations, there is a growing concern at European level among international bodies to produce recommendations, studies and reports on artificial intelligence, its impact on human rights and the action that should be taken. [7] The presence of artificial intelligence is not just an individual issue for some European countries, but part of the evolution of society in general, which is why a regulatory framework at European level is imperative.

The European Commission's own Communication COM/2018/237 on Artificial Intelligence for Europe stated that “the European Union needs to provide for a coordinated approach to artificial intelligence in order to achieve maximum results, but also to be able to meet the challenges it brings”. [1].

Prior to this communication, the European Economic and Social Committee stated in its opinion 2017/C 288/01 [8] that artificial intelligence crosses borders, and for this reason the appropriateness of global regulation must be assessed. AI regulation must draw clear boundaries so that fundamental rights and social values are not affected.

In all the measures taken, the European Union has taken into account the stimulation of industry and research through artificial intelligence, taking into account safety and fundamental human rights. Transforming the EU through artificial intelligence was set out in *the European AI Strategy* [1] in 2018 and considered the importance of the human factor in the process. [9]

2018 also saw the establishment of an Artificial Intelligence Expert Group, AI HLEG, to advise the Commission on the process of setting up a “European Alliance for Artificial Intelligence”, to facilitate the implementation of the European AI Plan and to generate a proposal for a document on the ethics and use of AI in relation to fundamental rights, both EU and Charter of Fundamental Rights. [10]

This group of experts published in 2019 the components that AI must meet to be considered trustworthy, namely legality, compliance with ethical principles and values, and resilience, technically and socially. The verification of the 3 components is done through an analysis of 7 requirements: 'human involvement and oversight; technical robustness and security; privacy and data governance; transparency; diversity, non-discrimination and fairness; societal and environmental well-being; accountability. [7]

Given the emergence of the field, the year 2021 marked new steps in artificial intelligence, namely: the Commission Communication on promoting a European approach to AI; a review of the coordinated Plan on Artificial Intelligence; the European Commission proposal for a Regulation laying down harmonised rules on AI and relevant impact assessment (the Regulation will be formally adopted in 2024). Concern for human rights is directly reflected in three interlinked legal initiatives, namely: a European legal framework for AI to address fundamental rights and safety risks; a framework on civil liability – adapting liability rules in the digital age and AI; a review of sectoral safety legislation (relating to technical equipment, safety, etc.). [9]

In its actions, the European Commission has taken into account the risks that AI poses and has sought to address them through a specific set of rules so as to play a leading role in AI worldwide. Divided into four categories of risks (unacceptable, high, limited, minimal/non-existent), the use of AI-based systems that affects safety, livelihoods and human rights is clearly prohibited. The high degree of risk of AI systems entails specific and strict obligations to be considered, limited risks must comply with specific

transparency requirements, and minimal or non-existent risks are not subject to specific requirements. [11]

The regulations aimed to protect rights such as “non-discrimination, the right to human dignity, respect for privacy and protection of personal data, equality between women and men, freedom of expression, freedom of assembly, the right to an effective remedy and to a fair trial" [3].

3. Education, a long-term measure

The measures taken at EU level are not only intended to set formal parameters for the use of artificial intelligence and prevent possible negative effects, but also to address the impact of artificial intelligence in a pragmatic and long-term way. From this perspective, the European Commission has generated a comprehensive plan to improve the skills needed in Europe as early as 2016. Acquiring and upgrading digital skills among citizens was part of the Commission's Recommendation to Member States. In this learning context, the Commission's concern for digital education cannot be ignored, wanting to exploit the effects of artificial intelligence in learning and training programmes. [1] Training European citizens is essential in facilitating the understanding and use of new technologies to their advantage, avoiding their potential pitfalls.

Thus, the European Commission has taken a human-centred approach to artificial intelligence, giving particular importance to digital skills. From this perspective, the priorities are nurturing talent and improving skills, developing a policy framework to ensure trust in artificial intelligence systems, and promoting the EU's vision of artificial intelligence in the world through the lens of sustainability and trust.

Looking at basic digital skills, Figure 1 shows the digital skills situation for the 16-74 age group in 2023. Thus, with an EU average of 55.6%, we see that although society has evolved at an accelerated pace and digitisation and artificial intelligence are increasingly making their presence felt in people's daily lives, preparing people for the digital age remains an area for improvement, especially in the countries at the bottom of the league table.

Digital competence indicators are an essential element of the key performance indicators in the context of the Digital Decade for Europe and the EU's “Digital Agenda”. According to this initiative, more than 20 million information and communication technology (ICT) specialists are expected to be reached by 2030, with an equitable gender distribution. It also aims to ensure that at least 80% of the population have basic digital skills. In addition, a full digitisation of public services is targeted, including full online access to essential public services, ensuring that all citizens have access to health records and that 80% of citizens obtain and use their digital identity. [12]

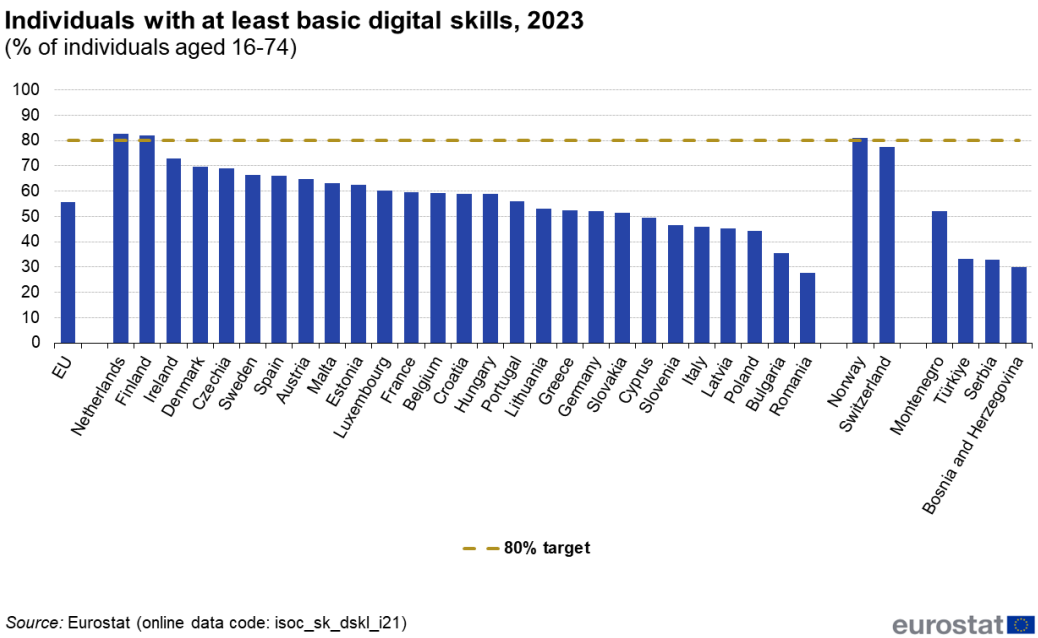

Fig. 1. People with at least basic digital skills, 2023 (% of individuals aged 16-74)
Source: Eurostat [13]

4. Conclusions and final considerations

Societies are evolving at a rapid pace through technology, and even as trends and citizens' needs change, ensuring their fundamental rights remains a priority that cannot be ignored. The presence of artificial intelligence-based systems and the habituation to them is increasingly felt in everyday life. Although their purpose is to improve and simplify our lives, they must be used in accordance with clear rules, so as to ensure that good intentions exist and possible negative effects are minimised.

Although artificial intelligence is ubiquitous, there has not been a concomitant process of human training. The use of AI and new technologies has a direct impact on the whole population, and reaching their full potential depends on people's ability to exploit them and keep up with their evolution. Educating, training and developing human resources is essential for future sustainable societies. From this perspective, preparing citizens for the digital age should be a priority for countries around the world, especially in relation to the impact that digitisation and the use of artificial intelligence will have on the field of work.

The regulations found at EU level are essential as this is an issue that crosses borders and requires an integrated perspective. The feasibility and quality of the measures could make the European Union a global benchmark for artificial intelligence technologies.

Moreover, the role of national laws is crucial. Each state must put in place procedures that allow the relevant authorities to assess the impact of AI-based systems on human rights. [14]

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Măsuri integrate la nivel european privind inteligența artificială în raport cu drepturile omului

Georgiana Mădălina MIHĂILĂ,
Doctorand, Școala Națională de Studii Politice și Administrative (SNSPA), Facultatea de Administrație Publică, București, România
georgiana.mihaila@administratiepublica.eu

Abstract
Prezenta lucrare explorează măsurile integrate adoptate la nivel european în ceea ce privește reglementarea utilizării inteligenței artificiale (IA), astfel încât să se asigure o respectare și protejare a drepturilor omului. Influența inteligenței artificiale în diverse domenii, de la economie la viața socială, a crescut considerabil. Din această perspectivă, Uniunea Europeană (UE) a dezvoltat un cadru legislativ și normativ care să permită utilizarea acestor tehnologii avansate fără a aduce atingere demnității umane, a libertăților fundamentale și a drepturilor omului. Printre aceste măsuri se numără implementarea unei abordări bazate pe riscuri, care clasifică aplicațiile IA în funcție de potențialul lor impact asupra drepturilor și libertăților individuale. În plus, UE promovează formarea și educația privind utilizarea etică a IA. Îmbunătățirea competențelor digitale necesare în Europa este esențială, astfel încât cetățenii să beneficieze de noile tehnologii în avantajul lor, evitând posibile capcane ale acestora. Cercetarea subliniază importanța unui cadru formal care să conducă la un ecosistem bazat pe inteligență artificială care promovează inovația, dar care, concomitent, respectă valorile și drepturile fundamentale ale omului. Inteligența artificială poate îmbunătăți semnificativ calitatea vieții cetățenilor, însă trebuie avute în vedere riscurile asociate și o bună prevenție a acestora. Utilizarea cu prudență a noilor tehnologii este o problematică ce preocupă statele din întreaga lume, motiv pentru care inițiativele de cooperare internațională sunt esențiale pentru armonizarea standardelor globale și promovarea unei guvernanțe responsabile a IA. Uniunea Europeană are în vedere formarea unor cetățeni capabili să navigheze și să influențeze pozitiv dezvoltarea tehnologică, fără a le fi afectate drepturile fundamentale, aspect cu un impact semnificativ pe termen lung, într-o societate ce se dorește a fi ancorată la noile realități, dar care menține echitatea socială.

Cuvinte cheie: protejarea cetățenilor în contextul noilor tehnologii, riscuri ale IA, educație și competențe digitale.

1. Introducere și delimitări conceptuale
Societățile evoluează într-un ritm accelerat, iar aceste transformări trebuie să vină în sprijinul oamenilor care le formează, fără a le aduce prejudicii, mai ales în materie de drepturi și libertăți. În contextul dezvoltării noilor tehnologii, prezența inteligenței artificiale se regăsește din ce în ce mai mult în viața de zi cu zi a cetățenilor.

Conceptul de inteligență artificială (IA) vizează sistemele care "manifestă comportamente inteligente prin analizarea mediului lor înconjurător și care iau măsuri, într-o oarecare măsură în mod autonom, în vederea atingerii unor obiective specifice" [1]. Prezența acesteia în viețile noastre a crescut de-a lungul timpului, influențând viața privată, socială și politică. [2] Cu toate că reprezintă un element fundamental al ideilor de reformare a comunităților cunoscându-i-se potențialul, utilizarea inteligenței artificiale prezintă o serie de riscuri, dar și de efecte ce pot fi catalogate drept negative. Din această perspectivă, amintim impactul pe care inteligența artificială l-ar putea avea asupra unor drepturi fundamentale precum cel la viață privată, demnitate, libertate de expresie, mișcare, securitate și protecția datelor. [3]

Utilizarea inteligenței artificiale are menirea de a îmbunătăți viața cetățenilor, inclusiv prin oferirea unor servicii calitative de asistență medicală, transport mai sigur, produse și servicii adaptate nevoilor acestora, creșterea accesibilității informațiilor și resurselor necesare educării și formării. Raportat la mediul privat, inteligența artificială poate sta atât la baza dezvoltării de noi produse și servicii, cât și la îmbunătățirea managementului muncii și a resurselor aferente. Contribuțiile sunt majore și în domenii cruciale și de interes în prezent la nivel European, precum economia verde și circulară, agricultura, turismul, medicina etc. Implicarea IA în îmbunătățirea serviciilor publice ar putea conduce, de asemenea, la o reducere a costurilor și la creșterea performanțelor, existând atât avantaje pentru resursa umană care formează administrațiile publice, cât și pentru cetățeni. IA poate fi utilizată pentru a revoluționa domenii precum "transportul public, educația, gestionarea energiei și a deșeurilor, și poate îmbunătăți durabilitatea produselor". [4]

Din păcate însă, uzul redus sau excesiv al inteligenței artificiale poate reprezenta un pericol, conducând fie la o implementare problematică și la neîndeplinirea obiectivelor, fie la generarea unor noi probleme, ceea ce subliniază că se impune un echilibru în utilizarea acestora și o bună cunoaștere a lor. Responsabilitatea aferentă daunelor pe care IA le-ar putea cauza face parte, de asemenea, din subiectele controversate în acest domeniu, afectând și încrederea pe care cetățenii o acordă noilor tehnologii. Concomitent, sunt controversate opiniile asupra efectelor IA asupra democrației, putând fi atât pozitive prin prisma creșterii gradului de implicare, informare și transparență, cât și negative raportate la algoritmii platformelor de socializare care sortează automat informația care ajunge la utilizator. [4]

În ceea ce privește câmpul muncii, IA a creat disensiuni deoarece ar putea conduce la eliminarea unui număr semnificativ de locuri de muncă, chiar dacă în același timp va permite crearea de noi posturi și îmbunătățirea celor existente. Educația nu ar putea fi ocolită de IA, iar utilizarea inteligenței artificiale ar putea avea un rol esențial în ceea ce privește prevenirea șomajului și calificarea persoanelor. [4]

Relația dintre noile tehnologii, implicit inteligența artificială, și drepturile omului nu a fost unitar stabilită în literatura de specialitate și în rândul practicienilor în domeniu, deoarece este una complexă și poate fi influențată de o multitudine de factori. Tocmai noutatea acestui subiect lansează provocări în ceea ce privește studierea lui, fiind un subiect de interes cu impact pe termen lung. [5] Prezența IA în toate activitățile cotidiene stârnește interes și încurajează cercetările, făcând parte din noua realitate față de care lumea trebuie să fie pregătită prin cunoașterea ei.

2. Inteligența artificială la nivelul Uniunii Europene

Pentru a permite atât utilizarea inteligenței artificiale la potențialul său maximal, cât și pentru a preveni posibilele efecte negative și afectarea drepturilor omului, reglementările în materie sunt necesare. Lipsa unui cadru juridic care să asigure claritate asupra conceptului și care să cuprindă norme asupra limitelor în utilizarea datelor ar putea conduce la o utilizare deficitară a IA și la un dezechilibru în materie de drepturile omului. Cadrul normativ trebuie să aibă în vedere și modul în care este urmărit impactul pe care IA îl are, răspunderea asupra încălcării normelor și sancțiunile posibile. [6]

Având în vedere aceste considerente, la nivel european poate fi remarcată o preocupare din ce în ce mai crescută a organismelor internaționale în ceea ce privește elaborarea de recomandări, studii și rapoarte referitoare la inteligența artificială, impactul ei asupra drepturilor omului și acțiunile ce ar trebui întreprinse. [7] Prezența inteligenței artificiale nu este o problematică individuală doar a unor state europene, ci face parte din evoluția societății în general, motiv pentru care un cadru de reglementare la nivel european este imperios.

Chiar în Comunicarea Comisiei Europene COM/2018/237 privind Inteligența artificială pentru Europa se preciza faptul că "Uniunea Europeană trebuie să prevadă o abordare coordonată a inteligenței artificiale pentru a obține rezultate maxime, dar și pentru a putea face față provocărilor pe care le implică" [1].

Anterior acestei comunicări, Comitetul Economic și Social European preciza în cadrul avizului 2017/C 288/01 [8] că inteligența artificială depășește granițele, iar din acest considerent trebuie evaluată oportunitatea unor reglementări la nivel global. Reglementările privind IA trebuie să traseze limite clare, astfel încât să nu fie afectate drepturile fundamentale și valorile sociale.

În toate măsurile întreprinse, Uniunea Europeană a avut în vedere stimularea industriei și cercetării prin prisma inteligenței artificiale ținând cont de siguranța și drepturile fundamentale ale oamenilor. Transformarea UE prin intermediul inteligenței artificiale a fost prevăzută în *Strategia europeană privind IA* [1] din anul 2018 și a luat în considerare importanța factorului uman în acest proces. [9]

Anul 2018 a marcat, de asemenea, înființarea unui grup de experți privind inteligența artificială, AI HLEG, având drept atribuții consilierea Comisiei în procesul de constituire a unei "Alianțe europene pentru inteligență artificială", facilitarea punerii în aplicare a Planului european privind IA și generarea unei propuneri de document privind etica și utilizarea IA în raport cu drepturile fundamentale, atât cele ale UE, cât și cele prevăzute de Carta Drepturilor Fundamentale. [10]

Acest grup de experți a publicat în anul 2019 componentele pe care IA trebuie să le respecte pentru a fi considerată de încredere, anume legalitatea, respectarea principiilor și valorilor etice și rezistența, din punct de vedere tehnic și social. Verificarea celor 3 componente se realizează printr-o analiză a unui număr de 7 cerințe: "implicare și supraveghere umană; robustețe tehnică și siguranță; respectarea vieții private și guvernanța datelor; transparență; diversitate, nediscriminare și echitate; bunăstare societală și de mediu; responsabilitate. [7]

Dată fiind emergența domeniului, anul 2021 a marcat noi măsuri în materie de inteligență artificială, anume: Comunicarea Comisiei privind promovarea unei abordări europene a IA; o revizuire a Planului coordonat privind inteligența artificială; propunerea Comisiei Europene de regulament de stabilire a unor norme armonizate privind IA și evaluarea relevantă a impactului (regulamentul fiind oficial adoptat în anul 2024). Preocuparea față de drepturile omului reiese în mod direct din trei inițiative juridice interdependente, anume: un cadru juridic european pentru inteligență artificială pentru a aborda drepturile

fundamentale și riscurile în materie de siguranță; un cadru privind răspunderea civilă – adaptarea normelor privind răspunderea în era digitală și IA; o revizuire a legislației sectoriale privind siguranța (referitoare la echipamente tehnice, siguranță etc.). [9]

În măsurile întreprinse, Comisia Europeană a avut în vedere riscurile pe care IA le presupune, încercând să le combată printr-un set specific de norme, astfel încât să joace rolul de lider mondial în materie de IA. Împărțite în patru categorii de riscuri (inacceptabile, ridicate, limitate, minime/inexistente), este în mod clar interzisă utilizarea unor sisteme bazate pe inteligență artificială care aduc atingere siguranței, mijloacelor de subzistență și drepturilor oamenilor. Gradul ridicat de risc a sistemelor de IA presupune obligații specifice și stricte ce trebuie avute în vedere, riscurile limitate trebuie să respecte cerințe specifice în ceea ce privește transparența, iar cele cu risc minim sau inexistent nu se supun unor cerințe specifice. [11]

Reglementările au avut în vedere protejarea unor drepturi precum "nediscriminarea, dreptul la demnitate umană, respectarea vieții private și protecția datelor cu caracter personal, egalitatea între femei și bărbați, libera exprimare, libertatea de întrunire, dreptul la o cale de atac eficientă și la un proces echitabil" [3].

3. Educația, o măsură pe termen lung

Măsurile întreprinse la nivelul Uniunii Europene nu au rolul doar de a trasa parametrii formali pentru utilizarea inteligenței artificiale și prevenirea posibilelor efecte negative, ci vizează și impactul inteligenței artificiale în mod pragmatic și pe termen lung. Din această perspectivă, Comisia Europeană a generat încă din anul 2016 un plan exhaustiv de îmbunătățire a competențelor necesare în Europa. Dobândirea și actualizarea competențelor digitale în rândul cetățenilor a făcut parte din Recomandarea Comisiei pentru statele membre. În acest context al învățării nu poate fi ignorată preocuparea Comisiei pentru educația digitală, dorind să exploateze efectele inteligenței artificiale în programele de învățare și formare. [1] Pregătirea cetățenilor europeni este esențială în facilitarea înțelegerii și utilizării noilor tehnologii în avantajul acestora, evitând posibile capcane ale acestora.

Astfel, Comisia Europeană și-a asumat o abordare centrată pe factorul uman în raport cu inteligența artificială, conferind o deosebită importanță competențelor digitale. Din această perspectivă, reprezintă priorități cultivarea talentelor și îmbunătățirea abilităților, elaborarea unui cadru de politică pentru asigurarea încrederii în sistemele de inteligență artificială și promovarea viziunii UE în lume asupra inteligenței artificiale prin prisma durabilității și încrederii.

Dacă ne raportăm la abilitățile digitale de bază, figura 1 pune în evidență situația competențelor digitale aferente intervalului de vârstă 16-74 de ani în anul 2023. Astfel, cu o medie a Uniunii Europene de 55,6% constatăm că deși societatea a evoluat într-un ritm accelerat, iar digitalizarea și inteligența artificială își fac din ce în ce mai mult simțită prezența în viața de zi cu zi a cetățenilor, pregătirea cetățenilor pentru era digitală rămâne un element ce trebuie îmbunătățit, mai ales în statele care se află la finele clasamentului.

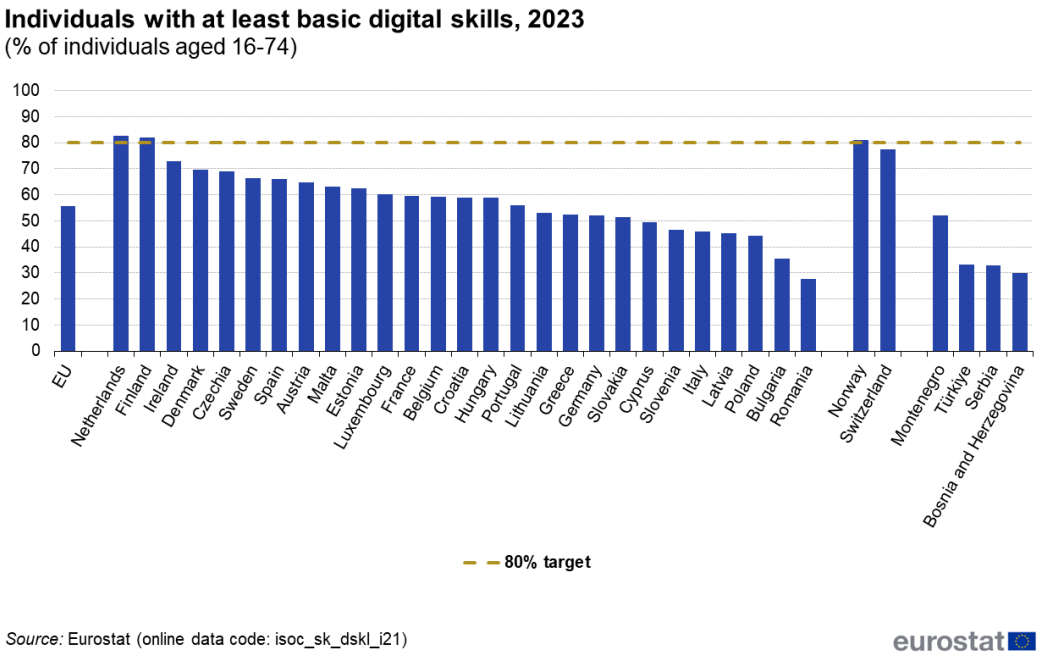

Fig. 1. Ponderea adulților care au cel puțin abilități digitale de bază, în funcție de țară, 2023 (Notă: % dintre persoanele cu vârstă cuprinsă între 16 și 74 de ani)
Sursă: Eurostat [12]

Indicatorii competențelor digitale constituie un element esențial al indicatorilor cheie de performanță în contextul Deceniului Digital al Europei și al "Busolei pentru dimensiunea digitală" a Uniunii Europene. Conform acestei inițiative, până în anul 2030 se preconizează atingerea a peste 20 de milioane de specialiști în tehnologia informației și comunicațiilor (TIC), cu o distribuție echitabilă pe criterii de gen. De asemenea, se urmărește ca minimum 80% din populație să posede competențe digitale de bază. În plus, se vizează o digitalizare completă a serviciilor publice, incluzând accesul online integral la serviciile publice esențiale, asigurarea accesului tuturor cetățenilor la dosarele medicale și obținerea și utilizarea identității digitale de către 80% dintre cetățeni. [13]

4. Concluzii și considerații finale

Societățile evoluează într-un ritm alert prin prisma tehnologiilor și chiar dacă tendințele și nevoile cetățenilor se schimbă, asigurarea drepturilor fundamentale ale acestora rămâne o prioritate ce nu ar putea fi ignorată. În viața cotidiană se resimte din ce în ce mai mult prezența sistemelor bazate pe inteligență artificială și obișnuința deprinsă față de acestea. Cu toate că menirea lor este de a ne îmbunătăți și simplifica viața, utilizarea lor trebuie să aibă loc cu respectarea unor norme clare, astfel încât să garanteze existența intențiilor bune și diminuarea posibilelor efecte negative.

Cu toate că inteligența artificială este omniprezentă, nu a avut loc concomitent un proces de pregătire a oamenilor. Utilizarea IA și a noilor tehnologii se răsfrânge în mod direct asupra întregii populații, iar atingerea potențialului lor maxim depinde de capacitatea oamenilor de a le exploata și de a ține pasul cu evoluția lor. Educarea, formarea și

dezvoltarea resurselor umane este esențială pentru viitoare societăți durabile. Din această perspectivă, pregătirea cetățenilor pentru era digitală ar trebui să reprezinte o prioritate a statelor din întreaga lume, mai ales în raport cu impactul pe care digitalizarea și utilizarea inteligenței artificiale o va avea asupra câmpului muncii.

Reglementările regăsite la nivelul Uniunii Europene sunt esențiale având în vedere că reprezintă o problematică ce depășește granițele și impune o perspectivă integrată. Fezabilitatea și calitatea măsurilor ar putea plasa Uniunea Europeană drept un reper la nivel global în materie tehnologii bazate pe inteligență artificială.

Mai mult decât atât, rolul legislațiilor naționale este unul crucial. Fiecare stat trebuie să pună bazele unor proceduri care să permită autorităților competente să evalueze impactul sistemelor bazate pe IA asupra drepturilor omului. [14]

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Hyperconnected horizons: decoding the digital sovereignty of european smart cities

Adrian-Victor VEVERA,
National Institute for Research and Development in Informatics, ICI-Bucharest, Romania,
victor.vevera@ici.ro

Ulpia-Elena BOTEZATU,
National Institute for Research and Development in Informatics, ICI-Bucharest, Romania,
ulpia.botezatu@ici.ro

Abstract
This article explores the intersection of governance policies and technological advancements in the context of smart cities, engaging with the entwined concepts of smart cities and digital sovereignty within the European landscape. Employing a poststructuralist lens, it critically examines the ramifications of stringent regulations on the incorporation of innovative technologies in smart cities. The analysis navigates divergent national perspectives, emphasizing the tension between digital sovereignty and an open-market ethos. Through nuanced exploration and case studies, the article seeks to unravel the complexities inherent in reconciling these paradigms, offering insights for policymakers, urban planners, and technology stakeholders navigating the intricate terrain of Smart City development amid Europe's pursuit of digital sovereignty. This succinct exploration contributes to academic discourse by fostering a critical dialogue around the intersectionality of technological innovation, governance, and urban development within the contemporary European context.

Keywords: digital sovereignty, smart cities, smart governance, ICT, technological innovation.

1. Introduction
The rapid advancement of the digital era has brought about significant changes in urbanization, giving rise to smart cities that utilize advanced technologies to optimize efficiency, sustainability, and the well-being of citizens. In the European context, the concept of digital sovereignty and its implications for cloud services has emerged as a crucial topic of discussion [1, 2]. The proposed Cybersecurity Certification Scheme for Cloud Services in Europe [3] serves as a focal point, driving a complex interplay between commercial and political dynamics.

Against this backdrop, major American technology companies, such as Amazon Web Services, Microsoft, and Oracle, have introduced customized cloud solutions designed specifically for the European market. These initiatives aim to address European concerns about data localization and exemplify the desire for digital autonomy [4]. This paper aims to rigorously examine the multifaceted aimplications that arise from the proposed European cybersecurity certification framework [5, 6]. It seeks to contextualize this framework within the intricate nexus of digital sovereignty, cloud infrastructure, and the evolving nature of Smart City development.

The core of this examination lies in the exploration of divergent national perspectives, particularly observed in the contrasting attitudes of France and Germany. France advocates for strict controls on non-European cloud providers, while Germany favors a more open-market approach. A thorough analysis is required to understand the complexities surrounding the proposed certification's scope, as it extends beyond the realm of

government to various commercial sectors. This analysis reveals that the discourse on this topic transcends technological considerations, encompassing broader geopolitical dimensions and creating significant tensions between digital autonomy and global market dynamics.

Furthermore, this paper seeks to move beyond a descriptive account of the topic and instead offers a critical evaluation of the ongoing debate. Utilizing a poststructuralist lens, the objective is to uncover the underlying discursive elements and examine how stringent regulations embedded within the certification framework might impede the seamless integration of innovative technologies critical for the advancement of smart cities. The resulting tension between digital sovereignty and an open-market ethos becomes a testing ground for the feasibility of Europe's pursuit of enhanced Smart City development.

Positioned at the confluence of technological innovation, governance mandates, and expanding urban networks, this investigation aspires to make a substantial contribution to the scholarly conversation around the synergy of digital sovereignty and Smart City evolution in the modern European context. Through the lens of empirical case studies and thorough analytical scrutiny, this paper offers fresh perspectives that challenge established narratives. It aims to provide a scholarly foundation for decision-makers, urban strategists, and technology stakeholders as they navigate the intricate challenges of fostering Smart City growth amidst Europe's relentless pursuit of digital autonomy.

In the subsequent sections, we embark on a comprehensive exploration of the European Cybersecurity Certification Scheme for Cloud Services. By dissecting its implications across multiple dimensions, we navigate through the evolving landscape of digital governance, technological innovation, and urban development.

2. Global context of digital sovereignty

In the modern era of information technology, the concept of digital sovereignty plays a pivotal role in shaping the discourse surrounding data governance and cyber autonomy [7]. Digital sovereignty represents the ability of nations or entities to maintain control and autonomy over their digital infrastructures, data flows, and information systems [8]. It mirrors the interplay between technological advancements, geopolitical factors, and the imperative to protect national interests in an increasingly interdependent world.

The genesis of digital sovereignty can be traced to the growing recognition of the vital role that digital assets play in economic, political, and societal domains. As information and communication technologies permeate every aspect of contemporary existence, the establishment and preservation of digital sovereignty become imperative. This recognition is reinforced by the increasing frequency and sophistication of cyber threats, necessitating strategic measures to enhance the resilience of nations against potential vulnerabilities in their digital ecosystems [6, 5].

In the European context, the principles of digital sovereignty gain enhanced significance, particularly with the rise of smart cities [9]. Smart cities represent the convergence of urban infrastructure and cutting-edge technologies, serving as hubs of innovation and efficiency

[10]. Digital sovereignty becomes essential to ensuring the integrity, security, and ethical utilization of data within these technologically-driven urban ecosystems.

As European nations advance their smart city projects, they encounter the intricate challenge of balancing technological innovation with the preservation of digital autonomy [11]. This concept of digital sovereignty transcends conventional cybersecurity approaches, enveloping a broader spectrum of strategic decisions encompassing data governance, infrastructural technology, and the cultivation of homegrown technological proficiencies. The complex interrelation between digital sovereignty and the evolution of smart cities in Europe necessitates a delicate equilibrium—leveraging global technological developments while protecting the unique values and interests of individual nations [12].

To adeptly traverse this convoluted terrain, a comprehensive understanding of the global context of digital sovereignty is indispensable. Grasping the multifaceted aspects of this concept lays the groundwork for appreciating the intricate dynamics at play, particularly in relation to the anticipated impact of cybersecurity certification schemes on cloud services and the overarching theme of digital sovereignty within the European framework.

2.1. Enhancing cybersecurity measures and strengthening cloud services in Europe

Digital governance in the European Union is currently focused on bolstering cybersecurity measures and ensuring the integrity of cloud services. One notable initiative driving this agenda is the proposed Cybersecurity Certification Scheme for Cloud Services [13]. This strategic effort aims to enhance the security protocols surrounding digital infrastructure in Europe, with a particular emphasis on safeguarding critical data against potential threats.

Moreover, recent initiatives undertaken by prominent American cloud service providers further highlight the dynamic nature of this discourse. Microsoft's “Cloud for Sovereignty” exemplifies their proactive approach, demonstrating an understanding of the evolving digital landscape and a commitment to aligning cloud services with European aspirations for digital autonomy [14]. Similarly, Oracle's “EU Sovereign Cloud” reflects their conscious effort to cater to the unique regulatory demands and security considerations prevalent within the European Union.

These initiatives by American tech giants respond to the increasing concerns within the European community regarding data sovereignty. As the European Union deliberates on comprehensive cybersecurity certification protocols, the strategic positions taken by major American corporations add complexity to the overall discourse [15]. This intersection between the proposed European scheme and the autonomous initiatives of American corporations represents a significant area where divergent ideologies surrounding digital governance and sovereignty converge.

In summary, the examination of current initiatives in Europe reveals a multifaceted landscape characterized by the interplay of regulatory frameworks and corporate strategies. This analysis serves as a foundational exploration into the evolving dynamics of digital sovereignty and cybersecurity within the context of European smart cities. It provides valuable insights into the broader implications on both regional and global scales.

2.2. Commercial and political battles in european digital policy

A heated dispute has unfolded among key European Union member states, especially France and Germany, over the crucial issues of digital sovereignty and the utilization of external cloud services. This complex issue showcases the interplay between economic imperatives and governmental principles within the broader context of European digital policy.

At the heart of the debate are divergent national perspectives on digital sovereignty and the role of non-European cloud providers. France, firm in its stance to protect its digital autonomy, urges for limitations on the influence of non-European cloud service providers, particularly those from the United States. This approach is in line with France's historical commitment to promoting national champions and maintaining control over strategic technological domains [16].

Conversely, Germany, a key player in the European Union, has adopted a stance that stands in contrast to France's position. Influenced by the Free Democratic Party's presence in key ministries in Berlin, Germany has voiced criticisms of France's push for digital autonomy and has shown support for a more open-market approach [17]. Notably, the German Federal Office for Information Security has shown favor towards initiatives such as the Amazon European Sovereign Cloud, illustrating a variance in regulatory perspectives compared to France.

The dynamics of this commercial and political tug-of-war are further complicated by the involvement of smaller EU member states, each with their own priorities and preferences. While France aims to bolster European digital capabilities through protectionist measures, smaller EU members like Estonia, the Netherlands, and Greece argue that such approaches could result in higher costs and detriment to healthy competition. These differing opinions among member states contribute to the complexity of forming a cohesive European stance on digital policy.

As a result, the disparities in national perspectives and the ensuing debates play a pivotal role in shaping the trajectory of European digital policy. The intricate interplay between commercial considerations and political ideologies adds depth to the ongoing narrative surrounding digital sovereignty, highlighting Europe's evolving position on integrating foreign cloud services into its technological landscape.

3. Exploring case studies

This section delves deeper into specific case studies, shedding light on the diverse approaches various cities have taken towards integrating cybersecurity certification initiatives into their smart city frameworks. We aim to illustrate the nuances in the implementation of digital sovereignty and cloud services adoption, underlining the unique challenges and solutions each city presents.

3.1. Barcelona, Spain – Comprehensive Smart City initiatives with digital sovereignty

Barcelona, a pioneer in smart city initiatives, has made significant strides in integrating technology into urban management. The city's approach has been multifaceted, focusing on improving public services, enhancing quality of life, and increasing urban efficiency. A

key aspect of Barcelona's strategy is its commitment to digital sovereignty, manifested through the adoption of open-source technology platforms. These platforms facilitate a transparent and secure management of citizen data, ensuring privacy and security in accordance with EU data protection standards [18]. By creating its own technology stack, Barcelona retains control over data and infrastructure, setting a benchmark for how cities can assert digital sovereignty while fostering innovation.

3.2. Estonia – A national blueprint for digital sovereignty

Estonia's journey as a digital nation is characterized by its comprehensive approach to digital governance and cybersecurity. The country's digital strategy, highlighted by the e-Estonia initiative, has been a cornerstone in establishing a secure and seamless digital society [19]. Estonia's success lies in its ability to integrate digital solutions across government services, ensuring citizen-centricity, efficiency, and security. The nation's digital sovereignty is evident in its robust data governance policies, which have enabled the development of secure digital IDs and e-services. Estonia's model demonstrates how digital sovereignty can be achieved through national strategy, offering lessons for smart city developers on integrating cybersecurity at every level of urban digital infrastructure.

3.3. Amsterdam, Netherlands – Data ethics in Smart City development

Amsterdam's smart city development is grounded in a strong commitment to data ethics and privacy. The Amsterdam Smart City initiative illustrates how urban innovation can be driven by collaboration between the public sector, private companies, and residents [20]. This approach ensures that technological advancements serve the broader community interests. Amsterdam's focus on ethical data usage, citizen engagement, and transparent governance has been crucial in maintaining digital sovereignty at the city level. This case highlights the importance of considering ethical implications in smart city development and the role of participatory governance in achieving digital autonomy.

3.4. Germany – Strategic cybersecurity and cloud computing development

Germany's approach to cybersecurity and cloud computing showcases a national strategy that balances open-market principles with digital sovereignty. The development of Gaia-X, a project aimed at creating a secure and competitive European cloud infrastructure, is indicative of Germany's commitment to technological self-reliance [21]. This initiative not only enhances Germany's digital infrastructure but also contributes to the broader European digital ecosystem. Germany's strategy underlines the potential for large economies to develop indigenous technological solutions while maintaining active participation in international collaborations and markets.

The exploration of these case studies — Barcelona, Estonia, Amsterdam, and Germany — provides a comprehensive view of the varied approaches to digital sovereignty and cybersecurity in smart city development. Each case study demonstrates unique strategies and solutions, reflecting the specific contexts and priorities of the respective cities and country. While Barcelona and Amsterdam focus on city-level initiatives, Estonia and Germany present national strategies that offer insights into broader policy frameworks. These diverse experiences contribute valuable lessons for cities and nations worldwide, highlighting the importance of customized approaches to digital governance in the era of smart cities.

4. Global community response

Evaluating the international community's reaction, particularly the positions expressed by the United States, Japan, and other non-European governments, towards the proposed European cybersecurity certification initiatives is of significant import within this discourse. An in-depth examination of these global perspectives is crucial for understanding the wider implications and potential diplomatic consequences of Europe's pursuit of digital sovereignty.

An analysis of the United States' standpoint uncovers notable concerns and reservations, evident in high-level diplomatic interactions. In a communication exchange between U.S. Trade Representative Katherine Tai and European Commission Executive Vice President for trade Valdis Dombrovskis, apprehensions regarding the French and EU cybersecurity certification schemes were articulated. The issue has escalated to a formal concern within the U.S. government, as highlighted by Kenneth Propp from the Atlantic Council.

Simultaneously, the responses from non-European nations, including Japan, add to the multifaceted global dynamics surrounding this issue. Comprehending their perspectives and potential objections is crucial for grasping how Europe's pursuit of enhanced cybersecurity measures is perceived beyond its borders.

Moreover, the involvement of international organizations and trade councils in this ongoing dispute introduces additional complexity to the discussion. These entities play a critical role in mediating and influencing global trade dynamics, and their participation in deliberations on European cybersecurity certification introduces another layer of complexity to the geopolitical implications. Examining the positions taken by such organizations provides valuable insights into the broader diplomatic landscape, shedding light on potential consequences and alliances formed in response to Europe's ambitions for digital sovereignty.

In summary, the international community's response to European cybersecurity certification proposals encompasses a complex interplay of diplomatic, economic, and strategic considerations. Analyzing the positions of key global actors and the involvement of influential international organizations is essential for gaining a nuanced understanding of the broader implications of Europe's efforts in digital governance and cybersecurity.

5. Economic and technological implications

Understanding the economic and technological impact of embracing or rejecting the proposed cybersecurity certification is crucial for the European landscape. This section conducts an in-depth assessment of the multifaceted consequences, examining both the economic and technological dimensions involved in the decision-making process of the certification framework.

To fully grasp the economic implications, a detailed analysis is undertaken to determine the potential outcomes that may arise from either adopting or dismissing the proposed cybersecurity certification. This evaluation encompasses a range of factors, including market dynamics, trade dependencies, and the overall financial well-being of the European

Union. The aim is to illuminate how the certification framework may influence the economic equilibrium, assessing whether the proposed measures promote resilience or pose potential disruptions to the economic structure of the region.

Simultaneously, this section explores the technological repercussions resulting from strategic choices made regarding cloud services and digital sovereignty. By analyzing the intricate relationships between technological infrastructure, data governance, and security protocols, the discussion seeks to reveal hidden consequences. It delves beyond immediate technological considerations to consider the broader scope of innovation, research and development, and the overall trajectory of technological advancement within the European smart city model.

Through this comprehensive exploration, the section provides a scholarly perspective that extends beyond a surface-level analysis, offering nuanced insights into the complex web of consequences that European stakeholders face in the evolving landscape of digital sovereignty and smart city development.

6. Conclusions and future perspectives

To conclude, this paper has diligently examined the complex interplay between digital sovereignty, cloud services, and the evolving landscape of smart cities in Europe. Key findings highlight the critical importance of addressing the tensions that arise from the convergence of national digital autonomy and the use of cloud infrastructure provided by non-European entities.

A comprehensive recapitulation of these findings emphasizes the multifaceted challenges encountered by European policymakers, urban planners, and technology stakeholders. The commercial and political complexities epitomized by the divergent positions of member states, particularly France and Germany, underscore the intricacies involved in reconciling aspirations for digital sovereignty with the principles of an open market.

As we navigate the dynamic terrain of contemporary smart city development, it is crucial to reflect not only on the current state but also to envisage the future. Based on the analysis presented, it is recommended that Europe's digital policy incorporates a balanced approach that fosters domestic technological capabilities while embracing global innovation. Future directions should carefully consider the economic, technological, and geopolitical implications inherent in these policy decisions.

Moreover, the evolution of smart cities necessitates a proactive engagement with emerging technologies, acknowledging the ever-changing nature of the digital landscape. As Europe strives to assert its digital sovereignty, it should envision a progressive and forward-thinking policy framework that protects national interests and facilitates the integration of cutting-edge technologies into urban environments.

In essence, this paper serves as a foundation towards a deeper understanding of the intricate dynamics shaping the digital future of European smart cities. The suggestions offered herein contribute to the ongoing discourse surrounding the delicate balance between digital

autonomy and international collaboration. They provide a scholarly foundation for future investigations into digital policy and the evolution of smart cities within the European context.

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Smart parking solutions: a comparative study of parking space subleasing models in smart cities

Mihai Adrian LUNGU,
Academy of Economic Studies, Bucharest, Romania
adrian.lungu@csie.ase.ro

Abstract
In the dynamic landscape of smart cities, efficient parking management is crucial. This article explores innovative approaches to subleasing parking spaces, drawing inspiration from the Airbnb model. The objectives outlined here include defining a framework for smart parking solutions, analyzing previous research on urban mobility and digital platforms, presenting key findings on the effectiveness of various subleasing models, discussing implications for urban planning and mobility, and highlighting the unique value of the proposed approach. This article aims to lay the foundation for providing a conceptual and practical framework for smart parking solutions, paving the way for the implementation of a sustainable and efficient model in urban parking space management. This approach not only offers practical solutions but also shapes a vision for the future of smart cities, emphasizing how technology can significantly contribute to optimizing mobility and quality of life in urban environments. The proposed application is specifically designed for individuals who have parking spaces allocated by the municipality and wish to sublease them. In conclusion, the detailed analysis of different parking space subleasing models provides positive insights into their efficiency and optimization.

Keywords: smart cities, parking solutions, urban mobility, digital platforms, subleasing models.

1. Introduction
In the past few decades, rapid urbanization and population growth have exerted increasing pressure on city infrastructure, as evidenced by global forecast reports [1]. In the context of this ever-changing urban landscape, the concept of the smart city has become an essential solution for efficiently managing resources and improving the quality of life for residents. Within this framework, one of the major challenges remains the proper management of parking, emerging as a critical aspect of urban mobility.

To address this type of issue, major cities are attempting various measures to make the city as smart as possible and make use of all available resources [2], such as rational land-use planning, the construction of new parking structures, and the development of intelligent software applications.

By promoting the efficient use of parking resources, these models contribute to reducing traffic congestion, thereby decreasing greenhouse gas emissions generated by moving vehicles. They also provide drivers with the ability to quickly find parking spaces, minimizing time spent searching and contributing to fuel savings and a reduction in pollutant emissions.

The purpose of this study is to explore and analyze innovative models for subleasing parking spaces within smart cities. In this context, the proposal is to define a conceptual framework for intelligent parking solutions, with a focus on efficiency and optimization of urban parking space utilization. This article not only suggests practical solutions but also outlines a vision for the future of smart cities, highlighting how technology can significantly contribute to optimizing mobility and improving the quality of life in urban environments.

1.1. Motivation

Parking, especially in urban areas, is an ongoing struggle and competition due to the limited number of available parking spaces [3]. As presented in the 'Vehicles in Use' report by the European Automobile Manufacturers' Association (ACEA) [4], the number of vehicles in use in the 27 EU member states, plus Iceland, Norway, and Switzerland, continues to rise and increased by 6.69% in 2021 compared to 2017 (Figure 1). If we take a look at land utilization in large cities in America, we can observe that parking coverage in San Francisco is 31%, in Los Angeles it's 81%, and in Melbourne, it's 76% [5]. Therefore, solutions need to be found to help cities address traffic congestion by providing smarter solutions for residents based on their needs. This can involve modifying existing parking spaces, constructing more multi-level parking structures, or finding ways to sublease existing spaces, whether they are public or private.

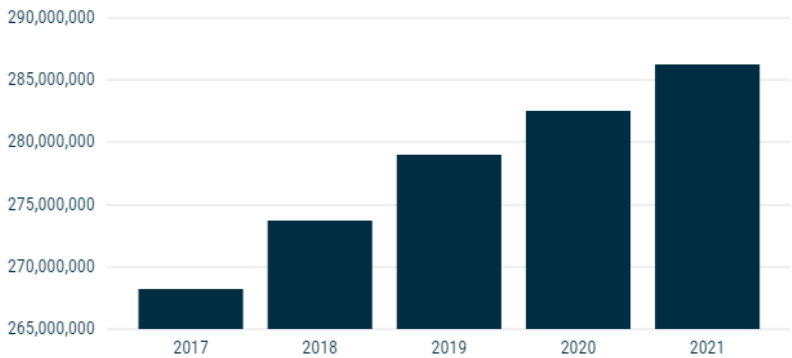

Fig. 1 The number of vehicles in use in the report presented by ACEA in the year 2023
Source: https://www.acea.auto/publication/report-vehicles-in-use-europe-2023/

The central aim of this research is to make a significant contribution to the development of smart cities by addressing a critical need of the population regarding the management of urban mobility. Increased congestion and shifts in people's preferences necessitate not only adaptation to new realities but also anticipation of future needs. In this context, the present study seeks to fill this gap by exploring and analyzing innovative models for subleasing parking spaces, drawing inspiration from the Airbnb model, known for its adaptability and efficiency in the realm of subleases. The proposed parking space subleasing model not only optimizes the efficient use of urban space but also promotes a sustainable and environmentally friendly urban environment.

At the conclusion of the literature analysis, a solution will be proposed to address the societal issue of traffic congestion. This solution involves granting individuals with private parking spaces allocated by the municipality or personal land the right to sublease their parking spaces or land to clients for a specific period through a mobile application.

2. Related work

In recent years, specialized literature has evolved to provide innovative solutions for designing a comprehensive information system regarding parking availability

management. These solutions cover various aspects, including the implementation of a parking reservation system, the development of parking occupancy detection technologies, and the efficient management of the entire process [6].

In the study presented by Jennath HS and his colleagues [3], it is observed that they proposed a solution to address the issue of limited parking spaces. They introduced a platform developed on Blockchain to lease underutilized lands by their owners to a winning agency. This agency would invest in developing the land and then lease it through a platform. Essentially, non-fungible tokens would be created for the parking spaces on the respective land, which would be transferred to the account of the leasing agency. The revenues would be distributed among the owner, agency, and government at the end. Initially, the agency takes the largest percentage of revenues to cover the investment, and then the percentages for the owner's revenues increase. The reason for choosing Blockchain for this project is that it is a distributed ledger technology that uses a consensus mechanism, allowing for trust, transparency, and data immutability [7].

Another study was conducted by Bassma Jioudi and colleagues [8], where they introduced a new architecture for intelligent parking based on multi-agent functions. Among the challenges addressed were the utilization of land, occupancy of public space, economic impact, and pedestrian safety. The system assigns optimal parking for a driver based on the chosen destination and a walking tolerance radius, with reservations created strictly online through a dynamic pricing policy. The proposed concept aims to enhance the driver's experience by combining real-time prices with reservation-sharing services. It was observed that static rates generally encourage the search for free or inexpensive parking spaces, while dynamically setting accurate hourly rates will determine how long a vehicle is parked. The development of the system involved multiple agent roles that depend on each other. Although the objectives of this study were achieved, the conclusion was drawn that the application could be further developed, with the desire to implement the option of drawing the driver's attention to public transportation alternatives.

A third study was conducted by Yi Liu [9], where an attempt was made to mathematically establish the relationship between the social benefits of the city and public parking fees. The study also aimed to observe whether shared parking (private parking owners, companies, hotels, individuals), complementary to public parking, alleviates the challenging parking issues in the city. For the study, the ideal scenario was considered where the number of travelers subjected to the test was fixed. Everyone had to depart from a specific point and reach the same destination, and they could travel by bus or car, excluding other means of transportation. The study's conclusion was that as parking fees increase, total revenues also increase, including parking fees and bus fares. However, for achieving maximum social benefits, urban public agencies need to develop an optimal price for each time interval.

