Educational Challenges and Opportunities in the Era of AI-Driven Smart Cities

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Abstract
Objectives: This paper aims to identify and analyze the most significant challenges and opportunities of the educational processes in smart cities, from both the perspective of providers and beneficiaries. **Prior work**: Currently, there is an increased interest in achieving results in a very short time, a trend that also affects the knowledge acquisition and delivery. This has led to the emergence of numerous platforms offering courses in various fields, often with exaggerated promises. On the other hand, traditional education systems are generally more rigid, requiring long-term effort and determination. The highly dynamic life in smart cities, along with social, technological, and economic changes, has created new individual expectations and a constant need for adaptation. Naturally, these changes are also reflected in the educational process. **Approach**: Based on existing literature, this paper aims to identify and propose solutions for solving these challenges and exploiting the opportunities, focusing on integrating the latest and most efficient technologies, but only to the extent that they bring real benefits to the citizens of smart cities. **Results**: As a result, there are numerous challenges for institutions and organizations that provide education in a formal setting, requiring continuous adaptation to meet the expectations of both beneficiaries and the market (curriculum, teaching style, interaction methods, etc.). **Implications**: The numerous and diverse technologies used in smart cities need to be understood and utilized effectively to contribute to the goal of a better quality of life for citizens, in a cleaner and safer environment. This requires educational adaptation by providers to meet beneficiary and market expectations. **Value**: The value lies in the paper's focus on integrating the latest and most efficient technologies, but only to the extent that they bring real benefits to the citizens of smart cities.

Keywords: educational process, smart people, digital technologies.

1. Introduction

The concept of the smart city has achieved great success over the past decades, being widely adopted by urban communities worldwide. It has become a milestone and a significant brand [1]. The evolution of smart cities has been made possible primarily by innovations in the field of information and communication technologies (ICT), with a focus on their efficient and sustainable application to enhance the well-being of citizens and support environmental sustainability. Smart cities, however, represent the outcome of a collective effort involving local governments, businesses, and citizens, emerging as a natural consequence of technological progress [2]. Their development is driven by the continuous efforts of communities made up of intelligent and educated individuals, fostering an environment that attracts others with similar skills and knowledge. This creates „a virtuous circle making them smarter and smarter" [3]. Aspects related to smart cities most often refer to improving the efficiency of city governance, infrastructure, business, healthcare, mobility, environment, and education. The overarching goal is to enhance citizens' quality of life within an environment characterized by sustainable economic development, a process facilitated using smart technologies. Concerns have grown further in the context of recent climate changes, which present serious causes for alarm. The

current trend is the integration of cutting-edge technologies, such as the Internet of Things (IoT), big data, machine learning, fifth-generation (5G) networks, various robotic and automated systems, electric vehicles, etc. [4, 5], with the aim of maximizing benefits and enhancing the functionalities provided by existing technologies.

Smart cities have been analysed from various perspectives – social, economic, technological, environmental, etc. – each of their dimensions holding significant importance. However, their evolution is primarily driven by two fundamental components: people and technology. These form the foundation for the development of all dimensions of smart cities, namely smart economy, smart mobility, smart living, smart governance, smart environment, and smart citizens.

From the perspective of education, smart people are of particular interest. This dimension of smart cities refers to leveraging technology to empower individuals and communities within cities, made possible through initiatives such as digital literacy programs, online education platforms, and the promotion of inclusive and accessible technologies [6, 7]. In this context, supported by local administrations and their fellow citizens, residents will acquire the necessary skills to utilize all the facilities provided by digital technology in smart cities, becoming more informed and empowered. According to [8], citizen involvement in smart city development projects is essential for the sustainable growth of cities, especially as creativity acts as a key driver [9]. This is facilitated through education, continuous learning, and the accumulation of knowledge, all of which serve as foundational pillars of smart cities.

In the context of the remarkable advancements of recent years, artificial intelligence (AI) plays an essential and increasingly expanding role in the development of smart cities, offering benefits across a wide range of fields such as finance, healthcare, security, agriculture, education, logistics, utilities, tourism, and manufacturing. However, it also presents numerous challenges and limitations, particularly related to technology, the environment, and organizational aspects.

