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Факультет менеджменту і маркетингу
Кафедра менеджменту, публічного управління та адміністрування

ДОПУСТИТИ ДО ЗАХИСТУ
В ЕКЗАМЕНАЦІЙНІЙ КОМІСІЇ:

Завідувачка кафедри,
д.держ.упр., проф.
_____Наталія БОНДАРЧУК
«_____» _____ 2024 р.

КВАЛІФІКАЦІЙНА РОБОТА

на тему: ВПРОВАДЖЕННЯ ІНОЗЕМНОГО ДОСВІДУ SMART-УПРАВЛІННЯ РОЗВИТКОМ ТЕРИТОРІАЛЬНИХ ГРОМАД В УКРАЇНІ

Освітньо-професійна програма «Публічне управління та адміністрування»
Спеціальність 281 «Публічне управління та адміністрування»
Ступінь вищої освіти: Магістр

Здобувач   **Олег ОНОПРІЄНКО**

Науковий керівник,
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Дніпро – 2024

Ministry Of Education And Science Of Ukraine
Dnipro State Agrarian And Economic University
Faculty of Management and Marketing
Department of Management, Public Management and Administration

PERMISSION TO DEFEND
AT THE EXAMINATION BOARD:

Head of the Department,
Doctor of Public Administration,
Prof.
_____**Nataliia BONDARCHUK**
«____» _____ 2024 p

IMPLEMENTATION OF FOREIGN EXPERIENCE OF SMART MANAGEMENT OF THE DEVELOPMENT OF TERRITORIAL COMMUNITIES IN UKRAINE

Educational and Professional Rogram "Public Management and Administration"
Specialty 281 "Public Management and Administration"
Degree of Higher Education: Master's

Applicant   **Oleg ONOPRIIENKO**

Supervisor,
Doctor of State Administration, Prof.   **Nataliia BONDARCHUK**

Dnipro – 2024

ДНІПРОВСЬКИЙ ДЕРЖАВНИЙ АГРАРНО-ЕКОНОМІЧНИЙ УНІВЕРСИТЕТ

Факультет: Менеджменту і маркетингу
Кафедра: Менеджменту, публічного управління та адміністрування
Освітньо-професійна програма: «Публічне управління та адміністрування»
Спеціальність: 281 «Публічне управління та адміністрування»
Ступінь вищої освіти: Магістр

ЗАТВЕРДЖУЮ

Зав. кафедри _____

«_____»_____ 202__р.

З А В Д А Н Н Я

на підготовку кваліфікаційної роботи

Онопрієнко Олега Дмитровича
(прізвище, ім'я, по батькові)

1. Тема роботи: «Впровадження іноземного досвіду SMART-управління розвитком територіальних громад в Україні» _
Науковий керівник: Бондарчук Н.В., д.н.держ.упр., проф.,
(прізвище, ім'я, по батькові, науковий ступінь, вчене звання)
затверджені наказом по ДДАЕУ від «___»_____202_року № _____
2. Термін подання здобувачем роботи: 4 грудня 2024 року _____
3. Вихідні дані до роботи: Закони України, Постанови КМУ, Накази Міністерства освіти і науки, Укази Президента України та інші нормативні документи, навчальні посібники, підручники, періодична література, праці провідних вчених, нормативно-правові документи ДДАЕУ
4. Зміст розрахунково-пояснювальної записки (перелік питань, які потрібно розробити)
1. Теоретичні основи SMART-управління та його роль у розвитку територіальних громад. Сутність і концепція SMART-управління. Сучасний стан впровадження SMART-управління в територіальних громадах. Стан і виклики розвитку територіальних громад в Україні. Оцінка готовності територіальних громад України до впровадження SMART-управління. Перспективи та стратегії впровадження SMART-управління в Дніпровському державному аграрно-економічному університеті. Рекомендації щодо адаптації міжнародного досвіду SMART-управління.
5. Перелік графічного матеріалу (з точним зазначенням обов'язкових креслень)
Проблеми впровадження SMART-управління в міських, напівміських і сільських громадах. Готовність до впровадження SMART-управління в міських, напівміських і сільських громадах. Доступність фінансових ресурсів для різних типів громад. Впровадження екологічних ініціатив сталого розвитку. Готовність інструментів SMART-управління для ДДАЕУ. Хронологія розробки нормативної бази для впровадження SMART-управління в ДДАЕУ. Екосистема SMART-інструментів для ДДАЕУ.

