

Urban-Rural Integration Dynamics in Light of Advanced Technology and Artificial Intelligence: Global Experiences

ديناميات التكامل بين المناطق الحضرية والريفية في ضوء التكنولوجيا المتقدمة
والذكاء الاصطناعي: تجارب عالمية.

Abdelghani GUETTALI^{1*}

¹Larbi Ben M'hidi University, Oum El Bouaghi, (Algeria),
guettali.abdelghani@univ-oeb.dz

Received Date:21/01/2026

Acceptance Date:30/04/2026

Abstract:

Urban-rural integration represents a major challenge and opportunity with the rapid development of advanced technology and the spread of artificial intelligence. The urban-rural relationship has historically been characterized by gaps in economic development, infrastructure, access to services, and social opportunities. However, digital technology and intelligent systems are beginning to reshape this relationship, by creating new possibilities for convergence between the two fields, with consequent new social and organizational challenges.

This research aims to analyze the dynamics of urban-rural integration in the context of advanced technology and artificial intelligence, drawing on diverse global experiences, highlighting the roles of civil society, regulatory frameworks, and social entrepreneurship in this transformation. The research also discusses the sociotechnological challenges associated with the use of artificial intelligence, especially with regard to vulnerable groups, highlighting its potential in promoting inclusion and spatial justice. The research concludes by proposing practical pathways for achieving more sustainable and equitable urban-rural integration in the digital age.

Keywords: urban-Rural Integration, Advanced Technology, Artificial Intelligence, Social Inclusion, Sustainable Development

ملخص:

يشكل التكامل بين المناطق الحضرية والريفية تحديًا وفرصة رئيسية في ظل التطور السريع للتكنولوجيا المتقدمة وانتشار الذكاء الاصطناعي. فقد ميزت العلاقة بين الحضر والريف تاريخيًا فجوات في التنمية الاقتصادية، والبنية التحتية، وإتاحة الخدمات، والفرص الاجتماعية. ومع ذلك، بدأت التكنولوجيا الرقمية والأنظمة الذكية في إعادة تشكيل هذه العلاقة، من خلال خلق إمكانات جديدة للتقارب بين المجالين، مع ما يترتب على ذلك من تحديات اجتماعية وتنظيمية جديدة.

يهدف هذا البحث إلى تحليل ديناميكيات التكامل الحضري-الريفي في سياق التكنولوجيا المتقدمة والذكاء الاصطناعي، مستندًا إلى تجارب عالمية متنوعة، مع تسليط الضوء على أدوار المجتمع المدني، والأطر التنظيمية، والمقاوالية الاجتماعية في هذا التحول. كما يناقش البحث التحديات السوسيو-تكنولوجية المرتبطة باستخدام الذكاء الاصطناعي، خصوصًا فيما يتعلق بالفئات الهشة، مع إبراز إمكاناته في تعزيز الشمول والعدالة المكانية. ويختتم البحث باقتراح مسارات عملية لتحقيق تكامل حضري-ريفي أكثر استدامة وإنصافًا في العصر الرقمي.

كلمات مفتاحية: تكامل حضري-ريفي، تكنولوجيا متقدمة، ذكاء اصطناعي، شمول اجتماعي، تطوير مستدام

*Corresponding author.

Urban-Rural Integration Dynamics in Light of Advanced Technology and Artificial Intelligence: Global Experiences

1. Introduction

Urban-rural integration has emerged as a critical challenge and opportunity in the context of rapid technological advancement and the proliferation of artificial intelligence (AI). Historically, the urban-rural divide has been characterized by disparities in economic development, access to services, infrastructure, and opportunities. However, the advent of advanced technologies and AI-driven systems has begun to reshape the contours of this divide, offering new prospects for integration while simultaneously introducing novel risks and complexities. This essay critically examines the dynamics of urban-rural integration in light of advanced technology and AI, drawing on global experiences and the roles of civil society, regulatory frameworks, and social entrepreneurship to understand both the potential and the pitfalls of this transformation.

