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Local self-government digital transformation in the context of sustainable development: potential of artificial intelligence

Transformação digital do autogoverno local no contexto do desenvolvimento sustentável: potencial da inteligência artificial

La transformación digital de los gobiernos locales en el contexto del desarrollo sostenible: el potencial de la inteligencia artificial

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It has been demonstrated that AI applications in sustainable local governance are establishing new standards for urban and rural development by providing novel solutions to both old and arising challenges.
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ABSTRACT

This article analyzes contemporary trends and challenges in the digital transformation of local self-government within the landscape of sustainable development, focusing on the potential of AI-based solutions for municipal and rural territories. The scope of research is determined by the fact that digital technologies and their intensive development influence the formation of not only new processes in management, but also the management relations of authorities and the population, generating open integration interaction between them. An interpretive, pragmatic and critical literature review methodology is employed to synthesize existing knowledge and identify key themes with practical implications. The findings demonstrate that AI applications in sustainable local governance establish new standards for urban and rural development by providing novel solutions to old and developing difficulties. However, the analysis also reveals that no one-size-fits-all solution exists; instead, a thorough evaluation of local needs, cultural settings, and potential problems is required. Adaptive tactics, rigorous data governance, and strong community relationships are essential for successful implementation.

Keywords: digital transformation; local government; AI; smart cities; rural development.

RESUMO

Este artigo analisa as tendências e os desafios contemporâneos na transformação digital do governo autônomo local no cenário do desenvolvimento sustentável, com foco no potencial das soluções baseadas em IA para territórios municipais e rurais. O escopo da pesquisa é determinado pelo fato de que as tecnologias digitais e seu desenvolvimento intensivo influenciam a formação não apenas de novos processos de gestão, mas também as relações de gestão das autoridades e da população, gerando uma interação de integração aberta entre elas. Uma metodologia interpretativa, pragmática e crítica de revisão da literatura é empregada para sintetizar o conhecimento existente e identificar os principais temas com implicações práticas. Os resultados demonstram que os aplicativos de IA na governança local sustentável estão estabelecendo novos padrões para o desenvolvimento urbano e rural, fornecendo soluções inovadoras para dificuldades antigas e em desenvolvimento. No entanto, a análise também revela que não existe uma solução única para todos; em vez disso, é necessária uma avaliação completa das necessidades locais, das configurações culturais e dos possíveis problemas. Táticas adaptativas, governança de dados rigorosa e relacionamentos sólidos com a comunidade são essenciais para uma implementação bem-sucedida.

Palavras-chave: transformação digital; poder local; IA; cidades inteligentes; desenvolvimento rural.

RESUMEN

Este artículo analiza las tendencias y retos contemporáneos en la transformación digital del autogobierno local dentro del panorama del desarrollo sostenible, centrándose en el potencial de las soluciones basadas en IA para los territorios municipales y rurales. El ámbito de la investigación viene determinado por el hecho de que las tecnologías digitales y su desarrollo intensivo influyen en la formación no sólo de nuevos procesos en la gestión, sino también en las relaciones de gestión de las autoridades y la población, generando una interacción de integración abierta entre ellas. Se emplea una metodología de revisión bibliográfica interpretativa, pragmática y crítica para sintetizar los conocimientos existentes e identificar temas clave con implicaciones prácticas. Las conclusiones demuestran que las aplicaciones de la IA en la gobernanza local sostenible están estableciendo nuevas normas para el desarrollo urbano y rural al aportar soluciones novedosas a dificultades tanto antiguas como en desarrollo. Sin embargo, el análisis también revela que no existe una solución única para todos los casos, sino que se requiere una evaluación exhaustiva de las necesidades locales, los entornos culturales y los problemas potenciales. Tácticas adaptativas, una rigurosa gobernanza de los datos y unas sólidas relaciones con la comunidad son esenciales para el éxito de la aplicación.

Palabras clave: transformación digital; gobierno local; IA; ciudades inteligentes; desarrollo rural.