6. Консультанти розділів роботи

Розділ	Прізвище, ініціали та посада консультанта	Підпис, дата	
		завдання видав	завдання прийняв

7. Дата видачі завдання_____11 жовтня 2023 р.__

КАЛЕНДАРНИЙ ПЛАН

№ з/п	Назва етапів кваліфікаційної роботи	Термін виконання етапів роботи	Примітка
1.	Вибір теми і об'єкта дослідження, розробка завдання і графіка робіт	жовтень 20223р.	
2.	Пошук та опрацювання літературних джерел	листопад-грудень 2023р.	
3.	Теоретичні основи SMART-управління та його роль у розвитку територіальних громад	січень - березень 2024р.	
4.	Сучасний стан впровадження SMART-управління в територіальних громадах	квітень - травень 2024р.	
5.	Рекомендації щодо адаптації міжнародного досвіду SMART-управління, розробка нормативної бази.	червень - листопад 2024р.	
6	Висновки	грудень 2024р.	
7	Оформлення роботи	грудень 2024р.	

Здобувач   _____   ___Олег ОНОПРІЄНКО
                  (підпис)   (прізвище та ініціали)

Науковий керівник _____   Наталія БОНДАРЧУК

РЕФЕРАТ

Тема: «Впровадження іноземного досвіду SMART-управління розвитком територіальних громад в Україні»

Кваліфікаційна робота містить: 85 с., 7 рис., 62 літературних джерела.

Об'єкт дослідження - це процес впровадження практик SMART-управління для розвитку територіальних громад в Україні з акцентом на адаптацію іноземного досвіду до місцевих умов..

Предмет дослідження є теоретичні, методологічні та практичні аспекти впровадження практик SMART управління розвитком територіальних громад в Україні на основі адаптації зарубіжного досвіду.

Метою роботи є аналіз та адаптація іноземного досвіду впровадження практик SMART-управління для розвитку територіальних громад в Україні.

Методи дослідження системний і порівняльний аналіз, емпіричні методи, моделювання, графічний метод і прогнозування для вивчення та адаптації практик SMART-управління до умов України.

Визначено теоретичні основи SMART-управління та його роль у розвитку територіальних громад. Проаналізовано зарубіжний досвід впровадження SMART-управління для розвитку громад. Досліджено сучасний стан впровадження SMART-управління в територіальних громадах України. Запропоновано напрями адаптації міжнародного досвіду та вдосконалення впровадження SMART-управління в Україні.

КЛЮЧОВІ СЛОВА
SMART-УПРАВЛІННЯ, ТЕРИТОРІАЛЬНІ ГРОМАДИ, РОЗВИТОК, ЦИФРОВА ТРАНСФОРМАЦІЯ, АДАПТАЦІЯ МІЖНАРОДНОГО ДОСВІДУ, ПУБЛІЧНЕ УПРАВЛІННЯ,.

KEYWORDS

SMART MANAGEMENT, TERRITORIAL COMMUNITIES, DEVELOPMENT, DIGITAL TRANSFORMATION, ADAPTATION OF INTERNATIONAL EXPERIENCE, PUBLIC ADMINISTRATION.