The discussion is structured as follows. The first section contextualizes the technological landscape influencing urban-rural dynamics, elucidating the driving forces of integration and the emergence of public interest technology. The subsequent sections analyze the sociotechnical challenges and opportunities in urban-rural integration, exploring the roles of civil society organizations, regulatory ecosystems, and social entrepreneurship. Special attention is paid to the intersectionality of technology, policy, and vulnerable populations, considering both the empowering and marginalizing effects of AI deployment. The essay concludes by synthesizing insights and proposing pathways for inclusive, equitable, and sustainable urban-rural integration in the era of advanced technology.

2. The Technological Landscape and Urban-Rural Integration

2.1 The Rise of Advanced Technology and AI

The digital revolution has fundamentally altered the fabric of societies worldwide, with advanced technologies such as AI, machine learning, and digital infrastructures permeating all spheres of life. These technologies hold the promise of bridging longstanding urban-rural disparities by enhancing connectivity, enabling remote access to services, and creating new economic opportunities (Knodel et al., 2025). The integration of AI in agriculture, healthcare, education, and public administration, for instance, offers rural communities the potential to leapfrog traditional development trajectories and participate more fully in the global economy.

However, the diffusion of these technologies is neither uniform nor unproblematic. The digital divide persists in many regions, with rural areas often lagging behind in terms of connectivity, digital literacy, and access to up-to-date infrastructure (Samarin et al., 2020). Furthermore, the deployment of AI systems can introduce new risks, such as algorithmic bias, surveillance, privacy breaches, and exclusion from decision-making processes, particularly

for marginalized rural populations (Hartmann et al., 2025). These complexities necessitate a critical examination of the sociotechnical dynamics at play in urban-rural integration.

2.2 Public Interest Technology and the Sociotechnical Turn

A salient development in recent years is the rise of public interest technology (PIT), which positions technology as a tool for advancing social justice, equity, and the public good (Knodel et al., 2025). PIT practitioners operate at the intersection of technology, policy, and civil society, aiming to ensure that technological advances serve broader societal interests rather than exacerbating existing inequalities. This perspective is crucial in the context of urban-rural integration, where technological interventions can either ameliorate or entrench divides.

PIT is characterized by its expansiveness, encompassing domains such as civic technology, participatory design, digital civics, and tech policy. Within this broad tent, the work of technologists in civil society organizations (CSOs) has become particularly significant. These practitioners navigate the complexities of integrating advanced technology into the fabric of society, often in contexts where resources, expertise, and institutional support are unevenly distributed (Knodel et al., 2025). The professionalization and community-building of PIT thus emerge as central themes in understanding the potential for technology-driven urban-rural integration.

3. Sociotechnical Challenges in Urban-Rural Integration

The Urban-Rural Digital Divide

Despite the transformative potential of advanced technologies, the urban-rural digital divide remains a persistent barrier to integration. This divide manifests not only in terms of physical infrastructure—such as broadband connectivity and reliable electricity—but also in digital literacy, access to devices, and the capacity to leverage technology for local development (Samarin et al., 2020). CSOs and civil society technologists often operate at the frontlines of these challenges, working to tailor **3.1 technological solutions to the specific contexts and needs of rural populations.**

One critical insight from studies of CSOs is that solutions designed for average or urban users frequently fail to account for the unique risk profiles, resource constraints, and operational realities of rural organizations and populations (Samarin et al., 2020). For instance, the adoption of mainstream communication tools that lack adequate security or privacy protections can expose rural CSOs to heightened risks, including surveillance, harassment, and political repression. Such vulnerabilities are exacerbated by the limited resources and technical expertise available to many rural organizations, underscoring the need for context-sensitive, inclusive technological interventions.

Urban-Rural Integration Dynamics in Light of Advanced Technology and Artificial Intelligence: Global Experiences

3.2 Security, Privacy, and Vulnerability

The integration of advanced technology and AI into rural contexts introduces a host of security and privacy risks. As highlighted by Samarin et al. (2020), CSOs—especially those operating in vulnerable or politically sensitive environments—are often ill-equipped to defend against cyber threats, surveillance, and targeted attacks. These risks are not merely technical but have profound implications for freedom of expression, organizational survival, and even personal safety.