Other studies [10] [11] have attempted to focus on the implementation of various types of sensors to accurately detect when a vehicle is about to park or to track it as it moves, indicating users where to park. Object recognition was performed through computerized techniques for identifying objects in images or videos by training models that learned the

inherent characteristics of the objects. In addition to the use of sensors and object recognition, one study successfully built a system aimed at assisting university staff in quickly and easily reserving a parking space in advance, to avoid wasting time and fuel when arriving at the campus.

The survey conducted by Trista Lin, Hervé Rivano, and Frédéric Le Mouël [5] aimed to comprehensively review the specialized literature from the period 2000-2016 regarding parking solutions. The goal was to observe the technologies applied to the development and evolution of parking, analyzing in detail all categories of sensors used, the network through which information was collected, types of patents registered for parking meters, payment methods, and driver guidance methods. As a result, they summarized the main methodologies used in existing works and their vision for addressing current parking-related challenges.

Following a careful analysis of various previous research on urban mobility, digital platforms, and associated technologies, the proposed approach aims to integrate technologies already used by other researchers in the development of smart parking, adding a distinctive element by focusing on interaction with individuals. The application suggests a dedicated solution primarily for individuals who have a parking space allocated by the municipality, providing them with the opportunity to sublease it in a manner similar to renting an apartment through the Airbnb platform.

Essentially, the application proposes the use of sensors placed on parking bollards to detect the presence of vehicles. Users can then make online reservations based on the availability of parking spaces. This approach represents an innovation in how smart parking interacts with the community, adding efficiency and simplifying the parking space management process.

3. Proposed work

The proposed application focuses specifically on the needs of individuals who have parking spaces allocated by the municipality and wish to make them available for subleasing during periods when they remain vacant or unused. By providing owners with the opportunity to sublease these spaces when not in use or unoccupied, the application contributes to the creation of a smart and sustainable urban environment.

The account validation within the application involves providing clear proof of ownership through a specific request. After this step, the process continues with the installation of the system and the creation of the actual announcement for subleasing the parking space. This initiative not only optimizes the efficient use of available parking space but also has a positive impact on the concept of a smart city.

By facilitating the subleasing of unused parking spaces, the application contributes to reducing carbon dioxide emissions, lower fuel consumption, and the decrease in the number of unauthorized parking. Thus, in the context of a smart city, this solution represents a step forward towards a more efficient and sustainable urban community, alongside other existing solutions on the market.

3.1. Software development and application logic

The software part proposes an application based on a client-server architecture. On the client side, we have a mobile application developed using React Native technology, serving as an intuitive interface for users. On the server side, Express.js will be employed with a MySQL database to manage parking and reservation-related information.

From the perspective of the parking space owner, they need to authenticate themselves in the application, providing various personal details, including proof of the contract with the municipality to verify ownership of the parking space. Subsequently, after verification and approval, the owner must submit a request indicating whether they want to continue with the process and whether they wish to use the parking system provided by the company.

If the owner chooses not to use the system for various reasons, such as already having a traditional parking barrier or not wanting to secure it in any way, the next step is to create a listing for the parking space. This involves adding details such as the address, photos, other essential information, and the price. If the provided system is not used, the owner will need to come in person each time to unlock the parking space for customers and lock it again at the end.

If the owner chooses to use the system, to facilitate the implementation and reduce the efforts of the customers, a specialized team will travel to their location at the time of purchase or rental of the system. The team will be responsible for installing the equipment and establishing connections, ensuring a seamless and hassle-free experience for users. This way, the proposed solution brings innovation to parking management, efficiently combining software and hardware technologies to meet the current needs of modern users. From the user's perspective, they could search for the destination they want to reach and check the available parking spaces during the selected time interval, making a reservation in advance. When they arrive at the destination and are within 50 meters of the barrier, they can press a button in the application to request the barrier to be lowered. When they are ready to leave and vacate the parking space, they will need to use another button to indicate their departure, making the parking space available again.

3.2. Hardware development and communication logic

The hardware component consists of a gateway (with wireless connectivity to the internet) and the parking barrier with batteries. The operational logic involves having a radio module mounted on the parking barrier, enabling communication with the gateway installed in the owner's house or apartment through a LoRa protocol-based radio connection. This allows the parking barrier to be placed at significant distances from the location of the gateway.
It is essential for the parking barrier to integrate magnetic sensors and laser parking sensors. The choice of these sensors is due to their ability to provide accurate and comprehensive information about the status of parking spaces. Magnetic sensors detect the presence of vehicles through changes in the magnetic field, providing a reliable indication of parking space occupancy or availability. In parallel, laser sensors measure the distance between vehicles, ensuring detailed information about the available space.

The integration of these advanced sensors contributes to optimizing parking space management and providing a precise and efficient experience for users. A built-in radio module in the barrier is imperative to facilitate seamless communication between the barrier, gateway, and the application server. This radio module ensures the efficient transmission of data collected by sensors to the gateway and, consequently, to the server, strengthening the real-time operation of the system and providing a quick response in access control and parking management operations.

The LoRa protocol is designed as a low-power, long-range network solution specifically tailored for Internet of Things (IoT) devices. This protocol facilitates efficient data transmission and reception in small quantities over long distances, all with low energy consumption [12].

In the context of using a parking barrier, it can communicate with a gateway mounted in the owner's house or apartment, benefiting from the efficient functioning of the LoRa protocol over considerable distances via radio waves. Thus, the barrier and gateway can exchange information and transmit or receive data to and from the server.

The gateway plays a crucial role in facilitating the connection between the parking barrier and the application server. When the server issues a command to release the barrier, it must send a corresponding request to the gateway's IP address over the internet. The gateway receives this command and transmits it to the barrier via radio waves. This detailed interaction between hardware and software components is illustrated in Figure 2, as presented in the article by Changqing Sun and colleagues [12], providing a clear perspective on each step of the communication process between systems.

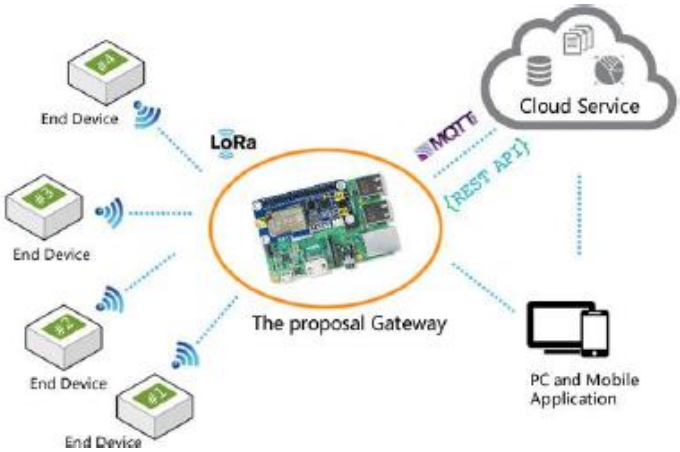

Fig. 2. Overview of LoRa Application Arhitecture
Source: https://sci-hub.se/10.23919/CCC50068.2020.9189480

Security of communication between the parking barrier, gateway, and server is paramount in the context of smart cities. By employing advanced encryption, multi-factor authentication, and HTTPS protocols, the system ensures the confidentiality and integrity of transmitted data. The implementation of continuous monitoring mechanisms, along with

regular device updates, including vulnerability management technologies, complements security efforts. Solutions against Man-in-the-Middle attacks and well-defined security policies, such as access management, add an additional layer of protection. In this way, a smart and secure urban ecosystem is created, leveraging modern technologies to prevent cyber threats.

4. Estimated results

By exploring and carefully analyzing various technologies available in the field of smart parking, this study has provided a detailed perspective on the current technological landscape. Through this research process, key technologies and principles were highlighted, serving as catalysts for shaping a clear vision of the future direction of my project.

The study has helped me compile a concise summary of the most used technologies and principles in the realm of smart parking. It has had a significant impact on my conception of how my parking space subleasing application should be designed. In particular, I have identified essential elements that can contribute to creating an innovative and efficient application.

I believe that integrating this application into the context of existing technologies for our city can transform urbanization into a smarter and more sustainable experience. By providing a parking space subleasing system tailored to the specific needs of our community, we can contribute to optimizing resource utilization and developing a more connected and efficient city.
This research and technological implementation direction not only bring individual benefits but can also contribute to collective progress towards a smarter and more environmentally friendly urban community.

5. Author's contribution

My involvement in this study consisted of a meticulous and detailed approach to the literature and other relevant sources in the field of smart parking. Specifically, I deepened my understanding by summarizing and synthesizing information obtained from various articles and studies related to this subject. This crucial stage of the process aimed to draw conclusions and identify key trends in smart parking technologies.

Through careful analysis of existing literature, I was able to formulate a clear perspective on emerging technologies, significant issues, and proposed solutions in the field. This solid foundation was essential for developing a robust conceptual framework and suggesting an innovative model for the parking space subleasing application.

My proposal for a parking space subleasing application by owners is based on conclusions drawn from the literature, adapted to the specific needs of our community. This involvement is reflected in the efforts to create a practical and efficient solution that not only addresses existing challenges but also contributes to the evolution towards a smarter urban infrastructure.

6. Conclusion and future perspectives

The research and meticulous analysis of smart parking technologies have culminated in the formulation of an innovative proposal: a parking space subleasing application for owners. This initiative was grounded in a profound understanding of relevant literature and other resources.

My involvement focused on synthesizing information from various sources to draw essential conclusions, thereby guiding the development of a practical solution. The proposal is rooted in the community's needs and aims to contribute to the evolution toward a smarter urban infrastructure.

In the future, practical implementation will provide relevant data for the continuous optimization of the application. Collaboration with the community and the integration of emerging technologies are essential steps for adapting and continuously improving the solution. Exploring how the application can contribute to sustainability and urban efficiency opens new perspectives for smart urban development. These efforts are crucial for transforming the concept into a beneficial reality, contributing to the improvement of the quality of life in our city.

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Un studiu comparativ al modelelor de subînchiriere a locurilor de parcare în orașe inteligente

Mihai Adrian LUNGU,
Academia de Studii Economice, București, România
adrian.lungu@csie.ase.ro

Abstract
În peisajul dinamic al orașelor inteligente, gestionarea eficientă a parcărilor este crucială. Acest articol explorează abordări inovatoare pentru subînchirierea locurilor de parcare, inspirându-se din modelul Airbnb. Obiectivele propuse aici includ definirea unui cadru pentru soluțiile de parcare inteligentă, analiza cercetărilor anterioare privind mobilitatea urbană și platformele digitale, prezentarea constatărilor cheie privind eficacitatea diferitelor modele de subînchiriere, discutarea implicațiilor pentru planificarea urbană și mobilitate, precum și sublinierea valorii unice a abordării propuse. Articolul de față își propune să constituie baza pentru furnizarea unui cadru conceptual și practic pentru soluții de parcare inteligentă, deschizând calea pentru implementarea unui model sustenabil și eficient în gestionarea spațiului de parcare urban. Această abordare nu numai că oferă soluții practice, dar și conturează o viziune a viitorului orașelor inteligente, evidențiind modul în care tehnologia poate contribui semnificativ la optimizarea mobilității și calității vieții în mediul urban. Aplicația propusă se adresează în special persoanelor fizice care au loc de parcare de la primărie și doresc să îl subînchirieze. În concluzie, analiza detaliată a diferitelor modele de subînchiriere a spațiilor de parcare ne oferă perspective pozitive în ceea ce privește eficiența și optimizarea utilizării acestora.

Cuvinte cheie: orașe inteligente, soluții pentru parcări, mobilitate urbană, platforme digitale, modele de subînchiriere.

1. Introducere
În ultimele decenii, urbanizarea rapidă și creșterea demografică au impus o presiune tot mai mare asupra infrastructurii orașelor, așa cum se arată în rapoartele de prognoză la nivel mondial [1]. În contextul acestui peisaj urban în continuă schimbare, conceptul de oraș inteligent a devenit o soluție esențială pentru a gestiona eficient resursele și a îmbunătăți calitatea vieții locuitorilor. În acest cadru, una dintre provocările majore rămâne gestionarea adecvată a parcărilor, devenind un aspect critic al mobilității urbane.

Astfel, pentru a rezolva genul acesta de problemă, marile orașe încearcă să ia diferite măsuri pentru a face orașul cât mai inteligent și să folosească toate resursele pe care ar putea să le folosească [2], precum planificarea rațională a terenurilor nefolosite, construirea de noi structuri de parcare, dezvoltare de aplicații software cât mai inteligente.

Prin promovarea utilizării eficiente a resurselor de parcare, aceste modele contribuie la diminuarea congestionării traficului, reducând astfel emisiile de gaze cu efect de seră generate de vehiculele aflate în mișcare. De asemenea, oferă șoferilor posibilitatea de a găsi mai rapid locuri de parcare, minimizând timpul pierdut în căutarea acestora și contribuind la economisirea combustibilului și la scăderea emisiilor poluante.

Scopul acestui studiu este de a explora și analiza modele inovatoare pentru subînchirierea locurilor de parcare în cadrul orașelor inteligente. În acest context, se propune definirea unui cadru conceptual pentru soluțiile de parcare inteligentă, cu accent pe eficacitatea și optimizarea utilizării spațiilor de parcare urbane. Acest articol nu doar propune soluții

practice, ci și conturează o viziune a viitorului orașelor inteligente, evidențiind cum tehnologia poate contribui semnificativ la optimizarea mobilității și calității vieții în mediul urban.

1.1. Motivația

Parcarea, în special în zonele orașului, este o luptă și o întrecere continuă din cauza numărului mic de spații de parcare disponibile [3]. După cum este prezentat și în raportul 'Vehicule în uz' creat de Asociația Constructorilor Europeni de Automobile (ACEA) [4], numărul de autovehicule care este utilizat la nivel european în cele 27 state membre, plus țările Islanda, Norvegia și Elveția, este în continuă ascensiune și a crescut cu 6.69% în anul 2021, față de 2017 (Figura 1). Dacă o să încercăm să aruncăm o privire și în America la modul în care sunt utilizate terenurile în orașele mari, o să putem observa că acoperirea parcării în orașul San Francisco este de 31%, în Los Angeles 81% și în Melbourne 76% [5]. Astfel, trebuie găsite soluții care să ajute orașele în privința congestionării traficului, oferind soluții cât mai inteligente pentru locuitorii orașelor în funcție de nevoile lor prin modificarea parcărilor deja existente, construirea a mai multor parcări supraetajate sau prin găsirea de modalități de subînchiriere a celor deja existente, fie că discutăm despre cele publice sau private.

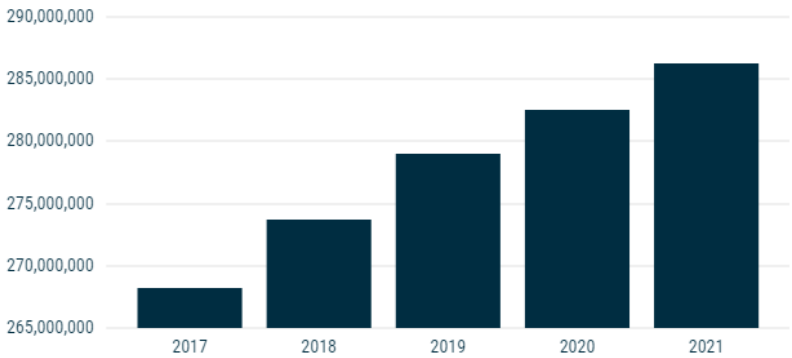

Fig. 1. Numărul de autovehicule în uz în raportul prezentat de ACEA în anul 2023
Sursa: https://www.acea.auto/publication/report-vehicles-in-use-europe-2023/

Motivul central al acestei cercetări este de a aduce o contribuție semnificativă la dezvoltarea orașelor inteligente, prin adresarea la o nevoie critică a populației în ceea ce privește gestionarea mobilității urbane. Aglomerarea crescută și schimbările în preferințele oamenilor impun nu doar o adaptare la noile realități, ci și o anticipare a nevoilor viitoare. În acest context, prezentul studiu își propune să umple această lacună prin explorarea și analiza unor modele inovatoare de subînchiriere a locurilor de parcare, cu inspirație din modelul Airbnb, recunoscut pentru adaptabilitatea și eficiența sa în domeniul subînchirierilor. Modelul propus de subînchiriere a locurilor de parcare nu doar optimizează utilizarea eficientă a spațiului urban, dar și promovează un mediu urban sustenabil și prietenos cu mediul.

La finalul analizei literaturii, se va propune o soluție care să ajute la problema societății legată de congestionarea traficului, în care se oferă dreptul cetățenilor care au o parcare

privată de la primărie sau un teren personal, să își subînchirieze locul de parcare sau terenul clienților pentru o anumită perioadă de timp prin intermediul unei aplicații mobile.

2. Lucrări conexe

În ultimii ani, literatura de specialitate a evoluat în furnizarea unor soluții inovatoare pentru proiectarea unui sistem de informații comprehensiv privind gestionarea disponibilității parcării. Aceste soluții acoperă diverse aspecte, inclusiv implementarea unui sistem de rezervare a parcării, dezvoltarea tehnologiilor de detectare a ocupării locurilor de parcare și gestionarea eficientă a întregului proces [6].

În lucrarea prezentată de Jennath HS și colaboratorii săi [3], putem observa că aceștia au propus drept soluție pentru rezolvarea problemei legate de locurile de parcare limitate, o platformă dezvoltată pe Blockchain prin care se pot închiria în special terenuri nefolosite de către propetari, către o agenție câștigătoare care va investi îm amenajarea terenului și îl va închiria prin intermediul unei platforme. Practic, pentru locurile de parcare de pe respectivul teren se vor crea jetoane nefungibile care vor fi transferate în contul agenției care se ocupă de închiriere, veniturile fiind împărțite la final între propietar, agenție și guvern. La început, procentul cel mai mare din venituri îl ia agenția până acoperă investiția, apoi cresc procentele pentru veniturile propietarului. Motivul pentru care s-a ales la nivelul acestui proiect să se folosească Blockchain, este pentru că este o tehnologie de registru distribuit care utilizează un mecanism de consens care permite încrederea, transparența și imuabilitatea datelor [7].

Un alt studiu a fost realizat de Bassma Jioudi și colaboratorii săi [8], unde aceștia au introdus o nouă arhitectură de parcare inteligentă bazată pe funcții multi-agent. Printre provocări, se numără posibilitatea de a se putea folosi terenul sau nu, ocuparea spațiului public, impactul economic și siguranța pietonilor. Sistemul atribuie o parcare optimă pentru un șofer în funcție de destinația pe care o alege și o rază de acțiune care reprezintă distanța pe care o tolerează să se deplaseze pe jos, rezervările fiind create strict online printr-o politică de prețuri dinamice. Conceptul propus dorește să îmbunătățească experiența șoferului prin combinarea prețurilor în timp real cu serviciul de partajare a rezervărilor. S-a mai constat faptul că tarifele statice favorizează în general căutarea locurilor de parcare gratuite sau ieftine, în timp ce stabilirea tarifelor orare corecte în mod dinamic vor determina cât timp este parcat un autovehicul. Pentru dezvoltarea sistemului, s-au folosit mai multe roluri de agenți care depind unii de ceilalți. Deși obiectivele acestui stiudiu au fost atinse, la sfârșit s-a luat concluzia că aplicația ar putea fi dezvoltată și mai mult, dorind să implementeze și opțiunea de a atrage atenția șoferului asupra mijloacelor de transport în comun.

Un al treilea studiu a fost realizat de Yi Liu [9], unde a încercat să afle matematic relația dintre beneficiile sociale ale orașului și taxele de parcare publică și să observe dacă parcararea comună (propietarii de parcări private, companii, hoteluri, persoane fizice), complementară parcării publice, ameliorează problema dificultăților de parcare în oraș. Pentru studiu, a plecat de la mediul ideal în care numărul de călători asupra cărora a efectuat testul era fix, toată lumea trebuia să plece dintr-un anumit punct și să ajungă la aceeași destinație și puteau să călătorească cu autobuzul sau cu mașina, fără să se ia în calcul și alte

mijloace de transport. Concluzia studiului a fost că dacă taxele de parcare cresc, veniturile totale cresc și ele, inclusiv taxele de parcare și tarifele de autobuz. Însă, pentru obținerea de beneficii sociale maxime, agenții publici urbani trebuie să dezvolte un preț optim pentru fiecare timp de interval.

Alte studii [10, 11] au încercat să se orienteze pe modalități de implementare a mai multor tipuri de senzori care să detecteze cu acuratețe atunci când un vehicul urmează să parcheze sau să îl urmărească în timp ce se mișcă pentru a indica utilizatorilor unde să parcheze mașina. Recunoașterea obiectelor s-a efectuat printr-o tehnică computerizată pentru identificarea obiectelor din imagini sau videoclipuri, prin antrenarea unor modele care au învățat caracteristicele inerente ale obiectelor. Pe lângă utilizarea de senzori și recunoașterea obiectelor, unul dintre studii a reușit să construiască un sistem al cărui scop este să ajute personalul universitar să rezerve din timp un loc de parcare rapid și ușor, pentru a nu mai pierde timp și combustibil atunci când ajung la facultate.

Sondajul realizat de către Trista Lin, Hervé Rivano și Frédéric Le Mouël [5] a încercat să parcurgă toată literatura de specialitate din perioada 2000-2016 privind soluțiile de parcare pentru a putea observa tehnologiile care au fost aplicate la dezvoltarea și evoluția parcărilor, analizând în detaliu toate categoriile de senzori care au fost folosiți, rețeaua prin care au adunat informațiile, tipurile de brevete înregistrate pentru parchimetre, metode de plată și metode de îndrumare a șoferilor. Ca și rezultat, au rezumat principalele metodologii utilizate în lucrările existente și viziunea acestora în ceea ce privește rezolvarea dificultăților actuale legate de parcare.

În urma unei analize atente a mai multor cercetări anterioare referitoare la mobilitatea urbană, platforme digitale și tehnologii asociate, abordarea propusă vizează integrarea unor tehnologii deja utilizate de alți cercetători în dezvoltarea parcărilor inteligente, adăugând un element distinctiv prin concentrarea pe interacțiunea cu persoanele fizice. Aplicația propune o soluție dedicată în principal persoanelor fizice care dețin un loc de parcare de la primărie, oferindu-le posibilitatea de a-l subînchiria într-un mod similar cu închirierea unui apartament prin platforma Airbnb.

În esență, aplicația propune utilizarea senzorilor amplasați pe blocatoarele de parcare pentru a detecta prezența autoturismelor. Astfel, utilizatorii au posibilitatea să facă rezervări online în funcție de disponibilitatea locurilor de parcare. Această abordare reprezintă o inovație în modul în care parcările inteligente interacționează cu comunitatea, aducând un plus de eficiență și ușurând procesul de gestionare a locurilor de parcare.

3. Lucrarea propusă

Aplicația propusă se concentrează în special pe nevoile persoanelor fizice care dețin locuri de parcare alocate de la primărie și doresc să le pună la dispoziție pentru subînchiriere în perioadele în care acestea rămân libere sau neutilizate. Oferind proprietarilor posibilitatea de a subînchiria aceste locuri atunci când nu sunt în uz sau când nu sunt ocupate, aplicația contribuie la crearea unui mediu urban inteligent și sustenabil.

Validarea contului în cadrul aplicației implică prezentarea unei dovezi clare a proprietății prin intermediul unei cereri specifice. După acest pas, procesul continuă cu instalarea sistemului și crearea anunțului propriu-zis pentru subînchirierea locului de parcare. Această inițiativă nu doar că optimizează utilizarea eficientă a spațiului de parcare disponibil, dar are și un impact pozitiv asupra conceptului de oraș inteligent.

Prin facilitarea subînchirierii locurilor de parcare neutilizate, aplicația contribuie la reducerea emisiilor de dioxid de carbon, consumul mai redus de combustibil și diminuarea numărului de parcări neregulamentare. Astfel, în contextul unui oraș inteligent, această soluție reprezintă un pas înainte către o comunitate urbană mai eficientă și mai sustenabilă pe lângă restul soluțiilor deja existente pe piață.

3.1. Dezvoltarea software și logica aplicației

Partea de software propune o aplicație care se bazează pe arhitectura client-server, unde pe partea de client discutăm despre o aplicație mobilă dezvoltată cu tehnologia React Native care are rolul să servească ca și interfață intuitivă pentru utilizatori, iar pe partea de server se va folosi Express.js cu o bază de date MySQL pentru a gestiona informațiile legate de parcări și rezervări.

Din perspectiva propietarului locului de parcare, acesta trebuie să se autentifice în aplicație unde trebuie să furnizeze mai multe detalii personale, printre care și o dovadă a contractului cu primăria în care să ateste faptul că acesta deține respectivul loc de parcare. Ulterior, după verificare și aprobare, acesta trebuie să facă o cerere prin care spune că vrea să continue procesul și că dorește sau nu să folosească sistemul de parcare pus la dispoziție de către companie.

În cazul în care nu dorește să folosească sistemul din varii motive, precum faptul că deja deține un blocator clasic sau nu vrea să îl protejeze în vreun fel, următorul pas o să fie să adauge anunțul cu locul de parcare și câteva detalii, precum adresa, poze, alte informații esențiale și prețul. În cazul în care nu se folosește sistemul pus la dispoziție, propietarul va trebui să vină personal de fiecare dată și să deblocheze locul de parcare clienților și să îl blocheze la final din nou.

În cazul în care dorește să folosească sistemul, pentru a facilita implementarea sistemului și a reduce eforturile clienților, o echipă specializată se va deplasa la locația acestora la momentul achiziționării sau închirierii sistemului. Echipa se va ocupa de montarea echipamentelor și stabilirea conexiunilor, asigurând o experiență completă și fără complicații pentru utilizatori. În acest fel, soluția propusă aduce inovație în gestionarea parcărilor, combinând eficient tehnologii software și hardware pentru a satisface nevoile actuale ale utilizatorilor moderni.

Din perspectiva utilizatorului, acesta ar putea căuta destinația la care acesta dorește să se ajungă și ar putea observa parcările disponibile în intervalul orar ales și să facă o rezervare în prealabil. În momentul în care acesta ajunge la destinație și se va afla la maxim 50m de blocator, va putea apăsa în aplicație un buton care va face o cerere la server să coboare

blocatorul. Când o să dorească să plece și părăsește locul de parcare, va trebui să folosească un alt buton prin care să anunțe că pleacă, iar locul de parcare va deveni iar disponibil.

3.2. Dezvoltarea hardware și logica comunicării între echipamente

Partea de hardware este compusă dintr-un gateway (cu conectivitate wireless către internet) și blocatorul de parcare pe acumulatori. Ca și logică de funcționare, blocatorul de parcare ar trebui să aibă montat un modul radio care îi va permite să comunice cu gateway-ul montat în casa sau apartamentul propietarului prin intermediul unei conexiuni radio bazate pe protocolul LoRa, permițând amplasarea blocatorului la distanțe semnificative față de locul în care se află gateway-ul.

De asemenea, este esențial ca blocatorul de parcare să integreze senzori magnetici și senzori laser de parcare. Alegerea acestor senzori se datorează capacității lor de a furniza informații precise și cuprinzătoare despre starea locurilor de parcare. Senzorii magnetici detectează prezența vehiculelor prin schimbările în câmpul magnetic, oferind astfel o indicație fiabilă cu privire la ocuparea sau disponibilitatea locurilor. În paralel, senzorii laser măsoară distanța între vehicule, asigurând informații detaliate despre spațiul disponibil.

Integrarea acestor senzori avansați contribuie la optimizarea gestionării spațiului de parcare și la furnizarea unei experiențe precise și eficiente pentru utilizatori. Un modul radio încorporat în blocator este imperativ pentru facilitarea comunicării fără probleme între blocator, gateway și serverul aplicației. Acest modul radio asigură transmiterea eficientă a datelor colectate de senzori către gateway și, în consecință, către server, întărind funcționarea sistemului în timp real și oferind un răspuns rapid în cadrul operațiunilor de control al accesului și gestionare a parcării.

Protocolul LoRa este conceput ca o soluție de rețea cu consum redus de energie, cu acoperire extinsă, special proiectată pentru dispozitivele Internet of Things (IoT). Acest protocol facilitează transmiterea eficientă și recepționarea datelor în cantități reduse pe distanțe lungi, totul la un consum energetic redus [12].

În contextul utilizării unui blocator de parcare, acesta poate comunica cu un gateway montat în casa sau apartamentul proprietarului, beneficiind de capacitatea protocolului LoRa de a funcționa eficient la distanțe considerabile prin unde radio. Astfel, blocatorul și gateway-ul pot schimba informații între ei și pot transmite sau primi date către și de la server.

Gateway-ul are rolul crucial de a facilita legătura între blocatorul de parcare și serverul aplicației. Atunci când serverul emite o comandă către gateway pentru a elibera blocatorul, acesta trebuie să trimită o solicitare corespunzătoare la adresa IP a gateway-ului prin internet. Gateway-ul preia această comandă și o transmite către blocator prin unde radio. Această interacțiune detaliată între componente hardware și software este ilustrată în Figura 2, prezentată în articolul lui Changqing Sun și colaboratorii săi [12], oferind o perspectivă clară asupra fiecărui pas al procesului de comunicare între sisteme.

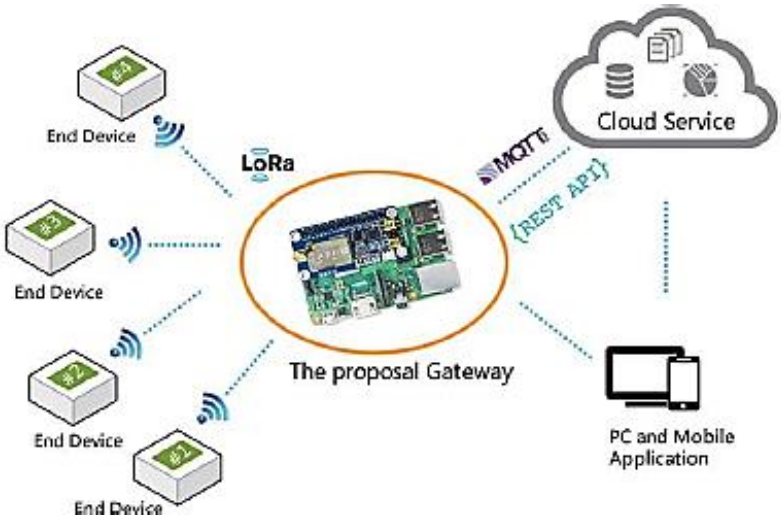

Fig. 2. Prezentare generală asupra arhitecturii aplicației LoRa
Sursa: https://sci-hub.se/10.23919/CCC50068.2020.9189480

Securitatea comunicării dintre blocator, gateway și server este fundamentală în contextul orașelor inteligente. Utilizând tehnologii precum criptarea avansată, autentificarea cu factori multipli și protocoalele HTTPS, sistemul asigură confidențialitatea și integritatea datelor transmise. Implementarea unor mecanisme de monitorizare constantă, precum și actualizările regulate ale dispozitivelor, inclusiv tehnologii de gestionare a vulnerabilităților, completează eforturile de securitate. Soluții împotriva atacurilor Man-in-the-Middle și politici de securitate bine definite, cum ar fi gestionarea acceselor, adaugă un strat suplimentar de protecție. Astfel, se creează un ecosistem urban inteligent și sigur, cu tehnologii moderne pentru a preveni amenințările cibernetice.

4. Rezultate estimate

Prin explorarea și analiza atentă a diverselor tehnologii disponibile în domeniul parcărilor inteligente, acest studiu a furnizat o perspectivă detaliată asupra peisajului tehnologic actual. În urma acestui proces de cercetare, au fost evidențiate tehnologii și principii cheie care au servit drept catalizatori pentru conturarea unei viziuni clare asupra direcției viitoare a proiectului meu.

Studiul m-a ajutat să realizez un rezumat concis al celor mai folosite tehnologii și principii în domeniul parcărilor inteligente. Acesta a avut un impact semnificativ asupra concepției mele privind modalitatea în care aplicația mea pentru subînchirierea locurilor de parcare ar trebui să fie proiectată. În particular, am identificat elemente esențiale care pot contribui la crearea unei aplicații inovatoare și eficiente.

Consider că integrarea acestei aplicații în contextul tehnologiilor existente pentru orașul nostru poate transforma urbanizarea într-o experiență mai inteligentă și mai sustenabilă. Prin furnizarea unui sistem de subînchiriere a locurilor de parcare, adaptat la nevoile specifice ale comunității noastre, putem contribui la optimizarea utilizării resurselor și la dezvoltarea unui oraș mai conectat și mai eficient.

Această direcție de cercetare și implementare tehnologică nu doar că aduce beneficii individuale, ci poate contribui și la progresul colectiv către o comunitate urbană mai inteligentă și mai ecologică.

5. Contribuțiile autorului

Implicarea mea în acest studiu a constat într-o abordare atentă și detaliată a literaturii de specialitate și a altor surse relevante în domeniul parcarilor inteligente. Mai precis, am aprofundat înțelegerea prin rezumarea și sintetizarea informațiilor obținute din diverse articole și studii legate de acest subiect. Această etapă crucială a procesului a avut drept scop extragerea concluziilor și identificarea tendințelor cheie în tehnologiile parcarilor inteligente.

Prin analiza atentă a literaturii existente, am fost în măsură să formulez o perspectivă clară asupra tehnologiilor emergente, problemelor semnificative și a soluțiilor propuse în domeniu. Această fundamentare solidă a fost esențială pentru a dezvolta un cadru conceptual robust și a sugera un model inovator pentru aplicația de subînchiriere a locurilor de parcare.

Propunerea mea pentru o aplicație de subînchiriere a locurilor de parcare de către proprietari are la bază concluziile trase din literatura de specialitate, adaptate nevoilor specifice ale comunității noastre. Această implicare se reflectă în eforturile de a crea o soluție practică și eficientă, care nu numai că abordează provocările existente, dar și contribuie la evoluția în direcția unei infrastructuri urbane mai inteligente.

6. Concluzii și perspective viitoare

Cercetarea și analiza atentă a tehnologiilor parcărilor inteligente au condus la formularea unei propuneri inovatoare: o aplicație de subînchiriere a locurilor de parcare de către proprietari. Această inițiativă a avut la bază o înțelegere profundă a literaturii de specialitate și a altor resurse relevante.

Implicarea mea s-a concentrat pe sintetizarea informațiilor din diverse surse pentru a trage concluzii esențiale, orientând astfel dezvoltarea unei soluții practice. Propunerea se bazează pe nevoile comunității și își propune să contribuie la evoluția către o infrastructură urbană mai inteligentă.

Pe viitor, implementarea practică va furniza date relevante pentru optimizarea continuă a aplicației. Colaborarea cu comunitatea și integrarea tehnologiilor emergente reprezintă pași esențiali pentru adaptarea și îmbunătățirea continuă a soluției. Explorarea modului în care aplicația poate contribui la sustenabilitate și eficiență urbană deschide perspective noi pentru dezvoltarea urbană inteligentă. Aceste eforturi sunt esențiale pentru transformarea conceptului într-o realitate benefică, contribuind la îmbunătățirea calității vieții în orașul nostru.

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Natural disaster and measures needed to reduce them

Cristiana SÎRBU,
Universitatea de Ştiinţe Agricole şi Medicină Veterinară Bucureşti, Academia de Ştiinţe Agricole şi Silvice "Gheorghe Ionescu Şişeşti", Fundaţia "Grupul de Iniţiativă Ecologică şi Dezvoltare Durabilă"
cris_sirbu@yahoo.com

Abstract
The paper presents the importance of cooperation in natural distaster reduction identified trough the work we started in 2016, by organising the Forum dedicated to the International Day for Natural Disaster Risk Reduction, benefiting from a valuable mix of experts from academia, universities, government, as well as experts from the European Union and around the world, including SMEs and civil society. In recent years there has been an increase in the frequency of risk factors threatening the life and health of the population, the environment and national heritage values, as well as the emergence of new risk factors, generated in particular by radical climate change and the diversification of economic activities using, producing and trading hazardous substances/materials. The main focus was to obtain information and draft measures and steps that need to be taken in order to achieve sustainable development and environmental sustainability. The activity identified the need to create a permanent advisory council to discuss all events and solutions that prove reliable in the event of natural and other disasters.

Keywords: natural disaster, sustainability, climate changes, cooperation.

1. Introduction
In accordance with resolution 44/236 of 22 December 1989 and resolution 56/195 of 21 January 2002 adopted by the United Nations General Assembly, the second Wednesday in October was designated as the International Day for Natural Disaster Risk Reduction as a means of promoting a global culture of disaster reduction – including disaster prevention, mitigation and preparedness.

In 2015, the United Nations set the International Day for Natural Disaster Risk Reduction on 13 October each year.

This global event raises awareness every year of the effects that natural disasters can have.

Climate change is of interest to all. It affects almost every socio-economic sector, from agriculture to tourism, from infrastructure to health. It impacts on strategic resources such as water, food and energy. They slow down and even threaten sustainable development, and certainly not only in developing countries.

The cost of inaction is high and will become even higher if we do not act immediately and decisively.

National security may be endangered by serious geophysical, meteoclimatic or related phenomena or dangerous human activities.

The year 2023 began with the most devastating earthquake in Turkish history, followed by similar events in Romania, then Syria, Italy, devastating fires in Greece and unprecedented storms in Bulgaria.

The European Union stressed that due to climate change, extreme events, which have led to emergencies, will intensify and multiply further.

2. Results and discussions

The efforts and measures to combat climate change should be strengthened both in the Union and globally.

The European Union Solidarity Fund has been established to respond to major natural disasters and to express European solidarity with disaster-stricken regions in Europe. The Fund was created in response to the severe floods in Central Europe in the summer of 2002. Since then, it has been used for 107 natural disasters such as floods, forest fires, earthquakes, storms and droughts. The Fund has also been mobilised for 20 interventions in response to health emergencies.

The effects of climate change are increasingly visible in Romania and internationally, and the most important challenge we face today is to stop climate change from getting worse. The "Ecological Initiative and Sustainable Development Group" Foundation has set up the first national and international forums on sustainable development, sustainability and environmental protection. The meetings organised over the years have raised interest in collaboration at civil society, academic and socio-political levels.

In 2007 we presented to the Romanian public the documentary by former US Vice President Al Gore, "An Inconvenient Truth", which won the Nobel Prize. At the same time as the presentation of the documentary, the book with the same title was launched in Craiova.

On 17 May 2010, the GIEDD Foundation welcomed Lester Brown, President and Founder of the World Watch Institute and the Earth Policy Institute, two global, not-for-profit, service-based climate change research organizations, as the first person in the world to advocate for the introduction of the concept of an eco-economy in 2001, in the book Eco-Economy: Building a future for the Earth.

More than ever we are concerned about the global evolution of climate change. In this regard, we in Romania have also tried in recent years, each individual, each organisation, each governmental institution, to join forces to become capable of informing the population and civil society in good time.

Every year, The "Ecological Initiative and Sustainable Development Group" Foundation, together with the Academy of Agricultural and Forestry Sciences "Gheorghe Ionescu Sișești", National Institute for Research and Development in Earth Physics, since 12 October 2016, we have organized the Forum dedicated to the International Day for Natural Disaster Risk Reduction, benefiting from a valuable audience of specialists from academia, universities, government, as well as experts from the European Union and around the world, including SMEs and civil society [1].

The need to attract European fundable projects and the benefits of developing the earthquake monitoring network were identified, as well as the need to develop strategic partnerships in documenting and training the specialists of today and tomorrow.

Romania's National Recovery and Resilience Programme (a mechanism created at EU level) as a financial instrument can provide public investment solutions until 2026 – the total financial allocation for Romania is €29.2bn and has over €14m in grants and €14.9bn in loans.Regional clusters have been part of the consultations and decisions taken for a predictable future, resilient to undesirable naturally occurring events.

It was also identified the need to create an advisory council to bring to the attention of the authorities the necessary measures to protect, inform and take action in the event of an earthquake or any other natural disaster and the importance of permanent collaboration of all decision-makers [2].

3. Conclusions

Climate change is an imminent threat to the world we live in, but we can all do something to combat it and build a better future. Risk reduction is about ensuring that natural hazards have a low destructive impact on lives, livelihoods and communities, which is achieved by building resilience, reducing risks and vulnerabilities. This is the responsibility of both authorities and individual citizens to work towards a world free from loss due to natural disasters by developing effective strategies that identify and reduce the potential causes of disasters, ensure rapid response in support of those threatened and ways to recover from them.

Acknowledgements

The study was conducted by The “Ecological Initiative and Sustainable Development Group” Foundation with the support of academia and specialized institution, starting in 2016, with the main purpose of working together to achieve sustainable development, environmental protection, information and supporting scientific collaboration.

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Smart and empathetic: the dual imperatives of effective political leadership

Ioana Andreea DOGEANU,
PhD Student at NUPSPA Doctoral School, Bucharest, Romania
ioana.dogeanu@administratiepublica.eu

Abstract
This paper aims to explore the convergence of intelligence and empathy within the realm of political leadership, examining how these attributes synergize to tackle contemporary challenges at both national and international levels. The objectives include investigating the interplay of intelligence and empathy in political leaders, analyzing how leaders possessing both qualities navigate intricate political landscapes, assessing the impact of a smart and empathetic approach on decision-making in situations demanding nuanced understanding, discussing potential policy implications arising from a leadership model that integrates both intelligence and empathy, and conducting a comparative analysis of leaders characterized by predominantly intellectual prowess, predominantly empathetic qualities, and a balance of both. Through these objectives, the paper seeks to provide valuable insights into the optimal combination of intelligence and empathy for effectively addressing the intricate challenges inherent in political leadership. The paper serves as a bridge between academia and real-word application, providing a nuanced understanding of smart and empathetic leadership that can inform future research, academic discourse, and practical decision-making in the realm of politics. Academics contribute to the expansion of knowledge and provide a theoretical foundation, offering researchers valuable insights for future studies. Meanwhile, practitioners, including politicians, derive practical guidance to improve leadership effectiveness and shape informed policy decisions. Through a synthesis of theoretical frameworks and empirical evidence, the article elucidates the multifaceted advantages of a smart and empathetic approach, shedding light on its implications for effective governance and societal well-being. The research outcomes may guide the formulation of policites that emphasize a balance between intellectual acumen and empathetic understanding, contributing to more informed and compassionate governance.

Keywords: governance strategies, decision-making processes, cognitive synergy, leadership models.

1. Introduction
This article delves into the intricate realm of leadership typologies, seeking to unravel the multifaceted dimensions of leadership through a meticulous examination of prevalent leadership models. Leaders, as architects of vision and agents of change, adopt diverse approaches to guide their teams towards success.

As organizations strive for adaptability and innovation, leadership styles become pivotal in shaping corporate culture and achieving strategic objectives. From charismatic and transformational leaders to those who emphasize situational adaptability, the spectrum of leadership models presents a rich tapestry of strategies employed by leaders to inspire and motivate people around them.

By navigatin through the labyrinth of leadership theories, this article aims to elucidate the defining characteristics of various leadership typologies. Whether exploring transactional, servant, or laissez-faire leadership styles, each model imparts a distinctive set of principles that influence organizational behavior and performance.

Despite the fact that you will find examples of leaders from other fields, not only the political one, my attention was mainly those who work in the political sphere.

The research questions formulated are: "What are the potential policy implications of a leadership model that integrates both intelligence and empathy, and how might it contribute to addressing intricate challenges in the realm of politics?", and: "To what extent does a smart and empathetic leadership approach contribute to the effective governance of nations, and how does it influence societal well-being?".

The research hypothesis is: "Political leaders who exhibit a harmonious convergence of intelligence and empathy will demonstrate enhanced effectiveness in addressing contemporary challenges".

The comparative analysis of leaders characterized by predominantly intellectual prowess, predominantly empathetic qualities, and a balance of both will reveal that those with a harmonious combination of intelligence and empathy exhibit superior leadership outcomes. Furthermore, the synthesis of theoretical frameworks and empirical evidence will underscore the multifaceted advantages of a smart and empathetic leadership approach, emphasizing its positive implications for effective governance and societal well-being.

Considering all of the above, I invite you to go through the content of this article in order to better understand the proposed topic.

2. Types of Leaders

In the complex tapestry of human endeavors, leadership emerges as a pivotal force shaping the course of societies, organizations, and individuals alike. The study of leadership goes beyond mere titles and positions. Types of Leaders serves as a comprehensive exploration into the diverse archetypes that define leadership in various contexts.

Within this chapter, I will strive to identify various categories of leaders, which specialized literature describes within specific parameters.

I will analyze the types of leaders having as critics the type of political legitimacy.
Legitimacy of political power "arises at the moment when individuals over whom it act recognizes it and accepts it" [1]. Irrespective of the nature of a structured and organized political system of the specific political regime in place, the substance of political power relies heavily on legitimacy [1]. Legitimacy emerges as a fundamental prerequisite for ensuring political stability [1].

Max Weber considered that legitimacy politics is closely linked to political authority, both of which are necessary conditions for maintenance a certain type of political power [Pârvulescu]. Political authority refers to the right to lead and take decisions, or allocate resources, a recognized right at the level of the whole society [1]. Legitimacy refers to form of recognition of this authority [1].
Weber believed that there were three types of legitimacy: rational-legal, traditional and charismatic [1].

Legitimacy of the rational-legal type is associated with structured political systems characterized by formalized political freedoms [1] These systems operate with established

rules governing socio-political interactions that are codified within a legal framework [1]. In such political organizations, the exercise and constitution of political power are contingent upon adherence to the law [1].

Leaders who exemplify of the rational-legal type often derive their authority from formalized systems and legal frameworks, are: Ruth Bader Ginsburg, former associate justice of the Supreme Court of the United States, her authority was derived from her role in interpreting and upholding the U.S. Constitution and legal principles [2]; Angela Merkel, the former Chancellor of Germany, Merkel′s leadership was grounded in adherence to democratic principles and the legal framework of the German political system [3]; Kofi Annan, the seventh Secretaty-General of the United Nations, who was based on adherence to international laws and treaties governing the United Nations′s mission and operations [4] and Warren Buffet, the chairman and CEO of Berkshire Hathaway, his leadership is characterized by a commitment to ethical business practices and adherence to regulatory framerworks in the financial sector [5].

Traditional legitimacy refers to the respect of the holders of political power by means of norms, beliefs, habits [1].

Leaders who derive their legitimacy from a traditional perspective often have their authority grounded in historical customs, cultural norms, or hereditary succession. Some examples: Queen Elizabeth II, the longest-reigning current monarch, her legitimacy is rooted in the British Monarchy′s historical continuity and traditions [6]; Pope Francis, his authority is deeply rooted in the traditions of the Catholic Church and the belief in apostolic succession [7]; Emperor Akihito, his legitimacy is rooted in the country′s historical imperial lineage and traditional role [8]; King Goodwill Zwelithini, the late Zulu King in South Africa, whose legitimacy was deeply rooted in Zulu traditions and customary leadership [9].

There are also societies in which political domination and power owe their stability and has sources in charismatic legitimacy, viewed as a belief that progress and good common, the aspirations and needs of the members of society are related to the exceptional qualities of a leader recognized by the group or community as entitled to impose "the best of the political orders" [1].

Leaders who derive their legitimacy from a charismatic perspective often have authority based on their personal qualities, charm, and ability to inspire and captivate followers: John F. Kennedy, the 35th President of the Unites States, known for his charisma, inspirational speeches, and the ability to connect with the American public [10]; Martin Luther King Jr., an influential leader in the American civil rights movement, celebrated for his charismatic leadership, powerful oratory, and commitment to nonviolent protest [11]; Che Guevara, a key figure in the Cuban Revolution, his charismatic leadership and revolutionary fervor made him a symbol of rebellion [12]; Steve Jobs, who was known for his charismatic presentation style, innovation, and the ability to inspire teams in the tech industry [13]; Billy Graham, an American Christian evangelist, who preaching style to connect with large audiences earned him widespread influence [14]; Nelson Mandela, who also had elements

of traditional and transformational leadership, his charisma played a significant role in uniting a divided South Africa [15]; Oprah Winfrey, a media mogul and talk show host, her charismatic personality has played a crucial role in her widespread popularity and influence [16].

These examples showcase leaders whose legitimacy is closely tied to their personal charisma, compelling communication skills, and the ability to inspire followers on a personal level. Charimatic leaders often create a sense of devotion and loyalty among their followers.

Nontheless, legitimacy of charismatic type is doubtful in some types of power regimes, as personal dictatorships, because, as a rule, the brilliant works or the special merits of the dictator appear only after he has come to power, propaganda to impose on the masses the image that only the dictator is worthy of being the head of the state [1].

3. Forms of Leadership

Leaders can also be characterized by the leadership model they adopt in: transformational leaders, charismatic leaders, transactional leaders, authoritarian leaders, servant leaders, populist leaders, conservative leaders, liberal leaders, nationalist leaders and global leaders.

Bernard M. Bass and Roland E. Riggo′s work on transformational leadership provides insights into a leadership style that goes beyond traditional transactional approaches [17].

The first typology of a leader adopt the model of a "transformational leadership", which is characterized by leaders who inspire and motivate their followers to achieve extraordinary outcomes and, in the process, let them develop their full potential [17].

The aspects of transformational leadership based on Bass and Riggio′s perspective are: idealized influence or "charisma″ by which we understand that they are seens as role models, they earn the admiration, trust, and respect of their followers, often through their personal qualities and actions; inspirational motivation, these leaders inspire and motivate their followers by creating a compelling vision of the future; intellectual stimulation, they encourage creativity and innovation among their followers; individualized consideration, the leaders pay attention to the individual needs and development of each follower; charismatic leadership, they often exhibit charismatic qualities, drawing followers in the through their charm, enthusiasm, and ability to articulate a compelling vision [17].

Second category of leaders is based on a charistmatic leadership. Scholars often distinguish charismatic leadership from transformational leadership, highlighting he former′s emphasis on followers identifying personally with the leader [18]

However, there is a lack of precise specification regarding the distinction between these two concepts [18]. While some researchers propose that charismatic leadership is a constituent of transformational leadership, others argue that the boundary between transformational and charistmatic leadership remains unclear [18]. This ambiguity is evident in the adaptable use of these terms across different research studies [18].