CONTENTS

INTRODUCTION

Relevance. The significance of this study lies in the transformative potential of SMART management practices, particularly in addressing the complex governance challenges faced by territorial communities in Ukraine. As technological advancements redefine governance globally, integrating foreign experience in SMART management is pivotal for achieving sustainable, inclusive, and efficient community development. This integration responds to the pressing need for modernization in Ukraine's governance structures, highlighted by the disparities in infrastructure, financial resources, and digital literacy across urban, semi-urban, and rural areas.

International best practices demonstrate the effectiveness of data-driven decision-making, IoT deployment, and citizen-centric approaches in optimizing public services and resource allocation. Adopting these methodologies can help Ukrainian communities overcome entrenched inefficiencies and elevate their participation in global digital transformation trends. This relevance is amplified by Ukraine's ongoing decentralization reforms, which aim to empower local governments and encourage innovative, localized governance strategies.

Through this research, actionable insights into adapting and localizing successful international SMART management frameworks will enable Ukrainian territorial communities to address their unique socio-economic and geographic challenges effectively. These findings contribute to broader academic and practical discourses on digital governance, aligning with Ukraine's aspirations for sustainable and equitable development. The study also highlights the importance of integrating legal, regulatory, and infrastructural improvements to establish a robust foundation for SMART management, ensuring long-term societal benefits and aligning local efforts with global standards.

Objective of the Study. The primary objective of this study is to analyze and adapt foreign experience in implementing SMART management practices for the development of territorial communities in Ukraine.

Tasks to Achieve the Objective. To achieve this objective, the following tasks were set:

- investigate the essence and concept of SMART management as a foundation for its practical implementation;

- identify the principles and key elements of SMART management and their relevance to community governance;

- analyze international practices in SMART management for insights into best practices and potential adaptations;

- assess the current state and challenges of territorial community development in Ukraine, emphasizing disparities in digital infrastructure and readiness;

- evaluate the readiness of Ukrainian communities for SMART management, focusing on technological, financial, and human resource aspects;

- examine the regulatory and legal framework in Ukraine supporting SMART management, identifying gaps and areas for improvement;

- develop tailored recommendations for adapting international experience in SMART management to Dnipro State Agrarian and Economic University (DSAEU);

- propose ways to enhance the regulatory framework to support SMART management within DSAEU;

- design a phased implementation plan for SMART management at DSAEU, emphasizing infrastructure development, capacity building, and sustainable practices.

Object of the Study. The object of the study is the process of implementing SMART management practices for the development of territorial communities in Ukraine, focusing on the adaptation of foreign experience to local contexts.

Subject of the Study. The subject of the study is the theoretical, methodological, and practical aspects of implementing SMART management practices for the development of territorial communities in Ukraine, based on the adaptation of foreign experience.

Research Methods. The study uses a combination of theoretical and empirical research methods, including: Systematic and comparative analysis to explore the principles and global applications of SMART management; case studies to analyze the current state of implementation in various contexts; Surveys and expert interviews to assess stakeholder readiness and identify challenges at DSAEU; Modeling and forecasting to develop a phased implementation plan.**;** Quantitative methods for evaluating the impact of SMART management tools and strategies.

Information Base of the Study. The informational base of the study includes: scholarly publications on SMART management, digital transformation, and sustainable development; reports and case studies from international organizations and educational institutions; regulatory documents and policies related to higher education and digitalization; data collected from surveys and interviews conducted at DSAEU.

The scientific novelty consists in the development of theoretical provisions and practical recommendations regarding the possibilities of adapting foreign experience of SMART-management of the development of territorial communities in Ukraine.

The main provisions of scientific novelty are as follows:

acquired further development:

- developing a tailored approach to SMART management implementation, incorporating global best practices and local needs;

- SMART management toolkit, including advanced application of technologies such as IoT sensors, cloud platforms and VR/AR to improve operational efficiency, academic quality and research capabilities to transform management processes in educational and research institutions;

improved:

- an integrated approach that will facilitate improved collaboration between universities and private organizations and provide access to additional funding,

expertise and technological resources necessary for the successful implementation of SMART management.