The lack of tailored security solutions for rural and civil society contexts reflects a broader neglect of the needs and practices of underrepresented groups in technological design and policy (Samarin et al., 2020). This oversight can undermine trust in technology, hinder adoption, and ultimately stymie the integrative potential of digital innovations. Addressing these vulnerabilities requires a participatory approach to technology development, one that centers the voices and experiences of rural communities and CSOs.

3.3 Algorithmic Bias, Accountability, and Governance

AI systems, while offering powerful tools for data-driven decision-making and service delivery, are also susceptible to biases and opaque decision processes that can disproportionately harm rural and marginalized populations (Hartmann et al., 2025). Regulatory frameworks such as the European Union's Digital Services Act (DSA) and Artificial Intelligence Act (AIA) have sought to address these challenges by introducing requirements for transparency, accountability, and third-party audits of AI systems.

However, as Hartmann et al. (2025) argue, significant regulatory gaps remain, particularly in providing access to data and models for researchers and civil society auditors. Without meaningful third-party oversight, rural populations may be subject to algorithmic harms—such as discriminatory resource allocation or exclusion from critical services—without adequate avenues for recourse or redress. The creation of an effective AI audit ecosystem, inclusive of civil society participation, is thus essential for safeguarding the interests of rural communities in the face of technological transformation.

4. Civil Society and Public Interest Technologists: Catalysts for Integration

4.1 The Role of Civil Society Organizations

Civil society organizations occupy a pivotal position in mediating the relationship between technology and rural communities. CSOs often serve as intermediaries, advocates, and implementers of technology-driven initiatives, leveraging their contextual knowledge and trust-based relationships to ensure that interventions are responsive to local needs (Knodel et al., 2025; Pustet et

al., 2025). Their engagement is especially critical in contexts where state or market actors may overlook or marginalize rural interests.

However, CSOs themselves face significant challenges in navigating the technological landscape. As documented by Samarin et al. (2020), many CSOs lack the resources, expertise, and tailored tools necessary to address their unique security and privacy needs. Furthermore, the integration of AI and advanced digital systems can impose additional burdens, requiring new forms of technical literacy, organizational adaptation, and cross-sector collaboration. Supporting the capacity-building and professionalization of CSO technologists is therefore a key priority for fostering effective urban-rural integration.

4.2 Practitioner-Led Innovation and Community Building

The experiences of PIT practitioners within civil society underscore the importance of practitioner-led innovation and community-building. Knodel et al. (2025) emphasize that public interest technologists often occupy hybrid roles—ranging from software development and data analysis to policy advocacy and organizational leadership—tailoring their work to the evolving needs of their organizations and communities. This versatility is both a strength and a challenge, as it demands a broad skill set and the ability to operate across disciplinary and sectoral boundaries.

4.3 The development of robust professionalization

infrastructures—including mentorship, peer networks, and philanthropic support—is crucial for sustaining and scaling practitioner-led innovation (Knodel et al., 2025). Conferences, fellowships, and collaborative platforms play an integral role in fostering knowledge exchange, solidarity, and collective action among technologists committed to the public interest. Such community-building efforts are particularly salient in the context of urban-rural integration, where local adaptation and cross-pollination of ideas are essential for addressing diverse challenges.

5. Civil Society in the Loop: AI-Assisted Tools and Participatory Design

The involvement of civil society in the co-development and oversight of AI-assisted tools is a promising avenue for enhancing the inclusivity and effectiveness of technology in rural contexts. Pustet et al. (2025) illustrate the value of feedback-driven adaptation in the development of open-source monitoring tools for civil society actors. By integrating user feedback into model refinement and deployment, these tools can be tailored to the thematic expertise and contextual realities of CSO users, fostering greater alignment with stakeholder needs and values.