For example, Barack Obama, the 44th President of the United States, is often described as a transformational leader and his leadership style exhibited characteristics of both transformational and charismatic leadership. He was giving proof of inspiration and vision, empowerment, inclusivity, communication skills and personal appeal.

Transactional leadership assume an exchanges between leaders and followers and is based on the idea of transactions or deals where leaders provides rewards or punishments in response to the performance of their followers [19]. Transactional leadership is contrasted with transformational leadership, which is more focused on inspiring and motivating followers to exceed expectations and transcend their own self-interest for the greater good of the organization [19].

Transactional leadership is often associated with leaders who use system of rewards and punishments to motivate and manage their followers. For example, Margaret Thatcher, the former Minister of the United Kingdom, known for her pragmatic and transactional approach to politics, emphasizing individual responsibility and free-market principles [20]; Rudy Giuliani, the former Mayor of New York City, who implemented a transactional and the use of strict measures to address crime [21]; Michelle Rhee, the former Chancellor of the District of Columbia Public Schools, known for implementing performance-based reforms, including teacher evaluations tied to student achievement [22].

Transactional leadership can be effective in situations that require clear guidelines, structure, and accountability, such as in routine and well-defined tasks.

Authoritarians willingly adhere to established authority, favor traditional norms, and may display aggression towards individuals or groups that challenge authority, deviate from conventional practices, or exhibit unconventional behavior [23].

Authoritarian leaders are characterized by a concentration of power, limited political freedoms, and strict control over their respective domains. Vladimir Putin, serving as President and Prime Minister of Russia, has been criticized for consolidation power and limiting political opposition [24].

Another exemples are: Xi Jinping, as the General Secretary of the Communist Party of China and the President of China, he has centralized authority, extended presidential term limits, and tightened control over various aspects of Chinese society [25]; Kim Jong-un, as the Supreme Leader of North Korea, he oversees a highly centralized regime with strict control over political, economic, and social aspects of the country [26] or Recep Tayyip Erdogan, the President of Turkey, who has faced criticism for consolidating power, limiting press freedoms, and suppressing political opposition [27].

Servant leadership is a leadership philosophy that emphasizes the leader′s primary role as one of service to others and the concept was introduced by Robert K. Greenleaf in his essay “The Servant as Leader”, published in 1970 [28]. Servant leadership operates on the principle that the most effective leaders are those who prioritize meeting the needs of their

followers over satisfying their own personal desires [28]. Instead of focusing primarily on their own requirements these leaders concentrate on ensuring the fulfillment of their followers′ needs, thus fostering motivation and loyalty [28].

Servant leaders can be found in various fields and at different levels of organizations: Mahatma Gandhi, the leader of the Indian independence movement, he is often cited as a servant leader for his emphasis on selflessness, humility, and dedication to the well-being of others [29]; Mother Teresa, a catholic nun and missionary, she devoted her life to serving the poor and sick and her acts of compassion and care for the less fortunate reflect servant leadership qualities [30] or Simon Sinek, an expert and author, who promotes servant leadership principles in his work and his emphasis on leaders who prioritize the well-being of their teams aligns with servants leadership [31].

Populist leaders often appeal to the concerns and grievances of the common people, positioning themselves as champions of the "ordinary" citizen against a perceived elite or establishment [32]. They tend to use populist rhetoric and messaging to connect with a broad base of supporters [32].

For instance, Donald Trump, the 45th President of the United States, known for this populist communication style, anti-establishement messaging, and focus on issues affecting the working class [33]; Marine le Pen, the leader of the National Rally Party in France, she is associated with right-wing populist politics, emphasizing anti-immigration policies and economic nationalism [34].

Conservative leadership in a political context refers to a style of governance and decision-making that is grounded in traditional values, a preference for incremental change, a commitment to preserving established institutions, and a cautious approach to social and economic transformation [35]. Conservative leaders typically advocate for the maintenance of cultural norms, social stability, and the protection of individual libertities [35]. They often resist rapid or radical changes, preferring to rely on established practices and institutions to guide policy decisions [35].

Some examples of individuals often associated with conservative leadership: Ronald Reagan, the 40th President of the United States, is a key figure in modern American conservatorism and his presidency focused on reducing government intervention in the economy, cutting taxes, and promoting a string national defense [36] and Viktor Orban, the Prime Minister of Hungary, leads the Fidesz party, and is known for his nationalist and conservative policies and his government has focused on immigration control, economic nationalism, and a strong emphasis on traditional values [37].

Liberal leadership refers to a style of leadership that aligns with the principles and values of liberalism, a political and philosophical ideology [38]. Liberalism emphasizes individual rights, equality, freedom, democracy, and the rule of law [38].

In the context of leadership, a liberal leader is someone who incorporates these principles into their approach to governance or organizational management [38].

For example, Justin Trudeau, the Prime Minister of Canada, is associated with liberal leadership and he has emphasized diversity, gender equality, and progressive social policies during his tenure [39]; Emmanuel Macron, the President of France, is known for his centrist and liberal stance and his leadership is focused on economic reform, European integration, and environmental initiatives [40] or Joe Biden, the 46th President of the United States, has a pursued a liberal policy agenda, including measures on climate change, healthcare, and social justice [41].

National leaders are individuals who hold influential positions within a country′s governance structure and play a pivotal role in guiding and shaping the direction of the nation [42].

A national leader, whether elected or appointed, may serve in various branches of the government, including the executive or legislative branch [42]. The responsabilities of a national leader span a broad spectrum, with a primary focus on safeguarding the sovereignty of their nation [42] Effective communication and interpersonal skills are essential attributes, along with a comprehensive understanding of their own language, culture, and those of foreign dignitaries they may engage with [42].

In this category of leadership, we can include: Xi Jinping, Vladimir Putin, Emmanuel Macron, Scott Morrison, Boris Johnson, Narendra Modi, Moon Jae-in or Macky Sall.

The last, but not least, category of leaders after the adopted leadership model are global leaders.

Global leaders, often seen as the leaders of the future, adeptly navigate the complexities of the international arena, establishing cross-cultural connections and promoting growth for businesses and communities worldwide [43].

Integral to global leadership is the infusion of traditional leadership qualities with a Global Mindset [43]. Cultivating a Global Mindset begins with the capacity to articulate a compelling vision, engage in strategic thinking, and inspire collaborative efforts [43]. To emerge as a global leader, one must demonstrate proficiency in navigating challenges and leveraging opportunities within the ever-evolving, dynamic landascape of the international ecosystem [43].

In the context of influential figures with a significant impact on a global scale, global leaders ca be found in a various fields such as politics, business, and advocacy, for example: Elon Musk, the CEO of SpaceX and Tesla, is a visionary entrepreneur and business leader with a global influence in the fields of space exploration and electric vehicles [44]; Jeff Bezos, the founder and former CEO of Amazon, is a global business leader who has played a transformative role in e-commerce and technology [45]; António Guterres, the Secretary-General of the United Nations, is a global leader in diplomacy and international relations [46]; Bill Gates, co-founder of Microsoft and a philanthropist, is a global leader in technology, business, and public health through the Bill & Melinda Gates Foundation [47]; Ursula von der Leyen, the President of the European Commission, is a key leader in

shaping policies for the European Union [48] or Mark Zuckerberg, co-founder and CEO of Facebook (Meta), is a global leader in social media and technology [49].

These examples represent a diverse range of global leaders, each contributing to their respective fields and influencing global discourse in various ways. Keep in mind that the impact and perception of global leaders may evolve over time.

As we can see in Figure I below, a global leader must present a series of attributions in order to be declared in this way.

Fig. 1. The order of global leadership
Source: https://cronkitehhh.jmc.asu.edu/blog/2015/04/inside-the-prism-of-global-leadership/

4. Conclusions

In conclusion, this paper has undertaken a comprehensive exploration of the nexus between intelligence and empathy in political leadership, shedding light on their synergistic potential in addressing contemporary challenges at both national and international levels.

Regarding the research questions from the introductory part of the paper: "What are the potential policy implicatios of a leadership model that integrates both intelligence and empathy, and how might it contribute to addressing intricate challenges in the realm of politics?" and "To what extent does a smart and empathetic leadership approach contribute to the effective governance of nations, and how does it influence societal well-being?", I think that a leadership model that integrates both intelligence and empathy can have several potential policy implications and contribute significantly to addressing intricate challenges in the realm of politics. In addition, a smart and empathetic leadership approach can

contribute significantly to the effective governance of nations, influencing societal well-being in various ways.

In essence, a leadership model that integrates both intelligence and empathy is poised to generate policies that prioritize the holistic well-being of the population, foster social harmony, and address challenges with a nuanced understanding of the intricate dynamics at play in the realm of politics.

The hypothesis of research: "Political leaders who exhibit a harmonious convergence of intelligence and empathy will demonstrate enhanced effectiveness in addressing contemporary challenges"; I believe that it aligns with the objectives outlined in this paper. The validity of my hypothesis depend on the evidence and findings presented in my research, and as I analyze the interplay of intelligence and empathy, conduct a comparative analysis of leaders, and discuss the implications for effective governance, I conclude that is a discernible pattern or correlation between leaders exhibiting a harmonious convergence of intelligence and empathy and their success in addressing contemporary challenges.

In summary, a smart and empathetic leadership approach contributes to effective governance by fostering inclusive decision-making, social cohesion, trust, and transparency. This, in turn, positively influences societal well-being through policies that prioritize health, education, economic equity, crisis resilience, environmental sustainability, and cultural preservation. The interconnectedness of these factors creates a framework for governance that addresses the holistic needs of a nation, promoting a more prosperous and harmonious society.

Under the empire of the above in the content of the work, I believe that this article could serve as a foundation for a more in-depth-exploration of this topic, particularly given the current dynamic shifts occurring in societies and power structures worldwide. In these transformative times, the global landscape calls for leaders who possess not only intelligence but also empathy.

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How research and development spending shapes societal welfare and sustainability metrics in Europe

Ioana-Maria URSACHE,
Alexandru Ioan Cuza University of Iași, Iași, Romania
ioana.ursache@feaa.uaic.ro

Mădălina-Ioana PETREA,
Alexandru Ioan Cuza University of Iași, Iași, Romania
ioana.petrea@student.uaic.ro

Abstract
This research delves into the intricate relationship between Research and Development expenditure and key societal indicators within European Union nations. Through this research we aim to elucidate the overarching relationship between the research and development investment and societal wellbeing, transcending borders and regions. Furthermore, we aim to assess the universal patterns between innovation funding and digital inclusivity, represented by the internet access rates. Another objective of this research is to determine the potential European impact of research and development allocations on sustainable practices, using the recycling rate of municipal waste and circular material use rate as key indicators. Nevertheless, we aim to contribute to the global dialogue on optimizing research and development spending for multifaceted societal and environmental advancements. Previous studies have illustrated the importance of research and development expenditure as a significant factor influencing a nation's growth, technological innovation and societal well-being. Within the European context, research has consistently shown the intricate dynamics between innovation spending and societal indicators. However, few have delved deep into the multi-dimensional outcomes of such expenditures, particularly in areas like poverty internet access and sustainable practices. Drawing upon prior studies highlight the significance of the Research and Development expenditure to national growth and societal well-being, this investigation employs a quantitative approach, sourcing data from official EU databases. Utilizing SPSS for statistical analysis, preliminary results reveal a positive correlation between the expenditure on research and development and internet access, as well as sustainable practices. The findings offer profound implications for both academia and practitioners, suggesting that investments on research and development shape diverse societal and environmental outcomes. Unique in its comprehensive exploration of the multifaceted impacts of research and development spending, this research bridges economic, societal and environmental paradigms, thereby enriching the existing academic discourse and aiding in the formulation of holistic developmental strategies within the European Union.

Keywords: sustainable practices, innovation, economic development, quantitative research.

1. Introduction
The development landscape is undergoing a significant paradigm shift in this era of extraordinary global challenges, moving towards a future where sustainable practices and societal well-being occupy center stage. The primary function of research and development spending, a fulcrum that drives innovation and directs economic advancement, is at the forefront of this revolutionary journey. Investigating in research and development not only supports technological progress but also establishes the foundation for all-encompassing answers to the complex problems that characterize our day. Europe stands out as a testing ground for understanding the complex indications between research and development spending, societal welfare and sustainability metrics as countries around the world struggle with the urgent problems of environmental degradation, social inequity and the narrowly balanced pursuit of economic growth and sustainability. The area is a global leader in the

search for a more peaceful cohabitation between human endeavors and the earth we live on because to its dedication to promoting a culture of inquiry and advancement.

This paper delves into the complex mechanisms at work, revealing the significant influence of research and development expenditures on the precarious balance between sustainability and societal well-being. Research and development have a profound impact on European nations that extends beyond the confines of labs and academic institutions. It shapes legislation, propels economic growth, and shapes the quality of life for individuals in a variety of places. We explore the strategic choices that are taken in research and development and look at how they affect social inclusion, environmental conservation, and the general well-being of European countries. We aim to shed light on how Europe. As a change agent, navigates the challenges of the contemporary world by closely examining the environment where innovation meets societal needs. This will provide insightful analysis into the changing narrative of global development during a time when sustainability and well-being are of utmost importance.

Research and development spending plays a crucial role in improving enterprise competitiveness by promoting innovation, technology transfer, and business process optimization [1]. Research and development investments can provide a source of competitive advantage in a highly competitive economy [2]. Research and development is particularly important in the automotive manufacturing industry, as it influences manufacturing safety behavior and ensures the production of safer cars [3]. Furthermore, research and development can address economic stagnation and environmental risks by creating new jobs, transforming energy production and consumption, and reducing reliance on fossil fuels [4]. In the context of manufacturing, plantation, and mining companies, research and development investment has a positive and significant correlation with eco-efficiency and firm value, highlighting its importance in improving these aspects [5].

Overall, research and development is essential for enhancing competitiveness, safety, environmental sustainability, and economic growth in various industries.

While the global context is undoubtedly crucial, this research focuses on Europe, a region renowned for its commitment to progressive policies, technological advancements, and sustainable practices. Europe’s unique socio-economic landscape provides an ideal canvas for examining the intricate interplay between research and development spending and key metrics, we aim to uncover nuanced insights that can contribute to the broader discourse on sustainable development.

Studying Europe is essential for understanding the dynamics between research and development collaborations in different regions. The article by von Proff et al. examines the collaboration intensity between regions in Europe and the United States, focusing on spatial, technological, and cultural distance as factors influencing collaboration activities [6]. The study uses a panel spatial interaction modeling perspective and reveals differences in collaborative knowledge creation and the spatial range of knowledge diffusion between Europe and the United States [7]. Additionally, the articles by Bhattacharya and Erdel highlight the prevalent use of hybrid warfare as a covert strategic tool in Europe,

specifically in the case of Russian aggression towards its neighboring states [8]. Understanding these patterns of hybrid warfare is crucial for informing foreign policy decisions in the region. Therefore, studying Europe provides valuable insights into both research and development collaborations and geopolitical dynamics.

1.1. Societal welfare and sustainability metrics in Europe

In the literature studied, several connections between the variables analyzed have been found. The central focus of our literature research was to find connections, if possible, between the research and development investments and other variables related to sustainability and innovation such as "people at risk of poverty or social exclusion", "recycling rate of municipal waste", "circular material use rate" and "level of internet access- households".

Gross domestic expenditure on research and development has a significant relationship with the risk of poverty or social exclusion, as literature suggests. As research and development spending is often considered a key driver of economic growth, innovation and technological progress, higher levels of gross domestic expenditure on research and development as a percentage of Gross Domestic Product are associated with higher economic growth and Gross Domestic Product per capita [9]. This suggests that investing in research and development can contribute to reducing poverty and social exclusion.

Additionally, it is highlighted the importance of income in determining the risk of poverty. In the European Union (EU), individuals earning no more than 60% of the national median income are considered at risk of poverty [10]. Therefore, increasing the spending on research and development and promoting economic growth can potentially lead to higher incomes and reduce the risk of poverty or social exclusion.

Gross domestic expenditure on research and development has a significant and direct impact on the recycling rate of municipal waste [11]. Business expenditure on research and development, private investments, and the gross domestic product expenditures on research and development also have a direct and significant impact on recycling rate of municipal waste [12]. On the other hand, environmental taxes have a significant and inverse impact on recycling rate of municipal waste [13]. The relationship between economic growth and waste generation is also important in understanding the recycling rate of municipal waste. Previous studies have shown a bidirectional causality between waste generation and economic growth in EU regions [14]. Additionally, research and development intensity is considered an important determinant of environmental quality, and the regional level plays a crucial role in waste management policies [15]. These findings suggest that increasing research and development expenditure and implementing economic tools and eco-innovation policies are necessary to promote recycling and reduce waste generation.

Gross domestic expenditure on research and development has a positive correlation with scientific rankings of countries [16]. This suggests that an increase in research and development budgets can lead to an improvement in scientific rankings. However, there is no direct mention of the relationship between gross domestic expenditure on research and development and circular material use rate in the studied literature. The literature primarily

focuses on the relationship between economic development and material use, rather than specifically addressing the relationship between research and development expenditure and circular material use rate.

2. Research methodology

This research is centered around understanding the multifaceted effects of R&D expenditure on critical societal and environmental indicators. While the study draws extensively from data within the European Union, its broader objectives aim to shed light on universal patterns and implications, making it relevant to a global audience. The primary areas of focus include:

Societal Well-being: One of the primary dimensions of the study is to ascertain how R&D investment correlates with the overall well-being of society. This is captured through indicators such as the risk of poverty and societal exclusion, which serve as proxies for broader societal health.

- Digital Inclusivity: The research seeks to understand how innovation spending might influence digital penetration and inclusivity, represented predominantly by internet access rates. As the digital divide remains a concern globally, the findings in this dimension can have wide-reaching implications.
- Sustainable Practices: With sustainability at the forefront of global concerns, this study delves into how R&D allocations potentially affect sustainable practices. By focusing on the recycling rate of municipal waste and the circular material use rate, the research provides insights into the environmental stewardship influenced by innovation funding.

However, while the research aims for universality in its implications, it is essential to recognize the primary reliance on European Union data. As such, some specificities and nuances may be more reflective of the European context, even as broader patterns emerge.

O1. To elucidate the overarching relationship between research and development investment and societal wellbeing, transcending borders and regions.

O2. To assess the universal patterns between innovation funding and digital inclusivity, represented by internet access rates.

O3. To determine the potential global impact of research and development allocations on sustainable practices, uning the recycling rate of municipal waste and circular material use rate as key indicators.

O4. To contribute to the global dialogue on optimizing research and development spending for multifaceted societal and environmental advancements.

The analysis of the data was performed using SPSS software and the relationship between variables were investigated first through correlation and further tested through regression analysis.

3. Research findings

In the light of the literature analyzed, the following variables (Table 1) were selected for the analysis: Gross Domestic expenditure on Research and Development, People at risk of poverty or social exclusion, Recycling rate of municipal waste, Circular material use rate and Level of internet access- households. All the data was collected from the Eurostat database, the data retrieved being for the year 2021, the newest data available online.

Table 1. The variables used for the statistical analysis

Variable	***Notation***	***Variable type***	***Measuring unit***
Country	Country	String	-
Gross domestic expenditure on research and development (R&D)	RD	Numerical	%
People at risk of poverty or social exclusion	PRP	Numerical	%
Recycling rate of municipal waste	RRMW	Numerical	%
Circular material use rate	CMUR	Numerical	%
Level of internet access – households	LIA	Numerical	%

Source: Authors' own representation

The descriptive statistics (Table 2) provide insight into the distribution and characteristics of the analyzed variables. R&D exhibits a mean of 1.78, indicating a moderate level of investment across the sampled countries. The slight positive skewness (0.478) suggests that some countries have higher than average R&D expenditures, such as Belgium, Sweden, Austria, and Germany with rates over 3% of GDP. The mean value of PRP is 20.4, having a positively skewed distribution (0.83), that indicates that only a few countries, such as Czechia, Slovenia, Finland, and Slovakia, have lower than average poverty rates, contributing to the rightward tail in the distribution.

Table 2. Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation	Variance	Skewness		Kurtosis	
								Std. Error		Std. Error
RD	25	.47	3.43	1.7898	.92972	.864	.478	.464	-.986	.902
PRP	25	10.70	34.50	20.4120	5.52881	30.568	.831	.464	.864	.902
RRMW	25	11.30	67.80	41.7800	15.25251	232.639	-.363	.464	-.396	.902
CMUR	25	1.40	33.80	9.8520	7.35986	54.168	1.609	.464	3.442	.902
LIA	25	83.53	99.18	91.8908	3.81874	14.583	-.098	.464	-.042	.902

Source: Authors' own representation in SPSS

The RRMW analysis presents a negatively skewed distribution (-0.363) that implies that most countries have higher recycling rates, with fewer samples with lower rates, contributing to a leftward tail in the distribution. The positively skewed distribution of CMUR (1.609) indicates that there are fewer entities with lower rates of circular material use, contributing to a rightward tail in the distribution. The higher kurtosis (3.442) suggests that the distribution has heavier tails than a normal distribution, indicating potentially extreme values. Lastly, LIA has a high mean of 91.8 and a normal distribution, as indicated by skewness (-0.098) and kurtosis (-0.042), values close to zero, suggesting a consistent and widespread level of internet access across the sampled entities.

To further investigate the relationship between variables, we performed a correlation analysis (Table 3).

The correlation matrix provides a comprehensive view of the relationships between key variables. Notably, Gross Domestic Expenditure on Research and Development (RD) exhibits significant correlations with various indicators, shedding light on potential linkages between research investment and societal outcomes.

Table 3. Correlation matrix

		Correlations				
		RD	PRP	RRMW	CMUR	LIA
RD	Pearson Correlation	1	-.515**	.616**	.371*	.432*
	Sig. (1-tailed)		.004	.001	.034	.016
	N	25	25	25	25	25
PRP	Pearson Correlation	-.515**	1	-.414*	-.253	-.408*
	Sig. (1-tailed)	.004		.020	.111	.021
	N	25	25	25	25	25
RRMW	Pearson Correlation	.616**	-.414*	1	.457*	.437*
	Sig. (1-tailed)	.001	.020		.011	.014
	N	25	25	25	25	25
CMUR	Pearson Correlation	.371*	-.253	.457*	1	.330
	Sig. (1-tailed)	.034	.111	.011		.054
	N	25	25	25	25	25
LIA	Pearson Correlation	.432*	-.408*	.437*	.330	1
	Sig. (1-tailed)	.016	.021	.014	.054	
	N	25	25	25	25	25

**. Correlation is significant at the 0.01 level (1-tailed).
*. Correlation is significant at the 0.05 level (1-tailed).

Source: Authors' own representation in SPSS

Firstly, a negative correlation between RD and People at Risk of Poverty or Social Exclusion (PRP) suggests that regions or countries with higher RD investment tend to have lower levels of poverty or social exclusion. This underscores the potential socio-economic benefits associated with increased research spending. Additionally, RD demonstrates positive correlations with positive environmental indicators—specifically, a higher Recycling Rate of Municipal Waste (RRMW) and Circular Material Use Rate (CMUR). This implies that regions with greater research investment are likely to demonstrate more sustainable waste management practices and circular material use. Conversely, PRP shows negative correlations with environmental indicators. A higher prevalence of people at risk of poverty or social exclusion is associated with lower recycling rates and, interestingly, a lower Level of Internet Access in Households (LIA). This latter association may highlight potential digital divides in regions facing higher socio-economic challenges.

The intricate interplay between these variables underscores the multifaceted impacts of research spending on societal well-being, encompassing economic, environmental, and social dimensions. As with any correlation analysis, these associations do not imply causation, but they do provide valuable insights for policymakers and researchers to explore further and potentially inform strategies aimed at fostering inclusive and sustainable development.
Based on these arguments, the following hypotheses emerge:

- **H1**: Investments in R&D have a negative influence on the percentage of *People at risk of poverty or social exclusion* (PRP).
- **H2**: Investments in R&D have a positive influence on the *Recycling rate of municipal waste* (RRMW).
- **H3**: Investments in R&D have a positive influence on the *Level of Internet Access in Households* (LIA).

These hypotheses are further tested using regression analysis, the influences with statistical significance at $p < 0.05$ level being presented next.

A first regression analysis (Table 4) assessed the variation of R&D expenditures in relation to the rate of poverty. The results of the regression analysis performed to test the effects of R&D independent variable on the dependent variable PRP indicated a statistically significant prediction model ($F=8.92$, $p <0.05$), with 26,5% of PRP variability (R Square = 0.265) explained by the negative effect of R&D ($\beta = -3.061$, $t = -2.880$, $p<0.05$). Thus, the regression model indicates that higher investments in research and development, as represented by Gross Domestic Expenditure on R&D, are associated with a statistically significant reduction in the prevalence of individuals at risk of poverty or social exclusion, supporting H1.

Table 4. Results of regression analysis (dependent variable PRP)

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.515[a]	.265	.233	4.841988

a. Predictors: (Constant), RD

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	194.395	1	194.395	8.292	.008[b]
	Residual	539.231	23	23.445		
	Total	733.626	24			

a. Dependent Variable: PRP

b. Predictors: (Constant), RD

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	25.891	2.135		12.127	.000
	RD	-3.061	1.063	-.515	-2.880	.008

a. Dependent Variable: PRP

Source: Authors' own representation in SPSS

A second regression analysis was used to assess the influences exerted by Gross Domestic Expenditure on R&D on *Recycling rate of municipal waste* (RRMW). The analysis results detailed in Table 4 revealed a statistically significant prediction model ($F = 14.051$, $p < 0.05$), explaining 37,9% of RRMW variability (R Square = 0.379) through the high positive effect of R&D ($\beta = 10.103$; $t = 3.748$; $p = 0.001$, significant at $p < 0.05$). Therefore, H2 is supported by the empirical evidence.

Table 5. Results of regression analysis (dependent variable RRMW)

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.616[a]	.379	.352	12.275691

a. Predictors: (Constant), RD

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	2117.410	1	2117.410	14.051	.001[b]
	Residual	3465.930	23	150.693		
	Total	5583.340	24			

a. Dependent Variable: RRMW

b. Predictors: (Constant), RD

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	23.697	5.413		4.378	.000
	RD	10.103	2.695	.616	3.748	.001

a. Dependent Variable: RRMW

Source: Authors' own representation in SPSS

Table 6 presents the statistical outputs of the regression analysis between Gross Domestic Expenditure on Research and Development (RD) and Level of Internet Access in Households (LIA). The regression model is statistically significant, explaining 18,6% of LIA variation (R Square = 0.186) and predicting the increase in households' access to internet at a statistically significant level ($F = 5.265$, $p = 0.031$). Moreover, the regression path coefficient β and its statistical significance (t statistics and p value) detailed in Table indicate a significant effect for the independent variable R&D ($\beta = 1.773$, $t = 2.295$, $p = 0.031$).

Overall, R&D has significant contributions to the development of various societal and environmental indicators as follows: it exerts the lowest positive influence on the Level of internet access (LIA) and the highest positive influence on the *Recycling rate of municipal waste*, as well as a strong negative influence on *People at risk of poverty or social exclusion*. Thus, all three hypotheses are supported by the data.

Table 6. Results of regression analysis (dependent variable LIA)

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.432[a]	.186	.151	3.518836

a. Predictors: (Constant), RD

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	65.196	1	65.196	5.265	.031[b]
	Residual	284.791	23	12.382		
	Total	349.987	24			

a. Dependent Variable: LIA

b. Predictors: (Constant), RD

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	88.718	1.552		57.179	.000
	RD	1.773	.773	.432	2.295	.031

a. Dependent Variable: LIA

Source: Authors' own representation in SPSS

4. Conclusions

In conclusion, the statistical analysis conducted through SPSS reveals insights into the relationship between research and development spending and societal welfare and sustainability metrics in Europe. Firstly, it is evident that research and development plays a pivotal role in shaping the recycling practices of municipal waste. The statistically significant and highest influence on the Recycling Rate of Municipal Waste highlights the instrumental role of innovation in waste management strategies. This emphasizes the importance of continued investment in Research and Development to foster sustainable practices that. Contribute to environmental preservation and resource conservation. Surprisingly, the analysis indicated notably lower positive influence of Research and Development on the Level of Internet Access (LIA). This intriguing finding suggests that while technological advancements and connectivity are crucial for societal progress, Research and Development spending may not be the sole determinant of widespread internet access. This calls for a nuanced approach in policymaking recognizing that additional factors beyond Research and Development may be influencing internet accessibility.

However, the most noteworthy revelation pertains to Research and Development's strong negative influence on the metric of People at Risk of Poverty or Social Exclusion. This counterintuitive outcome warrants further exploration and underscores the complexity of

societal dynamics. While Research and Development is traditionally associated with progress and prosperity, this finding prompts a critical examination of potential unintended consequences, signaling the need for inclusive and socially responsible innovation strategies.

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Energy ecosystems layered over hydrogen valleys for sustainable smart communities. Strategic framework for the Green Deal Industrial Plan implementation in Romania

Vlad STOICESCU,
Bucharest Univerity of Economic Studies, Sustainable Fuels Association, Bucharest, Romania
vs@rosurse.com

Catalin VRABIE,
National University of Political Studies and Public Administration (SNSPA), Public Administration Faculty, Bucharest, Romania
catalin.vrabie@snspa.ro

Teodora BIȚOIU,
National University of Political Studies and Public Administration (SNSPA), Public Administration Faculty, Bucharest, Romania
teodora.bitoiu@administratiepublica.eu

Abstract

This research effort aims to obtain a clear and concise image of the organizational environment in Romania, currently operational in economic ecosystems built around host cities that sustain their societal dynamics based on corporative value chains. In order for cities to thrive, we propose the adoption of the continental framework for sustainable economies, having sufficient normative and regulatory elements to build a strategic analysis in support of a swift transition of industries and transportation, and the cities they influence, to sustainability. The research objectives are to analyse the main economic stakeholders organizational design and behaviour in their host communities, their relationship with the local and central public administration, and build new synergies based on opportunities to finance sustainable development, starting from renewable energy and green hydrogen as main catalysers for the transition. The research is an evolution of our prior "The Smart Community: Strategy Layers for a New Sustainable Continental Framework", a quantitative study of the European regulatory framework for sustainability, that now demands a thorough examination of the implementation methods in member states. The examination aims to obtain data regarding the organizational impact on the host community, and extended influences on the value chain, data to be used in a hypothetical optimization scenario based on renewable energy resources financed from power purchase agreements, a consolidated intra-industries demand for green hydrogen in industrial processes and transportation for a green energy demand forecast, the European, central and local governmental intervention in subsidizing the effort to build new resources and the social effects of a renewed approach to business administration. Considering the Paris Agreement and European Green Deal, several academic efforts are visible on defining the transition mechanisms to sustainable economies, providing sufficient information for best practices and successful implementation examples, studies to be used in a qualitative review of academic literature to sustain the concepts herein. The study and research result in a conceptual framework and strategy for industrial and value chain pivot to sustainable practices, based on a geographical segmentation of Romania into regions of interest selected due to specific infrastructure characteristics, energy resources, access to technology, access to human resources, etc. Implications for the academic sector and researchers abound, as this theoretical approach will include industrial sectors in defining a base-line for their legally mandated effort to comply with costly regulations, confronted with social tension regarding the effects of enterprises within communities they operate in, approach that translates into net value for governmental, corporative, academic and social stakeholders in our effort to clarify the benefits and hurdles implied by sustainability.

Keywords: sustainable development, renewable energy, economic ecosystems, organizational design, green hydrogen.

1. Introduction

In the face of escalating environmental challenges and the global imperative for sustainable development, Romania finds itself at a crossroads, tasked with the significant undertaking of transitioning its high-energy-consuming sectors towards more sustainable practices. This qualitative review aims to dissect the multifaceted economic climates within Romania, identifying sectors poised for sustainable transformation through the lens of financial and policy incentives. The study employs a comprehensive methodology, beginning with an exhaustive literature review to ground the research in the existing academic discourse. Following this, a PESTLE analysis offers a macro-environmental perspective on Romania's readiness for such a transition, complemented by an exploration of key Romanian regions and economic organizations pivotal in this ecosystem.

The final objective is to map the landscape of sustainable industries within Romania, providing a strategic blueprint for leveraging renewable energy and green hydrogen technologies. By bridging the gap between potential and practice, this research contributes valuable insights into the implementation methods within the EU framework, highlighting Romania's unique opportunities and challenges in navigating its sustainable development trajectory.

This study is meant to be revisited in 2025, the first year of mandatory non-financial disclosure for companies that are subject to comply with the Corporate Sustainability Reporting Directive of the European Union, that has been transposed and applied to the Romanian legislative system. Our ambition is to stimulate the growth of a sustainable economy from the energy resource that influences a Guarantee of Origin for sustainable products and services, that can then be assimilated into sustainable value chains.

Starting from energy ecosystems, we thus suggest preventive and pre-emptive compliance with green legislation by ensuring a clean value chain for economic agents that affect communities they employ from or sale to, fostering a synergic sustainable growth of organizations with sustainable designs and smart communities that thrive in progress. Pre-emptive compliance is suggested as a means to stimulate the new sustainable economies and generate ecosystems for Net 0 production. However, after the first non-financial reports will have been issued, carbon offset schemes may influence a new wave of sustainable finances, element that will be of interest for further academic research.

Hydrogen is, according to the Green Deal Industrial Plan, the main catalyser of this sustainable organization design, as it can be an emissions free energy resource, energy transportation vehicle or energy storage technology, all at the same time. With vast financial resources directed by both public and private organizations to the development of the “Hydrogen Economy”, our ambition is to find how hydrogen influences the growth of smart communities and sustainable organizations in Romania.

2. Literature Review

The transition towards sustainable development within economic ecosystems, especially in the context of host cities and corporative value chains, is a global imperative. The continental framework for sustainable economies offers a strategic approach for cities and

industries worldwide to embrace sustainability. This research effort, building on our earlier study "The Smart Community: Strategy Layers for a New Sustainable Continental Framework," seeks to explore the implementation of sustainable practices within the European Union member states, with a focus on Romania[1].

Renewable energy and clean hydrogen emerge as pivotal elements in the strategic analysis supporting the swift transition towards sustainability. The adoption of these sustainable solutions is essential for addressing environmental challenges and promoting economic growth within the framework of the European Green Deal and the Paris Agreement [2].

Renewable energy and clean hydrogen emerge as pivotal elements in the strategic analysis supporting the swift transition towards sustainability. The adoption of these sustainable solutions is essential for addressing environmental challenges and promoting economic growth within the framework of the European Green Deal and the Paris Agreement. The European Green Deal aims to transform the EU into a sustainable, climate-neutral economy by 2050, emphasizing the reduction of greenhouse gas emissions, increasing renewable energy use, and promoting circular economy principles [3], [4]. A focus on renewable energy sources is fundamental to achieving these objectives, as demonstrated by the development of the energy sector in the EU, which relies chiefly on renewables to ensure an environmentally friendly and health-conscious transition [5]

The implementation of Guarantees of Origin (GOs) serves as a crucial mechanism for assuring the renewability of electricity supplies and promoting upstream emission reduction. These certificates, however, face challenges in transparency and incentivizing renewable capacity investment. Blockchain technology offers potential solutions by enhancing transparency and simplifying processes, thereby supporting sustainability commitments, and facilitating the transition to renewable energy resources [6]. This approach aligns with European initiatives and the Green Deal industrial plan, underscoring the importance of pivoting industrial design towards renewable resources to achieve a sustainable and climate-neutral economy by mid-century.

The transition to renewable energy, supported by GOs and emission reduction strategies, is pivotal for sustainable organizational design. These measures are integral to the broader objectives of the European Green Deal, which seeks not only to mitigate environmental impact but also to foster economic growth and societal well-being within a sustainable framework.

2.1. Renewable energy and green hydrogen: a global perspective and focus on Romania

Renewable energy sources and green hydrogen are increasingly recognized as essential for achieving sustainable development goals (SDGs) and mitigating climate change impacts. Green hydrogen, in particular, offers opportunities for economic and social development by creating job opportunities and reducing greenhouse gas emissions. Its application across various industries, including agriculture, steel production, concrete, transportation, and energy, demonstrates its potential to contribute significantly to global sustainability efforts [7]. Clean hydrogen is increasingly recognized as vital to the decarbonization of Romanian energy systems and regional economic ecosystems. Local initiatives such as

hydrogen-natural gas blending in distribution systems have demonstrated significant potential for reducing greenhouse gas emissions, underscoring the techno-economic feasibility and environmental benefits of these approaches [8].

Romania is making significant strides in integrating green hydrogen into its energy landscape as part of its commitment to sustainable development and climate goals. The Ministry of Energy of Romania has published the first draft of its long-awaited Hydrogen Strategy and Action Plan for 2023-2030, indicating a substantial step towards incorporating hydrogen into the country's energy matrix. This strategy underlines the need for significant investments in hydrogen infrastructure to support the country's transition towards energy sustainability and economic growth through decarbonization [9].

In support of this strategy, Romania has unveiled a state aid scheme aiming to boost investments in green hydrogen production capacities, which are to be powered by solar, hydro, and wind resources. This move is highlighted by the plans for a national auction to fund at least 100MW of green hydrogen production, following the European Commission's approval to provide up to €149m ($152m) in public finance for this initiative. This scheme has encouraged the development of new green hydrogen production facilities, including extensions of existing capacities, with companies and research facilities being able to bid for direct grants of up to €50m per project [10]. A crucial aspect is that the company that stands to gain most from this financial facility is OMV Petrom, one of the largest players in the European hydrocarbon-based fuels sector [11], issue that is consistent with the global trend of Oil&Gas organisations pivoting to sustainable alternatives. Moreover, the Romanian minister of energy has launched a new modernization facility to subsidize green hydrogen projects at the beginning of 2024, which again stimulates the market to pivot to renewable solutions. With Romania being a strong backer of nuclear energy and pushing a common agenda for this resource to be considered sustainable, it is beginning to look like green hydrogen might have another advantage by the form of clean nuclear energy projects subsidized from the Innovation Fund [12]

2.2. Sustainable organizational design in the Hydrogen Economy

The global push towards sustainable consumer behaviour and digital adoption underscores the importance of agile adaptation by organizations. Sustainable practices and green business models are crucial for addressing the challenges of climate change and achieving environmental sustainability. The integration of digital solutions enhances the efficiency of these practices, promoting sustainable consumption and production patterns across different sectors [13]. The organizational environment in Romania is integral to the transition towards sustainable economies. Studies have highlighted major shifts in sustainable consumer behaviour and the agility of retailers in adapting to these changes, emphasizing the importance of green business practices and digital solutions [14]. Furthermore, the role of quality governance in reducing pollution and promoting sustainable development has been identified as crucial, with a focus on renewable energy consumption's impact on pollution levels [15].

Green hydrogen represents a transformative energy solution across various industries and transportation, including agriculture, to significantly reduce emissions and enhance

sustainability within communities[16]. This renewable energy source, produced through water electrolysis using electricity from renewable sources, offers a clean alternative to fossil fuels without generating polluting effects. Its application spans several sectors, demonstrating its versatility and potential in contributing to a sustainable and decarbonized future [17].

The transition to green steel production is a critical step in the global journey towards decarbonization, particularly in heavy industries like ironworks. Green hydrogen, produced through the electrolysis of water using electricity from renewable sources, plays a pivotal role in this transition, serving both as a reductant and as fuel. The steel industry, responsible for a significant share of global CO2 emissions, is under increasing pressure to reduce its carbon footprint. Utilizing green hydrogen as a clean energy source offers a pathway to achieving net-zero emissions in steel production, aligning with environmental goals and regulatory mandates.

One pathway towards decarbonizing the steelmaking process involves enhancing energy efficiency, incorporating low-carbon fuels, capturing carbon emissions, and ultimately, employing clean hydrogen as both a reductant and fuel. Short-term solutions for greener blast furnace processes are being explored, with direct reduced iron (DRI) production combined with carbon capture, utilizing gasified waste or biomass, emerging as a viable mid-term option at some steel mills. The development and scaling of hydrogen production technologies are crucial to this transition, encompassing challenges not only within the steel industry but also in the supply of renewable power and suitable iron ores. Strategic integration and consideration of geographical factors are essential for an effective transition to green steel production [18][19].

Moreover, the application of green hydrogen extends beyond reducing emissions in the steelmaking process. It also plays a role in the broader industrial sector, including oil refining and chemical production, where it can partially or fully decarbonize the production of commodities such as anode copper and pig iron. The chemical industry, for instance, can utilize green hydrogen to decarbonize ammonia production, which is pivotal for fertilizer manufacturing. This demonstrates the versatile role of green hydrogen in achieving industrial decarbonization across various sectors [20]

A cited technical review highlights that green hydrogen could serve as an appropriate substitute for carbon-intensive fuels in cement kilns, presenting a potential for comparatively smooth integration into, or replacement of, process heat systems based on fossil fuels. This shift could contribute significantly to the industry's efforts to lower its carbon footprint and move towards sustainable production practices. The review concludes that the use of hydrogen as a source of process heat in cement manufacturing can present a viable pathway to decarbonize the sector, although challenges related to the scalability, cost, and infrastructure for hydrogen supply need to be addressed [21]

Furthermore, the demand and cost comparison of green hydrogen across various industries in Germany identifies the cement industry as one of the sectors where green hydrogen can play a significant role in decarbonization. The study acknowledges the challenges and the short-term increase in costs associated with transitioning to green hydrogen but emphasizes its potential to contribute to the long-term sustainability of the industry [20].

Academic findings demonstrate that the CO2 avoided costs across multiple test scenarios are significantly lower than the conventional decarbonized cement production process (DCPP) cost. This reduction in cost is attributed to the valorised production of additional products (urea and methanol) from captured CO2, showcasing the economic benefits of integrating green hydrogen into cement manufacturing. Moreover, another scenario that employs the Cu-Cl thermochemical cycle and a partially green electricity grid for hydrogen and oxygen production, emerges as the most favourable, presenting the lowest renewable energy to power (RenE2P) cost and the highest efficiency in CO2 capture, highlighting the practical and financial feasibility of adopting green hydrogen for cement decarbonization.

Findings suggests that green hydrogen can play a pivotal role in reducing the cement industry's carbon footprint while maintaining economic competitiveness, marking a significant step towards sustainable cement production.[22]

In the agriculture and livestock sector, green hydrogen can revolutionize energy consumption patterns, providing a sustainable alternative to traditional fossil fuels. It can support the industrial revolution in agriculture, enhancing access to energy resources, improving energy security, and reducing greenhouse gas (GHG) emissions. The deployment of green hydrogen in this sector is still in its infancy, facing barriers to large-scale adoption. However, with appropriate policies and financial incentives, it can emerge as a profitable technology for the future, contributing to sustainable development goals (SDGs) [23].

Green ammonia production for fertilizers: Green ammonia, synthesized from green hydrogen, stands at the forefront of this revolution. Produced through renewable energy-powered electrochemical and thermal processes, green ammonia presents a viable replacement for fossil fuel-based ammonia commonly used in fertilizers. Its adoption in the fertilizer industry can significantly reduce the carbon footprint of agricultural practices, promoting a shift towards cleaner, renewable sources of essential nutrients[24]. The integration of green ammonia into fertilizers supports the transition to a sustainable energy system, offering new opportunities across the fertilizer, transportation, and energy industries.

Cellulose-based hydrogels for slow-release fertilizers: Another innovative approach is the development of cellulose-based hydrogels that incorporate green hydrogen. These hydrogels can regulate the release of nitrogen fertilizers, offering a slow, sustained release that aligns with the nutrient uptake patterns of crops. This method not only improves the efficiency of fertilizer use but also minimizes nutrient leaching and environmental pollution. The hydrogels exhibit excellent absorbance capacity and durability, highlighting their potential for widespread agricultural applications [25].

In the chemical industry, green hydrogen is pivotal for achieving net-zero emissions. The industry, responsible for a significant portion of CO2 emissions, can benefit from replacing fossil-derived hydrogen in the synthesis of key chemicals like ammonia, hydrogen peroxide, methanol, and aniline with green hydrogen. This substitution can disrupt traditional production methods, paving the way for a low-carbon economy and contributing to the environmental sustainability of the chemical sector [26].

In transportation, hydrogen serves as a clean fuel alternative, capable of being used in fuel-cell electric vehicles (FCEVs) or burnt in internal combustion engines. This transition is vital for reducing GHGs and other harmful emissions, offering a sustainable path forward for the sector. Various countries support the research and development of hydrogen-powered vehicles due to their environmental benefits, showcasing the global recognition of hydrogen's role in achieving a sustainable transportation system[27].

Green hydrogen plays a crucial role in enhancing the sustainability of the fuel industry by reducing the aromatic component of fossil fuels and contributing to the production of synthetic fuels, synthetic natural gases, biogases, and biological fuels. Its application in these areas is pivotal for achieving carbon neutrality and advancing towards a more sustainable and environmentally friendly energy landscape.

Reduction of aromatic components in fossil fuels – green hydrogen's potential in the hydrogenation of vegetable oils demonstrates its capacity to produce high-quality biodiesel and environmentally friendly diesel fuel. This process, which involves compounding green diesel with hydro-treated diesel fuel and incorporating bio-additives, leads to diesel engines' fuel with improved lubricating properties and reduced wear scar diameter. The production of three-component environmentally friendly diesel fuel aligns with standards such as EN 590: 2009, indicating its viability as a substitute for conventional fossil fuels [28]

Synthetic fuels, natural gases, and bio-gases production – green hydrogen can be blended with natural gas/biomethane for transportation in existing gas networks, highlighting its role in emission reduction in hard-to-decarbonize sectors such as transport applications and certain industrial processes. This blend supports the production of synthetic fuels, such as synthetic kerosene in aviation, by reacting carbon dioxide (CO2) with hydrogen. Furthermore, hydrogen's environmental co-benefits, like the absence of air pollutant emissions when used as fuel, underscore its significance in the transition towards cleaner energy sources. Moreover, blending hydrogen with natural gas/biomethane for transportation in existing gas networks is a transitional strategy from fossil-based to renewable green hydrogen. Such blends, with hydrogen volumes of 5–20%, can be accommodated by most systems without significant infrastructure upgrades or appliance retrofits. This approach is gaining traction in Europe, aimed at decarbonizing natural gas grids, and promoting the European Hydrogen Backbone as a pivotal element in transitioning to renewable energy sources [29]

The generation of green hydrogen through biomass represents an environmentally friendly approach, with techniques aimed at enhancing conversion processes and leveraging Pressure Swing Adsorption (PSA) for cost-effective hydrogen extraction. This method, particularly when using pyrolysis, offers economic benefits due to the potential for valuable by-products. As such, biomass stands out as a promising source for the production of green hydrogen, paving the way for the creation of biogases and bio-based fuels. Additionally, the production of Sustainable Aviation Fuel (SAF) from biomass using methodologies like Fischer-Tropsch synthesis and Hydroprocessed Esters and Fatty Acids (HEFA) plays a pivotal role in the movement toward low-carbon aviation solutions. The introduction and expansion of SAF are pivotal for slashing aviation-related greenhouse gas emissions, aligning with international

efforts such as the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) to mitigate the environmental impact of aviation. This shift towards the adoption of synthetic hydrocarbon fuels underscores a global commitment to replacing traditional jet fuels with more sustainable options by the end of the century, despite facing hurdles in raw material availability and the evaluation of environmental impacts. [30]

The synthesis of Sustainable Aviation Fuel (SAF) via CO/CO2 hydrogenation presents a promising pathway for reducing carbon emissions in the aviation industry, aligning with goals for renewable energy assimilation. A thermodynamic investigation into the direct or indirect synthesis of SAFs from CO/CO2 hydrogenation has highlighted the temperature-dependent reduction in the reaction driving force for all products, emphasizing the thermodynamic favorability of various hydrocarbon products synthesized. This study reveals a thermodynamic preference for synthesizing SAF with a higher proportion of aromatic compounds, offering insights into potential pathways for optimizing fuel synthesis to improve efficiency. The findings underscore the importance of developing SAF with complex components to meet the standards set by the American Society for Testing and Materials (ASTM) D7566 and suggest a strategic approach to the synthesis process in industrial scenarios [31]

The incorporation of green hydrogen into the production of fuels and additives represents a significant advancement in the pursuit of carbon neutrality and environmental sustainability. By reducing the aromatic component of fossil fuels and facilitating the production of synthetic and bio-based fuels, green hydrogen not only contributes to the decarbonization of the energy sector but also promotes the development of cleaner and more sustainable fuel alternatives.

The integration of renewable-energy-based green hydrogen into the energy landscape supports the transition from fossil fuels to clean energy, optimizing the energy industry system and promoting strategic energy development transformations. This approach enhances energy security and aligns with global efforts to build a low-carbon, efficient, and clean energy structure [32].

District heating systems are pivotal in the transition to decarbonized energy systems, enhancing supply security. Despite the primary focus on electrification for decarbonization, green hydrogen emerges as a vital energy source for peak demand coverage, offering long-term storage in power-to-gas solutions and acting as a backup. The debate between utilizing pure hydrogen and building appropriate infrastructure versus employing hydrogen-derived synthetic gas, for which infrastructure already exists, is central to current research. Existing technological solutions and associated costs for utilizing either hydrogen or synthetic gas demonstrate the feasibility of integrating green hydrogen into district heating systems, offering a cleaner alternative to natural gas [33]

The technical and economic aspects of transitioning natural gas thermal power plants to green hydrogen also demonstrate the feasibility and benefits of such a shift. A case study in Nigeria highlighted the potential for significant CO2 emissions reduction and economic viability, with a return on investment within 4-5 years, emphasizing green hydrogen's role in decarbonizing the energy sector and contributing to global warming mitigation efforts [34].

The integration of green hydrogen technology into the energy framework of data centres represents a forward-looking approach to achieving sustainability in the IT industry. Green hydrogen can serve as a key to unlocking energy efficiency and reducing carbon emissions within these critical infrastructures. Optimizing the operation of microgrids for hydrogen-based heat supply through deep reinforcement learning demonstrates how green hydrogen can provide competitive production costs and act as a natural gas substitute for heating within the industry. This optimization paves the way for data centres to adopt green hydrogen for both electrical and thermal energy needs, significantly contributing to the decarbonization of the IT sector[35]. On the other hand, the role of artificial intelligence, data analytics, and optimization algorithms in advancing green hydrogen technologies for sustainable power supply within data centres emphasizes the synergistic relationship between green energy solutions and technological innovation[36].