INTRODUCTION

Over the last few decades, local government reform has occurred in various ways and at different rates around the world, with the goal of improving public service delivery by emphasizing citizen choice, personalizing services, and understanding and responding to service user needs. The use of technology to transform operations, inform policy, target resources, and make decisions has been a part of local governments' reform plans, which are often influenced by state and federal reform agendas. This has led to the acceleration of digital transformation processes, which are influenced by external pressures such as environmental technological change, private sector organizations' demands for change, and citizen demands that local governments adjust to the technological changes they encounter in their daily lives and at work.

The literature on the subject is limited and disjointed since, even among specialists, the phrase "digital transformation" is still ambiguous and not often utilized, despite the efforts local governments have made over the years. The uneven practice of digital transformation at the local level is also reflected in this fragmentation; over time, local governments have adopted disparate approaches that reflect their unique local circumstances, applying and utilizing various technologies for various purposes. Because of this, local digital transformation initiatives have taken many forms and encountered various obstacles, all of which have influenced local government reform initiatives in different ways. The full knowledge of digital transformation in local governments has been constrained by research that has generally addressed these differences by offering descriptive single case studies from a public administration viewpoint (Gasco Hernandez, 2024).

Understanding the digital revolution of local self-government within the framework of sustainable development receives even less attention. On the other hand, some academics believe that digital governance can lead to sustainable development (Elialee & Al-Qaysi, 2023). The potential benefits of artificial intelligence (AI) for municipal governance are highlighted. This might involve better decision-making, cost savings, and increased efficiency, especially in sustainability. Thus, analysis of current trends, best practices, and challenges in digital transformation of local self-government represent relevant vectors in today research in the field of sustainable development, green technology, public administration, as well as urban and community studies.

Scholars are paying close attention to how local governments are embracing and deploying AI systems because of the growing usage of AI in all kinds of organizations worldwide. A small number of empirical studies have been published, mostly in digital government journals, even though much of the research on the subject is still conceptual in nature and describes the advantages and difficulties of AI for government organizations generally (e.g., Criado & de Zarate-Alcarazo, 2022; Yigitcanlar et al., 2023).

Important terms are defined in literature. According to the statement, sustainable digitalization specifically entails promoting the creation and application of technologies that take sustainability into account, or sustainability by design. This guarantees that throughout their lifespan, technological innovations give ethical issues and environmental sustainability first priority (Puplampu et al., 2023; Poliova et al., 2024). Digitalization for sustainability, on the other hand, focuses on the proactive creation and application of digital tools to meet environmental goals, utilizing technology's capacity to promote favorable results for the environment and its people (Akkaya et al., 2023; Sydorchuk et al., 2024).

According to Zhong & Ma (2024), a city's sustainable growth is favorably correlated with its degree of digitization. According to the authors, local government has the power to strengthen the beneficial connection between digitization and the sustainable growth of a city. According to the report, a nation's sustainability is greatly increased via digital transformation (DT). Therefore, governments should create policies that guarantee the maximum chance of success in DT, the authors say. It is also critical to highlight how FDI and governmental laws affect economic sustainability. While FDI and government restrictions have a moderating effect on economic sustainability, Zhong & Ma (2024) show that DT has a substantially greater impact on economic sustainability.

Gudmundsdottir et al. (2024) examine sustainable digital transformation using a municipality as an example. In addition to discussing the significance of digital development and inclusion in the public sector, the study focuses on how change can be managed effectively within the public sector to improve sustainability. It emphasizes the necessity for organizations to prioritize information technology and users need to adapt to a changing world. According to the authors, public institutions play a crucial role in advancing social well-being and need to be able to change with the times while adopting sustainable practices (Kulikov et al., 2022; Pasichnyi et al., 2024). The importance of sustainability in resource management and the creativity in service delivery that results from digital transformation are also highlighted in the report. The situation of Reykjavík, which has a plan known as the Green Plan that started in 2020 and will run until 2030, is discussed by Gudmundsdottir et al. (2024). It is the city's long-term financial and investment strategy designed to improve the long-term well-being of its citizens. For the benefit of society, it aims to present the city's future vision and integrate the key programs and policies that support it. The Green Plan focuses on several topics, such as social concerns, public finances, and environmental and climatic challenges (Kryshtanovych et al., 2022). All activities should be guided by sustainable metrics. One