The rest of this paper is organized as follows: Section 2 reviews research related to the use of AI in education. Section 3 identifies and analyses the main barriers to AI adoption in smart cities, while Section 4 presents the primary challenges of adopting AI-based technologies in education, along with solutions for addressing them. This section includes an analysis of the opportunities offered by AI for the communities of smart cities. A summary of the main findings and conclusions is provided in Section 5.

2. Artificial intelligence in education

Education has always played an essential role in the evolution of society, being both a right and a moral obligation of citizens. Throughout history, it has undergone various changes. The dynamics of the educational process have been significantly influenced by the evolution of society, and in recent decades, notably by the development of ICT. At the same time, it is evident that education has made progress possible. The relationship between them is bidirectional. According to [10], until 1900, human knowledge doubled approximately every century, while by the end of World War II, it doubled every 25 years. Today, the rate

of growth is even higher due to the IoT, big data, increased computing power, processing speed, and data storage capacity. The educational system is the first to adapt to these changes to meet the expectations of the business environment and society.

In recent decades, digital technologies have played an essential role in social and economic life, driving fundamental changes in the way people think, live, work, and interact. The development of AI, particularly through the achievements in machine and deep learning witnessed in recent years, continues to generate a continuous dynamic across all dimensions of human life. The idea of using AI in education has been around for approximately 25 years, introduced in various forms and through diverse channels [11]. AI-based tools and applications, such as intelligent robots, assistive technology, intelligent tutoring systems, and adaptive learning systems, are increasingly used in both formal and informal education, from K-12 levels to universities. The most frequently cited benefit is the ability to personalize the educational process to meet the individual learning needs of each student. Research in this field is relatively extensive and addresses a wide range of aspects. In formal education, [12] explored the potential of AI to enhance teacher effectiveness and student engagement through the use of intelligent game-based learning environments, tutoring systems, and intelligent narrative technologies. In informal education, [13] analysed the possibility of using AI to educate citizens about public policies and to develop a mechanism aimed at increasing efficiency in high-uncertainty environments, fostering cross-sectoral collaboration in smart cities. [11] found, based on an analysis of 45 articles related to the use of AI in education, that very few studies were grounded in learning theories. Meanwhile, [8], without explicitly focusing on education, highlighted the significant role of citizen involvement in implementing smart city projects through digital co-creation. According to the authors, this approach involves active participation and 360-degree communication, yielding positive effects on awareness, urban strategy, and the development of long-term plans.

In another study, [14] reviews the literature and identifies three major paradigms related to AI in education: AI-directed, AI-supported, and AI-empowered. The authors effectively capture AI's role in addressing challenges related to teaching methods, clearly highlighting the characteristics of each paradigm and the benefits brought by the shift in approach regarding the use of AI-based technologies in education, made possible by technological advancements.

The AI-directed paradigm, or learner-as-recipient, positions the student as a recipient of the services provided by AI. In this approach, students follow predefined learning paths, adhere to specific learning procedures, and perform actions determined by AI to achieve preset objectives. While some advanced systems collect data about students to assess their levels and needs, this paradigm remains the least student-centred. It does not fully adapt to the individual needs of the student or the characteristics of the group.

The second paradigm, AI-supported, or learner-as-collaborator, involves collaboration between the student and AI to optimize the learning process. The system collects information about the student to tailor the learning process to their specific needs, marking a significant step toward student-centred learning through mutual interaction and sustained

collaboration [14, 15]. Data regarding students' acquired knowledge must be updated in real-time, given that both the state of the AI system and the students are dynamic. The system provides immediate feedback to students, which they can use to make decisions and improve the learning process.

The third paradigm identified by [14], referred to as AI-empowered or learner-as-leader, positions the student as the leader of the learning process. In this case, AI serves merely as a tool within a broader system comprising students, teachers, and other human actors who collectively support the augmentation of human intelligence and potential [16, 17], while ensuring transparency, accuracy, and interpretability [18]. In this approach, the goal of AI is to enhance human creativity, reasoning, and productivity rather than to automate processes. AI-driven education in the learner-as-leader paradigm must be interdisciplinary, integrating pedagogical, social, cultural, technical, and ethical aspects [14], aligning with human values and remaining student-centred. The student becomes the leader of their own learning process, while the teacher benefits from personalized support provided by AI systems to facilitate this journey.