Nevertheless, challenges remain in operationalizing such participatory approaches. Issues such as feedback bias, resource constraints, and the need

Urban-Rural Integration Dynamics in Light of Advanced Technology and Artificial Intelligence: Global Experiences

for robust governance mechanisms can hinder the scalability and sustainability of civil society involvement in AI development (Pustet et al., 2025). Addressing these challenges requires not only technical innovation but also institutional support, capacity-building, and the recognition of civil society actors as co-creators rather than passive consumers of technology.

6. Regulatory Ecosystems: Ensuring Accountability and Equity

6.1 The Need for Inclusive AI Governance

As AI systems become increasingly embedded in public services, resource allocation, and decision-making processes, the need for robust governance frameworks becomes ever more urgent. The European Union's DSA and AIA represent significant steps toward regulating the deployment of AI and digital platforms, with provisions for audits, transparency, and accountability (Hartmann et al., 2025). However, as noted earlier, these frameworks fall short in ensuring meaningful third-party access and oversight, particularly for civil society and rural stakeholders.

A critical gap identified by Hartmann et al. (2025) is the lack of data and model access for independent researchers and civil society auditors under the AIA. Without such access, the ability to detect, document, and remediate algorithmic harms—especially those affecting marginalized rural populations—is severely constrained. The establishment of a diverse AI audit ecosystem, incorporating compliance, oversight, and participatory evaluation, is essential for realizing the integrative potential of AI while safeguarding against its risks.

6.2 Third-Party Audits and the Role of Civil Society

Third-party audits by independent organizations—including CSOs, journalists, and academic researchers—are vital for ensuring accountability in the deployment of AI systems (Hartmann et al., 2025). Such audits can uncover biases, discriminatory outcomes, and unintended consequences that may otherwise go undetected. In rural contexts, where power asymmetries and resource constraints are often pronounced, the role of civil society in audit and oversight is particularly crucial.

However, the efficacy of third-party audits depends on several factors, including auditor independence, access to relevant data and models, and the capacity to interpret and act on audit findings (Hartmann et al., 2025). Regulatory frameworks must therefore be designed to facilitate, rather than hinder, civil society participation in oversight processes. This includes providing legal mechanisms for data access, supporting professionalization and training of auditors, and fostering collaborative relationships between regulators, technology developers, and civil society actors.

6.3 Toward a Diverse and Effective Audit Ecosystem

Building an effective AI audit ecosystem requires a recognition of the sociotechnical nature of algorithmic systems—that is, the interplay between technical components and the social, economic, and political contexts in which they are deployed (Hartmann et al., 2025). Audits must therefore go beyond narrow technical assessments to encompass broader evaluations of societal impact, inclusivity, and equity. This is particularly relevant for urban-rural integration, where the consequences of technology deployment can vary widely across contexts and populations.

A diverse audit ecosystem should include multiple forms of assessment—ranging from internal risk assessments and conformity evaluations to external audits and sociotechnical impact studies (Hartmann et al., 2025). Civil society actors, with their contextual expertise and grounding in local realities, are uniquely positioned to contribute to such holistic evaluations. Regulatory frameworks must be adapted to enable and incentivize their participation, ensuring that the voices of rural and marginalized populations are heard and acted upon in the governance of AI and advanced technology.

7. Social Entrepreneurship and Contextual Innovation

The Role of Social Entrepreneurship in Urban-Rural Integration

Social entrepreneurship has emerged as a significant force in addressing complex social challenges, including those at the urban-rural interface. By leveraging entrepreneurial approaches to create social value, social entrepreneurs can identify and respond to gaps left by state and market actors, particularly in the aftermath of disruptive events such as natural disasters (Wei et al., 2022). The intersection of social entrepreneurship, advanced technology, and AI presents new opportunities for fostering integration, resilience, and inclusive development.

Wei et al. (2022) demonstrate that the intensity of natural disasters can serve as a catalyst for social entrepreneurship, particularly among individuals who may otherwise lack conventional forms of human capital or who experience heightened fear of failure. In rural contexts, where disaster impacts are often more acute and state responses may be limited, the emergence of social entrepreneurs can play a critical role in mobilizing resources, addressing unmet needs, and catalyzing community-driven innovation.