of the most important initiatives in the Green Plan is the digitization of Reykjavík's services. It is an endeavor to modernize and simplify the city's services to make them more economically, ecologically, and above all socially sustainable. Increasing the percentage of services that may be accessed and delivered electronically and converting the city's services into digital solutions are the two primary improvements (Voronina et al., 2024). The city's change management procedures have a big impact on these environmental initiatives. The city's Green Plan's sustainability objectives will be impacted by how it handles these changes. The authors emphasize that sustainability and digital transformation are closely related, considering case-related insights (Pavlovskyi et al., 2024). Organizations may increase overall sustainability, cut down on waste, and lessen the environmental effect of their operations by adopting digital technology and practices.

With a focus on an Icelandic municipality, the research by Sigurjonsson et al. (2024) investigates the difficulties faced by municipalities in their digital transition. According to the report, the difficulties Icelandic towns encounter aligns with more general findings on the digital transformation of public administration. To secure a durable outcome from these activities, the research highlights the necessity of a complete strategy that integrates organizational, cultural, and technical improvements (Lelyk et al., 2022). It also emphasizes how digitization may improve the efficiency and accessibility of public services, fostering long-term sustainability, fairness, and social cohesion. To guarantee the success of digital projects in public services, the authors offer practical suggestions such as developing strong leadership, obtaining strategic funding, and encouraging a collaborative culture.

Numerous writers stress the importance of public institutions in advancing social well-being and the need to maintain their viability in their operations (Sang & Li, 2019; Brunetti et al., 2020). In order to achieve sustainability, an organization must adjust to a changing environment and integrate sustainable practices into its basic principles and day-to-day operations. This calls for the implementation of novel techniques and new technology, which can be difficult to manage without efficient change management (Gallardo et al., 2021).

In keeping with this, it should be mentioned that change agents are using AI more and more in several facets of their job. AI speeds up decision-making, simplifies and automates processes, and frees up time for strategic and people-centered transformation initiatives (Herberger & Dotsch, 2021; Avedyan et al.,2023). Specifically, the sluggish rate of digital change is a significant obstacle for municipal administration. Adopting cutting-edge AI technologies is sometimes challenging due to the conservatism of old government procedures. To solve this, governments may now swiftly create and deploy AI solutions that are customized to their unique requirements without the need for in-depth programming skills thanks to user-friendly platforms (Bashtannyk et al., 2024). This adaptability makes it possible to respond to changing needs more quickly and expedite procedures (Yigitcanlar et al., 2024). Platforms with user-friendly, intuitive designs reduce the requirement for complex technical knowledge. To guarantee a seamless deployment, they also provide extensive support, including tutorials, documentation, and committed customer service (Archuleta, 2024; Zayats et al., 2024).

All things considered; artificial intelligence is revolutionizing local government operations by providing cutting-edge technologies that greatly improve service delivery. However, one of the underdeveloped areas is still the role of AI in sustainable digital transformation in local governments.

METHODS

This study employs a literature review strategy to analyze the contemporary trends and challenges in the digital transformation of local self-government, with a specific focus on the potential of AI-based solutions within the context of sustainable development. Given the exploratory nature of this rapidly evolving field, this review offers a framework for synthesizing existing knowledge, identifying key themes, and highlighting gaps in the extant research. Jesson & Lacey (2006) emphasize the importance of a structured approach to literature reviews, which this study adheres to through a detailed and dialectical search and critical analysis process.

The review follows an interpretive and critical approach, rooted in the critical analysis of the conceptual and empirical findings presents in extant literature. This approach is aligned with the recommendations of Baumeister & Leary (1997), who advocate for narrative literature reviews with critical evaluations and synthesize findings to develop enhanced understanding of the topic. Baumeister & Leary (1997) highlight that this method allows for the examination of diverse perspectives, the evaluation of methodological choices in prior research, and the identification of potential biases or limitations, contributing to critical interpretation of the literature.