AI is employed in various forms in education, such as teaching robots, learning analytics dashboards, intelligent tutoring systems, adaptive learning systems, and human-computer interactions [14]. These technologies serve a wide range of purposes, including identifying individual learning styles, predicting dropout rates in online courses, managing student retention, assessing student performance, analysing emotional states, forecasting behaviour in game-based learning environments, and dynamically generating game levels to foster progress and maintain engagement in the learning process [11].

AI brings significant benefits to education, most notably the ability to personalize the learning process by analysing student performance, identifying weaknesses, and providing tailored materials or training to meet individual needs [19]. Additionally, it facilitates the creation of interactive learning materials, real-time assistance, and feedback, which can encourage students to actively engage in the educational process. For instance, [20] developed a machine learning-based framework to adapt learning content and deliver personalized materials to different students. This approach ensures that each student receives resources aligned with their interests, learning style, and capabilities. Moreover, AI-based technologies are becoming increasingly accessible, paving the way for innovative applications. Online platforms enable access to educational resources regardless of geographic location. Virtual laboratories can also be created, simulating classroom-like learning environments with the help of virtual and/or augmented reality.

3. Artificial intelligence in smart cities

A literature review conducted by [21] identifies eighteen barriers to the adoption of AI in smart cities, which are grouped into three categories: technological, organizational, and environmental (Table 1).

Table 1. The barriers of adoption AI in smart cities

Category	Barriers
Technological	Privacy, cyber security, lack of AI explainability, disruptive nature, singularity, decision-making, digital divide, complexity of understanding, use and implementation, data quality and availability
Organizational	Lack of financial resources, lack of infrastructure, limited skills of human resources, employee resistance to change
Environmental	Mass unemployment, public fears and non-trust, lack of legal framework, negative impact on sustainability, negative impact on economic development

Source: [21]

Privacy and cybersecurity are considered the most critical challenges, both in literature and in practice. Developing real solutions in this regard requires more than just the existence of robust ICT infrastructures. It necessitates the formulation of clear, widely adopted security strategies that predict attacks and mitigate their potential negative effects. Smart cities must be able to protect their citizens. In this context, establishing mechanisms to ensure cybersecurity by defining a framework that guarantees compatibility between human values and the use of AI is an essential part of the solution [22, 23]. The analysis of impact and the establishment of mechanisms to protect citizens must precede the adoption of AI. In this regard, a crucial role is played by leveraging the experience of different governmental actors at the national, state, and local levels [21, 24]. A key advantage today is the availability of successful models in this direction, including cities like Tokyo, Singapore, Chicago, San Francisco, New York, Amsterdam, London, etc.

AI explainability is an important characteristic that significantly influences user acceptance. Users need access to the entire decision-making process carried out by an AI-based system. This must be clear and transparent. Understanding this process often requires a high level of citizen education, which can only be achieved through systematic learning. Individuals involved in the development of smart cities should be aware that AI explainability is essential for building public trust in AI. Collaboration between educational institutions, public administrations, and the private sector is necessary to raise public awareness of AI, both for its acceptance and development. This collaboration is essential to improving the quality of services that smart cities will offer to citizens and entrepreneurs. According to [22], greater trust in AI systems could reduce inequalities by preventing bribery, intimidation, and ensuring transparency, as long as the algorithms are open and certified. However, the adoption of AI must not deepen digital divide and other social inequities, as social inclusion is a fundamental characteristic of smart cities.