7.1 Technology, Attention, and Opportunity Recognition

The attention-based view (ABV) posits that individuals' actions are shaped by the distribution and direction of their attention, which is influenced by contextual factors (Wei et al., 2022). In the context of urban-rural integration, advanced technology and AI can both direct attention to pressing

Urban-Rural Integration Dynamics in Light of Advanced Technology and Artificial Intelligence: Global Experiences

social problems and enable new forms of entrepreneurial action. For example, digital platforms can facilitate the identification of unmet needs in rural communities, connect entrepreneurs with resources and collaborators, and support the scaling of innovative solutions.

However, the effects of technology on opportunity recognition and entrepreneurial engagement are not uniform. Personal attributes such as gender, human capital, and risk tolerance interact with contextual factors to shape individuals' likelihood of engaging in social entrepreneurship (Wei et al., 2022). In rural areas, where access to education, networks, and capital may be constrained, technology can either mitigate or exacerbate these disparities, depending on how it is deployed and who has access to its benefits.

7.2 Policy Implications and Support Structures

The findings of Wei et al. (2022) highlight the importance of policy interventions that support social entrepreneurship in rural and disaster-affected contexts. Policymakers should not only focus on creating enabling environments for economic growth but also recognize the pivotal role of social entrepreneurs in addressing social needs and fostering integration. This includes providing targeted support for technology adoption, capacity-building, and risk mitigation, as well as facilitating access to networks, funding, and mentorship.

Moreover, the intersectionality of technology, entrepreneurship, and social context underscores the need for inclusive policy frameworks that account for the diversity of rural populations and the specific challenges they face. Interventions should be designed to lower barriers to entry, promote digital literacy, and ensure that the benefits of technological innovation are equitably distributed across urban and rural communities.

7.3 Vulnerable Populations, Inclusion, and Equity

Addressing the Needs of Vulnerable Populations

Urban-rural integration in the era of advanced technology must be attentive to the needs and vulnerabilities of marginalized populations. As Samarin et al. (2020) emphasize, CSOs representing vulnerable groups often lack the resources and tailored solutions necessary to navigate the risks associated with digital transformation. These organizations operate in contexts of heightened political, economic, and social risk, where the consequences of technological failures or abuses can be severe.

Ensuring the security, privacy, and agency of vulnerable populations requires a multi-faceted approach. This includes participatory design processes that involve affected communities in the development and deployment of technology, as well as the provision of accessible, context-sensitive tools and training (Samarin et al., 2020). It also necessitates ongoing research and evaluation to understand the evolving landscape of threats and opportunities, and to adapt interventions accordingly.

7.4 The Importance of Trust and Participatory Methods

Building trust is essential for the successful integration of technology in rural and vulnerable communities. As demonstrated by Samarin et al. (2020), research and intervention efforts must be grounded in transparent, participatory methodologies that respect the autonomy and agency of participants. Establishing trust involves clear communication about risks and safeguards, the use of anonymity-preserving incentive strategies, and the involvement of trusted intermediaries in outreach and implementation.

Feedback mechanisms and iterative design processes are also critical for ensuring that technological solutions remain responsive to the needs and contexts of users. Civil society actors, with their deep connections to local communities, are well positioned to facilitate such participatory approaches and to advocate for the interests of vulnerable populations in broader policy and regulatory debates.

8. Risks of Exclusion and the Need for Inclusive Design

Despite the potential of technology to foster integration, there is a persistent risk that the deployment of AI and advanced systems may lead to new forms of exclusion, particularly for those who are already marginalized. Algorithmic decision-making can inadvertently encode and perpetuate biases, while the lack of accessible interfaces or tailored support can render technology inaccessible to certain groups (Hartmann et al., 2025; Samarin et al., 2020).

Inclusive design principles—centered on accessibility, usability, and representation—are therefore essential for ensuring that the benefits of technological innovation are shared equitably. This includes not only technical considerations but also the active involvement of diverse stakeholders in governance, oversight, and evaluation processes.