As we navigate the complexities and challenges of transitioning towards a more sustainable and environmentally friendly industrial landscape within the European Union, the role of hydrogen as a versatile and clean energy vector under the Green Deal Industrial Plan becomes increasingly significant. With the backing of abundant financial resources and the proactive engagement of numerous companies in exploring its potential, hydrogen is steadily emerging as a pivotal element in the decarbonization of innovative industries. The dynamic nature of this exploration is underscored by the discovery of new uses for hydrogen on a daily basis, each offering a glimpse into a future where energy efficiency, sustainability, and economic growth coalesce. This continuous expansion of hydrogen's applicability not only exemplifies the ingenuity and resilience of European industries in the face of climate change but also reinforces the imperative to foster a collaborative, well-funded, and research-driven approach towards realizing the full spectrum of hydrogen's potential. As such, the exploration of hydrogen utilization in novel industrial sectors represents not only a testament to our current technological advancements but also a commitment to the sustainable development goals that define our collective aspirations for a greener, more resilient Europe.

2.3. Financing sustainable development globally

Financing mechanisms play a critical role in supporting the transition to sustainable development. The analysis of various funding sources, including European funds and green finance, highlights the importance of economic incentives in promoting sustainable practices. The entrepreneurial qualities of founders and the development of sustainable business models are essential for the economic sustainability of green initiatives [37]. The trajectory towards sustainable development has universally recognized the integration of finance with environmental, social, and governance (ESG) principles, placing sustainable finance at the forefront of efforts to foster greener economies. The European Union (EU), spearheading this transformation, has emerged as a paragon of sustainable finance, instituting a broad and strategic framework that serves as a global reference point. The EU’s leadership in this domain is supported by a well-established strategy and policy framework aimed at aligning the financial system with sustainable development goals, creating a more efficient and cohesive green finance market across Europe.

Global Consensus and EU Leadership – available academic research underscores the EU's vanguard position in sustainable finance, attributing it to its early origins, comprehensive

development experience, and a well-structured framework system. This assertion is complemented by the EU Action Plan: Financing Sustainable Development, which is highlighted as a pivotal initiative that stimulated regulatory action towards achieving sustainable development goals, significantly enhancing the efficiency of green finance within the interbank market. The plan's success in unifying European standards for green finance has facilitated an effective convergence among financial institutions [38].

Strategic Direction and Innovative Mechanisms – there is comprehensive research to shed light on the European Commission's 2018 action plan, detailing a strategy for the financial sector to support the transition towards a climate-neutral and inclusive economy [39] [40]. This strategy not only promotes financial stability but also endeavours to mobilize private capital, a crucial component in meeting the substantial investment requirements for sustainable development. Several research papers contribute to this discussion by exploring innovative financing mechanisms, such as sovereign green bonds and modifications to the European Central Bank's collateral framework, showcasing the EU's proactive approach in financing the sustainable development goals agenda [41] [42] [43].

The European Green Deal and Regulatory Framework – the EGD is designed as a roadmap to reduce carbon emissions by 55% by 2030 and achieve carbon neutrality by 2050, with a focus on solidarity, sustainable development, and environmental protection within the EU's constitutional framework [44]. private sector financing is crucial for the EGD, necessitating a regulatory framework to facilitate sustainable investments, with the EU Commission planning to invest EUR 1 trillion into the green transformation over the next decade [45]. EU sustainable finance policies, including the EU Taxonomy, have evolved, and accelerated in response to increasing awareness of the severity of climate and environmental crises, with the EGD being a key policy package [46].

The EGD outlines a plan for a resource-efficient economy, emphasizing the importance of a just and inclusive transition, efficient resource use, and the reduction of biodiversity loss and pollution [47]. Assessments of the EGD's ability to combine environmental, economic, and social objectives highlight the need for a just transition towards sustainable economies and societies, especially in light of the Covid-19 pandemic [48]. Sustainable finance is integral to the EGD, with regulatory tools such as the Taxonomy Regulation, Green Bond Standard, and Sustainable Finance Disclosure Regulation playing a significant role in directing private money towards sustainable investments. The EGD aims to make the EU economy sustainable and competitive by leveraging public funds and reorienting the financial system and private investments towards environmentally positive projects[49] [50].

The EU's sustainable finance framework is well-established, providing guidance and a unified standard for green finance business, influencing global green finance development. Critiques of the EGD include a lack of vision for a just, post-carbon economy, inadequate resources, and limited implementation tools, suggesting the need for broader green industrial policies. The discourse of sustainability within the EGD is questioned for potentially side-lining crucial environmental issues and reinforcing the political power of EU institutions [51] [52] [53].

2.4. Sustainable financing in Romania

The European Union (EU) is undergoing a significant transition towards sustainable finance, underscored by directives such as the Corporate Sustainability Reporting Directive (CSRD). This shift aims to integrate Environmental, Social, and Governance (ESG) considerations into financial decision-making processes, thereby funnelling investments towards sustainable development. Romania, as an EU member state, is part of this transformative movement. Sustainable finance in Romania involves redirecting investments to projects that consider ESG factors, aligning with the European Green Deal and the EU's sustainable finance agenda. The mechanism aims to mobilize private capital towards sustainable investments while ensuring the financial system's resilience to environmental risks. We reference academic findings to discuss the EU Green Deal's impact on sustainable finance, emphasizing the necessity of significant investments across major sectors and the pivotal role of the private sector in financing the green transformation. These insights are crucial for understanding the landscape of sustainable finance in Romania, as they reflect the broader EU policies influencing national financial strategies [54] [55]

The EU's regulatory landscape, including the EU Taxonomy and the Sustainable Finance Disclosure Regulation (SFDR), provides a structured approach to identifying and investing in sustainable economic activities. Well regarded critiques of the EU Sustainable Finance Strategy and its implementation challenges, such as the lack of standardized ESG metrics and inconsistencies in rule application have been documented in specific literature [56] [57]. These challenges are pertinent to Romania's adoption of sustainable finance practices, as they highlight the complexities of aligning financial strategies with sustainability objectives within the existing regulatory frameworks. Sustainable finance is reshaping investment landscapes and corporate strategies by emphasizing ESG considerations. Research includes a critical analysis of the EU Taxonomy, highlighting potential economic downsides and the risk of increased global emissions [58]. Conversely, we have detected articles that underscore the significance of National Development Banks in financing sustainable projects [59]. These discussions are relevant for Romania, showcasing the balance between regulatory expectations and market realities. The integration of sustainable finance into corporate strategies reflects a commitment to sustainability that can drive long-term economic and environmental benefits for the country.

In the context of Romania's transition towards a green and sustainable economy, the role of the EU's Resilience and Recovery Facility (RRF) and the Modernization Fund is paramount, particularly in financing green hydrogen projects. These mechanisms are not only pivotal for Romania but also align with the EU's wider environmental objectives. The RRF, a cornerstone of the NextGenerationEU program, is crafted to cushion the economic and social ramifications of the COVID-19 pandemic, thereby bolstering the resilience of EU economies, and promoting their green and digital transitions. For Romania, this translates into significant funding opportunities for hydrogen technology development, which is essential for decarbonizing industries and energy systems. Authors elaborate on how the RRF is integral in aiding the EU and its Member States to emerge stronger and more resilient from the crisis, highlighting the emphasis on green and digital transitions [60]. Similarly, another set of articles analyse the funding opportunities for Romania

through the National Recovery and Resilience Programme, underscoring the importance of efficient access and implementation of these support forms to enhance sustainable development efforts [61] [62] [63].

Parallelly, the Modernization Fund, aimed at EU member states with a GDP per capita below the EU average, supports investments in energy efficiency, renewable energy, and transitioning from coal. Hydrogen projects, especially those involving green hydrogen produced via electrolysis powered by renewable energy sources, are significantly advantaged by this fund. Financing the development and deployment of hydrogen technologies through the Modernization Fund aids Romania in reducing greenhouse gas emissions, modernizing its energy and industrial sectors, and bolstering energy security. Authors provide insights into the strategic importance of the RRF and the Modernization Fund in supporting the sustainable and resilient development of European economies, with a special focus on facilitating the green and digital transition[64] [65].

These financing mechanisms underscore the EU's commitment to assisting member states in their sustainable development endeavours. For Romania, the RRF and the Modernization Fund are critical in advancing its hydrogen economy, marking a significant stride towards realizing its sustainability and energy transition goals. This strategic emphasis on hydrogen within Romania's sustainable finance landscape signals the nation's potential to emerge as a leader in green hydrogen production and utilization, thereby contributing to the EU's collective efforts to mitigate climate change and transition towards a more sustainable future. The discussions nuanced in two of our academic findings highlight the instrumental role of these EU financial mechanisms in supporting Romania's sustainable development, underscoring the integrated approach towards achieving green and digital transitions in line with the EU's broader environmental goals [60] [61].

In aligning with the discourse on sustainable finance in Romania, the significance of the EU's Resilience and Recovery Facility (RRF) and the Modernization Fund in financing green hydrogen projects deserves emphasis. These financial tools are instrumental in Romania's shift toward a sustainable and green economy, reflecting the EU's broader environmental aspirations. The RRF, integral to the NextGenerationEU program, aims to alleviate the economic and social repercussions of the COVID-19 pandemic by bolstering the resilience of EU economies and promoting their green and digital transitions. For Romania, this represents a significant opportunity for funding the development of hydrogen technologies, a critical factor in decarbonizing industries and energy systems. The Modernization Fund, targeting EU member states with GDP per capita below the EU average, facilitates investments in energy efficiency, renewable energy, and the transition away from coal. Green hydrogen projects, especially those involving electrolysis powered by renewable energy sources, stand to gain substantially from this fund, assisting Romania in reducing greenhouse gas emissions, modernizing its energy and industrial sectors, and improving energy security.

These financing mechanisms underscore the EU's commitment to assisting member states in sustainable development pursuits. For Romania, the RRF and the Modernization Fund are crucial for advancing its hydrogen economy, signifying a major step toward meeting its

sustainability and energy transition goals. This strategic emphasis on hydrogen within Romania's sustainable finance landscape showcases the nation's potential as a leader in green hydrogen production and utilization, contributing to the EU's collective efforts to mitigate climate change and transition to a more sustainable future.

Supporting this narrative, [66] discuss the complexity of transitioning to carbon neutrality by 2050 in the EU, highlighting the need for changing the energy mix and the socioeconomic implications, especially in coal-mining regions like Romania. Their analysis offers scenarios for addressing these challenges, emphasizing the potential benefits of the RRF and the Modernization Fund in supporting a just transition. Similarly, [67] explores the effect of renewable energy consumption in Romania, highlighting the significant role of EU funding mechanisms in increasing renewable energy production and promoting green economic growth. These insights are pivotal for understanding the role of EU financial mechanisms in Romania's transition to a green economy, illustrating the intertwined paths of environmental sustainability and economic modernization.

Another mechanism that has taken shape in various forms throughout the European Union is the Important Projects of Common European Interest (IPCEI) framework, that embodies the European Union's strategic initiative to foster collaboration among EU Member States, supporting large-scale projects that significantly contribute to the EU economy, society, and environmental sustainability. These projects aim to tackle market failures in critical sectors and technologies, facilitating the development and deployment of innovative solutions vital for the EU's strategic objectives such as sustainability, industrial competitiveness, and digital transformation.

In the hydrogen sector, the IPCEI on Hydrogen represents a cornerstone effort under this framework, showcasing the EU's dedication to promoting a clean and innovative hydrogen economy. The “Hy2Use” project and the “HyDeal Ambition” are prime examples of such initiatives within the IPCEI on Hydrogen. They aim to upscale hydrogen production and utilization across various industrial sectors and to deliver green hydrogen throughout Europe at competitive prices via an integrated value chain, respectively. These projects span numerous applications, including hydrogen production through renewable energy sources, and the development of infrastructure for hydrogen storage, transportation, and distribution, as well as the application of hydrogen technologies in industries like steel manufacturing, chemical production, and transportation [17]. The collaboration fostered by IPCEIs on Hydrogen among Member States, companies, and research institutions is crucial for accelerating the EU's transition to a green economy, reducing carbon emissions, and achieving energy independence.

These initiatives are reflective of the EU's strategic approach to utilizing hydrogen as a fundamental element of its energy transition, aiming to establish a sustainable, efficient, and globally competitive hydrogen industry. Supporting the discussion on IPCEIs and their significance in the hydrogen sector, [68] provides an insightful analysis of the German National Hydrogen Strategy and its alignment with the EU's broader objectives, highlighting the importance of IPCEIs in advancing hydrogen goals. Furthermore, [69] describe existing and planned hydrogen production and consumption projects within the EU, emphasizing the pivotal role of low-emission hydrogen in transforming the transport and industrial sectors.

3. PESTLE Analysis of Romania

3.1. Political Analysis of Romania within the European Union

Romania's political landscape, especially in relation to its European Union (EU) membership, is multifaceted, reflecting both achievements and challenges. The nation's EU accession in 2007 was a landmark event, setting the stage for a complex interplay of compliance, governance reforms, and European integration dynamics.

EU Membership and Governance Challenges: Romania's EU membership was a significant milestone, heralding a period of substantial political and legislative transformation. However, this transition was not without its challenges. According to [70], [71], Romania's accession is depicted as a strenuous phase in the EU integration process, requiring intense efforts to align with EU norms, particularly in areas such as corruption, judiciary reform, and rule of law. Despite notable progress, Romania faced hurdles in democratic consolidation and combating political corruption, underscoring the nuanced impact of EU membership on governance practices. This narrative is supported by [72], who critically analyse the impact of EU membership on Bulgaria and Romania, highlighting the nuanced effects on national policies and the rule of law, indicating the complex dynamics of post-accession Europeanization.

The Journey Towards Europeanization: [73] offer insights into the negotiation dynamics preceding Romania's EU accession, emphasizing the country's efforts to meet the Copenhagen criteria. This examination sheds light on the negotiation processes, underscoring the critical role of acceleration and commitment in achieving exceptional outcomes in EU integration. In a similar vein, [74] delves into the compliance with EU law in Romania and Bulgaria, challenging the narrative of failed integration by showcasing Romania's adherence to EU legislation. This perspective highlights the importance of continuous monitoring and institutional support in fostering legal compliance and integration success.

Differentiated Integration and Economic Perspectives: [70] explores Romania's differentiated integration into the EU, evaluating the country's expectations, priorities, and achievements across various stages of EU membership. This analysis reveals a mixed record of progress and challenges, with Romania exhibiting strong support for EU integration despite remaining outside the Schengen area and eurozone. [75] discuss the economic aspects of Romania's EU membership, emphasizing the country's potential for economic growth and the critical role of investments in research and development. This economic perspective underscores the multifaceted benefits and challenges of EU integration, highlighting the importance of innovation and strategic investments in achieving long-term stability and growth.

Governance, Public Affairs, and Lobbying: the intersection of corporate governance, public affairs, and lobbying in Romania presents another layer of complexity in understanding the country's political landscape within the EU context. [76] outline the impact of public affairs and lobbying on corporate governance in Romania, suggesting that these elements are essential for developing sustainable business practices and macroeconomic growth strategies. This analysis highlights the evolving nature of Romania's governance and public policy landscape, emphasizing the need for ethical and effective engagement with democratic institutions and policymaking processes.

Global press impression of Romanian political environment: Romania's political landscape is marked by a coalition government aiming for stability ahead of the 2024 elections, amidst navigating policy differences within the coalition and addressing the need for reforms to unlock further tranches of European Union recovery funds. The coalition, formed by the leftist Social Democrats and the centre-right Liberals along with the ethnic Hungarian UDMR, is steering the country through a series of socio-economic challenges, including energy policies, healthcare reforms, and economic recovery post-pandemic. The Romanian President's move to appoint Marcel Ciolacu as the prime minister under a rotating premiership deal is a step towards ensuring political stability and continuity in governance. This move highlights the coalition's intent to prioritize long-term reforms and policy stability, addressing the complexities of governance while also managing Romania's position within the European Union, especially concerning recovery funds and fiscal policies. On the macro-policy front, Romania faces critical challenges in terms of economic growth, energy independence, and healthcare reforms, which are pivotal for its sustainable development and alignment with EU norms. The government's plans to extend energy support schemes and invest in new power production underline its focus on becoming energy-independent and addressing the inflationary pressures exacerbated by rising energy costs. Additionally, the upcoming electoral cycle with presidential, general, local, and European elections presents a crucial juncture for Romania to navigate its policy directions and political stability. These elections will be instrumental in determining the future course of Romania's domestic and foreign policies, including its commitment to European integration, fiscal discipline, and socio-economic reforms. The emphasis on political stability and continuity in governance reflects a strategic approach to address Romania's pressing challenges while ensuring alignment with broader European objectives, especially in light of the geopolitical developments in Eastern Europe and Romania's strategic position as an EU and NATO member [77], [78], [79].

As a result of synthesizing these insights, it becomes evident that Romania's political landscape, particularly in relation to its EU membership, is characterized by a blend of achievements, ongoing challenges, and strategic efforts towards Europeanization. The country's journey towards EU integration has been marked by significant strides in governance reforms, legal compliance, and economic development, albeit with notable obstacles in fully materializing its EU membership benefits. This nuanced narrative underscores the complexity of Romania's political and economic integration within the European Union, reflecting a broader trend of differentiated integration among member states.

3.2. Economic Growth and Diversification

Romania's economic landscape has experienced significant growth and diversification over the last two decades, contributing to catching up with advanced economies. A study on the economic complexity at the regional level is relevant in findings such that of areas with lower development levels that have been prone on experiencing the most notable shifts in economic complexity [80]. This indicates a broadening of industrial product diversification and an enhancement in the complexity of economic activities, especially in regions that were previously lagging behind.

Labour Market and Emigration: the labour market in Romania is uniquely affected by emigration, with a substantial portion of the workforce seeking opportunities abroad. This dynamic exerts pressure on the domestic labour supply and influences economic development strategies. Romania stands out in the European Union with the highest proportion of its GDP attributed to the agricultural sector, a testament to the sector's potential for significantly enhancing the nation's economic quality. Numerous studies and professional discussions emphasize agriculture's pivotal role, particularly considering Romania's extensive arable lands. This research delves into the distinctive characteristics of Romanian agriculture within the European context, outlining key strategies for rural development aimed at elevating work efficiency in this vital sector, illustrating the country's ongoing transition from an agriculture-based economy to one focused on services and industry, despite the decreasing contribution of agriculture to GDP [80], [81].

EU Structural and Investment Funds: EU funds play a crucial role in Romania's development, especially in addressing infrastructural gaps and fostering regional development. [82] examine the impact of foreign direct investment and other factors on economic growth, suggesting that the influx of foreign direct investment and the importation of goods and services are negatively influencing economic expansion in Romania. This complex relationship underscores the importance of strategic investment and the utilization of EU funds to stimulate sustainable economic growth and development.

Infrastructure and Development Challenges: despite economic growth, Romania faces challenges in infrastructure development, which is crucial for enhancing competitiveness and regional connectivity. Studies focusing on infrastructure investment and its impact on economic growth would provide insights into the specific areas where Romania needs to improve to sustain its economic development trajectory.

[83] highlight the evolution of road transport infrastructure in Romania and its economic implications, supporting the theory that the state of Romania's road infrastructure plays a crucial role in the economic growth of the nation and its capacity to engage in international commerce. Several authors have highlighted the importance of aligning Romania's essential infrastructures with European Union standards, pointing out the critical need to enhance and bolster the resilience of Romanian Critical Infrastructures for economic progression. This aligns with discussions on the strategic investments required in the national motorway network to foster economic growth [84]. The authors propose methodological improvements for assessing the criticality of infrastructures, particularly in the energy sector. Infrastructure research continues to assess the distribution and availability of urban blue infrastructure in Romanian cities, stressing the scarcity of blue infrastructure [85]. Their study suggests enhancing the multi-functionality of blue infrastructure to provide socio-ecological and economic benefits.
Large cities, and even the state capital, are confronted with urban challenges, as research finds and explores the role of spatial planning in addressing Bucharest's urban challenges. [86] argue that “innovative urban planning” is essential for transforming Bucharest into a more competitive and liveable European capital while [87] propose a digital tool for generating tailored solutions to promote sustainable development in rural areas of Romania. They identify depopulation as a key issue, suggesting that government support is crucial for implementing effective solutions.

Competitiveness and Innovation: the push towards competitiveness and innovation is vital for Romania's long-term economic resilience. Research exploring the role of education, innovation, and digital infrastructure in driving economic competitiveness would offer a comprehensive view of the strategies Romania needs to adopt to secure its position in the global economy. For Romania to secure its place in the global economy, a strategic focus on competitiveness and innovation is vital. Addressing infrastructure challenges is part of this strategy, alongside fostering a culture of innovation and technological advancement.

[88]discuss the dual nature of entrepreneurship in Romania as both an opportunity and a challenge. They underscore that Romania is positioned at the bottom among European Union countries in entrepreneurial development, stressing the necessity to diminish bureaucratic hurdles and enhance financing accessibility.[89] conduct a review on the green economy in Romania, identifying “incomplete legislation” as a major barrier to transitioning towards a green economy. This study underscores the potential for Romania to leverage its resources and EU incentives for green development. [90] investigate Romanian residents' attitudes towards transitioning to renewable energy sources. They identify dissatisfaction and slowdown in the adoption process, recommending “immediate strategic measures” for accelerating the transition. [91] assess the potential of artificial intelligence (AI) in Romania's healthcare system, noting significant promise but also “several ethical and logistical challenges”. The study calls for responsible AI implementation strategies. [92] highlight the environmental impacts of infrastructure projects on wildlife in Romania. They suggest measures to mitigate negative effects, such as roadkill, due to infrastructure development.

Romania's economy demonstrated resilience in the face of global challenges, achieving a growth rate of 1.8% in 2023, despite a slowdown from the previous year's 4.7%. This deceleration reflects the impacts of high inflation and subdued private credit growth which, in tandem with weak external demand, constrained domestic consumption. However, this was partially offset by substantial EU-funded investments in public infrastructure, which contributed to gross fixed capital formation. The European Commission's economic forecast anticipates a rebound, with GDP growth expected to increase to 2.9% in 2024 and further to 3.2% by 2025. This recovery is supported by an improvement in real disposable incomes, fuelled by a resilient labour market and minimum wage increases. Moreover, inflation is projected to decelerate from 9.7% in 2023 to 5.8% in 2024, and further to 3.6% in 2025, reflecting easing monetary conditions and declining energy and food prices. Romania's economic advancement is closely tied to its vibrant private sector, particularly in the renewable energy, transportation, and finance sectors, as highlighted in a World Bank report. The country's burgeoning IT sector is a testament to its potential for services sector growth, which could be further amplified by enhancing digital skills. This emphasis on the private sector is crucial for bridging Romania's living standards gap with the EU and addressing regional and social disparities. Additionally, Romania's effective utilization of EU funds has been a cornerstone of its economic strategy, having already drawn down over €6 billion in grants and loans, with ambitions to tap more than €10 billion annually until 2027. This strategic use of funds, coupled with advancements in justice reforms, positions Romania as a potential model of good governance within the region [93],[94],[95].

By integrating these aspects into the economic section of a literature review, one can offer a nuanced understanding of Romania's economic situation, underpinned by recent academic findings. This approach provides a solid foundation for further research and policy formulation aimed at fostering economic growth and sustainable development in Romania.

3.3. Social Analysis of Romania: Demographics, Urban-Rural Divide, and Implications

Romania has been experiencing significant positive social developments, reflecting resilience and progress across various sectors. This literature review synthesizes recent academic findings to provide an optimistic outlook on Romania's economic, social, and entrepreneurial landscape. [96] highlights Romania's tailored models and strategies for rural development and agriculture, aligned with European Union standards, showcasing a commitment to sustainable growth. The adoption of corporate social responsibility (CSR) practices, as detailed by [97], has become a transformative force within the Romanian business environment, contributing to economic growth and job creation. [98] offers a comprehensive analysis of Romania's evolution, emphasizing improvements in public health and the medical system, showcasing robust responses to global challenges like the COVID-19 pandemic. [99] discuss entrepreneurship as a key driver for economic and social development, acknowledging the vibrant entrepreneurial ecosystem in Romania. [100] investigate the relationship between internal migration and economic growth, highlighting the positive impacts of migration on regional economies. This underscores the importance of adaptive public policies for sustainable development and economic prosperity.

The rural demographic resilience and territorial evolution in Romania reveal a multifaceted picture of depopulation, adaptation to transitions, and socioeconomic impacts on access to basic services. [101] offer an extensive analysis over a century, highlighting the dynamic and fragile areas that require targeted public policies for sustainable spatial planning and environmental management. [102] explores the social consequences of population ageing in rural Romania, emphasizing regional disparities and the urgency to address rural depopulation. The study calls for solutions to mitigate the socioeconomic repercussions of this phenomenon, particularly in rural areas heavily impacted by these demographic shifts. Lastly, [103] provides a broad perspective on the socio-demographic trends in Romania, highlighting the significant role of migration in shaping the population landscape. The transition to EU integration has introduced complex dynamics in international migration, with economic reasons largely driving the current trends. This analysis underscores the evolving nature of migration and its implications for Romania's demographic future.

3.4. Technological Advancements in Romania

The IT sector in Romania has seen remarkable growth, becoming a significant contributor to the country’s GDP. [104] highlights the industry's doubling in value from 2015 to 2022, underscoring the sector's role in economic development and innovation. The concentration of IT businesses in urban centres, particularly Bucharest, has fostered a dynamic ecosystem for technological advancement. Financing mechanisms, such as the Bucharest Stock Exchange, offer vital support for small and medium enterprises (SMEs) in the IT sector. [105] examine these opportunities, highlighting the importance of accessible financing for innovation and growth, particularly in the face of economic uncertainties.

Digitalization's impact on economic growth is further explored by [106], who finds positive effects from digital adoption and patenting activities. This research suggests that focused digitalization strategies can enhance Romania's economic resilience and. The Covid-19 pandemic accelerated the e-market's growth, as documented by [107]. Their analysis of the Romanian e-market's expansion during this period offers insights into the digital transformation's acceleration under crisis. Lastly, [108] address the implementation challenges of ICT solutions in customer service management. Their findings underscore the critical role of ICT in enhancing service efficiency and the need for continued investment in digital infrastructure and education.

The remarkable expansion of Romania's IT industry, with its value doubling from 4.6 billion euros in 2015 to over 9 billion euros in 2022, underscores the sector's pivotal role in economic development and innovation. This growth has made a substantial impact on Romania's GDP, accounting for 7%, with a notable concentration of IT businesses in urban centres like Bucharest [104]. This geographical clustering has fostered a dynamic ecosystem for technological advancement and innovation, positioning Romania as a significant player in the global IT landscape.

The availability of financing opportunities for small and medium enterprises (SMEs) in the IT sector through the Bucharest Stock Exchange is crucial for fostering growth and innovation, especially in the context of economic uncertainties and post-Covid challenges [105]. These financing avenues are instrumental in enabling SMEs to navigate the economic landscape and invest in innovative strategies, thereby contributing to the dynamism of Romania's market. Digitalization and patenting activities have been identified as key drivers of economic growth, modernization, and diversification in Romania [106]. The positive influence of these factors on the economy suggests that strategic digitalization efforts can enhance Romania's economic resilience and competitiveness on the global stage.

The Covid-19 pandemic has accelerated the growth of Romania's e-market, reflecting the broader digital transformation of the economy. This expansion highlights the potential of digital retailing and underscores the importance of adapting to digital trends to sustain economic growth [107]. The implementation of Information and Communication Technology (ICT) solutions, particularly in customer service management, faces various challenges. Despite these obstacles, the ICT industry's significance in Romania's economy is undeniable, representing approximately 5.5% of the country's GDP in 2019. The study underscores the critical role of digitization and automation in enhancing service efficiency [108] [109] explore Romania's digital divide, emphasizing the need to identify and manage deeper determinants of digital literacy to make Romania fit for the digital age. Their analysis suggests that addressing foundational competencies and basic skills is essential for improving DESI performance and closing the digital gap.

Technological Developments in Hydrogen Energy in Romania: Romania's commitment to transitioning towards a sustainable and modern energy sector is increasingly focused on harnessing hydrogen technology. This literature review explores recent technological advancements in hydrogen energy within Romania, emphasizing its significance in the broader context of energy transition and sustainability.

Hydrogen and Natural Gas Blending: [8] conducted a techno-economic study on blending hydrogen with natural gas in Romania's distribution networks, particularly in Bucharest. They investigated the implications of injecting 5%, 10%, and 20% hydrogen into the natural gas system, focusing on energy efficiency, economic viability, and environmental benefits. This approach is pivotal for decarbonization efforts, showcasing a significant stride towards reducing greenhouse gas emissions while ensuring energy resilience. Hydrogen blending with natural gas is being explored as a means to improve system performance and reduce greenhouse gas emissions. A study has shown that blending hydrogen with natural gas can increase combustion energy and exergy efficiencies significantly, with improvements observed from 84.8% to 94.8% and 62.5% to 70.2%, respectively, when hydrogen addition ranges from 0 to 20%. Similarly, ammonia-natural gas blends have also been investigated, showing increases in efficiencies [110].

Hydrogen's Economic and Environmental Impact: [111] highlights the essential role of hydrogen in achieving the European Union's climate neutrality goals by 2050. The paper discusses the hydrogen market's evolution amid the Covid-19 pandemic and the European Commission's Hydrogen Strategy for a climate-neutral Europe. It emphasizes green hydrogen's potential to lower energy costs and reduce dependency on fossil fuel imports, underlining Romania's renewable energy capacity to significantly contribute to hydrogen production. Fuel Cell Technologies: [112] review the progress in hydrogen fuel cell technologies, particularly proton-exchange membrane fuel cells (PEMFCs), suitable for automotive applications. This comprehensive analysis spans key components, thermal and water management, and infrastructure development for hydrogen generation, storage, and transportation. The review underscores the global and national strategies toward adopting hydrogen as a crucial energy carrier, marking a step forward in Romania's energy transition journey.

Green Hydrogen Production Analysis: [113] delve into green hydrogen production, addressing technological and economic aspects. The study evaluates various electrolysis methods, with a focus on solid oxide electrolyser cells (SOEC) for their economic viability. It discusses production costs, including storage, compression, and distribution challenges, and presents achievements in the EU and Romania, offering insights into future perspectives for the hydrogen industry.

Hydrogen for a Cleaner Future: [114] assess hydrogen fuel and fuel cell technology's role in promoting a cleaner future. This review emphasizes hydrogen's zero-emission profile and its application in transport, distributed heating, and energy storage systems. It addresses the transition from fossil-based fuels to hydrogen, highlighting the scientific and socio-economic barriers that need to be overcome.

3.5 Legal Analysis: Romania's Legislative Landscape for Sustainable Development

Romania's approach to hydrogen and renewable energies aligns with its commitment to environmental protection and the transition to non-polluting technologies. A notable advancement is the exploration of hydrogen-natural gas blending in distribution systems. [8] conducted a techno-economic study simulating annual consumptions for hydrogen production capacities to be used in mixtures with natural gas. This method, considered one of the most significant changes toward decarbonization, indicates the legal and economic readiness of Romania to adopt innovative energy solutions. Furthermore, [115] explore the

societal benefits convincing households to support renewable energy development, identifying job creation, increased national energy independence, and pollution reduction as key motivators. This study underscores the necessity for supportive legal frameworks to foster public backing for renewable energy initiatives.

Environmental Affairs: [111] addresses the hydrogen market's potential to support the EU's climate neutrality goal by 2050, emphasizing green hydrogen's role in reducing energy costs and fostering a green economy. This highlights the legal framework's adaptation to accommodate renewable energy sources and reduce dependency on imported fossil fuels. [116] provide an analysis of Romania's energy sector using the autoregressive distributed lag model (ARDL), revealing long-term and short-term impacts of renewable energy on economic growth. Their findings advocate for legal measures promoting renewable energy adoption and transitioning to a low-carbon economy. [117] offer a comprehensive overview of the Romanian renewable energy market, emphasizing the critical role of policy and regulatory landscapes in attracting investments and facilitating project diversification. This underscores the importance of stable and supportive legislation for the growth of renewable energy sources.

ESG and CSRD Considerations: [118] delve into the Corporate Sustainability Reporting Directive (CSRD), highlighting its role in transitioning towards a sustainable environment. The CSRD, set to replace the Non-Financial Reporting Directive (NFRD), expands the scope of companies subjected to sustainability reporting requirements. This legislative shift aims to encompass a broader array of companies within the sustainability reporting framework, thereby enhancing the green transition. The authors note that the CSRD is set to have a substantial effect on financial reporting, mandating that companies on the Bucharest Stock Exchange comply with new reporting standards.

[119] study on Regulation (EU) 2019/452 outlines the establishment of a framework for screening foreign direct investments (FDI) into the EU, touching upon Romania's preparation to adopt national legislation in line with this regulation. This movement signals Romania's efforts to ensure FDI aligns with the EU's sustainability goals. [120] evaluates the CSR reporting practices of Romanian companies, revealing a trend towards improved sustainability reporting. The research indicates a preference for the GRI framework and ISO 26000 standard, which align with the EU’s sustainability reporting requirements. Romania's commitment to GRI and ISO 26000 standards in CSR reporting showcases its conformity with global sustainability reporting guidelines, promoting a corporate environment that is more transparent and accountable [120].

A critical examination of the EU's ESG regulatory framework, juxtaposed against global standards such as GRI, SASB, and TCFD, underlines the intricacy of the EU's approach to ESG reporting and its capacity to pioneer global sustainability practices. Despite its complexity, the EU's ESG framework is poised to establish a worldwide standard for sustainability reporting, shaping how global companies engage in ESG disclosure. [121]

Incorporating the latest legislative developments: Romania has taken a significant step forward in integrating hydrogen energy into its industry and transport sectors with the recent adoption of the Hydrogen Law. The Hydrogen Law focuses on enhancing Romania's

energy production capacity and strengthening its energy security. It mandates fuel suppliers to include a minimum percentage of hydrogen from renewable sources in their fuel mixes used in Romania, setting explicit targets that escalate towards 2030. By 2030, fuel suppliers are required to ensure that the energy value from non-biological renewable fuels supplied for the transport sector equals at least 5% of the total energy content of all fuels supplied for consumption or market use within the country. Furthermore, the law establishes progressive targets for the inclusion of non-biological renewable fuels and electricity from renewable sources for electro-mobility in the transport sector from 2024 to 2029, starting with 0% in 2024 and increasing incrementally to 4.5% by 2029. Non-compliance with these targets will result in fines, calculated by multiplying each megajoule (MJ) of shortfall by a government-established minimum value [122].

Romania's Ministry of Energy has published a draft Hydrogen Strategy and Action Plan for 2023-2030, marking a significant commitment to developing a hydrogen economy as part of its decarbonization goals under the National Resilience and Recovery Plan with the EU. The strategy, open for public consultation until 20 June 2023, aims to establish comprehensive hydrogen infrastructure, embracing both renewable and low-carbon hydrogen to achieve ambitious production and usage targets by 2030 [9]. The Hydrogen Strategy is set to be delivered in 2024 by the Price Waterhouse Cooper's – Horvath consortium. The European Commission has just approved a €3 billion support scheme for solar and onshore wind projects in Romania. This funding aims to increase Romania's renewable energy production and reduce carbon emissions, aligning with the EU's green transition goals. The scheme is part of Romania's efforts to boost its energy independence and sustainability and will have direct results in PPAs for electrolysers and green hydrogen production [123]. The minister of energy continues to finance the overhaul of the Romanian energy system and is now utilizing EUR 640 million from the Modernization Fund to enhance its power grid, as announced by the Ministry. This financial injection will support 21 projects aimed at expanding and modernizing the country's electricity distribution infrastructure. The initiative represents a significant step towards improving energy efficiency and reliability in Romania[124].

3.6 Environmental Analysis of Romania

Romania's environmental strategy reflects a comprehensive approach towards sustainability, tackling various sectors from circular economy initiatives to renewable energy adoption. This literature review synthesizes findings from recent research, offering insights into Romania's environmental management and sustainability efforts.

Transitioning from Linear to Circular Economy: the shift from a linear to a circular economy is essential for mitigating environmental degradation in Romania, especially in its eastern regions plagued by pollution and resource misuse. Research by [125] emphasizes the adoption of circular economy practices as crucial for preserving material and water resources. They propose sustainable alternatives that include the reuse of solid waste, wastewater treatment, and the promotion of organic agriculture, alongside a transition to renewable energy sources. These strategies are particularly aimed at combating environmental challenges like those observed in the Pungesti shale gas incident, showcasing the need for a holistic approach to sustainability.

Climate Change Mitigation through Fiscal Policies: Romania's commitment to climate change mitigation is evident through its implementation of fiscal measures and government expenditures dedicated to environmental protection. [126] have identified a significant impact of these measures on reducing greenhouse gas emissions in the long run, illustrating the effectiveness of government spending and green taxes in fostering a sustainable economic development. This alignment with the European Union's objectives underscores Romania's efforts to balance economic growth with environmental conservation.

Challenges in Real Estate Sustainability: The real estate sector in Romania faces hurdles in adopting sustainable practices. According to [127], despite Romania's commitment to EU environmental policies since its accession in 2007, the implementation of sustainable conditions in real estate development has been slow. The lack of interest from both private and public sectors in using low-carbon materials and addressing issues like illegal deforestation and waste management inefficiencies highlights significant areas for improvement in achieving sustainability goals.

Regional Variations in Environmental Protection: Environmental protection perceptions and actions exhibit notable regional differences within Romania. [128] point out that regions like West and Bucharest-Ilfov show a higher concern towards environmental protection compared to others. This variation underscores the necessity for region-specific strategies that address local environmental challenges and leverage unique strengths, ensuring a more targeted and effective approach to sustainability.

Renewable Energy as a Path to Sustainability: The renewable energy sector is pivotal for Romania's sustainable development and carbon neutrality goals. [129] highlight Romania's progress in integrating renewable energy into its power system, stressing the need for continued policy support and infrastructure development. The focus on diversifying the energy mix through renewable sources not only addresses climate change challenges but also positions Romania as a key player in the global shift towards a sustainable and energy-efficient future.

GPP – Green Public Procurement: Within the environmental analysis of Romania, green public procurement (GPP) emerges as a crucial tool for steering the nation towards sustainable development, albeit with challenges in implementation and adoption. [130] identifies a critical gap in the utilization of GPP criteria among Romanian contracting authorities, pinpointing the absence of mandatory GPP requirements and targets as a significant impediment to leveraging GPP for environmental goals. This is corroborated by [131], who advocate for integrating innovative solutions like aquaponics into Romania's GPP network to enhance sustainability in agriculture and aquaculture. Consumer attitudes towards green products, as analysed by [132], further underscore the necessity for heightened awareness and education to bolster GPP and sustainability initiatives. [133] discuss the role of green innovation within Romanian mobile commerce companies, emphasizing the importance of green training and supplier development in promoting sustainable business practices. Additionally, [125] review the transition towards a green economy in Romania, highlighting the challenges posed by barriers and legislation gaps while recognizing the potential for growth in the green economy sector through EU incentives. Together, these studies underscore the critical role and challenges of GPP in Romania's

environmental strategy, emphasizing the need for strategic approaches, enhanced consumer education, and legislative support to advance sustainable development goals.

4. Methodology

Building on the foundational work of the qualitative study on hydrogen valleys, the future efforts aim to construct a detailed landscape of sustainable ecosystems underpinned by green energy sources. These ecosystems are envisioned to encompass a wide array of industries, ranging from green steel manufacturing to sustainable agriculture, connected through a seamless flow of clean energy, primarily hydrogen. This envisages a transformative shift towards sustainability, where the origins of products and services are authenticated through guarantees of origin, ensuring a verifiable pathway of sustainability from the ground up. Such a framework not only promises environmental benefits but also heralds economic growth grounded in sustainability principles, offering a competitive edge in the global market through clean, certified products and services.

The methodology for the current part of the study involves a comprehensive mapping and analysis of organizations that can pivot towards sustainable methods by incorporating hydrogen into their operations. This includes:

4.1. Identification and Categorization: Listing all relevant economic agents in the region of interest, categorized by their industry sector (e.g., energy, manufacturing, agriculture). This involves a meticulous examination of existing databases, industry reports, and sustainability disclosures to capture a broad spectrum of organizations.

4.2. Geographical Mapping: Placing these organizations on a geographical map, preferably using a tool like Google Earth, to visualize their distribution, proximity to hydrogen production facilities, and potential for forming sustainable clusters. This dynamic map will serve as a living document, constantly updated with new data, collaborations, and developments in hydrogen infrastructure.

4.3. Infrastructure and Logistics Analysis: Evaluating the existing infrastructure and logistics capabilities in the identified geographical regions to assess their readiness for adopting hydrogen-based operations. This involves an analysis of renewable energy sources availability (for green hydrogen production), existing hydrogen production facilities, transportation logistics, and storage capacities.

4.4. Stakeholder Engagement and Data Collection: Engaging with these organizations through a structured questionnaire to gather insights on their current energy use, sustainability practices, interest, and readiness for integrating hydrogen into their operations. This step aims to identify potential early adopters and partners for pilot projects.

4.5. Value Chain and Ecosystem Development: Analysing the potential links between different organizations' products or services and the input of others, to form hypothetical sustainable ecosystems. For example, linking renewable energy producers with hydrogen producers, who in turn supply to industries like steel manufacturing or agriculture, creating a closed-loop system of clean energy use.

4.6. Sustainability Assessment and Reporting: Developing a framework for continuously assessing the sustainability impact of these ecosystems, including the reduction in carbon emissions, energy efficiency improvements, and socio-economic benefits to the communities. This will involve setting up a PowerBI platform to integrate and visualize the data collected, including non-financial reporting by organizations, to track progress towards sustainability goals.

4.7. Collaboration and Policy Recommendations: Based on the analysis, recommending potential collaborations between organizations, and suggesting policy interventions needed to support the development of these sustainable ecosystems. This could include incentives for green hydrogen production, subsidies for organizations transitioning to hydrogen use, and regulations for certifying the sustainability of products and services.

The overarching goal of this methodology is to create a detailed blueprint for building sustainable ecosystems powered by hydrogen, aligning with the global objectives of the Paris Agreement and the European Green Deal. By fostering cross-sectoral collaborations and leveraging existing infrastructure and resources, this approach aims to catalyse the transition towards a sustainable economy with hydrogen at its core.
In concluding, it's paramount to acknowledge the inherent limitations within the current study's scope, primarily confined to establishing the foundational framework through points 1 to 5. This encapsulation allows for a detailed exploration of organizations' pivot potential towards hydrogen utilization and the initial sketching of sustainable ecosystems on a geographical map, alongside infrastructure and stakeholder readiness assessments.

However, the intricacies of fully developing and optimizing these ecosystems, including a thorough sustainability impact assessment, active policy advocacy, and the formulation of an interactive, multi-dimensional inventory of these ecosystems, are beyond this study's immediate reach. These aspects are designated for a subsequent study, which aims to build upon the groundwork laid here by incorporating a more nuanced, interactive approach. This forthcoming endeavour will engage more deeply with the dynamic interactions within the ecosystems, refine the sustainability assessments with real-world data, and evolve the PowerBI platform into a living, interactive inventory. Such progression acknowledges the complex, iterative nature of transitioning towards a fully sustainable economy, underscoring the study's phased, building-block approach to achieving long-term environmental, economic, and social sustainability goals.

4.8. Model Construction

Our research model is a bottom-up approach started from the final draft of the National Hydrogen Strategy and Action Plan, public legal proposal drafted by consultants and affiliated NGOs for the Romanian Ministry of Energy. The document covers a broad and ambitious set of goals and objectives for the development and implementation of hydrogen technology in Romania. The strategy draft outlines specific targets for hydrogen production, usage, and infrastructure development, aiming to significantly reduce CO2 emissions and facilitate the transition towards a cleaner, more sustainable energy sector by 2030 and beyond. Our consideration is that the strategy draft is a top-down analysis that is

concentrated on the needs of the state and regulators rather than the needs of market players, revealing several limitations, including but not limited to:

a) **Top-Down Approach:** The strategy primarily addresses the roles of state regulators and governing bodies, focusing on setting national targets and frameworks. While necessary, this approach may overlook the importance of grassroots initiatives and the innovation potential at the market and community levels. Engaging with and stimulating the bottom-up innovation from industries, research institutions, and local communities and businesses could uncover practical challenges and innovative solutions that a purely top-down strategy might miss.
b) **Market and Industry Needs Analysis:** There's an implicit acknowledgment of the need for infrastructure development and legislative frameworks to support the hydrogen economy. However, the strategy might not sufficiently emphasize the importance of in-depth market analysis, including the specific needs of active market players like steel mills, fertilizer plants, and petrochemical plants. A comprehensive understanding of these needs is crucial for developing targeted action plans that address the practical aspects of transitioning to hydrogen-based solutions.
c) **Economic Viability and Cost Considerations:** While the strategy includes cost estimations and potential financing sources, the economic viability of transitioning to a hydrogen-based economy is a significant challenge. The strategy might benefit from a more detailed analysis of the economic impacts on different sectors, including the competitiveness of hydrogen solutions compared to existing energy sources. This also involves considering the readiness of various industries to adopt hydrogen technology and the impact on jobs and local economies.
d) **Technological Maturity and Innovation:** The document outlines objectives for the development and implementation of hydrogen technologies. However, the rapid pace of technological innovation in this field means that strategies must remain flexible and adaptable to incorporate new advancements. There's a need for continuous evaluation of the technological landscape to ensure the strategy remains relevant and leverages the latest breakthroughs for efficient and cost-effective hydrogen production and usage.
e) **Stakeholder Engagement and Collaboration**: Effective implementation of the hydrogen strategy requires collaboration across a wide range of stakeholders, including government bodies, industry, academia, and civil society. The strategy could place more emphasis on mechanisms for stakeholder engagement, ensuring that all relevant parties are involved in the decision-making process and that their insights and concerns are adequately addressed.

An assessment of the strategy draft clearly delineates issues left unsolved for market players that have manifested interest in joining the hydrogen economy. This study and the proposed future evolutions of this study plan on addressing these limitations. An academic approach with mixed qualitative and quantitative data manipulation is to incorporate more dynamic, iterative processes for stakeholder engagement, market analysis, and technological assessment. This research effort and the proposed updates to this document

are to result in a strategy that remains responsive to the needs of the market and the latest technological developments, ultimately contributing to its success and sustainability.

5. Results and Discussion

The analysis takes shape by developing a visual inventory of the required components for sustainable ecosystems and hydrogen valleys. We have sketched the effort on Google Earth, taking into consideration the following information deemed crucial for sustainable value chains:

5.1. Geographical Overview

Sub-sections for Major Regions:

- Romania is sectioned by the Carpathian Mountains and infrastructure is still to be built to properly connect all ecosystems amongst each other, resulting in peak operational efficiency and minimum carbon emissions resulted from logistics.
- Climate and natural resources have a direct influence in the production of hydrogen, starting from the possibility of installing new renewable energy resources based on the regional climate and spanning to the availability of water for the electrolysis processes.
- Infrastructure and logistics capabilities are considered for hydrogen transportation to consumers, which is a complex and sensitive issue, and for the expansion of the sustainable ecosystem to encapsulate all economic activity on extended value chains.

5.2. Renewable Energy Potential

Solar Energy:

- Regions with high solar irradiance;
- Current solar projects and future potential;
- Grid connection permits and status.

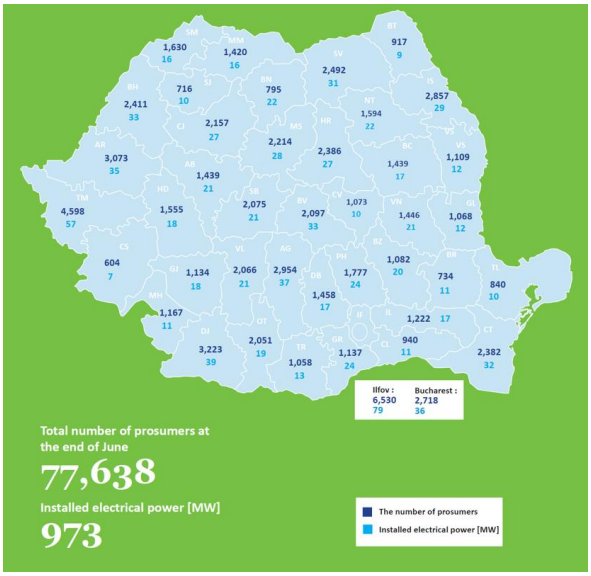
Wind Energy:

- Wind patterns and optimal locations for wind farms;
- Status of wind energy development;
- Grid connection permits and status.

At the time of elaborating this study, the market is highly restrictive and reactive against sharing information that reveals strategic development plans, investments, approved projects, or grid permitting status. The secrecy behind projects that otherwise would have been an efficient opportunity for CSR campaigns on behalf of investment consortiums has reasoning in the highly flawed and speculative nature of the grid connection permitting system in Romania, allowing malicious agents to reserve the entire bandwidth in a region where goodwill agents manifest intentions to invest.

We can, at the moment, obtain data about implemented projects that are operational and provide power to the grid, with prosumers passing the 1TW threshold, as visible in Fig.1 (a), and 4.5TW from solar and wind, as visible in Fig. 1 (b).

a.



b.