It is also essential to minimize the fear related to job displacement, and AI explainability can help with this. Undoubtedly, AI will lead to shifts in the labour market. This fear has always accompanied technological evolution since the Industrial Revolution. However, history has shown that technological change has generally created jobs, although it has also driven transformations in demand. Smart education can address this need by anticipating changes and adapting student education to meet future labor market requirements, rather than just the current ones. Some emerging roles in smart cities in the context of AI development include: digital twin specialists (responsible for creating and maintaining the data infrastructure, integrating urban data from various sources – e.g., hospitals, traffic,

energy consumption –, incorporating predictive models and machine learning, and creating scenarios to identify components that can and should be automated.), AI ethics officers (responsible for developing and implementing ethical principles in AI development and usage, monitoring the impact of AI decisions on urban communities, and promoting transparency in AI-based decisions), urban ecosystems landscape architects (responsible for designing intelligent and ecological infrastructure solutions for transport, energy networks, waste management, environment, etc., creating strategies for environmental protection, and optimizing resource consumption), smart cities project managers (responsible for coordinating projects that ensure the integration of AI and IoT technologies into scalable solutions tailored to the needs of smart cities, collaborating with stakeholders (governments, companies, citizens), and creating frameworks for implementation, standards, and best practices for integrating technologies in smart cities). The mentioned roles reflect how AI-driven smart cities intersect with education, offering new opportunities for the training of specialists and engagement in fields that are expected to experience rapid evolution. A study conducted by [25] identifies the following emerging jobs in smart cities: smart city planner, smart city IT manager, and smart city officer. These roles were identified through discussions with field experts and partners within the Erasmus+ project Smart-DevOps. For each role, the authors identified the necessary skills, which are useful in designing educational projects, whether referring to formal or informal education, short-term training or lifelong learning. The authors identified 102 skills, grouped into four categories: transversal (or soft) skills, generic IT skills, DevOps skills, and smart city-specific skills. The results reveal that the most important skills for the mentioned roles are social skills, project and process management, smart city context, policies, and operating procedures, urban management, and strategic vision & strategy development. The most valued specific knowledge strictly related to the ICT domain includes IoT, software development, GIS technologies/spatial data analysis, and big data analytics.

4. Education in AI-driven smart cities

The literature extensively highlights the impact of modern digital technologies in smart cities, particularly from the perspective of AI-based technologies [26, 27, 28]. However, the digitization of cities requires the development of skills related to digital technologies, which can be acquired through both formal and informal learning. In smart cities, universities are the main providers of specialists in ICT and, implicitly, in AI. However, all citizens should be the beneficiaries of knowledge on the developing topic of AI. Consequently, there is a need for at least widespread familiarity with the basics of AI: how to interact with it, how to leverage its functionalities and benefits, and the boundaries that should be set from an ethical perspective. Public administrations must support both the understanding of risks and the development of trust in AI. The lack of education and resources sets a significant challenge and limitation to AI adoption, restricting access for individuals, small organizations, or less affluent communities. Additionally, it is important for public administrations to simultaneously manage AI adoption and its impact on workforce displacement [22], as mentioned in the previous section. In this spirit, [29] analysed labour market demand for three categories of skills – human, business and digital – published in job advertisements from eight U.S. smart cities with populations exceeding 600,000. Their study findings reveal that the most in-demand skill in smart cities is communication (featured in 40% of job postings), followed by collaboration (21%), critical

thinking (21%), and analytical skills (17%). At the same time, 94% of job postings requiring new foundational skills are in the field of information technology, followed by analysis (91%) and science and research (91%). Regarding digital skills, data management and software development remain highly desired competencies. In the business enable category, business process management and project management dominate demand. Furthermore, creativity stands out as one of the most highly valued skills in smart cities, underscoring that concerns about widespread job loss due to AI development may be overstated.

In the context of the changes brought about by the development of smart cities on one hand and the increasing performance and impact of AI on the other, it is essential to adapt the education system to support and capitalize on the transition to smart cities. This does not imply an exclusive focus on training specialists in the ICT field, as highlighted by the previously mentioned study, particularly given that a significant number of tasks are being taken over by AI. This requires the development of creativity, critical thinking, and holistic approaches. Furthermore, fostering adaptability is essential, as the ability to respond promptly to economic and social changes is a prerequisite for adjusting to the dynamic living conditions in smart cities. In this context, the education system must ensure the development of transversal competencies such as critical and innovative thinking, complex problem-solving, information literacy, global citizenship, etc. Table 2 outlines several challenges posed by AI in smart cities from an educational perspective.