9. Global Experiences and Comparative Insights

Regional Variations and Contextual Adaptation

Global experiences with urban-rural integration in the context of advanced technology reveal significant regional variations in approaches, outcomes, and challenges. In the Global North, regulatory frameworks such as the EU's DSA and AIA provide a foundation for accountability but may lack the flexibility or inclusivity needed to address the specificities of rural contexts (Hartmann et al., 2025). In the Global South, where infrastructure gaps and resource constraints are more pronounced, CSOs and social entrepreneurs often play a more central role in driving technological adaptation and integration (Wei et al., 2022).

These variations underscore the importance of contextual adaptation and the avoidance of one-size-fits-all solutions. Successful integration efforts are

Urban-Rural Integration Dynamics in Light of Advanced Technology and Artificial Intelligence: Global Experiences

those that are attuned to local realities, leverage existing strengths and networks, and are responsive to the evolving needs and aspirations of rural communities.

9.1 Lessons from Civil Society-Led Initiatives

Case studies of civil society-led technological innovation offer valuable lessons for urban-rural integration. The practitioner-led research of Knodel et al. (2025) demonstrates the power of community-driven approaches in shaping the trajectory of public interest technology. Similarly, the participatory development of AI-assisted monitoring tools documented by Pustet et al. (2025) illustrates the value of feedback-driven adaptation and collaborative governance.

These experiences highlight the need for sustained investment in the capacity-building, professionalization, and networking of CSO technologists and social entrepreneurs. They also point to the importance of creating enabling environments—through policy, regulation, and philanthropy—that support experimentation, knowledge exchange, and the scaling of successful models.

10. Policy and Regulatory Recommendations

10.1 Drawing on global experiences, several policy and regulatory recommendations emerge:

Facilitate Data and Model Access for Civil Society Auditors: Regulatory frameworks should provide mechanisms for independent researchers and CSOs to access relevant data and models for audit and oversight purposes (Hartmann et al., 2025).

Support Capacity-Building and Professionalization of CSO Technologists: Investments in training, mentorship, and networking are essential for enabling CSOs to navigate the complexities of advanced technology adoption and integration (Knodel et al., 2025).

Promote Inclusive and Participatory Design Processes: Technology development should involve rural and vulnerable populations as co-creators, ensuring that solutions are tailored to their needs and contexts (Samarin et al., 2020; Pustet et al., 2025).

Encourage Social Entrepreneurship and Innovation Ecosystems: Policies should support the emergence and scaling of social entrepreneurs who address unmet needs in rural communities, particularly in the wake of disruptive events (Wei et al., 2022).

Develop Holistic and Context-Sensitive Regulatory Ecosystems: Governance frameworks must be adaptable to diverse contexts, balancing technical standards with considerations of equity, inclusion, and societal impact (Hartmann et al., 2025).

11. Technology and Artificial Intelligence: Successful Global Experiences: Algeria as a Case Study

This study examines the dynamics of urban–rural integration in the context of advanced technology and artificial intelligence, emphasizing how digital transformation reshapes spatial, economic, and social relationships between cities and rural areas. It highlights successful global experiences where smart agriculture, digital infrastructure, and AI-driven governance have reduced territorial disparities and enhanced rural development. The paper analyzes models from countries that have effectively integrated technology into rural planning, improving productivity, connectivity, and service delivery. is presented as a case study, focusing on its challenges related to regional imbalance, digital divide, and infrastructural limitations, alongside emerging initiatives in smart development. The study concludes that adopting AI-based policies and integrated territorial planning can foster sustainable development and strengthen urban–rural linkages in Algeria.

12. Conclusion:

Urban-rural integration in the era of advanced technology and AI is a complex, multifaceted process that holds both promise and peril. The deployment of digital infrastructures and AI systems offers unprecedented opportunities to bridge longstanding divides, foster inclusive development, and empower rural communities. Yet, these same technologies can also entrench inequalities, introduce new risks, and marginalize vulnerable populations if not thoughtfully governed and implemented.