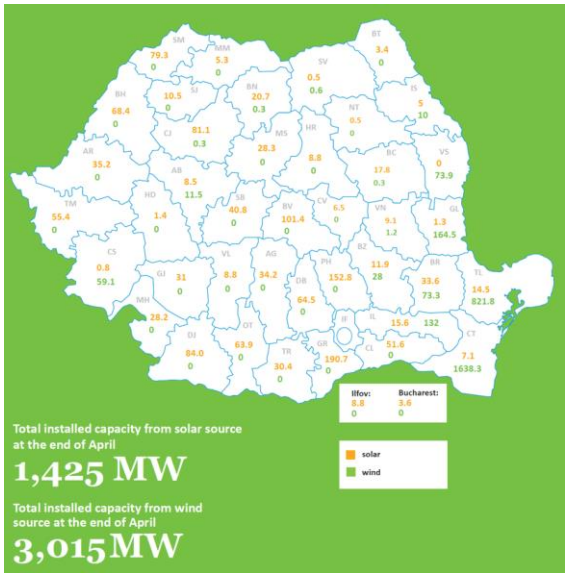
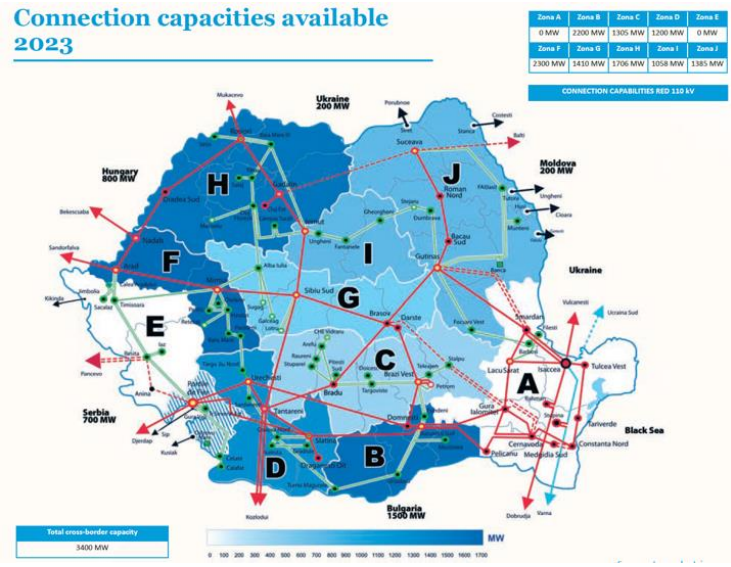


Fig. 1. (a) Map of Prosumers (Jun 2023); (b) Map of wind and Solar installed capacities (Apr 2023)
Source: Code of Good Practice for Renewable Energy in Romania 2023 – RWEA

However this practice is curbed by the introduction of new legislation, to come into effect in 2024, that requires a percentual investment guarantee escrow to be made available before the grid connection permit is issued. This is partially due to a cautious investment strategy on behalf of state infrastructure administrator (Transelectrica), as visible in Fig. 2.

a.



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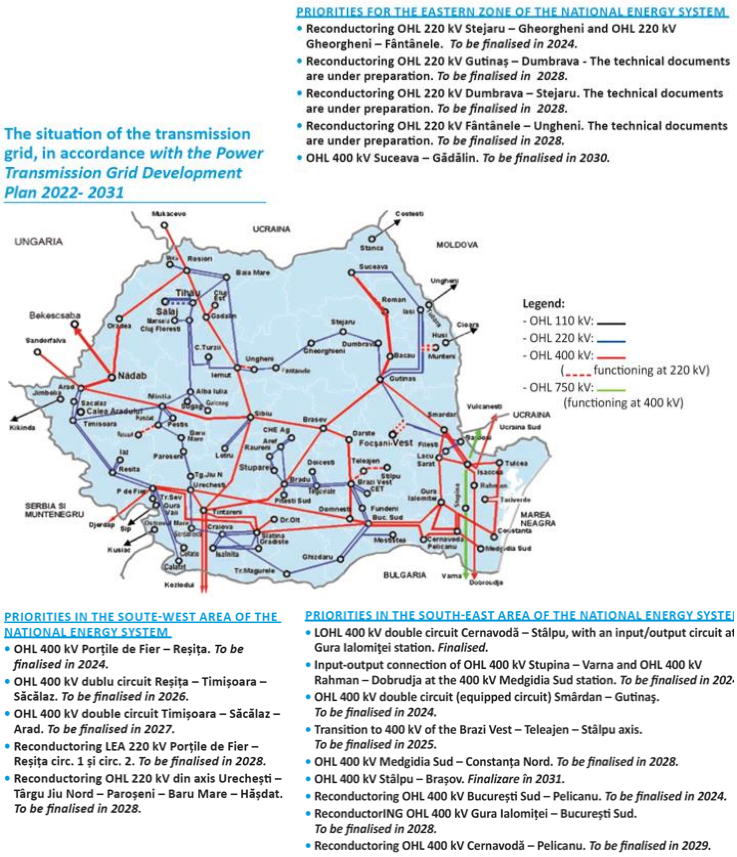


Fig. 2. (a) Romanian Grid Connection Capacities (2023); (b) power transmission grid development priorities
Source: Transelectrica – State Grid Administrator

The second part of our study will take full advantage of this legislation, having already contacted all renewable energy developers and raising the secrecy vale to have a clear and concise image of the developing renewable energy projects once legislation is in place to curb speculative behaviour.

Hydroelectric legacy:

- Hydroelectric power resources from dams on all rivers in Romania are a legacy left by the communist era in working condition, having been used to stabilize the grid in the past and now being used to generate clean power and contribute to a very attractive renewable energy mix evaluated at country level, as visible in Fig. 3.

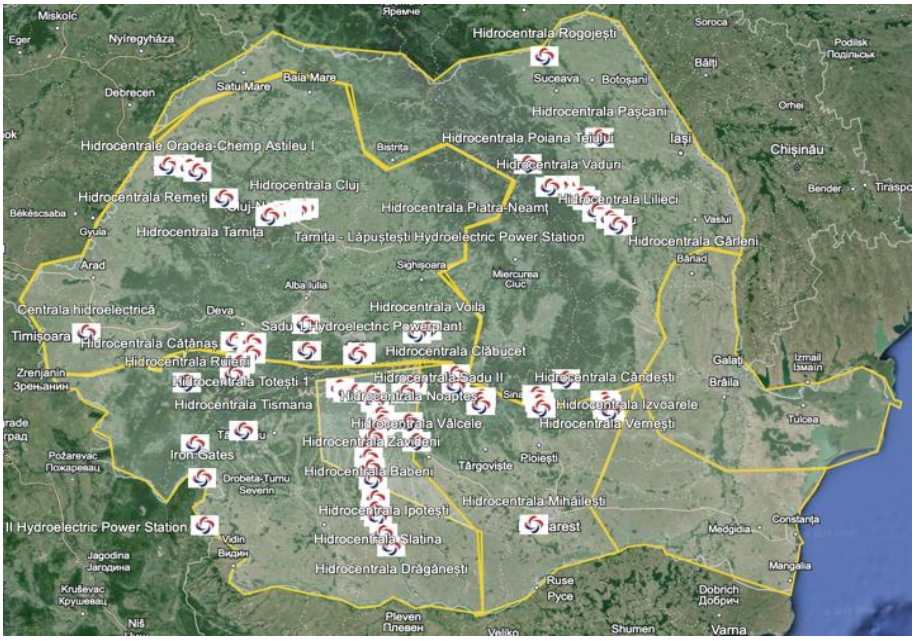


Fig. 3. Romanian Hydroelectric Dams (2023)
Source: Author's research and interpretation of data

- Hydroelectrica, the private/public enterprise that manages all of the hydroelectric resources has clear plans to continue investments in damming for new production capacities, despite environmental concern and NGO resilience.
- Hydroelectrica has acquired UCM Reșița, the main Romanian provider for hydro power technology.

Biomass Energy – biogenic Carbon and biological resources:

- Biomass sources for energy production that we have considered for the study are mainly relying on circular economy value chains. We have selected the landfills as primary resources, with the condition administrators start acquiring European funding for selective waste management and biological resources are transformed into energy resources based on available subsidies and schemes.

- Romsilva, the state agency for woodland management, that is also responsible for all the biospheres and natural reservations in Romania, has also been accounted for with the regional offices in every main city. However, they are represented in hundreds of locations, being a valuable asset in the management of biological resources.
- We have inventoried all wood mills, paper and cellulose mills, the F&B sector, and the main agriculture market players for our resources map, as visible in Fig. 4.

Fig. 4. Romanian Hydroelectric Dams (2023)
Source: Author's research and interpretation of data

All renewables are dependent on state transportation infrastructure. Where grid connection permits have reached a peak, the administrator of the electrical grid is following a cautious approach to grid modernization investments if the market does not show clear demand, especially after the industrial consumer downfall registered during the pandemic. Clean hydrogen production through electrolysis relies heavily on new wind and solar projects that can deliver power to the hydrogen plant.

Moreover, the transportation of hydrogen from plant to consumer is an issue that the industry needs to resolve with state implication and aid, as the required infrastructure and networks within the ecosystems must be a subject of political interest, accumulating multiple deciding factors from geographically linked territorial administrative institutions.

While Romania is abundant in hydroelectric power, the European philosophy around hydrogen tends to disqualify Hidroelectrica from providing power for "green" hydrogen production, as the E.U. stimulates the development of new energy resources. This

ultimately results in ignoring hydroelectric and nuclear capacities, until the Guarantee of Origin legislation will pass through Parliament.

However, opportunities abound in biomass and biological gasses, catching the attention of organizations that deal with biological residue. Considering biological waste now has a price, the waste management sector has newly invested interest in developing a circular economy ecosystem nation-wide, just estimating a need for sustainable transportation of said resources to incinerating facilities, for example.

Nuclear Energy:

- With nuclear energy being included into the EU Taxonomy Regulation as a clean energy resource, Romania is again in advantage as a clean energy provider, having two reactors operational at the Cernavodă plant and being the host country for the innovative SMR technology, via a Romania – US Memorandum of Understanding.

Microgrids:

- A concept that is being explored is the independent microgrid, resulted from a compromise between a pragmatic state administrator of the national grid, with a restrictive development strategy that is not attractive for potential investors in renewable capacities, and industrial sectors that rely on renewable resources for sustainable operations.
- The microgrid allows sustainable organizations to sign Power Purchase Agreements (PPAs) with renewable energy project developers, acting as guarantees for sustainable loan approval, working to the effect of financing the renewable energy project and to the benefit of the organization employing the energy resource into sustainable operations.
- The system functions similar to prosumer regulations, state grid only hosting direct delivery from energy supplier to industrial benefactor on restricted geographical areas, defined by the economic activity of the demanding organization(s).
- Moreover, the microgrid can act as a grid supplier if national systems fail.

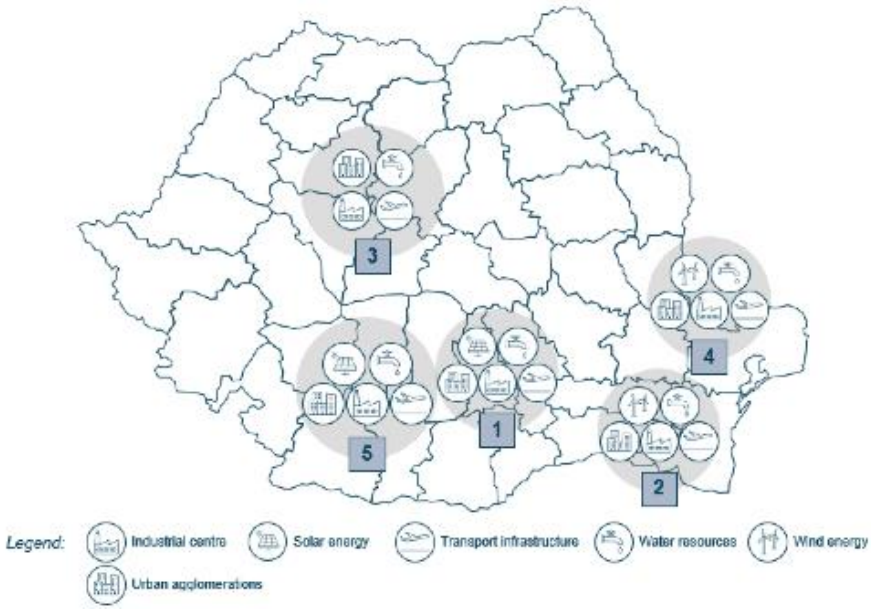
5.3. Hydrogen Opportunities

The concept of green hydrogen, produced through the electrolysis of water using electricity generated from renewable energy sources, holds significant promise for Romania's energy transition and environmental goals. As the country seeks to reduce its carbon footprint and enhance energy security, green hydrogen emerges as a key technology that can offer a sustainable alternative to fossil fuels across various sectors, including transportation, industry, and thermal services (central heating and cooling).

Given Romania's substantial potential for renewable energy, particularly from solar, wind, and hydroelectric power, the production and utilization of green hydrogen can play a pivotal role in achieving a low-carbon economy, driving innovation, and fostering economic growth within the region. This aligns with Romania's commitments under the European Green Deal and its own national strategies to embrace cleaner energy solutions and sustainable development.

The Romanian national hydrogen strategy is a programmatic document, required as a medium-term vision for the national authorities and European regulators, to negotiate investment budgets and aid schemes. The strategy is a requirement for the proper allocation of financial resources to feasible projects, with private and public institutions being stimulated to develop projects in the parameters of the programmatic documentation. However, as visible in Fig. 5, the current draft of the strategy is a very broad approach to a domain that requires granularity to the last detail, as the production of hydrogen requires consumers to immediately intake the production and generate a stable revenue stream, even with an intensive subsidies program backing the industry.

a.



b.

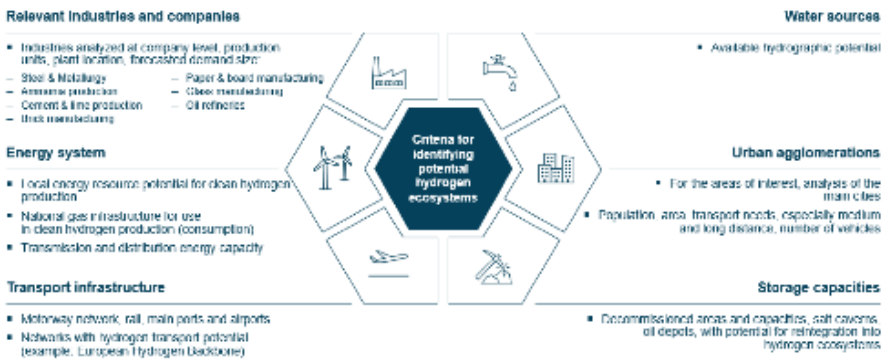


Fig. 5. (a) Prioritised hydrogen valleys based on multimodal demand ; (b) Legend of the selection criteria
Source: National Hydrogen Strategy November 2023 Draft – Ministry of Energy

The strategy is a very static and one-dimensional document. It rarely tackles issues upstream and downstream of hydrogen. This study and its evolutions resolve value chains

between energy providers, specific technology developers, hydrogen utilizers in the varied sectors with a direct approach to all the potential stakeholders that are active in the Romanian economy. Fig. 6 represents a summary of estimated green hydrogen and clean hydrogen consumption, by sectors expressed in percentages for the year 2030. Our ambition is to stimulate organizations to exploit the green financing mechanisms and increase these figures substantially, at least at a declarative level, after we have had concluded our quantitative analysis of the market following discussions with all the organizations identified on our Ecosystems Map.

	Total	Existing industry	Steel industry	Transport	Blending for CCGT
Hydrogen demand (tonnes/year)	288,0	41	24,2	168,8	54,0
CO_2 emissions reduction	2.885,0	384,5	748,7	1.547,8	338,0

Fig. 6. Hydrogen consumption / CO2 reduction
Source: National Hydrogen Strategy November 2023 Draft – Ministry of Energy

Throughout the year 2023, several opportunities came in effect for the hydrogen industry, to which the sector specific organizations have answered. An important opportunity has been the 100mw electrolysis projects tender, to which an overwhelming response from 19 companies has been received by the Ministry of Energy, as visible in Fig. 7. Four of these projects have actually been approved and financed from the Resilience Facility. However, a new call for projects has been issued by the Ministry of Energy, this time from the Modernization Fund, and all the rejected projects from 2023 are expected to be financed on this new axis.

Chimcomplex, Monsson Alma, OMV Petrom, SAPE, Frizon Holding, Intervenții Active în Atmosferă SA, Sudarec Romserv, Technomir, Copper Beech, Ground Investment, Elektra Power, Vermont Green, BPlus Advisory, Termoficare Oradea, Infra Expert, Alternative Green Project and Rohidrogen One are the 19 companies that have submitted projects on the Resilience Facility. Romania has ambitions for 2500MW electrolysis capacity installed by 2030, representing approx. 6% of the EU electrolysis capacity, according to the European Commission Hydrogen Strategy. That will result in a demand for roughly 5 new GW RES, basing the estimations while taking the additionality principle into account.

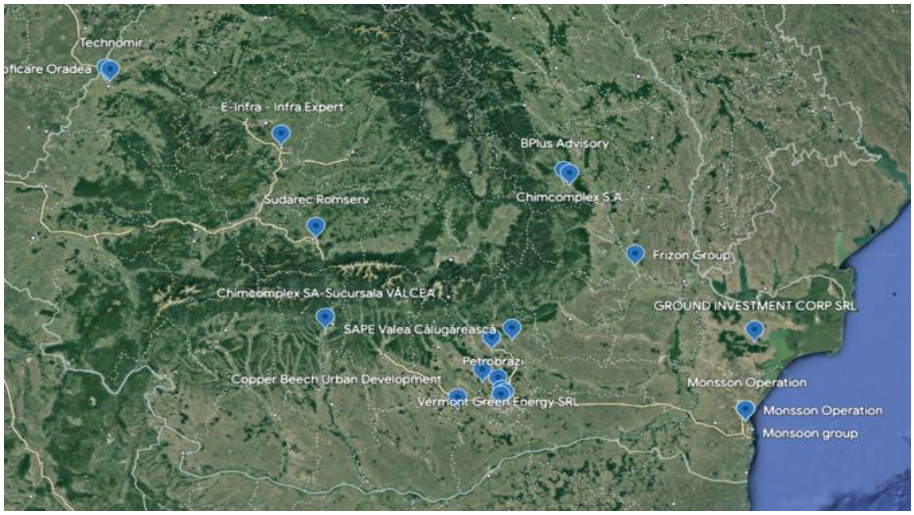


Fig. 7. Electrolysis projects submitted to Resilience Facility financing
Source: Author's research and interpretation of data

5.4. Industrial Ecosystems and Energy Transition

Our research outlines a detailed analysis focusing on specific regions in Romania identified for their potential in renewable energy integration and green hydrogen insertion, emphasizing their strategic importance in developing sustainable industrial ecosystems. Here's a summary of the key regions and their characteristics:

Ecosystem 1 centers around the regions of București, Ploiești, Târgoviște, Pitești, Vâlcea, Buzău, Oltenița, Giurgiu, and Turnu Măgurele, showcasing a robust foundation for renewable energy integration and green hydrogen production, underlined by their strategic importance for developing sustainable industrial ecosystems. Ecosystem 1 is visible for analysis in Fig. 8.

Fig. 8. Ecosystem 1
Source: Author's data inputs in Google Earth

Transportation and Logistics Access: this ecosystem enjoys exceptional multi-modal connectivity, including significant highways (A1, A2, A3), comprehensive railway networks, accessibility to Bucharest's airports, and Danube ports. Such infrastructure facilitates the seamless movement of goods and services across the region.

Biogenic Carbon Potential: the area is marked by high agricultural activity, forest resources, and a diversified industrial sector, including FMCG, tobacco, cement, steel, and chemicals. These features provide ample opportunities for carbon capture and sequestration initiatives, contributing to the reduction of carbon footprints.

Power Profile and Projects: hosting a considerable portion of Romania's photovoltaic (PV) projects, the region is at the forefront of renewable energy development, bolstered by European financing schemes. Plans for further expansion into renewable energy are well-supported, signifying a positive trajectory towards energy sustainability.
Hydrogen Prospects: with several electrolysis projects already receiving funding through the Resilience Program and plans for a hydrogen fuel-cell train network, the region is emerging as a pivotal area for hydrogen energy. This evolution represents a significant step towards achieving a low-carbon energy system.

Thermal Plants: the presence of thermal plants undergoing transitions to gas and potentially hydrogen signifies the region's move towards cleaner energy production. Efforts are underway, supported by modernization funds, to upgrade these facilities for enhanced efficiency and reduced environmental impact.

Specific Cities and Industrial Focus:

- **Bucharest and Ilfov**: Dominated by a diverse industry base including food processing, breweries, plastics, and textiles, with a significant focus on renewable energy and central heating system upgrades.
- **Ploiești – Câmpina**: Renowned as Romania's petroleum nucleus, this area is transitioning towards sustainable energy, housing refineries and FMCG producers.
- **Pitești – Argeș**: The site of the Automobile Dacia plant, presenting potential for green hydrogen utilization in automotive manufacturing and the petrochemical industry.
- **Vâlcea**: Acts as a center for chemical, petrochemical, agritech, and pharmaceutical industries, emphasizing hydrogen as a clean energy carrier.
- **Buzău**: This region is evolving its industrial output with opportunities in steel production, food and beverage, and renewable energy projects.

These regions collectively highlight strategic opportunities for the cultivation of sustainable ecosystems based on renewable energy and green hydrogen. Our analysis underscores the imperative for targeted investments, collaborative efforts among stakeholders, and infrastructure development to fully exploit these areas' potential, steering Romania towards a sustainable and competitive economic landscape.

Ecosystem 2: Constanța, Medgidia, Slobozia, and Călărași, presenting a promising landscape for renewable energy integration and green hydrogen production due to its strategic geographical advantages and natural resources. The map of Ecosystem 2 can be studied in Fig. 9.

Transportation and Logistics Access: the region boasts significant logistical advantages, including the only Black Sea ports in Romania capable of industrial operations due to favourable water depths. These ports, alongside Constanța's functional airport, which hosts a NATO base, and access to Danube ports in Medgidia and Călărași, provide excellent opportunities for the transportation of goods and services. Slobozia acts as a critical road intersection, offering distributed access to neighbouring ecosystems, with an efficient rail network for cargo operations.

Fig. 9. Ecosystem 2
Source: Author's data inputs in Google Earth

Biogenic Carbon Potential: this area is characterized by its rich agricultural activities, including abundant vineyards and mixed crops. The presence of industries under proactive private management across various sectors, from metallurgy to chemicals, alongside the two largest refineries in the country, contributes to its biogenic carbon potential. The Rompetrol – Midia Năvodari Refinery, subject to legislation enforcing green hydrogen production, highlights the region's focus on reducing the aromatic compounds in fuels. Moreover, the availability of algae from the Black Sea and the Danube Delta in the connected region is an advantage in biological resources management for this ecosystem.

Power Profile and Projects: wind power projects, despite facing grid access challenges, are prevalent in this region, which also hosts the Cernavodă Nuclear Plant. The overcrowded grid has led project owners to pivot towards energy storage in hydrogen, with a noticeable increase in demand for electrolysis plants. The region is at the forefront of renewable energy innovation, with Linde and Air Liquide already operating here, and Monsson's financed electrolysis system set to come online. The 1TW offshore wind project has been prepared for implementation, with government officials voting the specific legislation into effect and the EU allowing a 3 billion EUR grant for renewables contracts for difference, ensuring the viability and feasibility for this project, in particular.

Hydrogen Prospects: the strategic positioning for green hydrogen production is evident, with the region hosting several electrolysis projects. These projects, focusing on reducing greenhouse gas emissions, are supported by abundant renewable resources and legislative mandates for refineries to incorporate green hydrogen into their processes.

Thermal Plants and Renewable Energy Opportunities: with the presence of the Cernavodă nuclear plant and limited operational thermal plants, the region plans to modernize existing facilities for gas-to-power generation with hydrogen-ready technology. Although low photovoltaic opportunities are noted due to the prioritization of agricultural land, the region's excellent wind conditions support the feasibility of new wind power projects, especially offshore.

Industrial and Agricultural Profile: the ecosystem is home to a diverse range of industries, including the Petromidia Refinery, Monsoon Alma, Linde, Romcim, and various agriculture-intensive areas. The focus on clean production requires massive hydrogen production to support industries like cement, metal production, clean transportation, and green agriculture.

Ecosystem 2 embodies a dynamic blend of renewable energy potential, green hydrogen prospects, and strategic logistics and transportation access, setting a solid foundation for sustainable industrial development in Romania.

Ecosystem 3 encompasses the regions of Timișoara, Cluj-Napoca, Târgu Mureș, Făgăraș, Sibiu, Sebeș, Alba Iulia, and Hunedoara. It represents a densely populated industrial ecosystem with a vast network of road and rail connections facilitating efficient logistics. This ecosystem stands out for its abundant industrial resources, including a significant concentration of biological resources, offering a rich landscape for renewable energy and green hydrogen projects. The geography of Ecosystem 3 can be consulted in Fig. 10 bellow.

Transportation and Logistics Access: this ecosystem benefits from exceptional transportation and logistics access, including six operational international airports and extensive rail infrastructure undergoing modernization. The main A1 highway, which exits Romania at the Nădlac customs, along with the plan to connect Timișoara, Reșița, Semenic, and Orșova with a hydrogen-fuelled rail, underscores the region's commitment to sustainable transportation.

Fig. 10. Ecosystem 3
Source: Author's data inputs in Google Earth

Biogenic Carbon and Thermal Plants: intensive agricultural activity characterizes the region, alongside well-organized cooperatives between farmers and abundant chemical plants. The ecosystem houses several mills, factories, and industrial sites ready to enter the value chain for biogenic carbon. While most thermal plants have been conserved or sold to private operators for modernization with gas-to-power technology, there's a significant interest in installing electrolysers for green operations.

Power Profile and Projects: the ecosystem shows promise in renewable energy projects, particularly in wind and solar energy. Notably, the Reșița region is home to development projects exceeding 1000MW in mixed wind and solar capacities, taking advantage of optimal wind conditions in the mountainous areas. Despite the low wind and solar conditions within the central parts of the ecosystem, opportunities for renewable energy development are expanding, particularly towards the north and west. Reșița is the second city behind Cluj-Napoca, both in Ecosystem 3, to emit green bonds for sustainable long-term investments in public interest projects. Moreover, UCM Reșița, the industrial behemoth revitalised with Hidroelectrica finances is set to pivot to RES with a new investment strategy and the Green Public Procurement standards that have come into effect.

Hydrogen Prospects and Industrial Focus: with active operations by Linde and Air Liquide, and the approval of three electrolysis plants in Sibiu and Oradea, Messer presence in Reșița, the region is poised for significant advancements in green hydrogen production. Steel and cement mills are exploring the transition from hydrocarbon fuels to hydrogen, emphasizing the ecosystem's move towards sustainable industrial processes. The presence of ceramic producers and international airports mandated to integrate synthetic aviation fuels further highlight the ecosystem's diverse industrial base and its shift towards

sustainability. Timișoara is the Linde HQ in Romania, developing sustainable operations within this ecosystem and the whole country.

Regional Opportunities: Ecosystem 3 presents a unique combination of resource gathering potential, both biologic and non-biologic, and excellent rail-bound shipping capacities for processing plants in southern Romania. There are also numerous sustainability-optimization opportunities with industrial agents operating within this ecosystem, signifying a broader move towards compliance with sustainability standards.

This analysis of Ecosystem 3 underscores its strategic importance in Romania's transition towards a sustainable and competitive economy, focusing on renewable energy integration, green hydrogen production, and efficient transportation and logistics infrastructure.

Ecosystem 4, encompassing the regions of Galați, Brăila, and Tulcea, is poised as a strategic hub for sustainable industrial development, particularly in the metallurgical sector, with a high demand for hydrogen production. This ecosystem is characterized by its rich resources, strategic logistics access, and ongoing projects aimed at transitioning towards green energy and hydrogen use. A visual representation of the geographical positioning of Ecosystem 4 can be seen in Fig. 11 below.

Fig. 11. Ecosystem 4
Source: Author's data inputs in Google Earth

Transportation and Logistics Access: the regions enjoy comprehensive transportation and logistics access, including Danube cargo capabilities, partial highway access with modern or modernizing road infrastructure, rail cargo capabilities, and a significant airport project in Galați-Brăila. This infrastructure supports efficient movement and logistics, essential for the ecosystem's development and integration into wider economic activities.

Biogenic Carbon Potential: Ecosystem 4 is a rich agricultural area with abundant river vegetation and proximity to the seashore for potential algae extraction. The presence of intensive industries, including metallurgical, cement, and chemical sectors, further adds to the ecosystem's biogenic carbon potential, essential for sustainable development and green hydrogen production.

Power Profile and Projects: the region hosts wind power projects, although these face challenges due to grid access issues. The pivot towards energy storage in hydrogen signifies a strategic shift, aiming to circumvent the grid constraints with innovative solutions like hydrogen energy islands and offshore wind projects. Active operations by Linde and Air Liquide, including contracted electrolysers funded by resilience programs, underscore the move towards green hydrogen as a pivotal energy source for the area. The DAMEN shipyard situated in Galați, within Ecosystem 4, has just financed a re-technologization process for the entire factory, with the purpose to produce sustainable transportation vessels, fitted with biofuels, gaseous or hydrogen fuel cell technologies.

Thermal Plants and Modernization Needs: with thermal plants in the ecosystem having been conserved, there is a pressing need for modernization to gas-to-power and hydrogen-ready technologies. This transition is crucial for ensuring efficient public thermal services and aligning with sustainability goals.

Regional Opportunities and Industrial Focus: ecosystem 4 is recognized for its role as an education provider, industry host, and logistics hub, continuously evolving to meet the demands of sustainable development. The Liberty Steel Galați, undergoing modernization for green steel production, exemplifies the industrial shift towards green hydrogen, necessitating significant increases in power demand dedicated to hydrogen production. Other key players like ALRO Alum in Tulcea, recently selected as an aluminium provider for Airbus Industries, are actively pursuing emissions reduction, emphasizing the need for renewable energy and hydrogen in metallurgical processes.

Strategic Development and Sustainability: the establishment of the Galați-Brăila airport project, alongside the EU-funded suspension bridge connecting the three cities, enhances the ecosystem's logistics capabilities. This infrastructure development, combined with the region's industrial ambitions and renewable energy projects, positions Ecosystem 4 as a crucial area for Romania's transition to a sustainable and competitive economy, leveraging green hydrogen and renewable energy sources to fuel its industrial and agricultural sectors.

Ecosystem 5, covering areas including Craiova, Slatina, Târgu-Jiu, Reșița, Caraș-Severin, Drobeta Turnu-Severin, and Moldova Veche, is identified as a promising landscape for sustainable development, marked by significant industrial potential and renewable energy opportunities. A geographical representation of Ecosystem 5 can be found in Fig. 12.

Transportation and Logistics Access: this ecosystem benefits from an extensive transportation network, featuring two airports (Caransebeș Industrial and Craiova Passengers), multiple Danube ports ensuring robust internal logistics, and a comprehensive road network that includes ongoing highway development projects. These infrastructures facilitate multi-modal logistics capabilities, crucial for the ecosystem's industrial and renewable energy sectors.

Hydrogen Production and Demand: active participation from companies like Linde and Messer, particularly with Messer's headquarters in Reșița and operations by Linde in Chimcomplex Vâlcea, underscores the region's potential for hydrogen production. The ecosystem's industrial framework, including sectors such as steel production and automotive components, exhibits a growing demand for clean hydrogen, essential for modernizing operations and transitioning towards green steel production. Specific interest is manifested by the Banat Airport Caransebeș management for Synthetic Aviation Fuel production in this ecosystem, that requires clean hydrogen and biological carbon for refining. Remaining in the Caransebeș region, the recent acquisition and operationalisation of the "Oțelul Roșu" steel mill is an opportunity for the hydrogen industry, as the overhaul of this particular factory, to green steel standards produced with clean hydrogen, will influence a vast and ample value chain both upstream in infrastructure constructions and confections, and downstream in the regional RES and hydrogen sectors.

Fig. 12. Ecosystem 5
Source: Author's data inputs in Google Earth

Biogenic Carbon and Power Profile: despite the challenges posed by soil desertification in parts of the ecosystem, there remains a considerable potential for biogenic carbon resources, notably from ROMSILVA's forest administration. The region is also home to significant renewable energy projects, with over 1000MW development projects in wind and solar energy, highlighting a favourable environment for sustainable industrial production.

Thermal Plants and Renewable Energy: the ecosystem hosts several carbon-intensive gasses-to-power or coal-to-power plants. Governmental aid schemes from the Modernization Fund are set to update these facilities to embrace hydrogen and biological resources, signalling a shift towards cleaner energy production methods.

Regional Opportunities: Ecosystem 5 is uniquely positioned for intensive industrial development, benefiting from strategic connectivity to European destinations via the Danube and enhanced access to renewable energy resources. This connectivity, combined with the region's industrial and agricultural capabilities, presents a solid foundation for establishing Hydrogen Valley initiatives, aimed at fostering sustainable industrial ecosystems.

Industrial and Agricultural Focus: key cities within the ecosystem, such as Craiova and Drobeta-Turnu Severin, are noted for their industrial activities, including Ford OTOSAN and Holcim in Craiova and the Vrancart Cellulose and Paper Mill in Drobeta-Turnu Severin. These industries, alongside others in Slatina and Reșița, form the backbone of the ecosystem's economic potential, driving the demand for renewable energy and clean hydrogen for sustainable production processes.

Ecosystem 5 emerges as a critical area for Romania's industrial rejuvenation and transition towards sustainability. With its rich renewable energy prospects, significant demand for clean hydrogen, and robust transportation and logistics infrastructure, it is poised to contribute meaningfully to the country's sustainable development goals.

Ecosystem 6, as defined by the cities of Brașov, Miercurea Ciuc, Mureș, Satu Mare, Suceava, Botoșani, Iași, Roman, Bacău, Borzești, and Focșani, represents a diverse and dynamic region of Romania that spans from the heart of Transylvania, across the Moldavian plateau, to the eastern borders of the country. This ecosystem is characterized by a rich tapestry of natural landscapes, from the Carpathian Mountains to rolling hills and fertile plains, which provides a unique backdrop for both its ecological and energetic profiles.

Transportation and Logistics Access: Ecosystem 6, spanning strategic locations like Brașov and Iași, boasts a comprehensive transportation and logistics network essential for its diverse economic landscape. This includes an extensive road network with major national and European corridors, vital rail infrastructure supporting both freight and passenger services, and key airports facilitating domestic and international connections. The region's proximity to the Danube River enhances its logistics capabilities through river transport. Additionally, the presence of logistics centres and hubs streamlines the distribution of goods, underpinning industrial activities and agricultural output. Investments in infrastructure improvements and multimodal transport links are pivotal for enhancing regional economic growth and connectivity.

Hydrogen Production and Demand: enriched by industrial activities and a robust agricultural sector, this ecosystem presents significant opportunities for hydrogen production and demand. The presence of Chimcomplex, showing keen interest in hydrogen, underscores the region's potential as a hub for hydrogen energy development. The area's extensive agricultural industry, necessitating green fertilizers, complements this by driving demand for hydrogen as a key component in producing eco-friendly fertilizers. Given Romania's abundance of chemical and fertilizer plants, the region is poised to lead in the transition towards green hydrogen, leveraging its industrial and agricultural strengths

to fuel demand, support sustainability, and foster innovation in hydrogen technologies. This convergence of industrial need and green aspirations highlights Ecosystem 6's potential in shaping a sustainable energy and agricultural future.

Biogenic Carbon Potential: Ecosystem 6, characterized by its varied landscapes from the Carpathian Mountains to fertile plains, holds significant biogenic carbon potential. The region's extensive forests, managed by entities like ROMSILVA, offer vast resources for sustainable forestry and carbon sequestration efforts. Agricultural lands contribute through crop cultivation and potential for biomass energy production. Initiatives to harness biogenic resources, including agricultural waste and forest residues, for energy and material use could further enhance the region's sustainability and reduce carbon footprint. Optimizing these natural resources for bioenergy and eco-friendly products represents a key opportunity for Ecosystem 6 to advance its green economy.

Thermal Plants and Renewable Energy: thermal power plants are undergoing significant transitions to align with EU environmental directives, focusing on reducing emissions and securing environmental permits. Concurrently, there's a notable shift towards renewable energy sources, highlighted by solar and gas-powered projects, to foster a cleaner energy landscape. The region's industrial entities, especially those with a keen interest in hydrogen like Chimcomplex, mirror a broader national shift towards sustainability, emphasizing renewable energy and the phasing out of coal dependence.

Regional Opportunities: given the presence of significant industrial players across Ecosystem 6, including ArcelorMittal, Agrana, Holcim, Amazon, Autoliv, Vrancart, and many others within cities from Roman to Iași, Adjud, Onești, Brașov, Miercurea Ciuc, Suceava, Botoșani, and the Satu Mare region, the regional opportunities for development, innovation, and sustainability are vast and multifaceted:

- Industrial Synergy and Innovation: The diverse industrial base, from steel manufacturing (ArcelorMittal) to advanced technologies (Amazon Web Services) and automotive (Autoliv, Schaeffler), creates opportunities for synergies and collaborative innovation. Establishing research and development clusters can spur technological advancements and product innovations, driving economic growth.
- Agricultural Innovation and Bioeconomy: The presence of Agrana and Heineken Ciuc Brewery, alongside extensive agricultural lands, opens up opportunities for bioeconomy initiatives, leveraging agricultural by-products for energy production, and developing value-added agricultural products, enhancing the sustainability and profitability of the agricultural sector.
- Digital Transformation and IT Infrastructure Development: With technology companies like Amazon in the region, there's a significant opportunity to advance digital transformation across industries, improve IT infrastructure, and foster a digital economy that supports e-commerce, cloud computing, and remote working environments.
- Supply Chain Development and Logistics Enhancement: The geographical location and industrial diversity present opportunities to develop integrated supply chains, improve logistics and transportation infrastructure, and facilitate efficient distribution channels, both domestically and for export markets.

- Workforce Development and Education: Collaborations between industries and educational institutions can address workforce needs, providing specialized training and development programs in fields such as engineering, IT, and sustainable agriculture, ensuring a skilled workforce ready to meet future industry demands.
- Tourism and Cultural Heritage: Beyond industrial and agricultural development, the region's rich cultural heritage, natural landscapes, and historical sites offer opportunities for developing sustainable tourism, including cultural, eco-, and agro tourism, contributing to local economies and conservation efforts.

Ecosystem 6's blend of industrial activity, agricultural richness, and technological innovation, coupled with its natural and cultural assets, sets the stage for a dynamic regional development trajectory focused on sustainability, innovation, and cross-sector collaboration.

Socioeconomic Context: the region encompasses a mix of urban centres, such as the historic cities of Brașov and Iași, and rural areas with economies based on agriculture, forestry, and increasingly, tourism. The diverse economic activities, combined with cultural and historical richness, provide a solid foundation for sustainable development initiatives.

5.5. Industries of Immediate Interest and Priority

Energy (Refineries and Thermal Power Plants): This sector emerges as a top priority due to its substantial energy demand and significant potential for emissions reduction through the integration of green hydrogen. The analysis points to several key refineries and thermal plants, such as OMV Petrom and Electrica Furnizare, underscoring the critical need for transitioning to cleaner energy sources.

Synthetic fuels and gasses production: This sector as critical as it is innovative, with mandatory quotas for Sustainable Aviation Fuels being introduced and gradually growing, but with no supplier for this resource on the entire continent. This particular element is synthetized with clean hydrogen and captured carbon. Cleaning gases produced by the pyrolysis of biological waste requires clean hydrogen.

Steel Production: The steel industry, represented by companies like Liberty Steel and ArcelorMittal, is identified as another critical area for renewable energy integration. The sector's high carbon footprint and energy intensity make it a prime candidate for adopting green hydrogen technologies to reduce emissions and improve energy efficiency.

Chemical and Petrochemical: The document highlights the chemical and petrochemical sectors, including Chimcomplex and Oltchim, as essential for sustainable transformation. These industries stand to benefit from green hydrogen as a feedstock, reducing reliance on fossil fuels and decreasing carbon emissions in the production of chemicals and fertilizers.

Cement Manufacturing: With players like Holcim Romania and Heidelberg Materials, the cement industry's energy-intensive processes and significant CO2 emissions are

spotlighted. The adoption of green hydrogen and renewable energy sources could revolutionize this sector, lowering its environmental impact while maintaining production efficiency.

5.6. Challenges and Opportunities

Romania's trajectory towards a hydrogen-based economy underpins a spectrum of challenges and opportunities across infrastructural, regulatory, and collaborative dimensions, each intertwined with the broader objectives of sustainable development and energy transition.

Infrastructure Needs and Investment Opportunities: Romania faces substantial infrastructure needs to foster a hydrogen economy, from production facilities to storage and distribution networks. This challenge, however, opens up vast investment opportunities. The development of dedicated hydrogen pipelines, electrolysis plants powered by renewable energy sources, and the enhancement of existing gas networks to accommodate hydrogen blending are critical steps. These initiatives not only require significant capital investment but also present opportunities for public-private partnerships, drawing in expertise and funding from various sectors. Moreover, the divided and inconsistent political environment is unaware of several financing opportunities and responds with difficulty to proposals such as the development of a Romanian IPCEI for hydrogen (Important Projects for Common European Interest)

Regulatory and Policy Environment: Navigating the regulatory landscape presents a challenge, with the need for a coherent framework that supports hydrogen production, utilization, and market development. The opportunity lies in crafting forward-looking policies that incentivize renewable energy investments, streamline permits for hydrogen projects, and establish clear standards for clean hydrogen, thus creating a conducive environment for growth. Embracing EU directives and integrating them into national law can expedite this process, positioning Romania as a leader in hydrogen innovation within the region. Romania requires legislation for the Guarantees of Origin (GO) for hydrogen, specific legislation for Hydrogen Contracts for Difference in order to support the production, distribution and utilisation of hydrogen aided by subsidies. Moreover, specific legislation for type certification of hydrogen machinery is required in order to evaluate procurement tenders by means of European quality and safety standards, excluding off the market those components that cannot be accounted for in sustainability reports.

Collaboration between Government, Industry, and Academia: The complexity of transitioning to a hydrogen economy necessitates a collaborative approach among government bodies, industry stakeholders, and academic institutions. The challenge is to synchronize efforts, align objectives, and share knowledge and resources. The opportunity arises in leveraging this tripartite collaboration to drive innovation, research, and development in hydrogen technologies, ensuring a workforce skilled in new energy sectors, and piloting projects that demonstrate the viability and benefits of hydrogen solutions. Such collaborative platforms can also play a crucial role in public education and acceptance of hydrogen technologies, laying the groundwork for a sustainable energy future.

In addressing these challenges and capitalizing on the opportunities, Romania can advance its green agenda, fostering a sustainable and resilient energy ecosystem that contributes to its economic growth and environmental goals.

6. Case Studies

Examples of Successful Renewable Energy or Green Hydrogen Projects

Ørsted's Transition to Renewable Energy: Ørsted, originally a traditional fossil-fuel company, successfully transitioned to become the world's largest producer of offshore wind energy. The company strategically focused on wind power, leveraging early-stage projects in Denmark and the United Kingdom and significant in-house expertise in renewable energy. Ørsted's transformation was marked by adopting a serial production approach to offshore wind projects, moving away from highly customized, infrequent projects to more standardized, frequent developments. This shift required strong partnerships, particularly for turbine installation and supply, and led to innovative financing models, like the "farm down" model, which attracted significant investment for European projects .

Germany's Kopernikus Projects for Renewable Energy Research: Germany launched the Kopernikus Projects, the nation's largest renewable energy research initiative, with a €400 million investment aimed at advancing energy storage, developing renewable-centric power networks, adapting industrial processes to renewable sources, and integrating conventional and renewable energy production. This initiative is distinguished by its collaborative approach, involving research institutions, industrial companies, and civil-society bodies to work on complex challenges like converting intermittent renewable electricity into hydrogen. This reflects a holistic strategy to ensure public buy-in and address socioeconomic impacts alongside technological advancements.

Lessons Learned and Best Practices

Emphasis on Strategic Vision and In-House Expertise: Ørsted's successful pivot to renewable energy highlights the importance of having a clear strategic vision that identifies future growth areas based on existing competencies and market differentiation opportunities. Equally crucial is the presence of substantial in-house expertise to navigate the technological and operational shifts required for transitioning to renewable energy sources.

Collaborative and Interdisciplinary Approach: The Kopernikus Projects underscore the value of collaboration across disciplines and sectors to address the multifaceted challenges of renewable energy transition. Involving a wide array of stakeholders from the onset ensures diverse perspectives and expertise contribute to holistic solutions, enhancing project viability and public acceptance.

Innovative Financing and Business Models: Developing new financing models, such as Ørsted's "farm down" approach, can be pivotal in attracting the necessary capital for large-scale renewable projects. These models must balance investor interests with project risks, facilitating investment in the sector while enabling project developers to maintain strategic control and operational expertise.

Adaptability and Continuous Improvement: As the renewable energy landscape evolves, successful projects demonstrate the importance of being adaptable and continuously seeking improvements in technology, operations, and business strategies. This includes everything from streamlining production processes to exploring new market opportunities and technological frontiers, such as green hydrogen.

7. Conclusion and Recommendations

The investigation into Romania's transition towards sustainable development, emphasizing renewable energy and green hydrogen, has unearthed a multifaceted landscape brimming with both challenges and opportunities. This comprehensive study, underpinned by a detailed review of the academic discourse, PESTLE analysis, and strategic frameworks, has highlighted the pivotal role of renewable energy and green hydrogen in Romania's endeavour to align with the European Green Deal and the Paris Agreement.

Summary of Key Findings:

- Romania exhibits a significant potential for renewable energy expansion, especially in solar, wind, and hydroelectric power, which forms the backbone for a robust clean and green hydrogen production capacity.
- The exploration of hydrogen-natural gas blending and the burgeoning interest in green hydrogen from industrial sectors underscore the readiness and eagerness of the Romanian market to transition towards cleaner energy alternatives.
- Legislative advancements, particularly the Hydrogen Law and EU-backed financial schemes, lay a solid foundation for fostering a conducive environment for renewable energy investments and green hydrogen initiatives.

Strategic Recommendations for Leveraging Romania's Renewable Energy and Green Hydrogen Potential:

- Infrastructure Development and Investment:
    a) Accelerate investments in renewable energy infrastructure, focusing on enhancing grid capacity and resilience to facilitate the integration of solar, wind, and hydroelectric power at a larger scale.
    b) Prioritize the establishment of hydrogen production, storage, and distribution facilities to support the burgeoning hydrogen economy, ensuring that these infrastructures are strategically located to maximize efficiency and accessibility.
- Regulatory and Policy Framework Enhancements:
    a) Continue refining and expanding the legislative framework to support renewable energy and green hydrogen, including incentives for investment, streamlined permitting processes, and clear guidelines for green hydrogen certification.
    b) Implement and enforce a comprehensive national strategy for green hydrogen, aligning with EU directives and focusing on both production and consumption across various sectors.
    c) Define clear and concise parameters for technology certification and accreditation in the EU, especially for machinery under pressure and hydrogen industrial components that can present extreme risks if fabricated superficially.

- Fostering Collaborations and Partnerships:
    a) Encourage public-private partnerships to leverage expertise, resources, and funding from both governmental and private entities. Such collaborations could accelerate the deployment of renewable energy projects and green hydrogen production facilities.
    b) Encourage the development of sustainable consortia between private organizations with common ESG goals and value chain compatibility, for Upstream Emission Reduction in operations.
    c) Strengthen collaboration between academic institutions, research centres, and industries to spur innovation in green technologies and hydrogen applications, ensuring a continuous flow of skilled professionals and cutting-edge solutions.
- Market Development and Public Engagement:
    a) Develop market mechanisms to promote the adoption of green hydrogen across different sectors, including transportation, industrial processes, and residential heating and cooling, through incentives, tax breaks, and subsidies.
    b) Launch comprehensive public engagement campaigns to raise awareness about the benefits of renewable energy and green hydrogen, fostering a societal shift towards sustainable energy consumption patterns.
- CSRD Compliance
    a) Hydrogen is a vehicle for energy to reach production in several key industries, respectively the precise industrial sectors that produce the critical raw materials required for the upstream fabrication of thousands of products derived from steel, aluminium, chemicals, fertilizers, plastics.
    b) Clean/green hydrogen with a guarantee of origin utilization in the upstream manufacturing of products or services, resulting in preventive compliance with emissions quotas, accumulating the minimum amount of carbon in the non-financial report.
    c) With sufficient skills and transparency on behalf of the organization, the products an/or services sold by US and EU based companies can absorb the guarantee of origin, being themselves hunted on the market for their value. Their Net 0 value.

This holistic approach to harnessing Romania's renewable energy and green hydrogen potential not only paves the way for achieving national sustainability goals but also contributes significantly to the global effort to combat climate change. By strategically leveraging its natural resources, legislative advancements, and collaborative spirit, Romania can position itself as a leader in the green energy transition, inspiring other nations and fostering a sustainable future for generations to come. A quantitative completion of this study is programmed to begin soon, probing the organisations gathered in our first study, finding their compliance level with CSRD to establish a sustainability baseline for Romanian organizations, later conversing with deciding factors regarding a swift implementation of pre-defined quality assurance mechanisms for a sustainable organization design in the era of smart communities.

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Smart public transit insights

Alexandru SIROMASCENKO,
Ingenios.ro, București, România
alex@ingenios.ro

Cosmin POPA,
Ingenios.ro, Galati, România
cosmin@ingenios.ro

Corina DIMA,
„Dunărea de Jos" University of Galați, România
Corina.Bocaneala@ugal.ro

Abstract
Local public administrations should pay special attention to the implementation of the smart mobility concept because public transport is a key factor for the sustainable development of cities. This paper explores the analysis of public transportation performance using intelligent algorithms that process data obtained from GPS devices and various other sensors operating on buses. The results obtained from this analysis form the basis of an intelligent management of the public transport system. The proposed analysis model aids in evaluating the transport system's performance and improving the feasibility and suitability of the transport plan. The analysis of historical monitoring data facilitates timely, fact-based decisions. Our work explains why advanced IT solutions for transport management based on analytics should be present in all smart city projects, given that the efficient mobility of citizens increases the level of socio-economic development.

Keywords: smart cities, intelligent public transportation, mobility.

1. Introduction
The mobility of citizens is a key factor influencing the development of cities. Public transportation ensures access to workplaces, hospitals, schools, culture and public services. Urban mobility comes with a series of challenges that consist of increased traffic congestion, pollution leading to climate change and energy crises.

For this reason, public transportation comes with a number of advantages: public transport can be used by all citizens, regardless of income, easy access to workplaces and other points of interest in big cities, increased road safety due to control and professional drivers, lower costs for the community, reduced traffic congestion, reduced costs for fuel consumption, reduced pollution [1], [2], [3].