Table 2. Challenges and solutions for AI integration in education within smart cities

Challenge	Solutions
Competences	Adapting the curriculum to develop transversal competencies (critical thinking, complex problem-solving). Incorporating concepts such as AI, IoT, and big data into school curricula from the early stages of the educational process. Creating adaptive platforms that provide personalized lessons based on the student's profile, knowledge, skills, and capabilities. Developing interdisciplinary themes that integrate as many dimensions of smart cities as possible.
Inequal access to technology	Investments by local administrations or in public-private partnerships in ICT infrastructure and services. Facilitating access to learning platforms for disadvantaged groups, such as children from underprivileged families. Involving community members in mentorship projects aimed at individuals less familiar with technology. Creating learning platforms that require minimal technical resources.
Excessive reliance on technology	Integrating technology as a support, not a replacement, for both teachers and students. Supporting the development of socio-emotional intelligence in both formal and informal settings. Encouraging offline activities that create a balance between the use of technology and onsite education.
Ethical considerations	Educating students to distinguish between cheating and the use of AI technologies for enhancing knowledge. Creating assessment methods that include the use of AI. Using generative AI as a teaching tool in the classroom by designing AI-enhanced learning experiences.

	Actively involving students in the learning process by using AI as an assistant in completing tasks they are required to solve.
Large amounts of data required to train systems	Engaging the academic community by using AI in the classroom, even in the absence of well-defined rules and frameworks, to contribute to their formulation. Encouraging students to use AI technologies in their training programs. Establishing public-private partnerships to obtain the necessary funds to support AI-based system development programs.

Source: authors

The use of AI in education offers a range of opportunities for users, communities within smart cities, and for smart cities as a whole. Teachers in schools and universities can utilize AI-based technologies to support the learning process and interaction with students. At the same time, teachers have the opportunity to eliminate certain repetitive and routine tasks, becoming more prompt in providing feedback to students and stimulating an adaptive and personalized teaching process [30], as each individual has their own learning style determined by intelligence, skills, experience, personality traits, interests, etc. As a result, creating courses tailored to the profile of each individual can be highly beneficial. AI should become a partner in education that stimulates creativity and critical thinking, and if a task can be fully completed by AI, it is likely not challenging enough to foster deep (human) learning [31].

In the same context of adapting the educational process to technological and behavioural changes, the use of gamification has become important in education. Gamification is the application of game design elements to non-game activities such as education, business, health, in-service training, organizational management, social policy, etc. [32, 33]. It stimulates engagement, motivation, a positive attitude, active participation, collaboration, and potential behavioural changes [34]. Considering the massive investments in AI made by the e-gaming industry to increase their popularity and attractiveness, the use of AI in education by gamification becomes natural.

In smart cities, AI in education can provide real-time assistance and feedback, helping citizens in both formal and informal educational settings to better understand the areas where they need improvement. AI offers quick access to a synthesis of information relevant to the user. Currently, the volume of information available online is vast and poorly organized. As a result, accurately identifying the information a user needs at any given moment have become challenging. Searching for this information has become highly time-consuming. It involves going through many resources, often inconsistent or irrelevant to the intended purpose. AI has the capacity to process vast amounts of information, synthesize it, and provide students with the information they need in real time, giving them more time to use it creatively rather than spending it on the search itself. However, it remains essential for students to validate the information obtained and transform it into their own knowledge. There are still many concerns about the accuracy and consistency of information generated, especially in the context of the growing popularity of tools that utilize generative AI, such as ChatGPT, Gemini, Copilot, Jasper, Grammarly, etc.

Another aspect that should be mentioned is that the use of AI is often associated with distance learning. This is neither the goal nor the approach. Teachers must adopt AI-based technologies in the classroom. The concept of a smart classroom reflects the technological advancements integrated into educational spaces, involving the use of ICT tools such as mobile technologies, automated communication and learning tools, video projectors, cameras, sensors, facial recognition software, etc. [35]. These technologies are employed in the classroom to stimulate attention, performance, creativity, intelligence, and critical thinking in students. To achieve this, the curriculum must include AI and digital literacy from the early stages of the educational process. The Education 4.0 framework [36] suggests that the educational system must assimilate these technologies and focus on leveraging them to develop skills required by the labour market, such as creativity, leadership, problem-solving, critical thinking, etc.