The process involved an abductive strategy of literature search within academic databases, including Scopus, Web of Science, and Google Scholar, using keywords such as 'digital transformation,' 'local government,' 'artificial intelligence,' 'sustainable development,' 'smart cities,' and 'rural development.' The abductive strategy (Janiszewski & Van Osselaer, 2022), was developed with successive iterations between the consideration of the theoretical *status quo* and possible practical

avenues, considering the extant literature. In terms of operationalization, these iterative moments also accounted to the capture of both theoretical and empirical studies, encompassing a range of disciplines including public administration, computer science, and urban studies. This approach also draws upon the guidelines provided by Fink (2019), who offers specific strategies for conducting literature reviews, from formulating research questions to synthesizing and presenting findings.

The analysis of the selected literature was conducted in several stages. First, the key themes and concepts related to digital transformation and AI in local self-government were identified. Second, the literature was analyzed to identify trends and challenges in the implementation of digital technologies. Third, the potential of AI-based solutions for both municipal and rural territories was assessed. Finally, the findings were synthesized to provide a holistic understanding of the current state of research and to identify directions for practice inquiry. This synthesis process is guided by the principles of Petticrew & Roberts (2006), who provide methodological guidance on reviews in the social sciences, emphasizing the importance of detailed synthesis to draw meaningful and practical conclusions.

RESULTS AND DISCUSSION

The increasing demands brought on by climate change are linked with the need for digital transformation in local government. Beyond convenience, managers and public authorities are making sure their firms take the step of streamlining efficiency through automation and artificial intelligence (Castillo, 2023). Most agencies have already digitized their systems to increase safety, efficiency, and resilience in their physical operations, and additional investments are planned, according to a national survey conducted by the Center for Digital Government among 100 state and local government leaders in the United States (Government Agencies are Transforming Physical Operations, 2024). In general, growing extreme weather occurrences and the looming climate disaster are correlated with increased usage of technology. Climate change was highlighted by nearly half of respondents as the main driver of technical investment, including the use of electric vehicles and digital records systems to save paper waste. According to 67% of respondents, digitalization will be crucial to achieving their organization's sustainability aim, which is mentioned by 84% of those polled. According to the survey, systems and infrastructure that are networked are more robust in the event of a natural catastrophe and supply chain disruption (Denysiuk et al., 2023).

Additionally, data is becoming more and more crucial in almost every facet of local government as communities attempt to better grasp what the future holds. The only way to get this data is through technology. Along with expectations for increased reliability (66%) and the capacity to provide real-time updates (55%), constituent concerns regarding energy efficiency and a desire to lessen the environmental impact of their community are also driving tech adoption (cited by 39% of respondents in the report) (Government Agencies are Transforming Physical Operations, 2024).

One of the most evident applications of AI in the context of smart cities is for infrastructure management and urban planning. AI, for instance, can create digital twins by analyzing large databases (Gavkalova et al., 2022). These solutions are interactive reproductions of real-world cities that serve as sandbox environments for engineers and city planners to test their concepts. This test environment minimizes interruptions and maximizes resource allocation efficiency by enabling teams to estimate the impact of each solution in advance (Yermachenko et al., 2023). To test new smart city IoT sensors placed across the city and assess autonomous cars and food delivery in a controlled setting, for instance, several towns are building digital twins. Additionally, AI may be applied to predictive maintenance of buildings and public infrastructure, preventing expensive malfunctions, cutting downtime, and guaranteeing service continuity (Teixeira, 2023).

By offering data-driven insights and tools to build more livable, effective, and ecologically friendly cities, artificial intelligence is transforming sustainable urban planning. Urban planners may more accurately and successfully handle complicated issues like energy use, transportation congestion, and infrastructure development by utilizing AI (Gedeon, 2024). AI's capacity to examine enormous volumes of urban data makes it possible to spot patterns and trends that can guide more intelligent city planning choices (Byrkovych et al., 2023; Gupta et al., 2024). AI technologies provide scalable answers to urban sustainability problems, ranging from improving public transit systems to lowering building energy use and streamlining traffic. In particular, the following are important AI-driven urban planning techniques (Son et al., 2023; Wolniak & Stecula, 2024):