Approval of Research Results. The results of the research were presented and approved at the XII All-Ukrainian Scientific and Practical Conference "Development of Forms and Methods of Modern Management in the Context of Globalization" (November 8–9, 2024, Dnipro, Ukraine).

Additionally, the article "Implementation of the SMART System of Management of the Development of Territorial Communities: Experience and Perspectives" by Bondarchuk N.V. and Onopriienko O.D. was published in the scientific journal "Scientific Perspectives" (Series "Public Administration"), Issue No. 11(53), 2024. The article highlights the theoretical and practical recommendations for SMART management implementation in territorial communities, using examples of global best practices and proposing specific adaptations for Ukraine.

Structure. The structure of the qualification work consists of an introduction, three chapters, conclusions, and a list of references (62 sources). The main text comprises 85 pages, excluding appendices, and is illustrated with 7 figures.

CHAPTER 1
THEORETICAL FOUNDATIONS OF SMART MANAGEMENT AND ITS ROLE IN THE DEVELOPMENT OF TERRITORIAL COMMUNITIES

1.1 Essence and Concept of SMART Management

SMART management is an evolving concept within governance, integrating digital technology, data analytics, and a citizen-centered approach to foster more responsive, efficient, and sustainable communities. Originally derived from the acronym "SMART" — Specific, Measurable, Achievable, Relevant, and Time-bound — widely recognized as a framework for goal-setting and performance evaluation, SMART management in governance extends beyond traditional metrics to a broader strategic vision. This vision includes optimizing local service delivery, promoting transparency, and enhancing citizen engagement through the use of data and innovative technology [1, 2]. According to studies on smart community initiatives, the core of SMART management lies not only in the deployment of advanced technologies, such as Internet of Things (IoT) sensors and big data platforms, but also in the integration of these tools into governance processes, enabling a real-time, adaptable response to community needs and feedback [3, 4].

This approach represents a shift from traditional top-down governance models, where decision-making was often slow and detached from local realities, to a more dynamic and participatory system that actively incorporates stakeholder input and current data trends. The transition from "smart cities" to "smart territories" broadens this model to include rural and semi-urban areas, allowing a wider range of communities to benefit from digitalization and data-driven decision-making. Studies on global best practices have highlighted that for SMART management to be effective, it must not only be technologically advanced but also culturally and socially inclusive, ensuring that even small and resource-limited communities can participate and benefit [5, 6]. For Ukraine, this expanded

scope of SMART management offers an important opportunity for its territorial communities, particularly under the ongoing decentralization reform, to develop tailored, resilient governance models that address local economic, social, and environmental needs [7].

The essence of SMART management lies in its emphasis on the intelligent and strategic use of technology to address community needs. Unlike traditional governance models that rely on static, infrequent data collection, SMART management employs real-time data analytics to continually assess and respond to community demands and resource availability. This shift enables a more flexible and responsive approach to issues such as public safety, transportation, and environmental management, providing local governments with up-to-date insights that facilitate swift, informed decision-making [1]. According to recent studies, SMART management does not simply involve the deployment of digital infrastructure but is also rooted in the systematic integration of data analytics, automation, and citizen feedback mechanisms into the fabric of local governance [2].

In SMART management, technologies like the Internet of Things (IoT), cloud computing, and artificial intelligence (AI) play crucial roles. IoT devices, for instance, can monitor everything from air quality to traffic patterns, while AI-driven analytics convert this vast amount of data into actionable insights for policy adjustments and community services [3, 4]. By enabling continuous monitoring and analysis, these technologies empower local governments to detect trends and potential issues early, promoting a proactive rather than reactive approach to governance. Automation further enhances this model by streamlining processes, reducing administrative workloads, and allowing human resources to focus on strategic tasks [5].