The idea of developing an intelligent public transport system has appeared since the 1980s. A history of this concept's evolution is presented in [4]. Intelligent transport systems (ITS) are software applications that help with traffic management and supply information of interest to both administrative staff and passengers.

An ITS can provide historical data as well as real-time information for passengers and also for those who plan, design, build, and operate the transportation system [5]. One of the approaches of these transportation applications is studying the environmental impact of vehicle traffic [6]. Modern management systems take into account the fact that current transport fleets also include electric vehicles. Some of the ITS also address other aspects

such as smart parking which requires careful planning [7] A classification of ITS can be consulted in [8].

The use of sensors in many important domains that require urgent responses such as transport or medical assistance was possible due to the technological development that made these devices accessible from a technical point of view and in terms of price [9], [10]. An intelligent transport system (ITS) for organizing transport that reduces traffic congestion, time to destination, fuel consumption and pollution was proposed in [11]. This approach includes the traffic surveillance, vehicle surveillance, passenger surveillance and driver surveillance. ITS technology involving wireless communication can lead to security and privacy challenges, authentication, integrity, location privacy, identity privacy, anonymity issues [12], [13].

Our paper approaches the design of intelligent transport systems from two perspectives: timetables and passenger volumes. The timetable is essential for the quality of public transportation because it fulfills several functions: it helps travelers plan their trips, ensures an evenly distributed passenger load, reduces transportation costs, helps the management to evaluate the performance of the public transportation system.

The proposed approach helps to verify if trips are taking place as planned. The succession interval of vehicles in the stations is an important indicator of the good performance of public transportation. Delays are not desirable, but it is also not appropriate for buses to arrive before the planned time. When gaps are noticed between the timetable and the actual trip, the cause must be checked (moments of the day with heavy traffic, technical problems, the driver's driving style) and, from this point, decisions can be made on whether the problems can be easily fixed operationally, or if the timetable must be revised. In order to make it easier to understand, the compliance with the timetable and the information about the trips can be represented graphically.

The work is structured in three sections. The first section describes the framework for analyzing the performance of intelligent transportation systems. The second section presents a proposed approach for transportation system monitoring. The last part is a conclusion section.

2. Analysis of the performance of the public transport system

The analysis of a public transport system's performance is done from several perspectives:

- compliance with the trip schedule: the planned trips and vehicle allocation assume certain travel times and technical conditions which might not be achievable in practice, so certain planned trips might not be fulfilled;
- compliance with vehicle succession intervals on the route: similarly to the above perspective, but at a more detailed level, from a station perspective; this metric is important because it directly affects passenger satisfaction for several reasons: waiting time, travel time predictability, vehicle crowding;
- analysis of the number of passengers: the data received from the counting sensors installed on vehicles is aggregated at several levels – per vehicle, station, line and

the performance at each level is evaluated separately and combined in order to assess the adequacy of the transport planning to the demand;
- analysis of aggregated data using specialized charts and reports: the data must be presented from several interconnected perspectives, with each one being presented in a specialized, graphically suggestive way, in order to ensure both overviews and detailed analyses

2.1. The schedule

The traffic schedules are drawn up for each line and include the following stages:

- aggregating demand data based on demographics, land usage, surveys etc.;
- creating spatio-temporal origin-destination matrices;
- determining the stations and lines;
- creating the trip schedule by taking into account the temporal variability of demand;
- calculation of the necessary fleet on each line to cover the schedule from a cost efficient perspective, by taking into account depot locations, movement times, refueling, maximum usage time restrictions etc.;
- allocating drivers to the schedule while taking into account working conditions.

The allocation of vehicles is a critical step in establishing the schedule and is prone to generating problems if the input data does not reflect the reality on the ground: vehicle conditions and especially movement times throughout the day. Although certain problems can be resolved in real-time through vehicle reallocation, on the long run these create cost inefficiencies: a trip which is unfulfillable using the vehicles already on the road due to time desynchronizations should be rescheduled by taking into account real movement times instead of being assigned an available vehicle from the depot on the fly. This is where the feedback loop using real monitoring data allows the plan to be fixed.

2.2. Succession of vehicles on the route

The trips are not identical in most cases, either in length (as the duration per half-trip), or in density (the number of trips per hour is different across the day). Likewise, their succession and return to the terminus points is carried out in a strictly fixed order (but which changes depending on the periods of the day). The distance between two trips represents the circulation interval and can be represented down to station level.

This metric is important because it directly influences the system's ability to manage passenger inputs at every point in the network and every moment of the day. An inadequate vehicle availability interval, at each station, can cause both overcrowding, if the interval is too long, and wasted resources, if the interval is too short, so an appropriate frequency must be planned and followed during the day.

2.3. Analysis of the number of passengers

All the streets of a city constitute its street network. The street network has a certain structure and is used by all traffic participants. The totality of passengers transported in one hour, in one direction or in both constitutes passenger traffic. Passenger traffic is measured

in passengers per hour and per direction. The analysis of the potential of transportation of a neighborhood leads to the following relationship:

$U_j = L_j \frac{M}{L}$, where: (1)

- L_j is the number of inhabitants of the analyzed neighborhood;
- M is the total number of jobs in the city;
- L is the total number of inhabitants (of the city).

Using various measuring methods, such as bus sensors, surveys or street video cameras, the traffic flows for a certain urban area can be analyzed using appropriate mathematical models.

In addition to data collection, the scientific interpretation of recorded data is of particular importance. Comparing them with the values recorded in previous years, extrapolating them, establishing conclusions based on previous experiences constitute the elements of data processing and generalization. The basic principles for obtaining a technical-economic efficiency and a maximum precision of the measurements are the following:

- increasing the number of measurements, which has the consequence of increasing the probability of having accurate information about the studied phenomenon;
- the integration of information from various sources, which allows both data enrichment and cross-validation.

Using passenger counting sensors mounted on each vehicle door is a straightforward approach to creating a feedback loop for public transit performance evaluation and improvement. Such sensors, however, have certain limitations, especially in crowded scenarios and due to heterogenous passenger behavior. The data accuracy can be improved by using video surveillance with computer vision. This latter type of data can also be used for improving planning and scheduling, as it can also provide information for areas and time intervals not yet served by public transit.

2.4. Charts and reports

The data from the monitoring of public transit can be used in two main directions

- as a ready-aggregated input for the replanning and rescheduling activities;
- as a data repository with several aggregation levels available for aiding in problem identification and decision making.

For the former usage category, the data must be presented in such a way as to:

- ensure an adequate visualization of data, specific to the type of information being represented: movement times, deviations from plan, passenger numbers etc.;
- allow navigation from one level of aggregation to another;
- allow the visualization of correlations between different variables: individual trips, movement times, distance covered, vehicles, drivers, lines etc.

The reports and charts that the transport company management could use are:

- percentage of trips fulfilled;

- average movement times to/from stations and depots;
- deviations from real average and planned indicators;
- passenger counts per line and station;
- mesoscopic and microscopic events down to individual data packets received from the vehicle, in order to gain insights on the causes of deviations and anomalies: driver faults, missing sensor data, synchronization errors etc.

3. Proposed solutions

Mobility and passenger counter data in a public transport system can be obtained by installing devices on each public transport vehicle that can measure various indicators, such as GPS, counters for each access door, mobility data such as travel speed, deceleration force, odometer, fuel consumption, weight on each axle, data specific to the transport management: route, driver, bus, station at which it stopped, but also calculated data such as computed average speed, and distance traveled using GPS coordinates. Each bus transmits data continuously at a predetermined interval or discontinuously depending on a certain event that triggered the sending.

Multiple problems may arise, caused by the errors inherent to the hardware devices, the incorrect entry of certain details by the driver or the impossibility of data transmission due to signal obstruction. From a hardware point of view, there are a multitude of subsystems that work together, coordinated by a central system.

The following hardware systems can be placed within a vehicle for public transport:

- sensor that reads the data provided by the CAN bus, containing specific mobility information: acceleration, speed, braking etc.;
- sensors that read the number of passengers boarding or disembarking at each vehicle door;
- GPS sensor;
- mobile communication device.

The centralizer system installed on each vehicle collects a snapshot of these data and sends them according to preset scenarios: at a certain frequency or triggered by a certain event, eg: entering the station perimeter or opening the doors triggers the sending of a data package with the current indicator values.

In practice, problems may arise in the case of this hardware architecture, which will be detailed further on. The sensors that read the data provided by the CAN bus may not read the mobility data due to some hardware problems. The sensors that read the number of passengers can fail (only certain doors will transmit data). In the case of motion sensors, they can also be affected by the irregular movement of passengers or by crowding, which affects the measurement accuracy. The GPS sensor may have acquisition problems if the vehicle moves in certain areas where the GPS signal is not available or is available with very low accuracy.

This transmission can cause problems such as the incorrect detection of station stops, the incorrect reporting of non-compliance with the route, a speed/distance that is different from reality, etc. If the signal for the transmission of this data may be lost, certain routes may appear as missed.

Except for these potential problems due to the abnormal operation of the hardware components, there can be situations that arise because the driver does not stop at certain stations, does not correctly enter certain necessary data such as his ID or the selected route, drives faster than the planned schedule, etc.

The passenger counter data can be used either to determine the number of passengers in the respective vehicle, thus allowing for the generation of a heatmap map of the passenger density in a certain area or station.

We propose a model for data aggregation and analysis based on both hierarchical and network type relations, which aims to:

- take into account the different types of raw data:
    a) driver input data: driver id, selected line,
    b) vehicle driving indicators: odometer value,
    c) spatial awareness: GPS coordinates,
    d) transit indicators: door status, passenger counters;
- use operational context for data aggregation, matching and uncertainty reduction:
    a) GPS coordinates and structures of transit lines, stations and depots,
    b) vehicles and drivers,
    c) transit plan;
- provide resilience and minimize the impact of sensor errors and operational deficiencies:
    a) missing or unsynchronized data packages,
    b) missing or invalid GPS data,
    c) faulty driver operation;
- ensure a good performance in the process of data aggregation and analysis by pre-calculating various indicators and avoiding excessive fragmentation of aggregated data;
- retain the links between aggregated and raw data;
- allow for flexibility in data visualization, roll-up, drill-down, cross-inspection.

Our model is based on aggregating the raw data obtained from the vehicles into several types of time continuous events, allowing for several benefits:

- reducing the volume of records when analyzing the data;
- pre-calculating certain indicators for each event type;
- establishing various relations between events based on temporal intersection.

An event is generated by a succession of data packets which have something in common: the value of an indicator, a missing indicator, a certain matching between indicators and context etc. Each event is generated per vehicle and can be analyzed in relation to other

events for the same vehicle, or, in more advanced scenarios, the events of other vehicles. Each event has a time interval and may or may not be interrupted by other events, depending on their types.

3.1. Event types

The events in our model are grouped in several categories:

1. Driver events:
    - driver: describes the time interval in which a vehicle is driven by a specific driver, based on the current logged in driver mentioned in the data packets;
    - missing driver: describes the time interval when data received from the vehicle does not contain the driver identifier, due to non-synchronization / non-functioning of certain equipment or due to the end / non-start of a driver's work session.
2. Events about the movement of vehicles:
    - on the move: a time interval in which there is a mileage difference between any two consecutive data packets received from the vehicle. Outside stations, this event indicates that there is no time interval greater than the standard data transmission interval without mileage difference. The time difference may be smaller inside station perimeters due to more frequent data transmission. Additionally, this type of event can be parameterized in order to allow for a minimum duration required for triggering (more than two consecutive packages);
    - stationary: a continuous time interval containing at least two data packets in which there is no mileage difference between its start and end moments.
3. Events about the route:
    - additional attributes per event: selected route – route identifier, transmitted in each raw data packet as a result of its selection by the driver;
    - missing route: a time interval in which the received data does not contain the route identifier attribute, due to the omission of route selection by the driver or equipment malfunction. For the traceability of activities, it is necessary to have one or more routes for each type of activity, even for activities that do not describe the following of a transport line: withdrawal to the depot, shunting, special runs, etc.;
    - GPS error: raw data does not contain valid GPS positions due to non-initialization / malfunction of the device. For this reason, it is not possible to check compliance with the route, as it is not possible to confirm the presence of the vehicle in its vicinity;
    - maneuver: a route is selected that does not have a predefined route, so the proximity to it cannot be checked, and the GPS positions are valid;
    - outside the route: a route with a predefined route is selected, the GPS positions are valid, but they are not located at a distance less than *x* meters (parameter) from at least one of the segments that make up the route or from one of the polygons representing the stations related to the route;
    - on route: a predefined route is selected; GPS positions are valid and are less than x meters from a route segment or station polygon.

4. Events about stations / trip details:
    - additional attributes per event:
        a) selected route: by default, the selected route is the one carried out, since the presence in stations is checked only for stations of the selected route
        b) direction: forward/return – for two-way routes; forward only – for circular routes
        c) station number: sequence number of the current station within the route
        d) station reference: link to a database record that represents the station in the context of the current route (a station can belong to several routes)
        e) passengers boarded / disembarked
        f) planned station time interval: the time interval in which the vehicle was supposed to be present at the station, according to the traffic plan
    - station: the time interval in which the vehicle is inside the polygon that describes a station on the selected route;
    - doors open: generated by a set of consecutive reports indicating doors as open; due to the risk of desynchronization of equipment at the vehicle level, the range of the open door event may be partially or completely outside the range of the station;
    - closed doors: generated by a set of consecutive reports indicating that the doors are closed;
    - passengers movement: generated by a set of consecutive packages, where each package indicates a different value for the passengers counter than the previous package;
    - between stations: the time interval in which the vehicle is between two consecutive stations. Within a trip on a route with n stations there should be *n* station events and *n*-1 inter-station events;
    - invalid station: indicates the presence of the vehicle, within a trip, in an incorrect station due to and invalid order of travel compared to the previous station. This type of events can occur either due to a real deviation from the route or it can be an anomaly generated by GPS errors, in the case of routes with a certain topology (stations within the same route in proximity, on adjacent streets or in different directions of the same street).
5. Realized trip events:
    - additional attributes per event:
        a) number of stations planned,
        b) number of stations reached,
        c) planned trip identifier – may be missing if no matching planned trip was found,
        d) planned trip interval;
    - Trip: the time interval in which the vehicle made a trip on the selected route.
6. Unrealized events

Unlike the events listed above, unrealized events are generated based on the lack of data from the vehicle or the mismatch with the traffic plan of the vehicle. These events are

generated after the creation of the corresponding realized events, by checking the plan. Unlike realized events, in the time frame of unrealized events, data packets may indicate vehicle activities unrelated to them: off-route, GPS error, missing data, etc. Their purpose is to mark non-fulfillment of the plan through the same structure as the achieved data, in order to have a unified analysis and viewing approach within the graphical interface and reports. Unrealized events have the same additional attributes as their realized counterparts. They can be of the following types:

- missed station: the presence of the vehicle was not detected at all within the station in question, during a trip, in a time interval that ensures the correct order of the stations, by reference to the other validly reached stations. The missed station can be part of a completed trip, together with completed stations, or a missed trip, which contains only missed stations;
- missed trip: no station was reached within a planned trip, so the realized trip event could not be created.

3.2. Proposed graphical user interfaces

In order to leverage the benefits of data aggregation through event detection and statistics generation, we propose the following Graphical User Interfaces (GUIs)

3.2.1. Timeline of events

The event timeline GUI includes a graphical representation of individual event durations, as well as their overlapping, for a particular vehicle. The events are grouped into multiple timelines, based on their types, with events within a timeline being non-overlappable. The GUI allows zooming in and out in order to cover the desired time interval for inspection. A tooltip pops up when hovering over an event, allowing the user to see various information related to the event, such as its time interval and duration.

The timeline from factor of this GUI allows the user to get a visual representation of events' durations and overlapping, but this can also limit the amount of information that can be viewed in a glance, as events can be too long or too short, depending on the zoom level. The next proposed GUI overcomes these shortcomings.

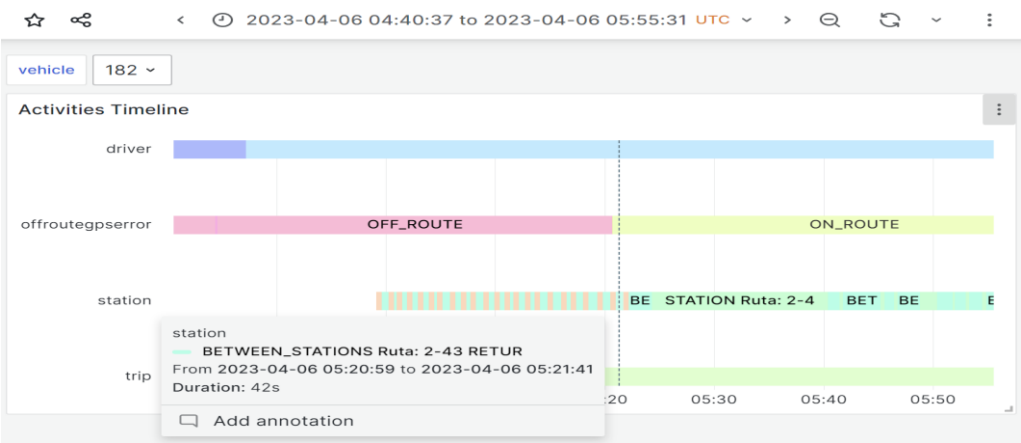


Fig. 1. Visual representation of events' durations and overlapping

3.2.2. General table of events

As a general feature, all the proposed Table GUIs allow pagination, and also filtering and ordering for each column. This particular Table GUI allows listing individual detected events, being a mesoscopic data GUI. In its basic use case it allows the user to inspect the timeline of events for a certain vehicle, allowing to hide and show types of events by preference. In more advanced scenarios, the column filtering and ordering combinations make possible insights such as: top trips by duration for certain routes, total number of missed trips for a route or vehicle, top off route events by duration etc.

The table form factor of this GUI allows an equal representation of events, regardless of their duration, but it doesn't feature a graphical representation of their time spans or overlapping.

Activity types	Date(*)	Route	Direction Name	Time From	Time To	Vehicle	Driver Names	Total No Of Stations	No Of Reached Stations	Matched Stations	Positions
OFF_ROUTE	06.04.2023	Retras		06.04.2023 00:00:05	06.04.2023 00:02:42	13AYO					14
NO_DRIVER	06.04.2023			06.04.2023 00:00:05	06.04.2023 04:46:58	13AYO					28
NO_DATA	06.04.2023			06.04.2023 00:02:42	06.04.2023 04:46:14	13AYO					
GPS_ERROR	06.04.2023	Retras		06.04.2023 04:46:14	06.04.2023 04:46:23	13AYO					8
OFF_ROUTE	06.04.2023	Retras		06.04.2023 04:46:25	06.04.2023 05:27:36	13AYO					179
DRIVER	06.04.2023			06.04.2023 04:47:14	06.04.2023 12:35:55	13AYO					2845
ON_ROUTE	06.04.2023	3		06.04.2023 05:27:44	06.04.2023 06:07:48	13AYO					254
TRIP	06.04.2023	3	RETUR	06.04.2023 05:27:44	06.04.2023 06:07:26	13AYO		18	18	18	251
TRIP	06.04.2023	3	TUR	06.04.2023 05:53:31	06.04.2023 06:34:02	13AYO		15	15	15	232
GPS_ERROR	06.04.2023	3		06.04.2023 06:08:11	06.04.2023 06:08:11	13AYO					1
ON_ROUTE	06.04.2023	3		06.04.2023 06:08:13	06.04.2023 16:23:27	13AYO					3998
TRIP	06.04.2023	3	RETUR	06.04.2023 06:31:53	06.04.2023 07:11:55	13AYO		18	17	17	247
TRIP	06.04.2023	3	TUR	06.04.2023 07:01:50	06.04.2023 07:38:10	13AYO		15	15	15	219
TRIP	06.04.2023	3	RETUR	06.04.2023 07:36:34	06.04.2023 08:18:22	13AYO		18	18	18	244
TRIP	06.04.2023	3	TUR	06.04.2023 08:09:17	06.04.2023 08:43:48	13AYO		15	15	15	198
TRIP	06.04.2023	3	RETUR	06.04.2023 08:42:02	06.04.2023 09:21:11	13AYO		18	17	17	244
TRIP	06.04.2023	3	TUR	06.04.2023 09:13:31	06.04.2023 09:48:31	13AYO		15	15	15	211
TRIP	06.04.2023	3	RETUR	06.04.2023 09:46:21	06.04.2023 10:28:17	13AYO		18	18	18	258
TRIP	06.04.2023	3	TUR	06.04.2023 10:17:59	06.04.2023 10:57:58	13AYO		15	15	15	242
TRIP	06.04.2023	3	RETUR	06.04.2023 10:56:25	06.04.2023 11:33:09	13AYO		18	18	18	224

1 2 3

Fig. 2. Representation of events

3.2.3. Event details

This GUI is accessible by selecting an event from the General Table of Events. It allows the visualization of several layers of information through multiple visualization types, from the perspective of the selected event:

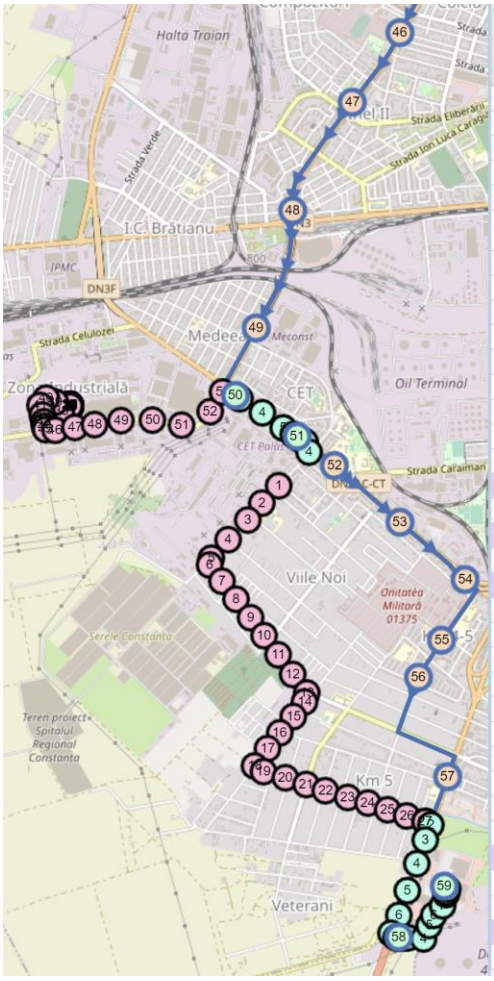
- a list of overlapping events;
- a map layer for the overlapping events;
- an additional layer for displaying the individual data packets that were the basis for each event in the list.

This flexible interface allows the inspection of both granular and aggregated data, as shown in the screenshot below. In this featured scenario, the user was inspecting an individual trip which had an abnormal number of missed stations. On a closer inspection, it was revealed

that the detected trip event was not a true trip, but it was detected automatically by the algorithm because:

- the driver left the depot with an actual trip line selected on the device;
- the vehicle entered the selected line's route at some point and continued on that route, passing by a number of stations in the correct order (50, 51);
- the vehicle exited the route after a number of stations and continued off-route until it reached the route again (stations 58, 59).

This situation is an operational fault on the driver's part, because the current task must be confirmed manually on the vehicle's external display. Even if the vehicle is not performing a trip, it must display the current task correctly (maneuver from the depot to the start of the line). From a passenger's point of view, this situation could have created confusion, especially when waiting in a station and seeing a vehicle passing by without stopping, but with the trip line shown on the display matching its current location.



	No.	Station	Time from	Time to	Positions	Activity types
	43		04:46:00	04:46:28	2	BETWEEN_STATIONS
	44	Izvor	04:46:28	04:46:58	0	MISSED_STATION
	44		04:46:58	04:47:36	3	BETWEEN_STATIONS
	45	Baba Novac	04:47:36	04:48:06	0	MISSED_STATION
	45		04:48:06	04:48:31	1	BETWEEN_STATIONS
	46	Sc.Nr. 23 C-tin Brancoveanu	04:48:31	04:49:01	0	MISSED_STATION
	46		04:49:01	04:49:38	3	BETWEEN_STATIONS
	47	Eliberarii	04:49:38	04:50:08	0	MISSED_STATION
	47		04:50:08	04:51:03	3	BETWEEN_STATIONS
	48	I.C.Bratianu	04:51:03	04:51:33	0	MISSED_STATION
	48		04:51:33	04:52:28	4	BETWEEN_STATIONS
	49	Spiru Haret	04:52:28	04:52:58	0	MISSED_STATION
	49		04:52:58	04:53:33	3	BETWEEN_STATIONS
	50	Cumpenei	04:53:33	04:53:35	2	STATION
		Ruta: 13	04:53:33	04:54:56	12	ON_ROUTE
☑	50		04:53:35	04:54:18	6	BETWEEN_STATIONS
	51	Piata CET	04:54:18	04:54:20	2	STATION
☑	51		04:54:20	04:54:45	4	BETWEEN_STATIONS
	52	Caraiman	04:54:45	04:55:15	0	MISSED_STATION
☑		Ruta: 13	04:55:12	05:01:42	27	OFF_ROUTE
	52		04:55:15	04:56:02	3	BETWEEN_STATIONS
	53	Campinei	04:56:02	04:56:32	0	MISSED_STATION
	53		04:56:32	04:57:18	3	BETWEEN_STATIONS
	54	Muzeul Militar National	04:57:18	04:57:48	0	MISSED_STATION
	54		04:57:48	04:58:29	3	BETWEEN_STATIONS
	55	Scoala Nr.37	04:58:29	04:58:59	0	MISSED_STATION
	55		04:58:59	04:59:22	1	BETWEEN_STATIONS
	56	Liliaciului	04:59:22	04:59:52	0	MISSED_STATION
	56		04:59:52	05:01:10	5	BETWEEN_STATIONS
	57	Mugurului	05:01:10	05:01:40	0	MISSED_STATION
☑	57		05:01:40	05:03:23	8	BETWEEN_STATIONS
		Ruta: 13	05:01:57	23:02:30	5691	ON_ROUTE
	58	Facultativa	05:03:23	05:03:25	2	STATION
☑	58		05:03:25	05:04:58	10	BETWEEN_STATIONS
	59	Auchan (C.L.)	05:04:58	05:14:46	42	STATION

Fig. 3. Detailed view of an event

3.2.4. Trip timeline

In Figure 4, several runs by different vehicles on the same line and direction are shown simultaneously. The horizontal axis illustrates the temporal dimension (the start and end times of the constituent events of the journey – stops at stations and movements between stations). The vertical axis illustrates the spatial dimension (distance traveled within the trip).

- a steeper slope of the chart lines means a faster travel speed. Station stops are marked by horizontal lines (there is no variation on the spatial axis, only on the time axis). Illustrating the spatial dimension based on the travel distances facilitates:
    a) visualization of distance differences between stations;
    b) correct display of speeds (slopes of lines);
- at the level of each station, it is possible to view the sequence of vehicles:
    a) the horizontal line indicates the presence of a vehicle in the station;
    b) the absence of the horizontal line indicates the absence of a vehicle in the station (on the selected route).

By simultaneously illustrating several runs on the same line and direction, it is possible to visualize:

- the differences between the travel speeds for the route sections;
- the differences between the times spent in the stations;
- the approaching or distancing of some vehicles on the temporal scale: in Figure 4, the emphasis is on the approaching around km 5 of the route for the two trips that started around 14:50. In certain cases, it is even possible for a vehicle to overtake another vehicle that started its trip before it.

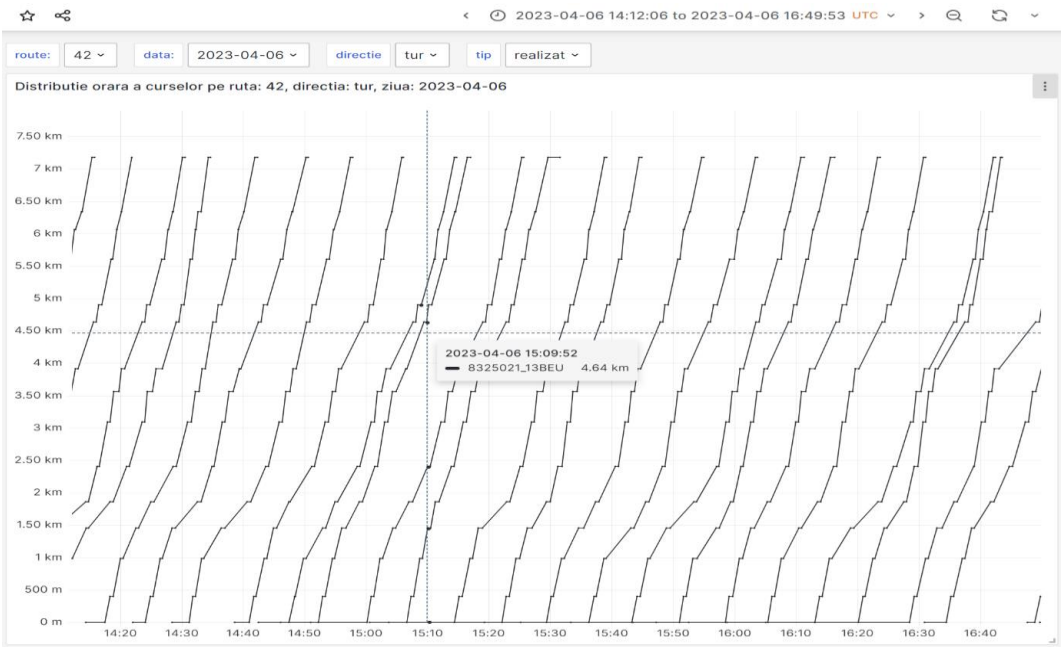


Fig.4. The trips timeline

3.2.5. Line statistics heatmap

This GUI allows for a condensed visualization of statistics for a selected line. The data is grouped on the columns by time intervals (hourly in the displayed case) and on rows by the constituent stations of the route. The user can select several statistics from the rightmost dropdown (time between stations as absolute real value, planned value, real value as percentage of the planned value etc.). In Figure 5, the accumulated delays relative to the planned times are shown in minutes. The color palette illustrates advances relative to the plan by warm colors, values within an acceptable margin of error in green (+/- 1 minute) and delays from the plan by cold colors. In the scenario depicted below, one can notice rushed starts of the trips for almost all hourly intervals, and also rushed reachings of the stations in the second half of the route for the intervals 6-7 and 19-21. Surprisingly, the final stations of the route are reached at the planned time, which might indicate anomalous driver behavior. The mid-section of the chart shows a generalized delay corresponding to the first half of the route, across several time intervals centered on the afternoon. This can be explained by the lack of correlation between the trip plan and the real traffic conditions in the affected time intervals and city areas. This type of visualization allows the transit operator to assess the level of plan suitability and the underlying data can be used in the planning calibration.

BD CT | Ruta 100C-RETUR (id: 56) | Ora de inceput 6 | Ora de sfarsit 21 | Tip Deviatie medie

Deviatie medie per statie (in min)

Statie\ Ora de start cursa	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Cap Linie Gara	3.78	2.15	0.86	1.46	1.82	2.03	0.51	1.26	1.21	1.34	1.55	1.01	0.96	1.59	3.11	3.97
Policlinica 2	-0....	-0.32	-0.57	-0.71	-0.68	-1.00	-0.88	-0.66	-1.06	-0.65	-0.99	-0.90	-0.82	-0.74	-0.45	-0.55
Bucuresti	0.03	-0.17	-0....	-0.31	-0.38	-1.00	-1.10	-0.80	-1.08	-0.61	-0.79	-1.04	-0.57	-0....	0.16	-0.37
Casa de Cultura	0.43	-0.74	-1.63	-1.40	-1.89	-3.00	-3.53	-3.16	-2.80	-2.11	-2.80	-3.11	-1.61	-0.41	0.56	0.34
Colegiul de Arta	0.44	-0.72	-1.64	-1.41	-1.91	-3.07	-3.60	-3.38	-2.88	-2.14	-2.85	-3.07	-1.65	-0.39	0.60	0.41
Portitei	0.37	-0.75	-1.83	-1.71	-2.22	-3.39	-4.07	-3.90	-3.22	-2.46	-3.34	-3.59	-1.76	-0.63	0.72	0.13
Farului	0.41	-0.77	-1.86	-1.69	-2.25	-3....	-4.10	-3.95	-3.29	-2.46	-3.38	-3.68	-1.74	-0.67	0.60	0.24
Dacia	0.41	-0.93	-2.02	-1.77	-2.34	-3.65	-4.28	-4.10	-3....	-2.70	-3.60	-3.80	-1.83	-0.79	0.56	0.17
Padre Pio	1.61	0.28	-0.83	-0.56	-1.22	-2.56	-3.16	-2.99	-2.41	-1.62	-2.75	-2.64	-0.63	0.30	1.59	1.34
Sc. nr. 7 Remus Opreanu	1.56	0.03	-1.14	-0.88	-1.57	-3.00	-3.69	-3.42	-3.07	-2.34	-3.83	-3.77	-1.20	0.06	1.54	1.29
Suceava	3.10	1.45	0.27	0.47	-0.28	-1.73	-2.39	-2.09	-1.41	-0.96	-2.40	-2.31	0.04	1.27	2.78	2.49
Dispensarului	3.08	1.55	0.38	0.61	-0.02	-1.52	-2.09	-1.71	-1.01	-0.77	-2.14	-1.97	0.07	1.50	2.90	2.55
Sat Vacanta	2.61	1.08	0.13	0.19	-0.34	-1.65	-2.43	-2.09	-1.72	-1.18	-2.36	-2.12	-0.30	1.07	2.47	2.11
Cap Linie Campus	3.27	1.75	0.92	0.85	0.16	-0.97	-1.43	-1.27	-0.87	-0.62	-1.07	-0.88	0.37	1.67	3.04	2.76
Smaraldului	3.29	1.83	1.17	0.96	0.31	-0.45	-1.16	-0.97	-0.55	-0.27	-0.68	-0.34	0.41	1.68	2.99	2.68
Hortensiei	2.78	1.83	1.06	0.98	0.07	-0.33	-0.93	-0.80	-0.39	0.02	-0.37	-0.15	0.38	1.40	2.71	2.43
Sere	3.57	2.43	1.92	1.84	1.10	0.49	-0.10	0.29	0.69	0.80	0.63	0.59	1.38	2.21	3.41	3.09
Selgros	3.99	3.14	3.11	2.70	2.24	1.74	1.26	1.37	1.97	1.93	1.64	2.01	2.24	3.14	3.88	3.79
Cap Linie TOM	0.29	0.03	-0.01	-0.06	0.02	0.18	0.07	0.24	0.19	-0.03	-0.15	-0.03	-0.08	0.01	-0.03	0.03

Fig. 5. Visualization of statistics for a selected bus line

3.2.6. Passenger volumes analysis

This GUI offers both an overview and a detailed analysis of passenger counts. On the left side, the map highlights the relative passenger volumes for all the stations on the network: the stations are colored according to the counter value quartiles, with the green stations having within 25% of the maximum passenger volumes. The map uses clustering in order to properly represent stations that are too close to each other. On the right side, there are two synchronized timelines, which display data for a single station selected from the map. The top timeline illustrates the deviations from the planned stop times, and the bottom one shows the passenger counter values for each individual stop within the station. This synchronized view allows the user to assess the influence that the deviation from the plan has over the passenger volumes. The passenger volume statistics can be used to reevaluate the transport planning on a citywide scale.

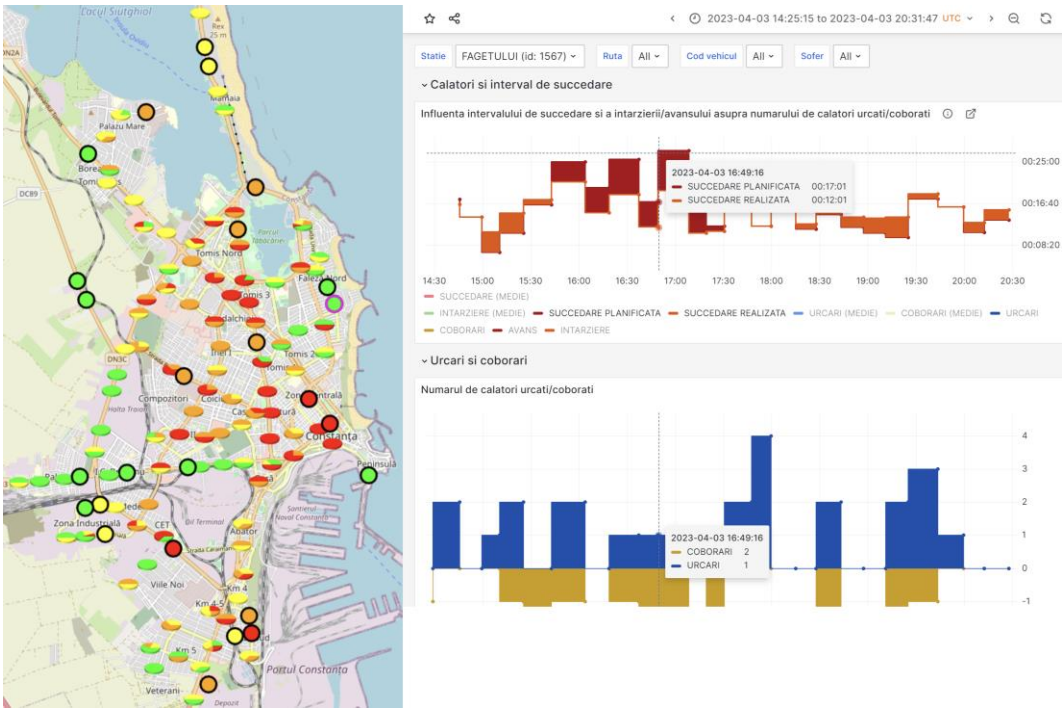


Fig. 6. Passenger volumes analysis

4. Conclusions

The improvement of public transport is a continuous concern of the public administrations of modern cities. Public transport systems can lead to traffic relief, reduced costs and environmental protection. This has enabled the development of intelligent transport systems (ITS) for public transit. Despite all the progress made, most public transport systems are missing the opportunities of using analytics on the operational monitoring data in a feedback loop for the improvement of transportation plan. Our proposed event-based approach offers a solid, standardized foundation for the development of data analytics that can aid in improving the performance of transportation systems based on real-world feedback. The proposed model helps public transit operators in monitoring the system's performance, identifying and analyzing anomalies at multiple levels of detail, by leveraging

the benefits of data aggregation and suggestive graphical visualizations. The event-based model also serves as a basis for the continuous generation of statistics which can facilitate the improvement of the public transit planning.

Acknowledgements
This research was supported by the project AUDITORIUM, POC 221, code 143690.

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IoT systems for efficient preservation of cultural heritage

Andrei DĂNILĂ,
Beia Consult International, Bucharest, Romania
andrei.danila@beia.ro

Robert-Alexandru STRECHE,
Beia Consult International, Bucharest, Romania
robert.streche@beia.ro

Filip-Emanuel OSIAC,
Beia Consult International, Bucharest, Romania
filip.osiac@beia.ro

Andrei-Mihai STEREA,
Beia Consult International, Bucharest, Romania
mihai.sterea@beia.ro

Cristina DOBRE ,
Beia Consult International, Bucharest, Romania
cristina.balaceanu@beia.ro

George SUCIU,
Beia Consult International, Bucharest, Romania
george@beia.ro

Abstract

The protection of cultural heritage remains a particular priority, as works of art are subject to inevitable degradation over time. This deterioration is influenced by the composition of the material, external environmental factors and human intervention. This study introduces an innovative Internet of Things (IoT) system designed to monitor and mitigate the complex causes of artefact degradation, while simultaneously ensuring a conducive museum environment for visitors. The proposed cloud-based solution offers a diverse range of functionalities tailored to the different materials found in museums, such as paintings, metals and textiles. By integrating cloud-based sensors, the system provides real-time data, facilitating rapid responses to variations from optimal conditions. By monitoring key factors such as temperature, humidity, vibration, air pollutants (CO2, NO2, SO2, O3) and volatile organic compounds, this approach facilitates a comprehensive understanding of the main causes of degradation of art objects. This work builds on the MUSEION project, which aims to develop an integrated IoT-based platform for sustainable management of environmental control and climate change adaptation of museum exhibits. The results obtained in this research highlight both the scalability, reliability and efficiency of the prototype system in reducing events related to chemical and physical processes contributing to artefact degradation, as well as the real-time assessment of Indoor Air Quality (IAQ) indices. By proposing an innovative Internet of Things (IoT) based solution for detailed monitoring of cultural heritage, the study makes a significant contribution to the field. The importance of the research is underlined by the thorough investigation and the results obtained, highlighting its potential to improve conservation practices in museum environments, thus providing a comprehensive approach to sustainable museum management and cultural heritage conservation.

Keywords: IoT, Cloud, real-time monitoring, indoor air quality, cultural heritage conservation

1. Introduction

In the realm of art conservation, considering technological advancements in Internet of Things (IoT) and Cloud Computing, a new perspective emerges regarding wireless microclimate monitoring in museums. Wireless sensor networks, specifically developed to monitor air quality and the materials of which museum exhibits are made, demonstrate their efficiency in assessing conservation conditions.

Continuous and real-time monitoring of factors affecting the state of artworks becomes essential for their long-term preservation and for transmitting the cultural heritage value to future generations. In the current technological context, remote monitoring focuses on the Internet of Things (IoT) concept. The implementation of this approach involves installing sensor nodes and gateways for data transfer to the Cloud, facilitating online monitoring and continuous surveillance of artworks. Easy access from the Cloud to data recorded by electronic sensors contributes to enhancing security and implementing preventive measures.

Internet of Things (IoT) involves objects' ability to intelligently communicate with their environment to provide real services via the internet. Remote monitoring and management of the environment become possible through IoT sensors, considering the improvement of cultural heritage conservation. In this context, the importance of Indoor Air Quality (IAQ) indices becomes evident. These indices play a crucial role in evaluating the museum environment and promptly alerting responsible personnel if conservation conditions are unfavorable for certain materials, thus preventing the accelerated degradation of artworks. Careful interpretation and analysis of these data are essential to ensure an optimal conservation environment for historical objects. The architecture presented in the article, with its prototype communicating with a web platform, illustrates how this data can be visualized and interpreted in the form of graphs, tables, or charts. The IoT system, with monitoring stations both inside and outside the museum, highlights low energy consumption, contributing to the efficiency and sustainability of the proposed solution.

The article is structured as follows: Section II provides the current state of knowledge in the field of artifact conservation and presents several alternative solutions to enhance artifact preservation. Additionally, Section III, titled “IoT System for Artefact Preservation and IAQ Analysis,” introduces the system used in this article, aiming to enhance the conservation of objects in memorial homes/museums by utilizing data from monitoring stations and calculating Indoor Air Quality (IAQ) indices. Section IV will encompass all the results obtained in this study, followed by the concluding section summarizing the entire article.

2. Related Work

In the contemporary context, various industries and sectors worldwide are confronted with the impacts of climate change and air pollution. Museums and heritage buildings, in particular, face significant challenges, with numerous artifacts at risk of damage or even destruction as a consequence of these environmental and climate alterations.

The preservation condition of artworks displayed in museums is significantly impacted by the quality of indoor air. While temperature and relative humidity are commonly monitored parameters, they are not the sole factors requiring control. Aerosol particulate matter (PM), including its concentration, size distribution, and chemical composition, is a crucial parameter that can adversely influence indoor air quality [1].

The preservation of exhibits in museums is significantly influenced by the air quality within, as airborne substances can lead to the deterioration of artifacts, irrespective of whether they are showcased in display cases. Chiantore et al. [2] elaborate on the significance and repercussions of materials employed in constructing museum display cases, which can be potential sources of harmful substances affecting the integrity of cultural heritage items. Acetic acid, for instance, is known to induce corrosion in bronze antiquities, lead artifacts, and copper alloys stored in wooden cabinets.

The article [3] also examines air quality as a source of pollutants affecting art objects. According to the study findings, particles like calcite and clays, as well as substances such as relative humidity (RH) and O3 resulting from restoration activities around historical museums, contribute to the gradual degradation of museum artifacts. Carbon dioxide serves as an indicator of human presence in a room but has a limited impact on material degradation. Nitrogen dioxide, emitted primarily from industrial facilities, accelerates the deterioration of art objects through oxidation processes. Ozone, classified as a secondary pollutant, degrades materials through oxidation mechanisms.

This paper [4] examines the air quality (temperature, humidity, light, and fungal contamination) within the Museum House in Salacea, Bihor county. It assesses the impact of these factors on the textile materials displayed inside, emphasizing the importance of safeguarding heritage elements and reducing risks to human health for inhabitants, tourists, museographers, and other individuals accessing the interior. The monitoring of temperature and humidity took place from June 3, 2018 to July 2, 2018, utilizing the KlimaLogg Pro thermo-hygrometer with data function logger (seven sensors). Other parameters, such as light intensity, were measured using the Extech SDL400 Luxmeter data logger, and oxygen levels were assessed with the Extech SDL150 Oxygen meter. Fungal contamination was determined through the Koch sedimentation method. Given that low temperatures coupled with high humidity can foster microorganism and mold formation, while high temperatures may dehydrate fibers, diminishing their strength and elasticity, it is imperative to maintain the standard microclimate of temperature and humidity within the museum house.

3. IoT System for Artefact Preservation and IAQ Analysis

The preservation of art objects is intricately tied to environmental parameters. The degradation rate is typically determined by factors such as temperature, relative humidity, radiation, and pollution. These factors act as agents of deterioration, influencing the overall condition of cultural heritage items.

3.1. Relevant Parameters

In the conservation of art objects, it is crucial to include relevant parameters for the preservation of cultural artefacts within acceptable limits, and risk assessment is carried

out by comparing measured indicators with target values from literature, guidelines and standards. In this context, continuous monitoring of air quality and deterioration factors is imperative for the preservation of art objects, and the proposed Internet of Things (IoT) system focuses on detecting pollutant levels in museums to proactively address possible risks.

To ensure comprehensive monitoring, two distinct stations were employed—one dedicated to assessing indoor air quality within the museum and another focused on monitoring the external air quality. The parameters measured by these stations are outlined in Table 1, which includes the units of measurement, acronyms, and names of the monitored parameters.

To ensure comprehensive monitoring, two distinct stations were employed—one dedicated to assessing indoor air quality within the museum and another focused on monitoring the external air quality. The parameters measured by these stations are outlined in Table 1, which includes the units of measurement, acronyms, and names of the monitored parameters.

Table 1. Indoor and outdoor air quality station parameters.

Indoor		
Name	Acronym	Unit of measure
Battery level	BAT	mV
Air temperature	TC	Celsius
Atmospheric pressure	PRES	Pa
Air humidity	HUM	Procente
Brightness	LUX	lux
Ammonia	NH3	ppm
Ozone	O3	ppm
Hydrogen sulphide	H2S	ppm
Particulate matter (PM1/PM2.5/PM10)	PM1, PM2_5, PM10	µg/m3
Outdoor		
Name	Acronym	Unit of measure
Battery level	BAT	mV
Air temperature	TC	Celsius
Atmospheric pressure	PRES	Pa

Air humidity	HUM	Procente
Brightness	LUX	lux
Sulphur dioxide	SO2	ppm
Carbon dioxide	CO2	ppm
Nitrogen dioxide	NO2	ppm
Particulate matter (PM1/PM2.5/PM10)	PM1, PM2_5, PM10	µg/m3

Source: Table realized within the MUSEION project

The use of two stations provides a complete understanding of air quality dynamics, both in the controlled environment of the museum and the outdoor environment. This two-station approach ensures that conservation efforts consider not only internal conditions, but also potential external influences on artifact degradation.

3.2. Architecture of the Proposed System

The proposed IoT system leverages a robust cloud-based architecture, offering an array of functionalities at an affordable price. The modularity of the prototype allows for swift configuration adjustments, ensuring adaptability to the specific needs of different customers.

The cloud infrastructure is the backbone of the system, facilitating scalability and accessibility. Cloud solutions enable the storage, processing, and analysis of vast amounts of data generated by the monitoring stations in real-time. This approach ensures that the system remains agile, adapting to the evolving requirements of artefact preservation.

The Museion project has produced a block diagram illustrating the innovative features of the proposed IoT system. This schematic, as shown in Figure 1, highlights the integration of sensors in the cloud, allowing the system to provide real-time information in case of deviations from the nominal values.

The integration of sensors in the cloud is an exceptional aspect of the system design. This integration ensures that data is not only collected, but also processed and analysed in real-time within the cloud infrastructure. This feature enhances the responsiveness of the system to changing environmental conditions, contributing to a proactive approach to artefact preservation.

The innovative nature of the proposed system lies in its ability to transmit real-time data to the cloud. This capability is essential for timely decision making and intervention in response to changing environmental parameters. The transmission protocol, MQTT (Message Queuing Telemetry Transport), ensures efficient and reliable data communication between monitoring stations and the central cloud infrastructure.

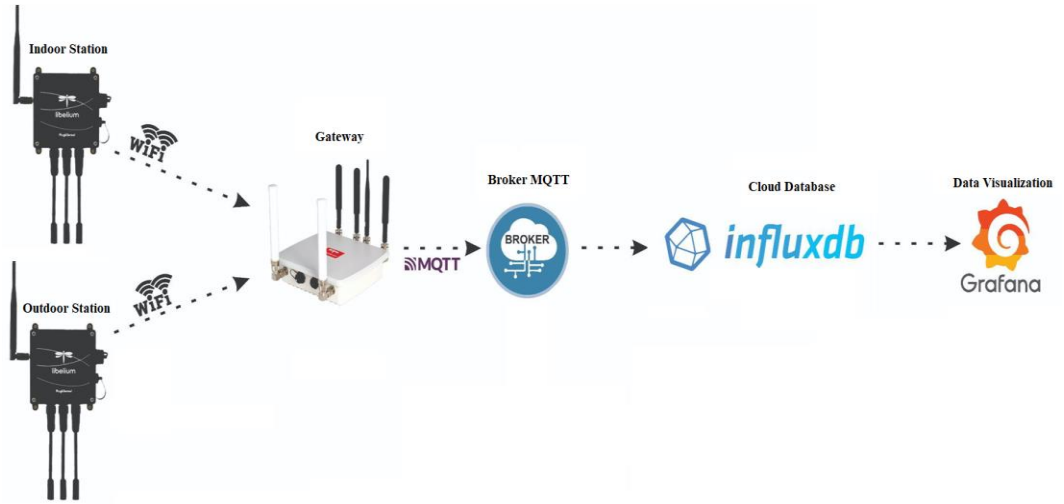

Fig. 1. System architecture
Source: Architecture realized within the MUSEION project

The data collected from the monitoring stations are stored in a dedicated database, namely InfluxDB. This database is designed to retain historical data, allowing for long-term analysis of environmental parameters. The visualization of parameter analysis is achieved through the Grafana platform, offering a user-friendly interface that presents data in the form of graphs, tables, and charts. Thresholds for each parameter can be set within Grafana, enabling the system to generate immediate alerts in case of unfavorable events.