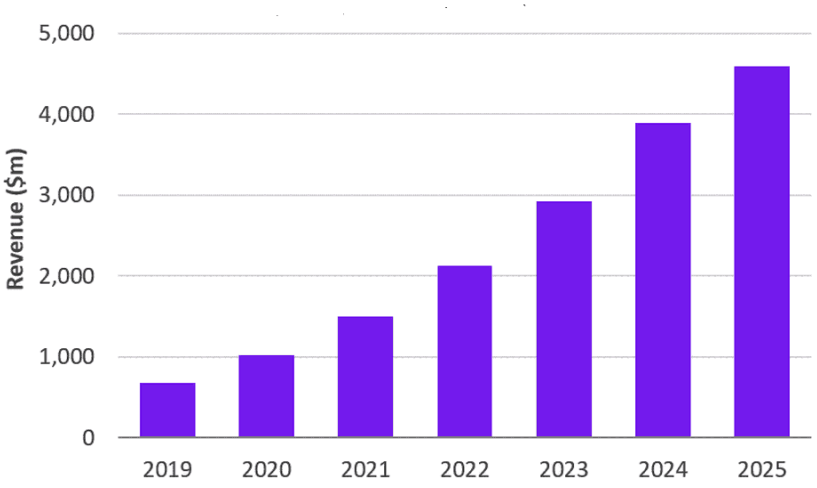
- Transportation & Traffic Management: AI systems forecast traffic patterns and make recommendations for enhancements to cut emissions and congestion.
- Building energy efficiency reduces urban carbon footprints by optimizing building energy usage with predictive analytics.
- Development of Smart Infrastructure: AI aids in the design and construction of environmentally friendly

infrastructure, such as parks and renewable energy sources.

With its Smart Nation effort, Singapore, for instance, is a prime example of using AI in urban planning. The city-state employs AI to improve environmental sustainability, urban transportation, and public services (Gaman et al., 2022; Arivazhagan et al., 2023). The use of AI to optimize traffic signals and public transit routes in order to enhance traffic flow and lower automobile emissions is one noteworthy effort. In addition to improving transportation efficiency, this project advances Singapore's larger environmental objectives (As et al., 2022).

Currently, algorithmic urban planning-based smart and sustainable development is thought to be built on top of data-driven planning technologies and urban big data analytics (Lazaroiu & Harrison, 2021; Nica, 2021). It is clear from Fig. 1 that the deployment of AI solutions for managing smart cities is expanding quickly.

Figure 1. Global smart city AI software revenue

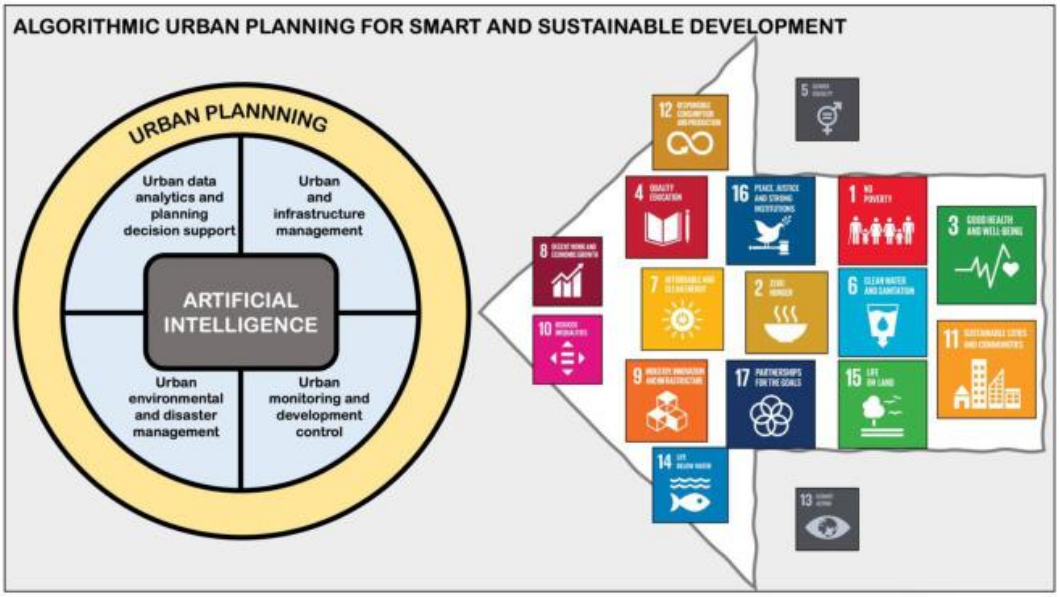


Source: Khang et al. (2024)