The experiences of civil society organizations, public interest technologists, and social entrepreneurs underscore the importance of participatory, context-sensitive approaches to technological integration. Regulatory frameworks must evolve to facilitate meaningful oversight, data access, and the active involvement of civil society in governance processes. Capacity-building, professionalization, and community-building are essential for sustaining innovation and ensuring that technology serves the public interest.

Ultimately, the success of urban-rural integration in the age of advanced technology depends on our collective ability to navigate the sociotechnical complexities of this transformation. By centering equity, inclusion, and the lived experiences of rural and marginalized populations, we can harness the power of technology to create more just, resilient, and integrated societies.

Références :

1. Hartmann, D., Laranjeira de Pereira, J. R., Streibörger, C., & Berendt, B. (2025). Addressing the regulatory gap: moving towards an EU AI audit ecosystem beyond the AI Act by including civil society. <https://arxiv.org/pdf/2403.07904v3>

Urban-Rural Integration Dynamics in Light of Advanced Technology and Artificial Intelligence: Global Experiences

2. Knodel, M., Balakrishnan, M., & Chambers, L. M. (2025). Shaping a Profession, Building a Community: A Practitioner-Led Investigation of Public Interest Technologists in Civil Society. <https://arxiv.org/pdf/2508.07230v1>
3. Pustet, M., Steffen, E., Mihaljević, H., Stanjek, G., & Illies, Y. (2025). Civil Society in the Loop: Feedback-Driven Adaptation of (L)LM-Assisted Classification in an Open-Source Telegram Monitoring Tool. <https://arxiv.org/pdf/2507.06734v1>
4. Samarin, N., Frik, A., Brooks, S., Cheshire, C., & Egelman, S. (2020). Surveying Vulnerable Populations: A Case Study of Civil Society Organizations. <https://arxiv.org/pdf/2003.08580v2>
5. Wei, S., Boudreaux, C., Su, Z., & Wu, Z. (2022). Natural disasters and social entrepreneurship: An attention-based view. <https://arxiv.org/pdf/2404.08620v1>
6. Clark, J. J. (2020). Uneven innovation: The work of smart cities. Columbia University Press.
7. Fourati, F., Ammar, M., Kamoun, F., & Ksentini, A. (2022). Bridging the urban–rural connectivity gap through intelligent networks. arXiv preprint arXiv:2202.12683.
8. Hu, S., Zhang, Y., Li, X., & Chen, Q. (2025). Research on urban–rural integration planning guidance and path realization in suburban areas of metropolis based on AI models. *Applied Mathematics and Nonlinear Sciences*, 10(1), 1–14. <https://doi.org/10.2478/amns-2025-0981>
9. Pasupuleti, M. K. (2025). Smart villages: IoT and AI for sustainable rural development. National Education Services.
10. Qin, S., Wang, H., & Ma, C. (Eds.). (2025). Digital transformation with AI and smart servicing technologies for sustainable rural development. CRC Press. <https://doi.org/10.1201/9781003478400>
11. Yin, Y., & Guo, S. (2023). Digital economy, technological innovation and urban–rural integration. In *Proceedings of the International Conference on Artificial Intelligence and Digital Economy* (pp. 312–319). Atlantis Press. https://doi.org/10.2991/978-94-6463-230-9_37
12. Zhu, H., Geng, C., & Chen, Y. (2024). Urban–rural integration and agricultural technology innovation: Evidence from global experiences. *Agriculture*, 14(11), 1906. <https://doi.org/10.3390/agriculture14111906>
13. Zhang, J., Liu, Y., & Wang, Z. (2025). How the digital economy promotes urban–rural integration through optimizing factor allocation. *Frontiers in Sustainable Food Systems*, 9, Article 1494247. <https://doi.org/10.3389/fsufs.2025.1494247>
14. Wirth, T., Čuček, L., & Bjørn, A. (2022). Rural smartness: Its determinants and impacts on rural economic welfare. *Electronic Markets*, 32(4), 2273–2291. <https://doi.org/10.1007/s12525-022-00526-2>