A significant advantage of the proposed system is its scalability and reliability. The modular design allows for easy customization according to the specific needs of different museums. The system's reliability is underscored by the utilization of established communication protocols, ensuring consistent performance in various operational scenarios.

3.3. Definition of the IAQ Index

IAQ (Indoor Air Quality), also known as indoor air quality, refers to the condition and composition of the air in an indoor space such as a building, home or office. IAQ is important for the health and comfort of people who spend a lot of time in these spaces. The IAQ index is a measure that indicates the indoor air quality of a space, and its value can directly influence the health and well-being of the inhabitants or users of that space.

The rate at which materials deteriorate is influenced by a limited set of factors, divided into four distinct categories corresponding to the following agents of degradation: inadequate temperature, inadequate relative humidity, radiation and pollutants. These factors dominate the deterioration process of all materials and can be seen as indicators of the state of preservation of a collection. An overview of conservation conditions can be obtained by identifying the risks associated with these indicators. These indicators can therefore be used to introduce the concept of Key Risk Indicators (KRIs), which are independent parameters that estimate whether certain conservation conditions are likely to damage the collection.

Among the 12 most important critical risk indicators are: relative humidity (RH) too high, RH too low, significant RH fluctuations, temperature (T) too high, T too low, significant T fluctuations, excessive lighting, exposure to ultraviolet light too intense, high concentration of oxidising gases (such as O3, NOx, SO2), high concentrations of organic gases (such as acetic acid, formic acid, formaldehyde), high concentrations of sulphur compounds (such as H2S, carbonyl sulphide (OCS)), and too high concentrations of dust (PM2. 5, PM10, dust particles).

The level of risk can be assessed by comparing measurements of an indicator with the accepted values or range of accepted values for each type of material as specified in literature, guidelines and standards.

Table 2 shows the accepted values or ranges of values for temperature, relative humidity and illumination applicable to the most common materials found in libraries and archives, while Table 3 contains the maximum allowable concentrations for certain pollutant gases.

Table 2. Permissible values/ ranges of temperature, relative humidity and illuminance for the most common materials in libraries and archives.

Materials	Accepted temperature	Accepted relative humidity	Accepted light level
Wood	16-18 °C	50-60%	<50 lux
Leather	16-22 °C	40-55%	50 sau 150 lux
Textile	16-20 °C	40-55%	50 sau 150 lux
Paper	16-22 °C	35-55%	50 sau 150 lux
Photos	2 °C – color photos 18 °C – other types	30-50%	<50 lux
Cellulose nitrate	10 °C	<50%	50 lux

Source: Table realized within the MUSEION project

Table 3. Maximum permissible concentrations for some pollutant gases

Polluting Gas	Permitted Concentration (μg/m³)
Ozon	25
Dust particles	75
Nitrogen oxides	5
Carbon dioxide	45
Sulphur dioxide	1

Source: Table realized within the MUSEION project

4. Results

The monitoring solution, which includes the implementation of the IAQ algorithm within the system, consists of a network of sensors and monitoring stations that collect data about the environment inside the museum, such as temperature, humidity, lighting levels and concentration of pollutant gases.

The system has been tested in the “Ion Minulescu” Memorial House over a significant period of time, allowing the collection of an extensive amount of data to ensure a more accurate calculation of air quality indices. In the initial phase, a visualisation of all the parameters monitored in the museum was carried out and a high-level evaluation was performed to identify and correct possible errors. Subsequently, the data were presented in the visualisation platform in graphical form.

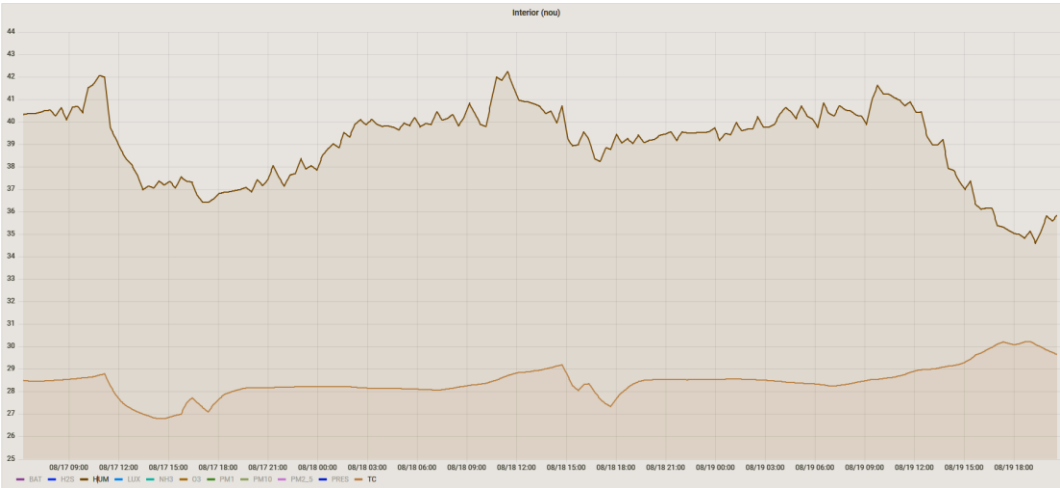

Fig. 2. Indoor temperature and humidity variation
Source: Grafana own platform

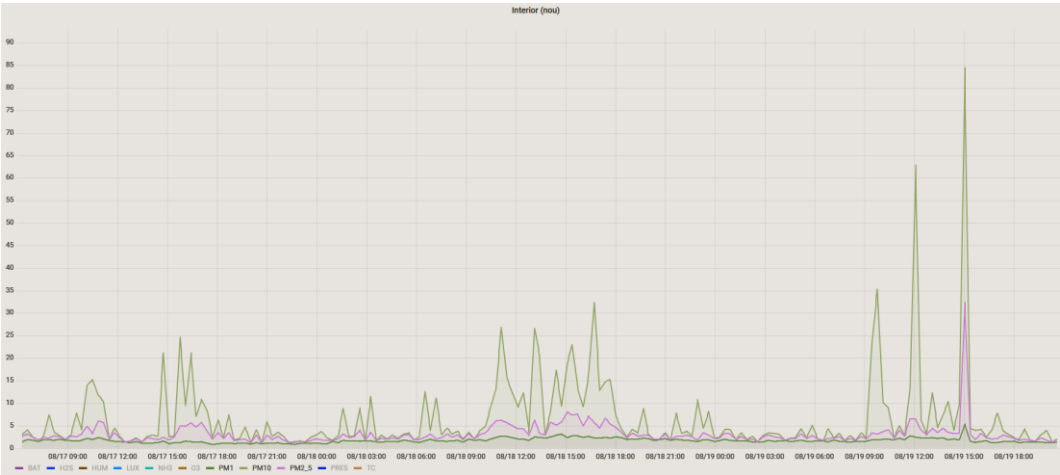

Fig. 3. Variation of PM1, PM2.5 and PM10 indoors
Source: Grafana own platform

IAQ implementation involves a number of essential components, including sensors for measuring temperature and relative humidity, monitoring stations for data collection, an MQTT broker for efficient transmission of information to the Museion platform, the Node-RED platform for data processing and calculation of IAQ scores. The IAQ algorithm defines specific ranges of values for temperature and humidity, and IAQ scores are assigned to these ranges according to air quality and health risk guidelines. Details of these ranges are given in the tables below.

Table 4. IAQ scores according to temperature range

Temperature (0C)	Critical risk indicator/numerical shortfall			
	Ls	Ms	Hs	VHs
< 0	1	1	1	1
0 – 18	0.05	0.25	0.5	0.75
18 – 24	0.05	0.05	0.05	0.05
24 – 30	0.05	0.05	0.25	0.25
30 – 40	0.05	0.5	0.5	0.75
> 40	0.25	0.75	1	1

Source: Table realized within the MUSEION project

Table 5. IAQ scores according to relative humidity range

Relative humidity (%)	Critical risk indicator/numerical shortfall			
	Ls	Ms	Hs	VHs
0 – 10	1	1	1	1
10 – 30	0.5	0.75	0.75	1
30 – 50	0.05	0.25	0.75	0.75
50 – 65	0.05	0.05	0.05	0.05
65 – 80	0.75	1	1	1
> 80	1	1	1	1

Source: Table realized within the MUSEION project

The IAQ algorithm assigns specific scores to the risk categories Ls, Ms, Hs and VHs (low, medium, high and very high) for each relevant range. The implementation of the algorithm was carried out using the Node-RED platform, chosen for its ability to efficiently manipulate data and create processing workflows. The algorithm itself consists of a function that analyzes the data from the monitoring stations and fits them appropriately into pre-defined ranges. The data is transmitted to the Node-RED platform via the MQTT protocol, and the results of the algorithm are also sent to the visualization platform using the same protocol. The information received from the monitoring stations, including temperature and humidity, is processed by the IAQ function in Node-RED. The algorithm compares these values with the defined ranges to determine risk categories and assign appropriate scores for Ls, Ms, Hs and VHs. The flow used by the IAQ algorithm is illustrated in the figure below.

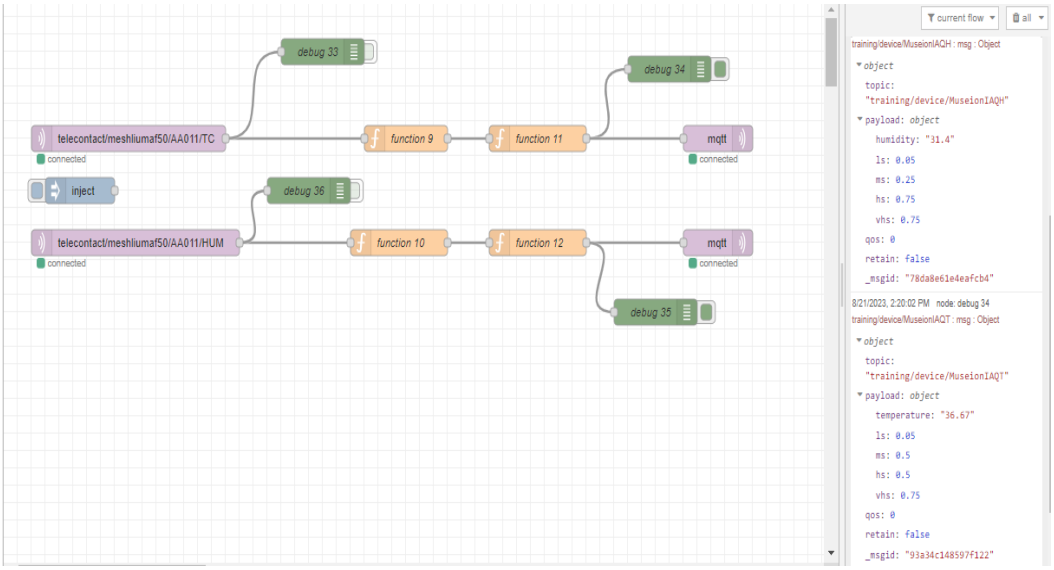

Fig. 4. Implementing IAQ modules in Node-RED
Source: Beia Node-RED flow

IAQ information is presented as graphs and tables in the solution management interface, making it easy to quickly identify potential air quality problem areas and take appropriate action. This presentation allows managers to access the information in an intuitive way and interpret it both in graphical form for visual understanding and in tabular form for specific details. The data in tabular format are illustrated in the figures below.

Time	Umiditate	Ls	Ms	Hs	VHs
2023-08-21 05:00:00	27.44	0.05	0.05	0.25	0.05
2023-08-21 04:00:00	30.11	0.05	0.05	0.31	0.05
2023-08-21 03:00:00	30.55	0.05	0.05	0.50	0.05
2023-08-21 02:00:00	31.50	0.05	0.05	0.50	0.05
2023-08-21 01:00:00	34.08	0.05	0.25	0.50	0.75
2023-08-21 00:00:00	34.91	0.05	0.25	0.50	0.75
2023-08-20 23:00:00	35.51	0.05	0.25	0.50	0.75
2023-08-20 22:00:00	35.64	0.05	0.25	0.50	0.75
2023-08-20 21:00:00	35.48	0.05	0.25	0.50	0.75
2023-08-20 20:00:00	35.36	0.05	0.25	0.50	0.75
2023-08-20 19:00:00	35.03	0.05	0.25	0.50	0.75
2023-08-20 18:00:00	34.57	0.05	0.25	0.50	0.75
2023-08-20 17:00:00	33.97	0.05	0.25	0.50	0.75
2023-08-20 16:00:00	35.49	0.05	0.25	0.50	0.75
2023-08-20 15:00:00	33.03	0.05	0.25	0.50	0.75
2023-08-20 14:00:00	26.25	0.05	0.25	0.25	0.75
2023-08-20 13:00:00	23.19	0.05	0.25	0.12	0.75

1 2 3 4 5 6 7 8

Fig. 5. Visualization of the IAQ scores in the platform according to relative humidity
Source: Grafana own platform

Temperatura IAQ

Time	Temperatura	Ls	Ms	Hs	VHs
2023-08-21 05:00:00	24.76	0.05	0.05	0.25	0.25
2023-08-21 04:00:00	25.19	0.05	0.05	0.25	0.25
2023-08-21 03:00:00	25.34	0.05	0.05	0.25	0.25
2023-08-21 02:00:00	26.21	0.05	0.05	0.25	0.25
2023-08-21 01:00:00	27.03	0.05	0.05	0.25	0.25
2023-08-21 00:00:00	27.71	0.05	0.05	0.25	0.25
2023-08-20 23:00:00	27.44	0.05	0.05	0.25	0.25
2023-08-20 22:00:00	30.11	0.05	0.16	0.31	0.38
2023-08-20 21:00:00	30.55	0.05	0.50	0.50	0.75
2023-08-20 20:00:00	31.50	0.05	0.50	0.50	0.75
2023-08-20 19:00:00	34.08	0.05	0.50	0.50	0.75
2023-08-20 18:00:00	34.91	0.05	0.50	0.50	0.75
2023-08-20 17:00:00	35.51	0.05	0.50	0.50	0.75
2023-08-20 16:00:00	35.64	0.05	0.50	0.50	0.75
2023-08-20 15:00:00	35.48	0.05	0.50	0.50	0.75
2023-08-20 14:00:00	35.36	0.05	0.50	0.50	0.75
2023-08-20 13:00:00	35.03	0.05	0.50	0.50	0.75

1 2 3 4 5 6 7 8

Fig. 6. Visualization of the IAQ scores in the platform according to temperature
Source: Grafana own platform

The implementation of the IAQ algorithm in the project has had a significant and beneficial impact on the quality of the indoor environment. This initiative has enabled the project to substantially improve air quality management, react promptly to potential problems and create a more pleasant and healthy environment for both visitors and museum staff.

5. Conclusions

The proposed IoT system for artefact conservation in museum environments promises efficiency and relevance from the first experiments. Data collected from monitoring stations located both inside and outside the “Ion Minulescu Museum” indicate controlled storage conditions and low levels of pollution. Our research not only stops at identifying critical environmental factors for the various materials in the collections, but also at implementing a real-time monitoring system. This system allows rapid adaptation to environmental changes, and the IAQ algorithm developed contributes to the assessment of indoor air quality specific to cultural heritage conservation needs. However, extending the system for benchmarking across different museum locations remains a challenge. Continued research will be essential to optimise and effectively integrate the system in various museum contexts.

In conclusion, this research represents a significant step towards cultural heritage preservation through IoT technology. Our system not only streamlines the management of environmental conditions, but also opens new perspectives for an innovative approach to artefact conservation and sustainable museum management.

Acknowledgements

This project and work was supported by a grant of the Romanian Ministry of Research and Innovation, CCCDI – UEFISCDI, project number: 256 /2021, project code: PN-III-P3-3.5-EUK-2019-0211.

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Educational needs in green education: a survey-based exploration among Romanian students

Miruna-Elena ILIESCU,
National University of Political Studies and Public Administration, Bucharest, Romania
miruna.iliescu@comunicare.ro

Abstract
This paper aim aligns with recommendations from recent research, exploring greenwashing education among Romanian socio-economic students. The study aims to contribute insights into the specific educational needs within the social fields concerning greenwashing and discern the potential implications for consumer behavior in this context. The current study builds upon preceding research conducted by the author, where professionals in ecological fields underscored the prevalence of deceptive practices, leading to the misleading of urban consumers. The limited comprehension of green claims and regulatory nuances among urban inhabitants emerged as a salient contributing factor. Employing a survey-based methodology, the research captures practical insights from students in socio-economic fields. The 16-question questionnaire explores participants' perceptions and knowledge on green claims.Preliminary findings indicate varying levels of awareness and experiences with greenwashing among Romanian students. The survey data provides insights into factors influencing the recognition of deceptive environmental claims, their impact on consumer choices, and perceived corporate responsibility.The study's implications extend to academics, researchers, and practitioners interested in sustainable communication and consumer behavior. For smart city development, addressing students' greenwashing awareness gaps is crucial. Integrating sustainability into urban education can empower citizens for informed choices. At the community level, combating greenwashing requires targeted programs fostering environmental literacy. Hence, in academia, identified gaps highlight the need for integrated greenwashing modules, preparing future professionals for sustainability challenges. This research offers a nuanced perspective on greenwashing by centering on Romanian students' perceptions. Its value lies in informing interventions, policies, and education efforts to combat greenwashing, fostering an informed and sustainable consumer base. The insights contribute uniquely to the Romanian context, enriching the global discourse on sustainable practices and consumer awareness.

Keywords: sustainable communication, greenwashing awareness, green claims.

1. Introduction
As global concerns about environmental sustainability intensify, the need for comprehensive education on greenwashing becomes increasingly apparent. This paper delves into this imperative by aligning with recent research recommendations and focusing on the greenwashing education landscape among Romanian socio-economic students. With a broader objective of contributing insights into specific educational needs within social fields and discerning potential implications for consumer behavior, this study addresses a critical aspect of sustainable development.

Building on previous research conducted by the author, which highlighted deceptive practices influencing urban consumers, this study takes a focused approach. The prevalence of greenwashing underscored the limited comprehension of green claims and regulatory nuances among urban inhabitants, establishing a foundation for this investigation. Employing a survey-based methodology, the research captures practical insights from students in socio-economic fields, utilizing a 16-question questionnaire to explore their perceptions and knowledge regarding green claims. Preliminary findings from the survey indicate varying levels of awareness and experiences with greenwashing among Romanian students. This research sheds light on factors influencing the recognition of deceptive

environmental claims, their impact on consumer choices, and perceived corporate responsibility. The implications of the study extend to academia, researchers, and practitioners interested in sustainable communication and consumer behavior. For smart city development, addressing students' greenwashing awareness gaps is crucial, advocating for the integration of sustainability into urban education to empower citizens for informed choices.

At the community level, combating greenwashing necessitates targeted programs fostering environmental literacy. The value of this research lies in its nuanced perspective on greenwashing, centering on Romanian students' perceptions and enriching the global discourse on sustainable practices and consumer awareness. By informing interventions, policies, and education efforts, this study contributes to fostering an informed and sustainable consumer base in Romania and beyond.

2. Literature review

Greenwashing has become a critical issue in the context of sustainability and environmental claims, especially as consumer awareness and interest in nature and climate change have surged globally in the past years. With a heightened focus on environmental preservation and climate change mitigation, the term “sustainability” has evolved to encompass not only environmental concerns but also the broader influences on communities, cultures, and interpersonal connections. As individuals demand for sustainable and ethical products rises, the consumer goods market faces increased pressure to provide environmentally friendly outputs that align with consumer expectations. Academic research has explored the challenges in defining and verifying sustainability claims, emphasizing the need for businesses to adapt to meet these evolving consumer expectations.

Amidst the growing demand for sustainable and ethical products, the market for consumer goods is witnessing increased pressure to provide environmentally friendly outputs that minimize damage to the environment. The rise in online searches related to nature loss and biodiversity, along with the amplification of environmental concerns on social media, underscores the urgency for businesses to adapt and meet consumer expectations for sustainable practices. In this context, green or environmentally friendly products were defined as those causing less harm to the environment in terms of pollution and resource depletion or those that can be recycled or maintained [1]. In the absence of a globally acknowledged definition or methodology for determining sustainability, the term has been increasingly used by politicians and marketers as a catchphrase, potentially diluting its original meaning. As globalization continues to shape supply chains, the outsourcing of manufacturing to foreign suppliers by retailers has become commonplace. However, this trend has given rise to the unethical practice of supply chain greenwashing, wherein retailers selectively disclose information about their upstream suppliers, exaggerating the environmental benefits of ostensibly green products to consumers. In the quest for improved environmental standing and competitive advantage, many companies employ green marketing strategies to appeal to environmentally conscious consumers. However, this endeavor is not without risks, as green marketing claims may be perceived as 'greenwashing,' potentially leading to ethical harm and impacting a company's profitability. Building on existing greenwashing studies, two studies involving interviews with consumer product and

consulting firms were conducted [2], as well as an experiment with consumers interacting with a company website. Results revealed that perceived greenwashing not only influences environmental and product perceptions but also correlates with consumers' happiness during website interactions. The degree of website interactivity was also found to be linked to perceived greenwashing, environmental and product perceptions, and the extent of interaction with the website. This research sheds light on the multifaceted impact of green marketing, providing insights for both research and managerial practices. Additionally, the moderating role of greenwashing perceptions was explored in the relationship between environmental concern and the green purchasing behavior of post-millennials [3]. The findings suggested that greenwashing perceptions diminish the effects of environmental concern on green behavior, highlighting the crucial role of awareness in shaping the environmentally conscious consumption patterns of post-millennials.

The unethical practice of greenwashing poses a significant threat to the growth of sustainable products and markets, undermining essential efforts to address climate change, pollution, and social justice. Greenwashing involves false marketing communication that falsely labels products as sustainable, eroding the value of genuinely green products and impairing consumers' ability to discern between sustainable and non-sustainable options. This deceptive practice also erodes trust in products claiming to be environmentally friendly, impeding the necessary transformation toward sustainability. A different study sheds light on potential remedies, demonstrating that providing consumers with reliable, transparent, traceable, and tamperproof product information can counteract perceived greenwashing, particularly in the context of ecological foods [4]. Surprisingly, the research reveals that blockchain information proves more effective than certification systems in safeguarding consumers against the threat of greenwashing. The study emphasizes that information validating authenticity not only fosters the development of sustainable products but also protects intellectual property rights for suppliers and ensures a secure supply of green products to consumers. In challenging the conventional reliance on certifications, the findings advocate for the robust potential of blockchain technology to empower green consumers and enhance the credibility of sustainable development initiatives.

Another recent study employs machine-aided textual analysis on a comprehensive dataset of 725 corporate sustainability reports, aiming to empirically assess the extent to which climate discourse, or 'talk,' within these reports aligns with actual performance outcomes, or 'walk,' measured by changes in greenhouse gas emissions over a decade [5]. The investigation reveals nuanced findings regarding the 'talk-walk' relationship, contingent upon the nature of the discourse and the involved climate change actors. The study identifies a divergence in climate commitments, discerning between genuine intentions and instances of 'greenwashing,' where symbolic gestures overshadow substantive action. This discrepancy is attributed to a phenomenon of false signaling in climate transitioning, driven by misaligned incentives. A notable outcome of the research is the identification of operational improvements talk as a significant predictor of climate performance enhancement, providing a more optimistic perspective. Conversely, reactive strategies are found to correlate with poor climate performance. These results underscore the importance of considering diverse corporate climate strategies beyond emissions reduction, emphasizing the multifaceted nature of businesses' contributions to the climate transition.

It is crucial to evaluate environmental claims based on the product's major environmental consequences throughout its lifecycle and supply chain. When these claims are false or difficult to verify, the term “greenwashing” is applied, reflecting a deceptive marketing practice that can also be termed eco-washing, eco-bleaching, green makeup, or whitewash. The ongoing challenge remains in establishing standardized criteria and metrics to objectively assess and communicate the environmental impact of products and services, thereby curbing the prevalence of greenwashing in the marketplace.

To address the ambiguity surrounding environmental claims, European regulations and guidelines have sought to define terms like “green” or “environmentally friendly.” According to the European Commission definitions, greenwashing is described as the practice of suggesting or creating the impression, through commercial communication, marketing, or advertising, that a product has a positive or no impact on the environment or is less damaging than competing goods or services. Such claims may pertain to the product's composition, manufacturing process, disposal methods, or anticipated reductions in energy consumption or pollution during usage.

2.1. Greenwashing in business-to-consumer communication

Greenwashing in business-to-consumer communication has been a persistent issue, with origins dating back to the mid-1980s when oil firms like Chevron first engaged in deceptive green advertising practices by downplaying their environmental impact. Despite early violators, the trend of companies attempting to portray their products as environmentally friendly has intensified over the years, with many seeking to cultivate an eco-conscious corporate image.

In recent years, the Volkswagen emission crisis in 2015 emerged as a pivotal event, representing a significant case of greenwashing that impacted consumer engagement on Facebook brand pages across several European countries. Investigating the effects in France, Germany, Turkey, and the United Kingdom, the study conducted a six-year analysis of consumer interactions, including likes, comments, and shares on Volkswagen's Facebook brand page from January 2012 to December 2017. A study employing autoregressive–moving average models to discern the nuances of online consumer engagement revealed distinct country-specific attitudes toward greenwashing, with negative engagement observed in the United Kingdom and Turkey, positive engagement in Germany, and no change in France during the fourth quarter of 2015 [6].

When consumers perceive a business's environmental claims as misleading or insincere, greenwashing becomes evident. This phenomenon has prompted increased scrutiny and a growing awareness of the need for transparency in environmental communication practices.

Meanwhile, the pervasive issue of greenwashing in the context of increased consumption of green products was also addressed. Introducing a computational model incorporating fuzzy logic techniques, a study aimed to mitigate uncertainty in decision analysis processes related to consumer satisfaction with green products [7]. The fuzzy rule-based system facilitated the analysis of consumer behavior and perception of greenwashing, offering insights into the impact of deceptive practices on green product confidence in retail. This

approach contributes to understanding the attitudes of green consumers and provides a quantitative method for decision-making regarding variables influencing consumer behavior in the face of greenwashing [7].

In recent paper, authors delve into the impact of perceived greenwashing on customer satisfaction, focusing on cases where firms overcommit or fail to deliver on socially responsible actions [8]. The study, utilizing data from the American Customer Satisfaction Index (ACSI) for U.S. companies, reveals a negative link between perceived greenwashing related to green product innovation (GPI) and the ACSI index. The effect is attributed to corporate policies exceeding corresponding actions, not lower implementation levels. The study further demonstrates that a firm's capability reputation mitigates the negative effect of greenwashing on customer satisfaction. This research provides a distinct perspective by associating greenwashing with corporate hypocrisy and emphasizes the role of capability reputation in shaping customer perceptions, offering essential insights for corporate strategies in managing greenwashing concerns.

2.2. Greenwashing in the EU

In business-to-consumer communication, promotional practices involving green attributes encompass a wide range of elements, including statements, information, symbols, logos, graphics, and brand names. These elements, along with their interplay with colors, can be found on packaging, labeling, advertising, and across various media channels, including websites. The European Commission defines these practices broadly, emphasizing that any organization qualifying as a 'trader' and engaging in commercial practices toward consumers falls under the scope of scrutiny.

As the global landscape evolves and awareness of environmental issues grows, the challenge persists in developing more robust frameworks and regulations to effectively combat greenwashing. Achieving clarity in guidelines, both at the EU level and within individual Member States, remains crucial to fostering greater accountability and transparency in business-to-consumer communication, thereby curbing the prevalence of deceptive green practices in the marketplace. Recent studies and developments in this area emphasize the ongoing need for vigilance and regulatory measures to protect consumers from misleading green claims.

Addressing deceptive green claims in the European Union, the primary legislative instrument is the Directive 2005/29/EC, known as the Unfair Commercial Practices Directive. This directive targets unfair practices that impact the economic interests of consumers, explicitly addressing deceptive green claims. While some Member States have implemented national guidelines to complement EU-level regulations, there is still a notable need for greater clarity in this domain. Existing guidelines primarily focus on environmental claims but do not comprehensively regulate all aspects of greenwashing practices.

In Romania, a study published recently investigates greenwashing in business-to-consumer communication in Romania, aiming to understand its causes and distinct characteristics [9]. Interviews with senior practitioners in sustainability-related fields were conducted,

revealing the complexity of greenwashing driven by unclear terminology, inadequate regulation, and a lack of education. Two primary forms of greenwashing were identified: misleading product claims visible to customers and image-oriented claims, often associated with corporate social responsibility efforts. Challenges include difficulties in composting biodegradable products and a lack of clear regulations in sustainability reports. Participants expressed concerns about public information gaps and proposed solutions at both the public and individual levels. Notably, no specific action points for companies were identified, suggesting a subconscious reluctance to associate profit-making with genuine sustainability actions. Overall, the study emphasizes the need for education, regulatory clarity, and transparency to address deceptive green claims in Romania.

3. Methodology

This section outlines the research methodology employed to captures practical insights from students in socio-economic fields in Romania, with a focus on three operationalized concepts: education, perception, and impact.

The research adopted a quantitative approach, utilizing a structured questionnaire to collect data. A cross-sectional design was employed to capture a snapshot of students' perceptions and experiences regarding greenwashing. The study aimed to understand the relationships between the operationalized concepts and employ structural equation modeling (SEM) analysis using SmartPLS.

3.1. Participants

The participants in this study were university students in Romania, aged 18 to 25 years old. A convenience sampling technique was utilized to recruit participants, targeting diverse academic backgrounds and ensuring representation from different educational institutions.

The primary data collection instrument was a structured questionnaire consisting of 16 questions. The questionnaire was designed to measure three main constructs: education (students' knowledge about greenwashing and sustainability practices), perception (how students perceive greenwashing in marketing communications), and impact (the influence of greenwashing on students' decision-making and consumer behavior).

The questionnaire was developed based on a thorough review of the literature on greenwashing, consumer behavior, and sustainability education. Questions were framed to align with the operationalized concepts and were designed to be clear, concise, and applicable to the Romanian context. The survey utilized a Likert scale for most questions, allowing participants to express their agreement or disagreement on a scale from 1 to 5.

The survey link was distributed to participants via email, university platforms, social media channels, and in person at physical meetings. Participants were informed about the purpose of the study, the voluntary nature of their participation, and the confidentiality of their responses. The survey was conducted from September to November 2023, with a complete pool of 103 relevant responses from students in socio-economical sciences, aged 18-24. To ensure the self-assessment was accurate, validation questions have been included in the first section of the questionnaire.

The table 1 below presents the gender distribution of the respondents, indicating at a balanced sample of respondents, with 60.2% percent of respondents women and 39.8% men.

Table 1. Gender distribution among respondents

	Frequency	Percentage
Female	62	60.2%
Male	41	39.2%

Source: Author's own research

Respondents in this study are pursuing diverse master's degrees in communication-related fields such as public relations, social media, marketing, foreign languages, philosophy, business administration, educational sciences, and advertising. This reflects a comprehensive approach to communication, showcasing interdisciplinary expertise in digital strategies, market insights, cross-cultural understanding, and creative advertising within today's professional landscape.

3.2. Data Analysis

SmartPLS was chosen as the analytical tool for this study due to its suitability for structural equation modeling. PLS-SEM, a causal-predictive approach to Structural Equation Modeling (SEM), prioritizes prediction in statistical model estimation, providing causal explanations for observed relationships. SmartPLS, a variation-based SEM tool, specifically PLS-SEM 2.0, is employed for theory confirmation, exploration, and target construct prediction in complex structural model analyses. The research method has gained widespread attention, especially in disciplines like organizational management, international management, and human research management. This study contributes to enhancing the application of PLS-SEM in the knowledge management discipline. Literature sources offer detailed guidance on the utilization of PLS-SEM. The selected approach is particularly suitable for research aiming at theoretical framework validation with a prediction component, complex structural models, and theory development for a better understanding.

The analysis will primarily focus on the relationships between the three operationalized variables: education, perception, and impact. The measurement model will assess the reliability and validity of the latent constructs, while the structural model will explore the direct and indirect effects between variables. The table 2 presents the type of each variable.

Table 2. Independent and dependent variables

Independent/ exogenous variables	EDU
Dependent/endogenous variable	PER, IMP

Source: Author's own research

Hypothesis 1 – The way students perceive greenwashing in marketing communications (PERception) significantly influences its impact on their decision-making and consumer behavior (IMPact).

Hypothesis 2 – Students' knowledge about greenwashing and sustainability practices (EDUcation) significantly influences how they perceive greenwashing in marketing communications (PERception).

The table 3 presents the concepts and indicators' operationalization for quantitative research based on author's previous research, supported by literature review. A total of 3 variables, and 12 indicators define the scale.

Table 3. Constructs and indicators operationalization based on author's previous research and supported by literature review

Questions	Indicators	Construct
1. How actively do you seek information to verify environmental claims made by companies before making a purchase? 2. How confident are you in your ability to recognize and distinguish between genuinely eco-friendly products and those engaging in greenwashing? 3. How would you rate your ability to describe a situation or product that led to your feelings of being deceived by environmental claims?	EDU-1 EDU-2 EDU-3	EDU (education and proactive interest in greenwashing)
1. To what extent do you believe greenwashing is a common practice in the business world in Romania? 2. To what degree have you ever felt deceived by environmental claims made by a company or product in Romania? 3. How would you rate your ability to understand of "greenwashing" concept? 4. How strongly do you consider certain signs or factors as indicative of greenwashing in advertising or product labeling? 5. How would you rate your ability to notice a situation or product promoted through greenwashing activities?	PER-1 PER-2 PER-3 PER-4 PER-5	PER (percieved actions of greenwashing)
1. How often do you choose one product over another because of the claim that it is more environmentally friendly? 2. To what extent does a company's reputation regarding the environment and sustainability practices influence your purchasing decisions? 3. To what degree do you believe companies in Romania should bear responsibility in ensuring that their environmental claims are accurate and transparent? 4. How strongly do you agree that there should be stricter regulations in Romania to prevent greenwashing?	IMP-1 IMP-2 IMP-3 IMP-4	IMP (impact of identified greenwashing activities)

Source: Author's own research

In this study, we have chosen to retain the PER-5 item despite its comparatively weaker load (0.68). High outer loadings on a construct signify that the associated indicators share a substantial amount of commonality, effectively contributing to the overall representation of the construct. While a standardized outer loading of 0.708 or higher is often considered a benchmark, it is noteworthy that newly developed scales may yield weaker outer loadings. Instead of automatically discarding indicators below the 0.70 threshold, we conducted a thorough examination in this paper. Our analysis focused on the potential effects of removing the item on composite reliability. Importantly, this scrutiny revealed that the removal did not adversely impact the content validity of the construct.

Table 3. Constructs and indicators operationalization based on author's previous research and supported by literature review

	EDUCATION	IMPACT	PERCEPTION
EDU-1	0.738		
EDU-2	0.824		
EDU-3	0.876		
IMP-1		0.807	
IMP-2		0.829	
IMP-3		0.817	
IMP-4		0.745	
PER-1			0.798
PER-2			0.798
PER-3			0.912
PER-4			0.869
PER-5			0.681

Source: Author's own research

Subsequently, an examination of internal consistency reliability was conducted, as depicted in the table below (Table 5). The results confirm the model's internal consistency, with composite reliability values surpassing 0.70. These values range from 0.85 (EDU) to 0.90 (PER). Jöreskog (1971) has established a direct association between high rho_a values and reliability levels. Generally, values falling within the range of 0.70 to 0.90 are considered acceptable, while those equal to or exceeding 0.95 are viewed as problematic. Proceeding with the analysis, convergent validity is substantiated by the AVE values, all exceeding 0.50. The range spans from 0.64 (IMP) to 0.66 (PER), indicating that the constructs have the capacity to clarify at least 50 percent of the observed variability in their respective items.

Table 5. Measurement model – reliability and convergent validity values

	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	Average variance extracted (AVE)
EDUcation	0.856	0.860	0.855	0.664
IMPact	0.877	0.878	0.877	0.640
PERception	0.908	0.914	0.908	0.665

Source: Author's own research

The subsequent examinations focus on discriminant validity through heterotrait-monotrait (HTMT) ratio. Initially, according to Henseler et al. (2015), the HTMT ratio of correlations should not surpass 0.85 (HTMT < 0.85). In this study, all values remain below this threshold, with a range between 0.53 and 0.64.

Table 6. Discriminan validity – Heterotrait-monotrait (HTMT) ratio

	EDUcation	IMPact	PERception
EDUcation			
IMPact	0.532		
PERception	0.589	0.645	

Source: Author's own research

In summary, this comprehensive analysis affirms the model's robustness. While the conventional benchmark for standardized outer loadings is 0.708, this nuanced approach

considered newly developed scales, avoiding automatic dismissal of indicators below this threshold. The internal consistency reliability analysis confirmed the model's strength, with composite reliability values ranging from 0.85 to 0.90. Convergent validity was substantiated by AVE values exceeding 0.50, indicating constructs' ability to clarify over 50 percent of observed variability. Discriminant validity, assessed through the heterotrait-monotrait (HTMT) ratio, adhered to guidelines, with all values below 0.85. These results highlight the model's reliability, validity, and robustness, providing a strong foundation for future research applications.

3.2. Results discussion

After evaluating the measurement model, a bootstrapping technique involving 5000 resamples was applied to assess the structural model. The model, highlighting p values, is depicted in Table 7. To validate the significance of obtaind p values, R-square and F-square were calculated. Since the significance of the findings and the predictive significance of the constructs has proven medium to highly significant, Table 7 presents the the total indirect and direct effects.

Table 7. Total effects – Mean, STDEV, T values, p values– PLS-SEM

Relationship	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (|O/STDEV|)	P Values	Hypohesis
EDUcation -> IMPact	0.385	0.385	0.085	4.516	0.000	
EDUcation -> PERception	0.594	0.590	0.087	6.789	0.000	H2 confirmed
PERception -> IMPact	0.649	0.647	0.074	8.816	0.000	H1 confirmed

Source: Author's own research

The results of the analysis confirm the validity of both Hypothesis 1 and Hypothesis 2. Hypothesis 1, asserting that the way students perceive greenwashing in marketing communications significantly influences its impact on decision-making and consumer behavior, has been substantiated. This underscores the crucial role of perception in shaping the influence of greenwashing on consumer actions.

Furthermore, Hypothesis 2, positing that students' knowledge about greenwashing and sustainability practices significantly influences how they perceive greenwashing in marketing communications, is also supported. This emphasizes the pivotal role of education in shaping students' perceptions regarding greenwashing, highlighting the importance of knowledge in influencing their attitudes and responses to marketing messages.

The confirmation of both hypotheses underscores the interconnected nature of perception, education, and their collective impact on consumer behavior in the context of greenwashing in marketing communications.

Conclusions

The confirmation of both Hypothesis 1 and Hypothesis 2 underscores the intertwined dynamics of perception and education in shaping consumer behavior regarding greenwashing in marketing communications. Students' perceptions significantly influence

the impact of greenwashing on their decision-making and consumer behavior, while education plays a pivotal role in shaping how they perceive such marketing practices.

The study holds significant implications for academics, researchers, and practitioners engaged in sustainable communication and consumer behavior. For the development of smart cities, addressing gaps in students' awareness of greenwashing becomes paramount. The study suggests that integrating sustainability into urban education can empower citizens to make more informed choices, contributing to the overall goal of creating environmentally conscious communities. At the community level, the battle against greenwashing necessitates targeted programs that foster environmental literacy among citizens.

Consequently, in academia, the identified gaps underscore the need for integrated greenwashing modules, preparing future professionals to navigate and address sustainability challenges in their respective fields. These implications highlight the potential for positive change at both individual and community levels through enhanced awareness, education, and informed decision-making regarding greenwashing practices.

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Employing AI in Regional Development: The Need for a Strategic Approach

Gabriela MARCHIS,
Danubius University of Galati, Romania
gabrielamarchis@univ-danubius.ro

Abstract
Navigating the age of AI is challenging not only because of its novelty, but also because of its rapid progress and unpredictable impact. AI is substantially influencing the labor market, industrial services, agricultural processes, value chains and also the organization of workplaces. Thus, a better understanding of the potential of AI and its pitfalls becomes crucial when developing national strategies. The main focus of this article is to investigate if AI is fit for an overall balanced regional development. The process of setting up a policy framework for AI technologies is very complex and it is useful to learn from the experiences and achievements of other regions or countries that have successfully implemented or adopted AI in regional development. Therefore, to draw some lessons for Romania in designing the national AI strategy and related policies, we needed to explore the landscape of AI policymaking at the international level. In Romania, AI was born and advanced mainly in academia and the private sector, through research and innovative programs. The bottom-up approach in mainstreaming AI together with its cross-sectorial impacts raise important challenges for our policymakers because, as through the national strategy and related policies, they need to find a proper equilibrium, by creating environments that enable AI development and growth, while, simultaneously mitigating the risks posed by AI. In addition, equal distribution of the benefits of AI represents a key social concern. By analyzing the current and future opportunities and trends of AI in regional development and discussing the challenges and risks associated, along with exploring some examples and case studies from different regions or sectors that have successfully implemented or adopted AI, we consider that this article will be helpful for decision making and governance processes at different levels, to enable even faster scale development of AI for regional development.
The conclusion section briefly presents some recommendations and suggestions for Romania to improve its AI readiness and capacity for regional development and provides some suggestions for future research or action on AI in regional development.

Keywords: cross-cutting policies, partnership-driven approach, balanced regional development.

1. Introduction
In the age of artificial intelligence, countries and regions around the world are establishing strategies and initiatives to ensure that new technologies improve the lives of their citizens. Since 2017, when Canada published the world's first national AI strategy, the development of national policies and strategies focusing specifically on AI evolved, and according to OECD AI Policy Observatory, there are over 620 national AI policies from over 60 countries and the European Union [1]

Even if AI is considered to be a relatively new phenomenon, its progress and impact on society and the economy, ranks it among the most powerful technologists of our time, the technological progress being revolutionary. AI can contribute to regional development by improving efficiency, productivity, innovation, sustainability, inclusion, etc., in various sectors and activities, such as health care, education, transportation, manufacturing, etc..

In this context, national governments and regional and intergovernmental organizations have raced to put in place AI-targeted policies to maximize the opportunities AI presents in critical areas, like climate, agriculture, energy, public health, education, and cybersecurity [2] .

But, the opportunities that AI presents for socio-economic development should be taken into accont in correlation with the its risks, especially in critical areas such as cybersecurity, biosecurity, or safety. AI can be a key element in regional development, improving the economic, social and environmental aspects of different regions, but in the whole process of designing, developing, using and evaluating AI products, services and systems, the "different actors" involved should consider and mitigate associated risks that arise, such as ethical, social, legal, technical, etc..

The purpose of this article is to explore the opportunities and trends of AI in regional development, and to draw some lessons for Romania, which is a country with a low level of AI readiness and capacity compared to other European countries, but also has a high potential for AI development and adoption. Therefore, the main focus of this article will be to investigate the following 3 research questions:

- What are the current and future opportunities and trends of AI in regional development?;
- What are the challenges and risks of using AI in regional development?;
- What are the best practices and lessons learned from other regions or countries that have successfully implemented or adopted AI in regional development?.

By analyzing the current and future opportunities and trends of AI in regional development and discussing the challenges and risks associated, along with providing some examples and case studies from different regions or sectors that have successfully implemented or adopted AI, we consider that this article will be helpful for decision making and governance processes at different levels, to enable even faster scale development of AI for regional development.

The conclusion section briefly presents some recommendations and suggestions for Romania to improve its AI readiness and capacity for regional development and provides some suggestions for future research or action on AI in regional development.

2. AI in regional development

Artificial intelligence (AI) has been in development since the 1950s and is expected to be one of the biggest disruptors of the 21st century, with the impact affecting the economy, the built environment, society and most professions, including the planning profession [3].

In the field of regional science, AI is still an emerging topic, the main themes identified in study performed by Lazzeretti et al. in 2023 being: Industry 4.0, smart cities, big data, AI and related technologies (robotization, IoT, augmented and virtual reality) [4].

The literature on the role and impact of AI in regional development can be divided into two main streams, which are not mutually exclusive, but rather complementary, as they offer different insights and perspectives on how AI affects regional development:

- the micro-level effects of AI on individual sectors or activities in a region, such as healthcare, education, transportation, manufacturing, etc [5] [6] [7]
- the macro-level effects of AI on the overall economic, social, and environmental conditions of a region, such as growth, employment, innovation, sustainability, inclusion, etc..

Moreover, the systematic literature review on AI & economic development topic, performed by Qin et al. and published in the collection of studies "AI in the Knowledge Economy and Society: Implications for Theory, Policy and Practice" in 2023, identified five main research themes on the opportunities offered by AI in different areas [6]:

- AI supports intelligent decision-making;
- AI empowers social governance;
- AI enhances labor and capital;
- AI accelerates Industry 4.0;
- AI fuels innovation.

But these opportunities that accelerate regional economic development, embodied in improving efficiency, productivity, innovation, sustainability, inclusion, etc., come along with some challenges, in terms of ethical, social, legal, technical aspects.

Furthermore, due to each region's readiness and ability to absorb AI opportunities, interregional disparities may increase. Therefore, there is a need of a strategic aproach on how to use AI as a key driver of regional development, taking into account the potential inequalities it can generate. A wide range of sectors or individual activities at the regional level can benefit or be affected by AI, so the main focus of decision makers should be to ensure that AI is used in a responsible, inclusive and sustainable manner.

2.1. Opportunities and trends

The application of AI in regional development has the potential to address various challenges across different sectors, improve efficiency and sustainability, enhance quality of life, and stimulate economic growth in underdeveloped regions.

The automation of tasks and processes in various business sectors such as healthcare and biotechnology, education, transportation, manufacturing, logistics and agriculture will enhance productivity by streamlining operations, reducing costs and increasing efficiency. The advancements of various industries' outcomes will attract investments and talented and skilled workforce to the specific regions.

In addition, AI can enable the development of smart cities, providing a better quality of life for residents in specific regions by optimizing resource allocation and waste management; improving transportation systems to optimize traffic flow, reduce congestion and carbon emissions; and improving public services, including public safety through intelligent surveillance systems.

Also, regional development planning and management can be foster by AI powered algorithms in order to identify areas that need improvement, prioritize infrastructure development projects, and allocate resources more efficiently.

Furthermore, AI powered systems can be used to optimize the energy management, by analyzing the energy usage patterns, predicting peak demands, and recommending energy-saving strategies and integrating more effectively renewable energy sources such as solar and wind into the regional energy grid.

Withal, AI-based algorithms can be used to mitigate the effects of climate change by developing early warning systems for natural disasters and assisting authorities in their emergency response efforts.

In summary, AI has the potential to significantly impact regional development, but it is important to note that fostering innovation in AI applications specific to regional needs requires a high level of AI literacy. Therefore, it is critical that policymakers and stakeholders prioritize AI education and skills development programs in order to equip their workforce with the skills needed to participate in the AI economy. In this context, close collaboration between academia, industry and government is needed to facilitate knowledge sharing and promote innovation in AI applications specific to regional needs.

2.2. Challenges and risks

Beyond the opportunities that AI brings for regional development (overcoming the infrastructure gaps; increasing productivity in various industries by optimizing service operations, marketing and sales, product and service development, strategy and corporate finance and supply chain management; creating innovative digital solutions for urban and regional planning; enhancing creativity and culture, supporting learning and innovation; addressing climate change and green transition), it also raises ethical concerns such as data privacy, bias and the digital divide; job displacement due to automation and also, cybersecurity risks.

A major challenge relates to ethical issues, and it can be difficult to ensure that AI systems respect human rights, values and norms. By collecting personal and sensitive data, AI systems can expose individuals and regions to potential data breaches, cyber attacks or data misuse. It is therefore necessary to establish clear guidelines and regulations to address issues such as privacy, data protection and algorithmic transparency. Additionally, AI models rely heavily on the availability of high-quality data to provide solutions for decision makers. If, in some regions, the availability of relevant data is limited or outdated, fragmented or biased, the solution provided by AI algorithms will be suboptimal, with significant negative consequences. Furthermore, if the data used to develop AI models is biased or lacks diversity, it can lead to inequitable outcomes and perpetuate or even exacerbate existing inequalities.

Regions with better access to various resources such as infrastructure (including research centers, innovation centers and incubators that can stimulate entrepreneurship, attract investment and promote the growth of high-tech industries), financing and financial incentives (including public and private investments, grants, loans and venture capital), skilled and educated workforce (with an adequate level of AI knowledge and who can provide technical expertise and training programs to drive growth in specific regions) are more likely to benefit from AI adoption. But this can lead to a potential digital divide between regions, with some areas experiencing faster growth and development compared to others, affecting the goal of cohesion policies, which aim to reduce disparities and promote balanced development across regions and countries.

The adoption of AI technologies might lead to workforce displacement, with certain job roles being replaced by AI systems. The changing job market will potentially cause unemployment and social disruptions. At the same time the skill gap between the demand and availability of AI talent can be significant. Therefore, it is necessary to invest in retraining and upskilling programs to help individuals adapt to the new reality of labor market.

Lastly, cybersecurity risks are a significant concern as AI systems can be vulnerable to attacks and, if compromised, can have severe consequences for critical infrastructure and public safety. Misuse or unauthorized access to sensitive data collected by AI systems can have serious consequences for individuals and organizations, eroding public trust and hindering the adoption of AI technologies for regional development.