The size of the worldwide market for AI in smart cities is anticipated to reach around USD 345.3 billion by 2033, expanding at a compound annual growth rate (CAGR) of 27.3% between 2024 and 2033 (AI in Smart Cities Market, 2024).

AI applications in sustainable urban planning are revolutionizing city development by providing creative answers to both established and new problems. Cities may become more efficient, sustainable, and conducive to a high standard of living for their citizens by using AI tools and approaches. The knowledge and practice landscape of algorithmic urban planning to achieve smart and sustainable development, connecting urban planning with SDGs, is depicted in Fig. 2 below.

Figure 2. Current landscape of algorithmic urban planning to achieve smart and sustainable development



Source: Son et al. (2023)

The effects of AI in urban settings are already exhibiting encouraging outcomes, which demonstrates the close relationship between AI and SDGs at the local level. Crime rates have decreased by up to 20% in places that deploy AI-driven surveillance systems because of more proactive enforcement. As a major step toward sustainability, communities that use AI for environmental monitoring have seen pollution levels drop by 15–25% over a few years (AI in Smart communities Market, 2024).

The application of AI primarily focused on two separate but related domains: (a) Urban policy, decision-making, and planning activities; and (b) Urban service delivery and operations (such as traffic management, garbage collection, etc.). Furthermore, cooperation and partnership between important stakeholders are necessary to achieve broader AI adoption. Several stakeholders must work together to create a smart and sustainable city; the use of AI will support the execution of smart city projects that address infrastructural and urban issues (Anthony Jr., 2021; Pyatnychuk et al., 2024). Convergence of human and artificial intelligence is also essential for sustainable growth.

For local governments to serve their citizens in both urban and rural locations, digital transformation technology is crucial. The relationship between artificial intelligence (AI) and rural development is a crucial area for investigation in the current technological landscape (Chen et al, 2024). Understanding how AI might be used to spur good change in rural environments is crucial as societies experience fast digital revolutions (Oliveira et al., 2023). The strategic use of artificial intelligence to improve sustainable development in rural regions is known as "AI for Rural Development" (AIRD).

The larger history of AI and rural development programs is deeply intertwined with the tale of AIRD. Early initiatives to employ technology for rural upliftment, which date back many decades, mostly concentrated on more basic technologies like agricultural mechanization and better communication infrastructure (Zayats et al., 2024). But these programs frequently lacked the sophistication and flexibility needed to tackle the many, interrelated problems that rural communities face (Qin et al., 2024). With its ability to analyze data, identify patterns, and create predictive models, artificial intelligence (AI) has completely changed the environment. Although most AI's early applications were in urban settings, during the past 10 years, its ability to meet the requirements and situations of rural communities has come to light. Increased data availability, better computer power, and a better grasp of AI's potential across a range of industries are some of the causes driving this change.

AI has been gradually incorporated into rural development initiatives, frequently on a project-by-project basis. Pilot projects and discrete initiatives were common features of early endeavors, which typically lacked the size and systemic integration required for broad effect (Kussainov et al., 2023). However, the quantity and scope of AI-driven rural development initiatives have significantly increased in recent years. Increased funding from governments, charitable institutions, and businesses in the private sector are some of the drivers driving this acceleration. It is also a result of politicians and development professionals realizing more and more how important AI may be to reaching SDGs in rural regions (Qin et al., 2024).

Crucially, AI's actual promise for rural development is found in its capacity to empower people and promote self-sufficiency, not only in its technological prowess (Mattos, 2023). Therefore, a sophisticated grasp of both technological capabilities and the sociocultural settings in which they are used is necessary for the successful deployment of AIRD. Building local competence, guaranteeing data ownership, and encouraging responsible innovation must be the main priorities. These are essential responsibilities of local self-government.