In smart cities, there is still a digital skills gap among various user categories, who, at the same time, are significantly exposed to technology. The integration of AI into the educational system, through traditional or innovative methods, as well as into daily life, can enhance users' preparedness by providing targeted information or by familiarizing them with the context and allowing them to deepen their understanding later, as appropriate. The creation of personalized content, another feature offered by AI, plays an important role in this regard. Customizable interfaces are particularly valuable given the diverse intellectual and physical abilities of students. According to studies, students who received individual guidance surpassed their peers in traditional classrooms in 98% of cases [37].

Career guidance is an area where AI can provide important information, especially in a digitalized environment such as smart cities, by identifying interests, passions, talents, and offering tailored recommendations to each user, maximizing their professional development potential. According to [19], the system can facilitate the exploration of personalized career paths based on the experiences of human professionals, with the lessons learned being used for career counselling activities.

AI-based education in smart cities (and beyond) must be inclusive and equitable, support the training of teachers for AI-assisted education, and incorporate inclusive systems for data collection and utilization. At both regional and global levels, there are numerous concerns regarding the adoption of AI in education. For example, at the European Union level, three directions have been outlined for maximizing the use of AI in education: learner-supporting AI, teacher-supporting AI, and institution-supporting AI [19, 38]. The World Economic Forum has outlined four key strategies for Education 4.0, aimed at "unlock the transformative potential of these technologies to enhance learning outcomes (…) generating high-quality insights and tools, engaging influential education leaders, mobilizing the global education industry, and accelerating robust national public-private partnerships" [36]. The same organization highlights the importance of both dimensions of AI use in education: "teaching about AI is equally crucial to teaching with AI" [39], as well as the importance (and necessity) of lifelong and student-driven learning, accessible and inclusive learning, problem-based and collaborative learning, and personalized and self-paced learning. These initiatives aim to encourage the adoption of AI in education to prepare graduates to respond appropriately to ethical challenges, use technology

responsibly, understand its limits and biases, acquire critical digital literacy, recognize AI, and be aware of the social implications of its use.

3. Conclusions

This paper discusses the challenges and opportunities presented by AI-based technologies in the context of smart city development. Digital transformation has a significant impact on the educational process. The curriculum in schools and universities must be adapted to the ever-changing informational demands. Moreover, schools are preparing specialists for a labour market that is characterized by a certain degree of uncertainty. Today's students will face expectations from companies that these companies cannot yet precisely define. As a result, the educational process must be open to change, critically assimilating technological advancements that, in recent years, have been centred around AI.

Early familiarization with the benefits and risks associated with the use of AI is important. In the context of developing ultra-digitalized smart cities, acquiring knowledge in this field at an early stage is even more crucial. It can make the difference between integration and exclusion. The outcome must be reflected in the sustainable economic, social, and environmental development of smart cities. Certainly, the use of AI brings numerous benefits such as personalized education tailored to the knowledge and needs of the recipient, global access to educational resources, the development of emerging careers, and sustainable education. However, challenges in adopting AI are evident, such as the need to quickly adapt curricula, unequal access to technology, excessive reliance on technology, ethical or privacy concerns, the identification and preparation for future competencies and emerging roles, and the difficulty of training systems.

To be used optimally and to their full potential, AI must be integrated into all dimensions – pedagogical, cultural, economic, and social – through established, tested, and validated educational theories. They must support inclusive and equitable education, principles that are fundamental to the development of smart cities.

References

[1] Z. Allam and P. Newman, "Redefining the Smart City: Culture, Metabolism and Governance," *Smart Cities*, vol. 1, no. 1, pp. 4-25, Jul. 2018.

[2] C. Schachtner, "Smart government in local adoption – Authorities in strategic change through AI," *Smart Cities and Regional Development (SCRD) Journal*, vol. 5, no. 5, 2021.