Additionally, SMART management represents a shift from traditional, top-down approaches to a more adaptive and participatory model, where governance is responsive to real-time data and stakeholder input. The integration of citizen feedback mechanisms, such as digital platforms where residents can report issues

or participate in decision-making, fosters a more engaged and empowered community [6]. This participatory approach not only improves transparency but also builds trust, as citizens see their voices reflected in local policies and decisions. By focusing on both technological innovation and civic engagement, SMART management fosters a collaborative environment in which local government and citizens work together to address challenges and improve quality of life [7].

Moreover, SMART management promotes efficiency by optimizing resource allocation based on data-driven assessments. For example, energy management systems can automatically adjust lighting in public spaces depending on real-time usage, reducing costs and conserving resources [8]. This data-informed, adaptable approach aligns with sustainability goals, allowing communities to reduce waste, minimize environmental impact, and develop resilient infrastructures capable of withstanding future challenges [9].

Several fundamental principles define the SMART management model in the context of territorial communities:

1.   Data-Driven Decision Making: SMART management emphasizes the use of big data and analytics to make informed decisions. By collecting and analyzing real-time data, local governments can address issues such as traffic congestion, energy consumption, and public safety with greater precision. Research highlights that effective SMART management requires robust data infrastructure, including IoT (Internet of Things) sensors and digital platforms, that collect information across various sectors (Smart Communities Inside Local Governments: A Pie in the Sky?, 2021).

2.   Citizen-Centric Services: A defining feature of SMART management is its focus on citizen needs and experiences. Through digital engagement tools, communities are encouraged to participate in governance processes, offering input and feedback on local policies. This participatory approach not only fosters transparency but also enhances community trust in local authorities (Towards Creating Place Attachment and Social Communities in the Smart Cities, 2021).

3.   Efficient Resource Allocation: SMART management enables more efficient use of resources, as it allows governments to monitor usage patterns and optimize resource distribution in areas such as water, energy, and waste management. Studies on smart cities and communities have shown that digital tools can significantly reduce resource wastage and improve overall sustainability (Multi-level Governance for Sustainable Innovation in Smart Communities, 2020).

4.   Interoperability and Integration: SMART management relies on a connected system in which various municipal functions are integrated. This interoperability allows for seamless communication across departments and more coherent service delivery. For example, integrating data from transportation, utilities, and healthcare departments can improve emergency response times and enable coordinated action in crisis situations (Smart Villages: Comprehensive Review of Initiatives and Practices, 2022).

5.   Adaptability and Resilience: Modern SMART management systems are designed to adapt to evolving challenges, including environmental risks and economic shifts. The use of predictive analytics, for instance, enables communities to anticipate and respond to potential issues, from natural disasters to shifts in population dynamics. Adaptability is particularly important in the Ukrainian context, where territorial communities face varying socio-economic and environmental challenges (New Strategies to Improve Governance in Territorial Management: Evolving from 'Smart Cities' to 'Smart Territories', 2021).

The concept of SMART management has evolved significantly alongside technological advancements that enable more sophisticated data collection, processing, and real-time responsiveness. Initially, SMART management emerged as a cornerstone of the "smart city" movement, focusing primarily on urban areas where dense populations and infrastructural complexity demanded innovative solutions to improve efficiency, reduce congestion, and enhance the quality of public services. In these settings, technologies such as IoT networks, big data analytics, and AI-driven platforms were first deployed to optimize traffic flow,

manage energy consumption, and streamline waste collection, setting a high standard for modern urban management [1].

However, as the benefits of SMART management became more evident, the concept began to extend beyond densely populated cities, evolving to address the unique needs of rural and semi-urban areas under the framework of "smart territories." This expansion has allowed a wider range of communities to leverage the advantages of digitalization, using tailored approaches that consider factors like population density, resource availability, and local economic conditions. In these non-urban contexts, SMART management applications often focus on improving access to healthcare, enhancing agricultural productivity, and managing natural resources sustainably, offering solutions that respond to specific local challenges [2].