To address these challenges and risks, it is important to have a comprehensive approach that includes collaboration between governments, businesses, communities and AI experts to develop strategies that maximize the benefits of AI while reducing the associated risks. To ensure public trust, inclusiveness and sustainability, and a responsible deployment of AI in regional development, policy makers should develop ethical frameworks, regulations and norms, based on best practices on how to leverage AI for regional development.

3. Lessons for Romania

The process of setting up a policy framework for AI technologies is very complex and it is useful to learn from the experiences and best practices of other regions or countries that have successfully implemented or adopted AI in regional development. Therefore, to draw some lessons for Romania in designing the national AI strategy and related policies, we need to explore the landscape of AI policymaking at the international level.

According to OECD AI Policy Observatory, AI strategy is defined as “a policy document that communicates the objective of supporting the development of AI while also maximizing the benefits of AI for society.” [8].

The Artificial Intelligence Index Report 2021 highlights the state of the art of different countries in setting national and regional AI strategies, which are policy initiatives that aim to guide the development and use of AI in different fields and sectors. These documents were classified in 3 main cathegotries [1]:

- published strategies:
    a) 2017: Canada, China, Japonia, Finland, United Arab Emirates.
    b) 2018: European Union (Coordinated Plan on Artificial Intelligence), France, Germany, India, Mexico, United Kingdom, Sweden, Taiwan.
    c) 2019: Estonia, Russia, Singapore, United States, South Korea, Colombia, Czech Republic, Lithuania, Luxembourg, Malta, Netherlands, Portugal, Qatar.
    d) 2020: Indonesia, Saudi Arabi, Hungary, Norway, Serbia, Spain.
- strategies in public consultation: Brazil, Italy, Cyprus, Ireland, Poland, Uruguay.
- strategies announced: Argentina, Australia, Turkey, Bulgaria, Chile, Israel, Kenya, Latvia, Malaysia, New Zealand, Sri Lanka, Switzerland, Tunisia, Ukraine, Vietnam.

Even if, most of them share a similar format, that includes: goals, principles, priorities, actions, and indicators to measure, they differ in terms of scope, focus, funding, and implementation. Among similarities, we can list the following topics:

- promoting research and innovation in AI;
- developing human capital and skills for AI;
- fostering trust and ethical use of AI;
- ensuring inclusive and sustainable development of AI;
- enhancing international and multi-stakeholder cooperation on AI.

The Report offers active links to some of national and regional AI strategies, which are very useful for further investigations.

At the European Union level, there is a Coordinated Plan on Artificial Intelligence, first published in 2018 and revised in 2021, which sets out a joint approach to boost Europe's competitiveness and ensure trust in AI [9].

Furthermore, the European Commission's Joint Research Centre (JRC), the European Commission's science and knowledge service and the Organisation for Economic Co-operation and Development (OECD) published in 2021 a joined document "National strategies on Artificial Intelligence – A European perspective", which reviews the national AI strategies and identifies five key policy areas to apply AI for social and economic benefit [8].

- human capital;
- from the lab to the market;
- networking.
- regulation;
- infrastructure.

National approaches to AI and supporting policies differ in terms of strategic priorities, budget allocations, implementation timeframe, level of detail of proposed actions and sectoral focus [10].

Some examples of national and regional AI strategies are provided in the Communication from the European Commission, "Fostering a European approach to Artificial Intelligence", with the aim to learn from each other and to bring good practices to the European level [9]. Hence, it becomes important to monitor and examine national AI strategies in order to build synergies that shape the EU vision on AI.

Statistical information regarding Romania's progress in absorbing AI is presented in the AI-Watch platform of the European Commission [11] which monitors the development, uptake and impact of Artificial Intelligence for Europe.

According to available information on Romania's progress in improving its AI readiness and capacity, in 2020 our country launched an EU-funded project on the creation of a national framework in the field of AI for the period 2021-2027, but the deadline for publishing this strategy by at the end of 2022 was exceeded.

It is obvious that Romania is struggling with the development and implementation of the national policy framework in the field of AI. There is no universally valid formula, but some lessons in designing a national AI strategy can be drawn from the experience of other states.

First, it is important to establish a vision and mission statement that articulates the Romania's aspirations and values for AI development and use. The vision and the mission should comply with the European approach on AI.

Second, it is necessary to define a set of strategic objectives and priorities in line with the country's vision and mission, in order to address the key AI opportunities and challenges.

Addressing the ethical, legal and societal implications of AI involves close engagement and collaboration between experts from the public and private sector, government expertise, academia and the business sector, supported by technology and legal consultancy services. Therefore, an important step is to create a governance framework that defines the roles and responsibilities of various stakeholders, such as government agencies, industry, academia, civil society and even international partners.

For example, at the national level, policy initiatives on AI governance can be approached in two different ways:

- establishing ministries or regulatory bodies to take direct responsibility for AI;
- embedding of AI responsibilities into existing ministries.

In both scenarios, we strongly recommend AI training for Romanian government officials.

Another suggestion is to establish strategic frameworks or priorities for industry, academia and other government initiatives with a view to achieve a coordinated and comprehensive approach by integrating AI policies into operational plans.

The next step is to design the roadmap and action plan that outlines the specific initiatives, programs and policies that will be implemented to achieve the strategic objectives and priorities.

Last but not least is the establishment of a monitoring and evaluation mechanism that tracks the progress and impact of the national AI strategy and allows for feedback and adaptation.

To speed up AI advances, Romania must invest in education, research, and infrastructure. In this context, our recommendation is that Romania's national AI strategy should respond to the EU vision and be interconnected with other national policies, in order to promote the responsible and inclusive AI research, development and deployment.

In addition, we recommend the use of data and new data analysis methods to improve decision-making and planning processes. Romania's decision-makers should also focus on identifying new innovative financing mechanisms and adopting cross-sector and multi-stakeholder approaches in the planning and governance process of AI-targeted policies.

4. Conclusion and policy recommendations

Navigating the age of AI is challenging not only because of its novelty, but also because of its rapid progress and unpredictable impact.

AI is substantially influencing the labor market, industrial services, agricultural processes, value chains and also the organization of workplaces. Thus, a better understanding of the potential of AI and its pitfalls becomes crucial when developing national strategies.

In Romania, AI was born and advanced mainly in academia and the private sector, through research and innovative programs. The bottom-up approach in mainstreaming AI together with its cross-sectorial impacts raise important challenges for our policymakers because, as through the national strategy and related policies, they need to find a proper equilibrium, by creating environments that enable AI development and growth, while, simultaneously mitigating the risks posed by AI. In addition, equal distribution of the benefits of AI represents a key social concern.

In this context, Romanian policymakers, in their mission to pave the way for this AI-driven future and get maximum value from AI, should investigate the AI journeys of other countries and look at best practices that helped executing AI successfully. Networking, partnerships and the diffusion of good practice can be the path to a comprehensive and integrative national strategy for AI.

Last but not least, strengthening the knowledge base about AI and stimulating the awareness of decision makers about the enormous potential of using AI, but also the concrete risks, play a major role to enable the development of strategic and programming documents for regional development.

Our governors' mission is to focus significant and targeted investment in infrastructure, human capital, ethical design and value-based implementation of AI. Next, a diverse range of perspectives is needed to define problems and formulate policy objectives. Thus, expert consultations together with public consultation will help to assess the effectiveness of policies by ensuring the representativeness and diverse input of a wide range of stakeholders.

Summarizing the main findings of this research paper, there is a strong need for coordination across our government authorities, to improve Romania's regional development readiness and capacity in the field of AI and to ensure coherence within national policies, but also with the EU legislative framework regarding AI-targeted policies.

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Citizenship and Public Space. A Gender Perspective

Cătălina FRÂNCU,
SNSPA, Faculty of Political Science, Bucharest, Romania
catalina.a.francu@gmail.com

Abstract
The aim of this research project is to connect the exercise of citizenship with access to, and use of public space for women. The hypothesis that women's hindered access [1] to public space is influencing their exercise of substantive citizenship, and thus their career choices, their representation in public office, and the amount of freedom of movement they dispose of will be guiding the direction of our research. We want to establish the truth value of this statement through the intersection of urban and gender studies in order to generate strategies pertinent enough to deal with the issue. This study would mean another step taken into the direction of gender equity, which would directly improve the body of knowledge policy-makers, urbanists, sociologists, and human geographers would have at their disposal in elaborating studies, strategies, and in formulating advice; therewithal, it implies an indirect economic benefit, as safer cities are more prosperous. Our project is conceived as a comparison between the present status of women from different backgrounds in Bucharest and Vienna: a post-communist, relatively economically-challenged Eastern European capital and a Central European gender-mainstreaming oriented capital, considered to be one of the safest and most livable cities in Europe.
Keywords: urban planning, inclusive city, gender-mainstreaming, cities for women.

1. Introduction
The subject of our study is the influence of the urban environment on gender performance and gender discrimination of women. The study methods are both quantitative and qualitative data collection through interviews and focus groups in two European cities: Bucharest and Vienna, with emphasis on the gradient influence of urban forms have on each other (there are major functional differences between the two — e.g. Vienna is constituted of 50% equally distributed social housing in, whereas Bucharest tends to ghetto the public housing, if it exists at all). Given the extensive body of knowledge on Western cities and a lack thereof on the rest of Europe, our focus comes to adjust the balance with central and eastern case studies. There are important structural differences both between Eastern and Western cities, but similarities to be studied under the same lens.

The practical question we aim to answer is how do women perceive their hindered access to public space and how does that influence other aspects of their lives like exercising citizenship, access to public office, civic involvement, career choices? The question is to be tackled across class, age, ethnicity, sexuality, and ethnicity with the aim of drawing intersectional conclusions, taking into consideration the particularities of each body. We aim to make contact in both cities with NGOs involved in urban communities and to thus gain permission and access to a relevant number of people who would then credibly inform our research. Vienna experienced a strong raise in gender mainstreaming practices, "the fair shared city", while Bucharest is still reluctant to use the word 'gender'.

2. Objectives
It has been widely debated [2] [3] [4] and proved [5] that women are usually the major transiters of the public space [6]. Women also constitute the usual victims of street harassment in the public space [7] [8], which further generates defence mechanisms involving recalculating routes [8] , avoiding certain areas, not looking men in the eyes, not

answering when catcalled, not stopping, walking fast, watching their body language, watching their attire, being aware of the time of the day [9]. The stress of so doing pushes women to avoid certain areas of the city altogether [10] to the point of moving out of their homes if the surroundings become hostile [9]; it restricts their access to public space, implicitly controlling their trajectories, thus the timetable of their entire day [10].

After Fenster's feminist analysis of Lefevbre's "right to the city", citadinship [11] evokes two fundamental rights of the citadin:

- The right to appropriate (the right to use) urban space;
- The right of participation.

In her comparative analysis of London and Jerusalem she finds that women are the second-class citadins who cannot fully exercise these rights. Lack of appropriation of the urban space and lack of participation in its making lead to women feeling alienated, having no means to create a sense of belonging [12].

Bondi and Rose [13] highlight Pratt and Hanson's work [14], arguing that "differences are always constructed through lived geographies of placement. This means that axes of identity such as those of race, class, sexuality, age and gender never operate aspatially but are inextricably bound up with the particular spaces and places within which, and in relation to which, people live.", which makes for a strong case in the favour of a thorough comparative study between the western and eastern gendered urban practises.

Bondi and Rose [13] further quote Melissa Gilbert [15], Linda Peake [16], Valerie Preston and Guida Man [17], and Stuart Aitken [18], saying that "Qualifying feminist appeals to cities as spaces of fluidity and movement, they showed how locally many urban lives are still lived (…) although this does not necessarily apply to all groups of women [19],„ implying a need for an intersectional approach, which we aim to integrate in our study.

3. Women and the Public Space. Factors of Influence

There are three interrelated factors which keep women alien to the urban space: street harassment, poor (or unilateral or generic) urban design, and a poor public transport system. Each of them generates certain behaviours (from the part of women) and has major consequences on women's lives (independently of their behaviour). Their consequences are detailed in what follows:

3.1. Street Harassment (men's control over women's movement and bodies)

Street harassment is a major issue, manifested to different degrees all the way from the western world to the east. In the west, women slowly gained access to the public space – first in the company of the husband, father, brother, then friends, colleagues, always needing an escort to shield their reputation, then on their own. However, although formally women acquired the right to use public space unescorted, a woman alone is for many men an invitation to intrude [20]. For some men still, the presence of women evokes sexual promise [21] embedding the idea that this is the reason women are there.

As women emancipated and began transiting the public space on their own, they remained targets in the eyes of men. When harassing, men reinforce their control on women's bodies, instilling fear of sexual violence which keeps them submissive and unresponsive [20]. Women's reaction to street harassment varies throughout the globe, with more conservative countries seeing a rise in women drivers specifically as a response [22]. In the West, however, we see an emancipatory movement reclaiming public space for women (Vienna, Amsterdam). The difference in response finds its answer in the Western tradition of using public space as a resource for citizenship [23], representation, and pure pleasure, while the East typically uses it as a transitory passage from one point to another [4].

Experiences and attempts at violence, and incidents of sexual harassment produce a space from which women are excluded on account of their gender. Social and emotional aspects, such as increased feelings of vulnerability, lack of social support, and a feeling of not having control over what is happening to oneself, have spatial consequences [24].

3.2. Urban Design

However subtle, the particularities of urban design have a massive impact on the well-being of urban inhabitants [25] [26] [27] [28]. Yet women, as one group not taken into consideration by "generic" design, face particular challenges generated by the morphology of the city.

First, disconnected urban wastelands are facilitating grounds for the unfolding of violence, as are blind walls or cul-de-sacs without natural surveillance [28] or streets without ground-floor activity [26]. They enable "turf wars" between gangs, thus confiscating urban land from all dwellers – and every unsafe place is more so for women, minorities, and the elderly, at the same time providing enabling grounds for sexual harassment.

Secondly, absence of urban facilities adapted to the female body and needs keeps women indoors (lack of public toilets – women need to urinate more often than men do [29] and their periods [2] require attendance). A myriad of football fields exclude women from certain areas, but their tax money is still used for financing them. The zonfication of the modernist city that many American urban areas were modelled upon put a considerable distance between the points women have to reach in order to accomplish their routine tasks (caring for people, working, picking up children from school, taking them to the doctor, etc.), which considerably reduces their amount of free time. Furthermore, because of the common misconception that women prefer the indoors [30] public policies enter the vicious cycle of not even trying to provide suitable milieus for women to access public space.

Lack of representation in the public space throws women into a spiral of non-belonging, erasing them from the city's history as well as off its streets while need constantly brings them out of their homes, in a sense of illegitimacy.

However, Bondi and Rose emphasise that "these developments [focusing on the mutual construction of gendered identities and spaces] are fruitful and productive in helping to uncover pervasive assumptions about gender, in problematising a panoply of emotional

experiences of which fear is but one, and in overcoming a polarity between viewing urban space as either constraining or enabling for women."

3.3. Public Transport

The third factor is strongly related to the previous two and it significantly impacts women's possibility of disposing of their own time. Given the myriad network people involved in "care work" (overwhelmingly women) navigate daily [31], as opposed to the simple trajectory home – work – home, the proximity as well as transportation connectivity between key urban points are the two decisive components in the configuration of a typical day in a woman's life.

Because strategies employed by women to avoid street harassment involve going around certain areas instead of through them when that would prove more efficient, public transport plays a key role in saving their time. However, especially in Eastern Europe, there is a considerable lack of strict regulation, which in certain cases makes using public transport a highly inefficient alternative.

Space and Time are two invaluable resources for access to substantive citizenship [32] [33]. Our premise is that street harassment, poor urban design and poor transport systems heavily impact women's abilities to develop their full civic, urban and political persona, as well as their substantive citizenship.

Lack of women in public office often reiterates strategies unfit to their needs, which further takes away women's access to public space, thus thwarting their access to public office. It's a vicious circle that can only be broken through addressing street harassment, urban design and public transport integratively.

We argue that a "fair shared city" [31] is more welcoming to everyone without disadvantaging men in any way. We aim to focus our study on the different approaches to public space, transport and street harassment on a comparison between Vienna and Bucharest. This choice allows for enough similarities and differences to make for a savoury study of women's urban life.

4. Research Questions

Our main research question is „how do women perceive their hindered access to public space and how does that influence other aspects of their lives such as exercising citizenship, accessing public office, civic involvement, career choices?"

Hereafter a set of sub-questions derived from operating the concepts formerly implied.

1. How does access to public space or lack thereof influence women's substantive citizenship?
2. What methods of women ghettoisation [8] are used and which are conscious, which unconscious?
3. How do poor urban design and generic urban planning reinforce women's oppression in the public space?
4. What role does urban design play in street harassment and vice-versa?

5. What impact does representation or lack thereof have on women's sense of belonging in the city and how does that further shape their use of the public space?
6. Conscious and unconscious oppression of women in the public space: street harassment (with its consequences); urban design (with its consequences – surveillance, aesthetics, cleanliness, accessibility); public transportation (with its consequences).

5. Research Context

Given the strong similarities and massive migration phenomenon between Eastern and Western Europe, together with a powerful tendency to systematically compare them, the geographical coordinates of this study will mainly encompass these two cultural areas.

Western (and Central) Europe shows a strong tradition of both oppression (bourgeoisie, colonialism, empires) as well as individual freedom (the French revolution, Industrial Revolution, Civil Rights Movements, Feminism, etc.), while Eastern Europe is still subjugated to the supremacy of dictatorships (or shadows thereof) and is witness to an embryonic fight for civil rights. However, since entering the EU many Eastern-European ex-communist countries have actively been fighting for the same rights as the West has fifty years ago (abortion rights, political equality, equal pay, etc.), which would make for a highly compelling comparison. Moreover, part of Eastern Europe (especially the Balkans) was heavily influenced by Middle-Eastern practices, many of which are still visible to this day in law, urban design, mentality, traditions, etc., making it a fertile terrain for fruitful questioning likely to be useful to other parts of the world as well.

Scholarly debates, apparently antithetic, argue on one side that the prevalent sentiment women feel in the public space is fear, with high reported levels thereof in elderly women – while data suggests that young racialised males are the bodies most exposed to violence [13] – and on the other side, that the city is a place for women's liberation [34]. We argue that rather than being contradictory, the two perspectives are complementary and the debate cannot be carried in the absence of an intersectional perspective that would also account for age, ethnicity, race, sexual orientation, and class. The interdependence of the two stances is endemic in many applied urban studies [10] [35] [36] Thus, these various studies elaborate how urban public space is 'purposely representational of certain societal ideals ' (…) and how it is also shaped through routine everyday practices, and organised resistance to, and transgressions of, such regulation (…)." [13]

However progressive and inclusive the western part of the world becomes, there are important, neighbouring areas where women and minorities are prevented through deliberate or implicit tactics from the appropriation of public space. We want to study and emphasise the difference and similarities generated by culture and everyday practise of citadinship between the Western and Eastern (understood here as Eastern Europe) World in order to enable the development of actual urban tactics of inclusion.

Moreover, the communist dictatorial hegemony froze the civil rights movement, thus submitting the woman two a bi-layered patriarchy: husband and state, while completely erasing the voices of minorities and/or the minorities themselves. As Jenny Robinson

argued, urban studies are profoundly dependent on a “Western, developmentalist concept of modernity” [13] and impose a fictitious modernisation strategy for the poorer countries – a problem we wish to address.

Surprisingly, though, there are studies in feminist geography which explicitly evoke higher geographical inequality in more socially equal countries than in more unequal ones, like the United States and Sudan:”the pre-pubescent girl in Sudan experiences greater equity in spatial range with boys in her cohort than her counterpart in a large metropolis in the United States, and may have considerable freedom to explore the environment.” [37]

which calls for a thorough comparison between the East and the West that would challenge any canon, thus adding to the complex layers of the intersection between the environment and the gender variable.

The emerging research on gendered geography in Romania [38] is pointing towards a wide variety of issues ranging from sexual harassment, to lack of urban representation, sexist messages, and transportation issues. Even though living in a city is liberating for women comparing with their lives in the country side [34], there is much evidence of sexist oppression in Bucharest, the Romanian capital. Here, the two facets of the debate brought forth by Bondi and Rose [13] are irreparably intertwined making for a convoluted topic of discussion.

6. Methodology

We aim to research the questions through ethnometodological qualitative methods in virtue of their subjective quality. Grünberg warns us of the tendency to superimpose the dichotomy reason-nature, science-experience, with the quantitative-qualitative methods [39]. Without wishing to make a quality distinction between qualitative and quantitative methods, given the phenomenological aspect of the urban lived experience, our study would extensively benefit from the predominant use of the former.

After Schultz, Husserl, and Wagner, the ethnomethodological approach primarily draws from the interpretation of certain subjective experiences felt in relationship with the city. The approach assumes that the lived experience is interpreted by an active consciousness, which plays a part in generating the perceived object of experience.

“Garfield and Sacks contest all the a priori bonds with an existing social structure and concentrate rather on the way individuals re-enact and manage the social structures, attributing meanings to them.” [40]

The quantitative method will be employed in order to identify specific problematic areas in all three categories of street harassment, urban design, and public transportation. Behavioural mapping will be used to determine the most problematic areas of chosen cities — we are to pay special attention to their common urban development, similar social composition and similar described urban “atmosphere”, revealing the mechanisms that seem to add up to what might pass as “free choice” but are in fact a series of unconscious constraints which manipulate the individual.

The people we will target for interviews are female, middle and lower class, and of different ethnicities with the aim of interviewing both representatives of the majority as well as the minority. For example, in Bucharest, Romania, we would choose Caucasian Romanian women as representative of the majority and Roma Romanian women representing the minority.

To relevantly conclude on the comparative study, we would use GIS methods as means to synthetise the information gathered. It would allow for further appropriation of the GIS methods by feminist study, thus further democratising the practice.

“Simultaneously, the humanities and social sciences experienced a 'spatial turn' expressed in the increased use of spatial and cartographic metaphors. (…) They have examined cartography's legacy in the production of authority through mapping people and territories from a position of power (e.g., colonial, state, surveillance, or military).” [41]

7. Relevance

Although the advantages of the city undoubtedly liberated women compared to the country side, as Wilson argues [21] and although some women (usually middle to upper class white women, especially who drive or have a driver) are not as exposed to the dangers of the city as are the other groups of women and minorities, the issue of the woman as alien in the city, along with blacks, other people of colour, sexual minorities and ethnic minorities is still prevalent in 2020.

See the debate summed-up by Vacchelli and Kofman: In her ground-breaking book The Sphinx in the City Elisabeth Wilson [21] argues that feminist scholarship concerned with cities was in danger of perpetuating anti-urbanism already prevalent in much mainstream urban theory and practice [13] where the city was depicted as a place that constrains, disadvantages and oppresses women. Wilson condemned much feminist writing as ‘hostile to the city’, and further argued that ‘recent feminist contributions to the discussion of urban problems have tended to restrict themselves narrowly to issues of safety, welfare and protection ’[13] instead of asserting women’s rights to the risks of the city recognising that the city has consistently emancipated women more than rural life or suburban domesticity ever has. On the contrary Wilson states that cities enable women to escape the constraints of normative expectations by widening their horizons. We see urban space as constructed by gender, class and race difference where minorities are disadvantaged and representationally excluded, as with Muslims in Paris or migrant women in many cities, such as Buenos Aires and Zurich [42].

In light of this we propose a comparative study of the gendered urban experience in Bucharest and Vienna which would serve as basis for a critical analysis of the advantages and disadvantages of both areas through listing morphological similarities and differences together with women’s perceptions thereof. Such an endeavour would allow for a parallel emphasis on success strategies (Vienna) [31] in contrast with sexist cities (Bucharest) [38]. The profound inequalities cities present the citizens with are generated by a series of mishaps and/or unconscious bias. We aim to diminish the possibility of mishap to a minimum in order to be able to deal with bias separately and without confusion, through

directed and efficient action. The dwellers of our cities, be they male, female, or other, deserve to live in equity – given that a "fair shared city" would be a rise in welfare for every citizen, we are firmly convinced that this study will be relevant to all.

Furthermore, as there is a growing pressure to design more sustainable cities, taking into account dimensions such as biodiversity and technology, we will inevitably replicate the discriminations already embedded in our cities should we leave them unchecked. Gender is, of course, only one of the dimensions worth researching, together with exclusions based on disability, the pressure of profit on our natural areas and of green spaces in the city, etc. However, we only stand a chance of mending the wrongs by deeply understanding the forces that make our cities and addressing them in an integrated, intersectional manner.

Acknowledgements
This proposal would not have been possible without guidance and advice from Prof. Yasminah Beebeejaun (University College London) and Read. Ryan Powell (University of Sheffield) who helped me develop variegated strains of research on urban discrimination. I would like to further acknowledge Assist. Lect. Diana Neaga (Nicolae Titulescu University) and Prof. Laura Grünberg (University of Bucharest) whose research on instances of sexism in the Romanian capital are priceless to the further development of this project. Furthermore, I thank my colleague, Zeppelin editor-in-chief arch. Ștefan Ghenciulescu for the ceaseless opportunities and encouragements to dive deep into the understanding of the city fabric with all its implications from both an urban/architectural and sociological perspective. Finally, I would like to recognise the priceless contribution of my partner, Teodor Călinoiu, whose questions and multiple readings of this text perfected the idea and helped develop it into a workable project.

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Enhancing irrigation systems with SolarEdge technology

George SUCIU,
BEIA Consult International, Bucharest, Romania
george@beia.ro

Robert FLORESCU,
BEIA Consult International, Bucharest, Romania
robert.florescu@beia.ro

Stefania DINU,
BEIA Consult International, Bucharest, Romania
dinustefania20@gmail.com

Maria NICULAE,
BEIA Consult International, Bucharest, Romania
maria.niculae@beia.ro

Abstract
SolarEdge technology is an established advancement in solar energy, optimizing photovoltaic system performance through innovative hardware and software. Its primary objective is to maximize solar energy production and enhance efficiency in intelligent storage systems. The use of power optimizers for individual panels ensures efficient control, eliminating shading issues and system-wide malfunctions. The technology includes a versatile hybrid inverter that operates autonomously or collaborates with alternative sources like batteries or the grid. Remote management ensures seamless operation, while the real-time monitoring platform offers insights into energy production and consumption, facilitating prompt intervention. Compared to traditional approaches, SolarEdge offers higher energy efficiency, rapid issue resolution, advanced management, and potential battery integration. The article underscores SolarEdge's efficacy in addressing energy production and monitoring challenges, particularly shading and monitoring limitations. The technology optimizes individual panel energy generation, enhancing integration with alternative sources for increased output. The article also explores SolarEdge's real-time monitoring and its potential in sustainable irrigation. In conclusion, SolarEdge transforms photovoltaic systems, efficiently addressing challenges and extending to innovative applications, maximizing energy utilization sustainably. The article is structured into sections: Introduction establishes context, Related Work compares existing approaches, The SolarEdge Solution details the technology, SolarEdge's Role in Advancing Sustainable Irrigation explores its application, and Conclusions summarize its impact on photovoltaic systems and sustainable energy.

Keywords: SolarEdge technology, photovoltaic systems, energy optimization.

1. Introduction
Traditional photovoltaic systems have long grappled with obstacles such as shading, panel discrepancies, and restricted monitoring capabilities. These issues not only curtail energy efficiency but also hinder the potential for maximum energy generation [1]. Enter SolarEdge technology, which orchestrates a transformative paradigm shift by confronting these challenges head-on. The cornerstone of SolarEdge's solution lies in the implementation of power optimizers for individual panels. By expertly mitigating the effects of shading, these power optimizers ensure that energy generation remains efficient and unhindered, even in the presence of unfavorable conditions.

Further augmenting the efficiency of energy conversion, SolarEdge leverages hybrid inverters that not only enhance energy conversion processes but also seamlessly integrate with alternative energy sources. This integration not only bolsters energy production but

also offers a versatile framework for optimizing power utilization. As a result, SolarEdge technology not only enhances energy generation but also opens avenues for a diversified energy ecosystem.

In the journey towards efficient and sustainable energy systems, monitoring plays an indispensable role. SolarEdge's sophisticated monitoring platform offers real-time tracking and issue identification, constituting a vital component of operational efficiency. By enabling prompt detection of performance issues, this monitoring platform ensures that the system operates at its optimal capacity, ultimately leading to maximized energy output.

Moreover, SolarEdge's impact transcends the boundaries of energy generation; it extends to revolutionizing irrigation systems. By embracing SolarEdge technology, irrigation processes stand to benefit from improved energy efficiency and operational optimization. This paves the way for sustainable and effective water management, a critical facet in the global pursuit of agricultural and environmental sustainability.

In conclusion, SolarEdge technology emerges as a transformative force in the realm of photovoltaic systems. By strategically tackling shading, monitoring limitations, and even irrigational challenges, it underscores a comprehensive approach to harnessing solar energy's potential. With an unwavering commitment to efficiency and sustainability, SolarEdge presents a compelling narrative that envisions a greener future powered by innovation.

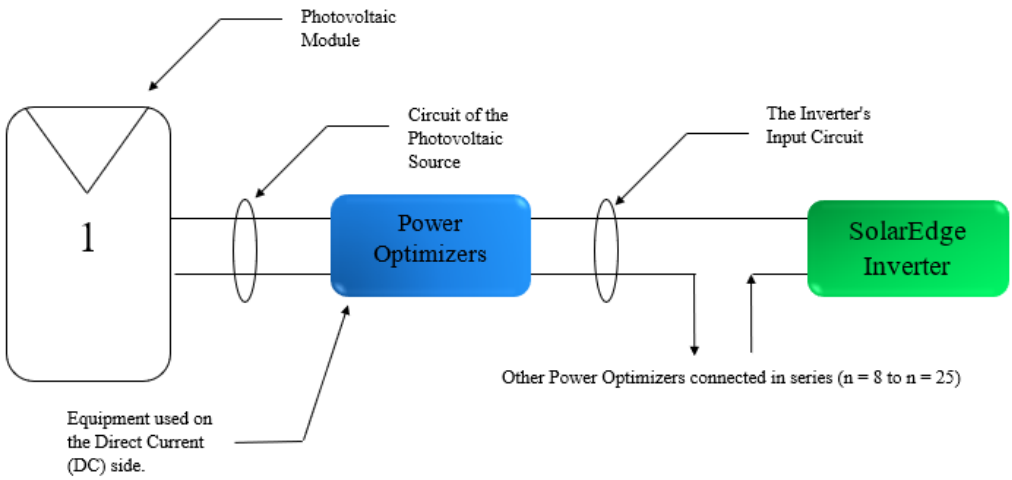

Fig. 1. General architecture of the SolarEdge PV system.

The article also explores SolarEdge's real-time monitoring and its potential in sustainable irrigation. In conclusion, SolarEdge transforms photovoltaic systems, efficiently addressing challenges and extending to innovative applications, maximizing energy utilization sustainably. The article is structured into sections: Introduction establishes context, Related Work compares existing approaches, The SolarEdge Solution details the technology, SolarEdge's Role in Advancing Sustainable Irrigation explores its application, and Conclusions summarize its impact on photovoltaic systems and sustainable energy.

2. Related work

The development of sustainable energy resources is one of humanity's most urgent challenges, as increasing energy demand is in great conflict with the world's limited availability of fossil fuels. Among various kinds of sustainable energy resources, solar energy is considered promising due to its inexhaustible supply, widespread presence, large capacity and environmental friendliness [2].

Solar energy offers a viable solution to address the energy demands crucial for humanity's survival on Earth. Its applications span a range of sectors, including electricity generation through solar panels, thermoelectric generators, and Rakine cycle technology. Furthermore, solar power facilitates water purification, agricultural product drying, refrigeration, and pollution-free irrigation through solar-based pumping systems. Researchers worldwide have extensively explored solar energy's potential in these applications [3].

Advances in Internet of Things (IoT) technology have made it possible to remotely operate, monitor, and control distributed solar energy resources. His IoT-based solar energy system design for smart irrigation is of critical importance to regions around the world facing water and power shortages. Therefore, in this work, such a system is designed. The proposed system uses a single-board system-on-chip controller ("controller") with built-in WiFi connectivity and connectivity to solar cells to provide the necessary operating power. The irrigation pumps are operated by the controller by issuing the proper actuation command signals after reading field soil moisture, humidity, and temperature sensors. The controller also monitors the groundwater level. This is important to prevent the pump motor from burning out due to the well water level. The proposed system has three modes of operation: local control mode, mobile supervisory control mode, and fuzzy logic-based control mode. A prototype was designed, built and tested to validate the proposed system [4].

Power shortages and high diesel costs are impacting the city's water supply and irrigation pumping needs. Therefore, using solar energy to pump water is an effective substitute for conventional systems that rely on grid power and diesel [5]. Over the past decades, clean and renewable energy has become a priority for the majority of countries from an environmental and economic perspective. One of the best solutions is to harness the abundant and almost free solar energy to power all sectors, especially the irrigation sector. Large amounts of solar radiation occur during the growing season of crops that require frequent irrigation [6] .

Mitigating electricity deficits and rising fuel costs is vital for efficient irrigation. Solar energy presents an attractive alternative to traditional electricity and diesel-driven water pumping systems. This approach powers irrigation water pumps alongside sprinklers, with a focus on conserving both electricity and water. Incorporating photovoltaic (PV) technology, which generates electricity from sunlight, drives the motor powering the solar pump [7]. By synergizing the sprinkler system with cost-effective and environmentally friendly PV technology, the consumption of both electricity and water is minimized [8].
A new way to mix AC and DC power via an all-in-one soft-start converter/regulator offers the opportunity to reduce costs, diversify fuel sources and provide continuous off-grid power in remote locations. By installing an electric submersible pump with solar power in

combination with a diesel generator, diesel energy can be replaced with a renewable fuel source. Benefits of adopting renewable fuel sources include reduced greenhouse gas emissions per bale of cotton produced and reduced labor required to monitor and maintain conventional diesel irrigation systems [9]. Emissions calculations show a reduction of 26% or 35 kg CO2eq per bale of fluff, a reduction of 2,665 tonnes/CO2eq over the life of the project [10] .

The most convenient energy available today is solar energy harnessed by solar cells that convert thermal energy from the sun directly into electrical energy. Sun tracking, converting direct current to alternating current, and using timers to operate agricultural engines are all active research topics. During tracking, the solar panel is always oriented perpendicular to the sun's rays, effectively charging the battery where the light intensity is higher, and the energy in the form of DC is converted to AC through an inverter [11]. The energy required from the battery is used to run the motor. To automate the stepper motor, its shaft is fitted with a silicon solar panel controlled by a microcontroller. Two sensors are connected to the microcontroller, one to record the position of the sun and the other to record the day and night. The first sensor detects the position of the sun attached to the solar panel and the stepper motor is controlled accordingly so that the light beam is always perpendicular to the solar panel. An AT89C51 microcontroller is used for this logic and embedded C program coding is provided in the KEIL Micro Vision Editor. We analyzed the average amount of energy available from the pump, the efficiency that the panel achieves during operation [12].

3. The SolarEdge solution

3.1. The problem

In the pursuit of sustainable and efficient energy production, conventional photovoltaic systems often tackle a range of challenges that hinder optimal performance. Among these challenges, shading effects, panel discrepancies, and deficient monitoring mechanisms emerge as significant hurdles that hinder energy generation's full potential.

Shading, whether from bordering structures or natural obstructions, poses a considerable threat to energy generation. When even a single panel is cast in shadow, the entire system's efficiency can be compromised. Additionally, variations in panel manufacturing can result in output discrepancies, where some panels outperform others. These variations not only undermine the overall system's efficiency but also impede the system's ability to generate energy uniformly.

Furthermore, the limitations of traditional monitoring approaches restrict the timely identification of performance issues. This lack of real-time insights often leads to undetected inefficiencies that accumulate over time, resulting in reduced energy generation. Consequently, the inefficiencies in energy production and monitoring culminate in suboptimal performance, preventing the goals of sustainability and efficiency.

SolarEdge technology emerges as a revolutionary approach, tackling the problems head-on. By integrating power optimizers at the panel level, shading effects are mitigated, and individual panels' performance is optimized. Moreover, the hybrid inverter with advanced

control capabilities maximizes energy conversion and facilitates integration with alternate energy sources.

3.2. The solution

SolarEdge leads in a transformative paradigm that not only addresses the limitations of conventional photovoltaic systems but also reshapes our perception and utilization of solar energy. In response to challenges related to energy production and monitoring in traditional photovoltaic setups, the innovative SolarEdge technology emerges as a revolutionary remedy. This section delves into its essential components and the way it challenges established conventions. The SolarEdge approach entails a revolutionary shift that optimizes energy generation and control through the integration of advanced hardware and software. By implementing power optimizers at the panel level, issues like shading and performance limitations are eliminated, leading to the maximization of energy output. This technology also collaborates seamlessly with alternative sources such as batteries or the grid, ensuring adaptability to diverse energy requirements. The inclusion of a remote management system enables real-time monitoring, facilitating efficient energy utilization. SolarEdge's transformative impact extends beyond mere efficiency, propelling photovoltaic systems into a new era of flexible, data-driven energy management.

3.3. Unveiling SolarEdge technology

SolarEdge's visionary solution rests upon an ingenious integration of advanced components that revolutionize the performance of photovoltaic systems. At the heart of this innovation lies the deployment of power optimizers at the individual panel level. These power optimizers act as sentinel guardians against shading effects, ensuring that even in the presence of partial shading, energy generation remains optimized.

By distributing intelligence to each panel, SolarEdge's power optimizers engage in dynamic power point tracking, adapting to the prevailing conditions to maximize energy production [13]. This granularity of control ensures that energy loss due to shading is minimized, encouraging overall system efficiency. Furthermore, panel discrepancies are neutralized, as each panel's performance is optimized independently, culminating in uniform energy generation across the entire system.

The pinnacle of SolarEdge's innovation is embodied by its hybrid inverter with advanced control capabilities. This component not only enhances energy conversion efficiency but also catalyzes seamless integration with alternate energy sources. By supporting bidirectional energy flow, the hybrid inverter facilitates the injection of surplus energy back into the grid, ensuring that no energy generated goes to waste.

As a testament to SolarEdge's effectiveness, the technology's implementation leads to significant improvements in energy output and operational efficiency. The harmonious synergy between power optimizers and the hybrid inverter transforms photovoltaic systems into dynamic power-generating hubs, capable of adapting to varying conditions and extracting maximum energy from the available resources.

Intriguingly, the impact of SolarEdge technology extends beyond energy generation to sustainable agriculture. By optimizing energy production and ensuring efficient monitoring, SolarEdge opens doors to enhancing irrigation practices. The application of

SolarEdge's principles in irrigation systems potentially revolutionizes water management, a critical aspect of sustainable agriculture.

In the subsequent sections, we delve deeper into the mechanics of SolarEdge technology, exploring its impact on monitoring, irrigation, and the wider landscape of renewable energy. Through its innovative approach, SolarEdge reshapes the landscape of photovoltaic systems, offering an efficient, sustainable, and future-oriented solution to the energy challenges of today.

4. SolarEdge's role in advancing sustainable irrigation

As SolarEdge technology revolutionizes the landscape of photovoltaic systems through enhanced energy production and monitoring, its impact extends beyond electricity generation. This section delves into the transformative role SolarEdge plays in revolutionizing irrigation practices, conducting in a new era of efficient and sustainable water management [14]. SolarEdge technology offers specific benefits in the context of irrigation by providing an innovative solution for sustainable water management. By optimizing photovoltaic system performance and ensuring efficient energy production, SolarEdge technology not only addresses energy challenges but also empowers the effective utilization of solar energy for irrigation purposes. The real-time monitoring platform enables precise tracking of energy production and consumption, allowing for timely adjustments to irrigation schedules based on available energy resources. This integration of SolarEdge technology with sustainable irrigation practices contributes to water conservation and increased agricultural productivity, showcasing its versatile and impactful role in advancing both energy efficiency and water management [15].

4.1. Enhancing energy-efficient irrigation

The conventional landscape of irrigation systems has long been sustained by energy sources that are deeply established in traditional power grids. These sources, often reliant on fossil fuels, not only impose a substantial economic burden but also come with significant environmental consequences. The consumption of these finite resources and the associated emissions have cast a shadow on the sustainability of conventional irrigation practices. Furthermore, the unpredictability of energy costs and supply disruptions exacerbates the challenges faced by agricultural operations, which are already susceptible to various external factors. Amid these challenges, a transformative solution emerges through the integration of SolarEdge technology. This integration marks a pivotal departure from the norm, offering a revolutionary approach to powering irrigation systems. By harnessing the inexhaustible potential of solar energy, SolarEdge technology introduces an entirely new dimension to irrigation practices. This paradigm shift not only addresses the limitations of traditional energy sources but also showcases a forward-looking commitment to sustainable and environmentally friendly energy solutions. Solar energy, abundantly available through sunlight, represents a remarkable departure from conventional energy sources. SolarEdge's adoption of this renewable energy source aligns seamlessly with the global movement towards cleaner and greener energy solutions. By tapping into the sun's vast potential, SolarEdge technology not only mitigates the economic and environmental challenges posed by conventional energy sources but also contributes to a more sustainable energy landscape. This alignment with the broader shift towards renewable energy

underscores SolarEdge's commitment to leading in a future characterized by reduced carbon footprints, minimized resource depletion, and enhanced energy security.

4.2. Optimized operational efficiency

The integration of SolarEdge's innovative power optimizers and advanced control capabilities into irrigation systems indicates a new era of operational efficiency that is unparalleled in its impact. Drawing from their well-established success in photovoltaic systems, SolarEdge's power optimizers play a pivotal role in ensuring that solar energy is harnessed to its fullest potential, even when confronted with challenging conditions such as partial shading. This transformative technology optimizes each individual solar panel's energy production, virtually eliminating energy losses caused by shading. As a result, the operational efficiency of irrigation systems powered by SolarEdge is remarkably enhanced, guaranteeing a consistent and reliable energy supply that transcends the limitations of traditional energy sources.

In the realm of traditional energy-dependent irrigation, interruptions and fluctuations in energy supply are common, often leading to disruptions in agricultural operations and compromised crop yield. The inclusion of SolarEdge's power optimizers effectively addresses these challenges, offering a solution that not only ensures uninterrupted energy supply but also mitigates the risks associated with energy source vulnerabilities. By capitalizing on the fundamental efficiency of solar energy and leveraging advanced control mechanisms, SolarEdge empowers irrigation systems to operate seamlessly, regardless of external factors that would otherwise hinder their performance.

This optimized operational efficiency aligns perfectly with SolarEdge's overarching commitment to sustainability and resource conservation. By seamlessly integrating power optimizers into irrigation, SolarEdge provides an adaptable and intelligent solution that not only elevates the energy output but also enhances the overall operational stability of agricultural systems. Through this integration, SolarEdge not only innovates a new level of efficiency within irrigation practices but also fosters a paradigm shift towards sustainable energy utilization, setting new standards for agricultural productivity and ecological responsibility.

4.3. Real-time monitoring for precision irrigation

SolarEdge's groundbreaking approach revolves around its advanced monitoring platform, which has already proven effective in optimizing energy production. This expertise seamlessly extends to irrigation systems, revolutionizing water resource management. This section explores how SolarEdge's real-time monitoring empowers precise irrigation practices with unparalleled accuracy and efficiency. The platform provides real-time insights into vital parameters like water usage and soil moisture, enabling farmers to tailor irrigation strategies for optimal crop growth. The synergy between energy production and monitoring is a game-changer, directing surplus energy to power irrigation during peak demand, efficiently utilizing water resources without compromising energy efficiency. This harmonious balance between energy and irrigation monitoring fosters responsible water use and productive harvests. By harnessing real-time monitoring, SolarEdge not only tackles inefficient irrigation but also sparks data-driven agriculture, optimizing schedules

and achieving higher yields sustainably. The integration of SolarEdge's monitoring platform into irrigation propels the sector towards a more technologically advanced and sustainable future.

4.4. Paving the way for sustainable agriculture

SolarEdge's technology goes beyond mere efficiency gains in irrigation, making a substantial contribution to sustainable agriculture amidst global challenges. By enhancing energy efficiency and operational aspects, it addresses environmental concerns and aligns with the objectives of responsible resource consumption. The integration of SolarEdge into irrigation conserves water, reduces carbon emissions, and encourages eco-conscious methods. SolarEdge redefines farming by showcasing how innovation can align with sustainability, benefiting crops and the environment. It advances efficient irrigation, fostering a greener agricultural sector and marking a pivotal step towards a sustainable future.

4.5. General approach to irrigation

SolarEdge's approach to irrigation is a general transformation of water management systems that integrates energy production, monitoring, and irrigation. This comprehensive solution optimizes resource utilization by efficiently directing surplus energy to power irrigation during peak demand. Real-time monitoring enhances precision and control in irrigation practices, enabling informed decisions to minimize water wastage while maximizing crop yields. This integrated approach fosters a balanced synergy between energy and agriculture, promoting responsible and eco-friendly farming practices while addressing challenges in both sectors. SolarEdge's innovative approach redefines resource management, ensuring a harmonious and sustainable relationship between energy and agricultural needs.

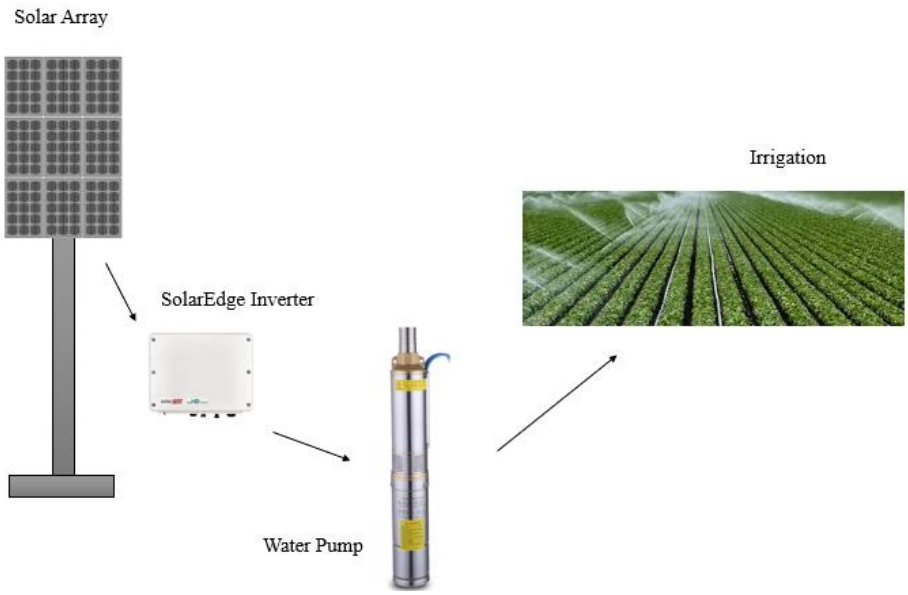

Fig. 2. The conceptual framework detailing the implementation of SolarEdge Technology within irrigation systems.

5. Challenges and limitations

While the integration of SolarEdge technology into irrigation systems presents a promising advancement in sustainable agriculture, it's important to acknowledge and address its potential challenges and limitations.

5.1. Technical and performance challenges:

SolarEdge technology relies on solar energy, which is inherently intermittent. This variability can impact the consistency and reliability of power supply for irrigation, particularly in regions with fluctuating weather conditions.

The integration of advanced solar technology adds complexity to the irrigation systems [16]. This necessitates regular maintenance and technical expertise, which might not be readily available in all agricultural regions, and which might increase the overall costs of operation above the threshold set by local fuel prices in the case of diesel generators and electricity prices in the case of power-grid powered irrigation systems.

5.2. Socio-economic challenges:

Technology Adoption Barriers: Farmers, especially in developing countries, may face barriers in adopting new technologies due to lack of awareness, technical know-how, and reluctance to change from traditional methods [16]. Furthermore, the economic viability of solar powered water irrigation systems, will be hindered by the high cost of adoption; thus, the return on investment period may be too long to justify the initial expense, especially without subsidies or financial incentives. Coupled with the lack of a financing option for smaller farmers, although more economically feasible in the long term, most farmers will choose traditional methods for powering up irrigation systems for vast areas, consisting of diesel powered generators.

The upfront costs of installing SolarEdge systems can be significant. This includes the cost of solar panels, inverters, batteries for storage, and installation labor, potentially making it less accessible for small-scale farmers or those in developing countries.

5.3. Environmental and regulatory challenges:

The manufacturing process of solar panels, including the extraction of raw materials, can have environmental impacts that should be considered in a sustainability assessment. Studies are yet to show whether the current technology of PV cells makes their lifetime carbon footprint lower than that of a diesel generator. However, lower localised pollution will be ensured with the use of a SolerEdge system.

Waste Management: At the end of their life cycle, solar panels and batteries require proper disposal or recycling. This raises concerns about waste management and environmental sustainability.

Regulatory Hurdles: In some regions, there may be regulatory challenges or a lack of supportive policies for the integration of solar technology in agriculture.

5.4. Suggestions for further research and information:

International Renewable Energy Agency (IRENA): IRENA provides comprehensive resources on renewable energy technologies, including solar-powered irrigation systems.

Agricultural Extension Services: Local agricultural extension services can offer practical insights and resources on the implementation of solar technology in farming.

SolarEdge Technologies Publications: Reviewing publications and case studies directly from SolarEdge Technologies can provide detailed technical information and updates on their latest innovations.

Academic Journals: Journals focusing on renewable energy, sustainable agriculture, and environmental studies often publish research on the advancements and challenges of solar technologies in agriculture.

Government Agricultural and Energy Departments: National and regional departments often have resources and data on renewable energy initiatives in agriculture, including potential funding and subsidies.

By addressing these challenges and limitations, stakeholders can work towards more efficient, accessible, and sustainable integration of SolarEdge technology in irrigation systems, paving the way for advancements in agricultural practices.

6. Conclusions

This articole introduced the main concepts of how SolarEdge technology brings about a transformative change in the realm of photovoltaic-enhanced irrigation systems. By addressing shading, monitoring limitations, and inefficiencies in energy production, SolarEdge not only maximizes energy generation but also extends its impact to sustainable irrigation practices. The integration of solar energy into irrigation systems marks a significant stride towards a greener future, where technology and innovation converge to create more efficient and eco-friendly solutions. With its versatile approach and commitment to efficiency and sustainability, SolarEdge paves the way for a world powered by the sun, nurturing both energy generation and agriculture.

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