[3] V. Albino, U. Berardi and R. M. Dangelico, "Smart Cities: Definitions, Dimensions, Performance, and Initiatives," *Journal of Urban Technology*, vol. 22, no. 1, pp. 3-21, Jan. 2015.

[4] L. D. Radu, "Disruptive Technologies in Smart Cities: A Survey on Current Trends and Challenges," *Smart Cities*, vol. 3, no. 3, p. 1022–1038, Sep. 2020.

[5] S. Carboni, "Smart Cities in comparison: An analysis of the best Smart Cities," *SCRD*, vol. 8, no. 3, p. 65–78, Apr. 2024.

[6] R. Wolniak and K. Stecuła, "Artificial Intelligence in Smart Cities—Applications, Barriers, and Future Directions: A Review," *Smart Cities*, vol. 7, no. 3, p. 1346–1389, Jun. 2024.

[7] D. Kumar, "The Making of Smart Citizenry: Decoding "Smart Citizen," *SCRD*, vol. 7, no. 2, p. 85–96, Jun. 2023.

[8] D. Popescul, L. Murariu, L. D. Radu and M. R. Georgescu, "Digital Co-Creation in Socially Sustainable Smart City Projects: Lessons from the European Union and Canada," *IEEE Access*, vol. 12, p. 71088–71108, 2024.

[9] M. J. Montesano and P. O. Lee, "Urbanization in Southeast Asia: Developing Smart Cities for the Future?," in *Regional Outlook*, ISEAS Publishing, 2011, p. 96–100.

[10] R. B. Fuller and K. Kuromiya, Critical path. New York, NY: St. Martin's Pr, 1981.

[11] X. Chen, H. Xie, D. Zou and G. J. Hwang, "Application and theory gaps during the rise of Artificial Intelligence in Education," *Computers and Education: Artificial Intelligence*, vol. 1, p. 100002, 2020.

[12] V. K. Chaudhri, D. Gunning, H. C. Lane and J. Roschelle, "Intelligent Learning Technologies: Applications of Artificial Intelligence to Contemporary and Emerging Educational Challenges," *AI Magazine*, vol. 34, no. 3, p. 10–12, Sep. 2013.

[13] S. J. Mikhaylov, M. Esteve and A. Campion, "Artificial intelligence for the public sector: opportunities and challenges of cross-sector collaboration," *Phil. Trans. R. Soc. A*, vol. 376, no. 2128, p. 20170357 , Sep. 2018.

[14] F. Ouyang and P. Jiao, "Artificial intelligence in education: The three paradigms," *Computers and Education: Artificial Intelligence*, vol. 2, p. 100020, 2021.

[15] C. P. Rosé, E. A. McLaughlin, R. Liu and K. R. Koedinger, "Explanatory learner models: Why machine learning (alone) is not the answer," *Brit J Educational Tech*, vol. 50, no. 6, p. 2943–2958, Nov. 2019.

[16] S. J. H. Yang, H. Ogata, T. Matsui and N. S. Chen, "Human-centered artificial intelligence in education: Seeing the invisible through the visible," *Computers and Education: Artificial Intelligence*, vol. 2, p. 100008, 2021.

[17] N. W. Y. Law, "Human development and augmented intelligence," *The 20th International Conference on Artificial Intelligence in Education (AIED 2019)*, 2019.

[18] M. O. Riedl, "Human-centered artificial intelligence and machine learning," *Hum Behav & Emerg Tech*, vol. 1, no. 1, p. 33–36, Jan. 2019.

[19] C. Vrabie, "Promisiunile Inteligenței Artificiale (AI) Administrației Publice și Orașelor Inteligente," *Proceedings of the Smart Cities International Conference (SCIC)*, vol. 11, pp. 9-46, 2024.

[20] R. Bajaj and V. Sharma, "Smart Education with artificial intelligence based determination of learning styles," *Procedia Computer Science*, vol. 132, p. 834–842, 2018.

[21] A. B. Rjab, S. Mellouli and J. Corbett, "Barriers to artificial intelligence adoption in smart cities: A systematic literature review and research agenda," *Government Information Quarterly*, vol. 40, no. 3, p. 101814, Jun. 2023.