The significance of equality, inclusiveness, and community empowerment is emphasized by the social dimension of AIRD. All members of a rural community should gain from AI solutions, which should address current disparities and prevent marginalization of vulnerable groups. Promoting sustainable resource management and reducing the environmental impact of AI applications are the main goals of AIRD's environmental component (Zilinska et al., 2022; Ortina et al., 2023). This involves using AI to forecast natural disasters, manage water supplies, track deforestation, and improve agricultural methods. It also necessitates considering the energy usage of AI technologies, striving for eco-friendly solutions, and reducing their negative effects on biodiversity. The goal of AIRD's economic component is to raise living standards and provide economic possibilities in rural communities (Nekhai et al., 2024). This involves applying AI to boost agricultural output, provide farmers better access to markets, support the growth of rural enterprises, and generate new revenue streams. It also entails seeing the AI-driven solutions' economic viability, making sure they are affordable and providing rural communities with long-term advantages. Long-term, sustainable economic growth is the aim, not simply immediate profits (Naidoo, 2024).

Numerous facets of rural development might benefit from breakthroughs and enhancements made possible by AI technology. Advances in data processing and machine learning (ML) are revolutionizing AI's ability to manage enormous volumes of data, which may help rural communities thrive sustainably by identifying strong and practical patterns (West & Allen, 2018). By offering text-based features and speech recognition, artificial intelligence (AI) can assist in removing literacy obstacles among the underprivileged. Additionally, AI can evaluate farmers' microinsurance claims, resulting in higher output, income, and food security. It is crucial to remember, too, that rural communities would not have access to or affordability for AI resources, which would exacerbate digital divides and heighten isolation. Strictly concentrating on AI may potentially

ignore the need for community involvement and local expertise, leading to unsuccessful projects. Furthermore, the integration of AI technology may be hampered in rural locations due to a lack of adequate high-speed internet connectivity.

The necessity of a nuanced, context-specific approach to AIRD is highlighted by lessons learnt from both successful and unsuccessful deployments (Asian Development Bank, 2024). There is no one-size-fits-all approach; instead, local demands, cultural settings, and potential difficulties must be carefully considered. Effective data governance, flexible tactics, and solid community collaborations are essential components of success.

FINAL REMARKS

Communities might become more sustainable, effective, and livable as result of the revolutionary process of integrating AI technology into local self-government. Local governments may use evidence-based policies, distribute resources effectively, and respond quickly to new issues by utilizing data-driven insights.

However, there are several obstacles associated with local self-government's sustained digital transition. Specifically, there are many advantages to integrating AI with smart cities, but there are also security, privacy, and ethical issues. Concerns regarding personal privacy and the possibility of misuse are brought up by the extensive use of surveillance technology, particularly face recognition. Strong legal frameworks and careful thought are needed to strike a balance between the benefits of AI in improving public safety and upholding individual rights. Furthermore, to avoid the development of digital gaps between urban and rural people, it is imperative that AI technologies be inclusive. All residents, regardless of socioeconomic background, must have equal access to AI-driven services and technology to take advantage of the advances in local development.

Thus, sustainable digital transformation in local self-government based on AI, represents both broad field of advantages and potentials, and an array of challenges which cannot be ignored. Comprehensive research in needed in this vein, involving local government bodies, experts, and community representatives, to develop customized solutions fitting concrete places and communities and contributing to SDGs achievement within the landscape of SDGs localization.

Future research in emerging economies should prioritize two key areas: first, there is a need for in-depth investigation into context-specific strategies for implementing AI in local self-government, with a focus on addressing the unique infrastructural, socio-cultural, and economic challenges prevalent in these diverse settings to ensure equitable and sustainable development outcomes. Second, comparative studies are crucial to explore the effectiveness of various governance models and policy frameworks in fostering responsible AI adoption within local self-government in emerging economies, emphasizing critical aspects such as data privacy, ethical considerations, and robust citizen engagement mechanisms.

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B. data research and statistical analysis:	16.6%	16.6%	16.6%	16.6%	16.6%	16.6%
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