[22] Y. K. Dwivedi and et al., "Artificial Intelligence (AI): Multidisciplinary perspectives on emerging challenges, opportunities, and agenda for research, practice and policy," *International Journal of Information Management*, vol. 57, p. 101994, Apr. 2021.

[23] G. Waizel, "Marketing insights when shifting cybersecurity technologies to the cloud or hybrid cloud in the context of smart cities," *Smart Cities International Conference (SCIC)*, p. 171–184, 2024.

[24] A. Kankanhalli, Y. Charalabidis and S. Mellouli, "IoT and AI for Smart Government: A Research Agenda," *Government Information Quarterly*, vol. 36, no. 2, p. 304–309, Apr. 2019.

[25] T. Panagiotakopoulos, O. Iatrellis and A. Kameas, "Emerging Smart City Job Roles and Skills for Smart Urban Governance," in *Building on Smart Cities Skills and Competences*, Springer International Publishing, 2022, pp. 3-19.

[26] H. Ahvenniemi, A. Huovila, I. Pinto-Seppä and M. Patasius, "What are the differences between sustainable and smart cities?," *Cities*, vol. 60, p. 234–245, Feb. 2017.

[27] R. Jucevičius, I. Patašienė and M. Patašius, "Digital Dimension of Smart City: Critical Analysis," *Procedia - Social and Behavioral Sciences*, vol. 156, p. 146–150, Nov. 2014.

[28] S. Paroutis, M. Bennett and L. Heracleous, "A strategic view on smart city technology: The case of IBM Smarter Cities during a recession," *Technological Forecasting and Social Change*, vol. 89, p. 262–272, Nov. 2014.

[29] W. Markow, D. Hughes and M. Walsh, "Future skills, future cities: New foundational skills in smart cities," *Herndon Business-Higher Education Forum*, 2019.

[30] K. S. Chan and N. Zary, "Applications and Challenges of Implementing Artificial Intelligence in Medical Education: Integrative Review," *JMIR Med Educ*, vol. 5, no. 1, p. e13930, Jun. 2019.

[31] N. Cohen, "Generative AI In Classrooms: Cheating or The Future of Education?," 2024. [Online]. Available: https://www.forbes.com/sites/niritcohen/2024/09/22/generative-ai-in-classrooms/.

[32] F. F. H. Nah, V. R. Telaprolu and et al., "Gamification of Education Using Computer Games," in *Human Interface and the Management of Information. Information and Interaction for Learning, Culture, Collaboration and Business*.

[33] F. Pana-Micu, "Teoria grafurilor în optimizarea rețelelor de infrastructură urbană într-un oraș inteligent," *Smart Cities International Conference (SCIC)*, p. 333–344, 2024.

[34] I. C. Bâru, "Educație prin gamificare," *Proceedings of the 7th Smart Cities International Conference (SCIC)*, pp. 65-75, 2019.

[35] E. Dimitriadou and A. Lanitis, "A critical evaluation, challenges, and future perspectives of using artificial intelligence and emerging technologies in smart classrooms," *Smart Learn. Environ*, vol. 10, no. 1, p. 12, Feb. 2023.

[36] World Economic Forum, "The future of learning: How AI is revolutionizing education 4.0," 2024. [Online]. Available: https://www.weforum.org/stories/2024/04/future-learning-ai-revolutionizing-education-4-0/.

[37] B. S. Bloom, "The 2 Sigma Problem: The Search for Methods of Group Instruction as Effective as One-to-One Tutoring," *Educational Researcher*, vol. 13, no. 6, pp. 4-16, Jun. 1984.

[38] W. Holmes, J. Persson, I. A. Chounta and et al., "Artificial intelligence and education: a critical view through the lens of human rights, democracy and the rule of law," Council of Europe, Strasbourg, 2022.

[39] World Economic Forum, "Education 4.0. Ensuring emerging technologies improve education quality". World Economic Forum," 2024. [Online]. Available: https://initiatives.weforum.org/reskilling-revolution/education-4-0.