For rural and semi-urban regions, this shift is transformative. It enables local governments and community leaders to implement data-informed strategies that not only improve service delivery but also support long-term development goals. By integrating digital infrastructure with local governance, smart territories can utilize real-time data to optimize resource allocation, predict and mitigate risks, and ensure that residents in less populated areas receive equitable access to essential services. Furthermore, this transition to smart territories promotes social and economic inclusion by fostering digital literacy and providing opportunities for community engagement and participation, strengthening community ties and promoting resilience [3].

In Ukraine, the adaptation of SMART management to territorial communities is particularly relevant due to the country's ongoing decentralization reforms. These reforms aim to empower local authorities, granting them greater autonomy in decision-making and resource management. Territorial communities, once considered peripheral to national development, are now increasingly recognized as essential actors in regional economic growth, social stability, and environmental stewardship. By adopting SMART management principles, these communities can optimize their governance practices, align with broader national

and international development goals, and contribute to building a more cohesive and resilient national framework [4].

This evolution of SMART management from urban to rural applications underscores the adaptability of the concept and its potential to address diverse governance challenges across different community types. As Ukraine continues to decentralize, the adoption of smart territory principles offers a practical pathway to sustainable, data-driven governance that strengthens local communities and enhances their role in shaping the country's future [5].

International experiences underscore that effective SMART management requires a supportive regulatory framework and sustained investment in digital infrastructure. Without these foundational elements, even the most innovative SMART management initiatives may struggle to achieve their full potential, as they depend on the seamless integration of technology, governance, and community engagement. In countries with mature SMART management systems, such as Singapore and several European Union member states, governments have not only focused on deploying advanced digital tools but also on crafting comprehensive policies that lay the groundwork for sustainable and equitable development [1]. These policies typically encompass various regulatory and strategic dimensions, including data privacy, cybersecurity, open data standards, and cross-sectoral interoperability, which are essential for building trust and ensuring smooth, collaborative operations across public and private sectors [2].

For instance, Singapore has become a global leader in SMART management by establishing a "Smart Nation" framework that emphasizes connectivity, digital readiness, and the development of a high-tech infrastructure accessible to all citizens. Through this framework, Singapore has integrated digital services into nearly every aspect of daily life, from transportation and public safety to healthcare and education, while safeguarding personal data and promoting digital literacy [3]. This dual focus on innovation and inclusion has been instrumental in achieving not only technological advancement but also in fostering a sense of community ownership and involvement. Singapore's approach highlights that SMART

management should be as much about people as it is about technology, reinforcing the importance of social cohesion in the digital age [4].

Similarly, within the European Union, member states have adopted various SMART management strategies under the umbrella of the "European Smart Cities" initiative, which emphasizes sustainable urban development, social inclusion, and environmental responsibility. EU policies promote collaboration across municipalities and regions, encouraging shared standards and best practices that allow smaller communities to benefit from the experiences of larger, more technologically advanced cities. This collaborative model reduces implementation costs, increases access to cutting-edge solutions, and ensures that communities of different sizes and resources can participate in the digital transformation [5]. Countries like Denmark, Finland, and the Netherlands have further demonstrated the importance of public-private partnerships in SMART management, where businesses and local governments work together to develop and fund infrastructure projects, making smart technologies more accessible to local populations [6].

These international examples show that successful SMART management initiatives are not solely focused on improving efficiency but are designed to promote equity and social inclusion as well. Such policies ensure that technological advancements benefit all segments of society, regardless of their location or socio-economic status, thereby promoting inclusive development across diverse community types. In this way, a well-supported regulatory framework not only facilitates the effective implementation of SMART management but also helps bridge the digital divide, allowing rural, urban, and semi-urban communities alike to share in the benefits of digitalization [7]. By emphasizing inclusivity, these countries demonstrate that SMART management can be a powerful tool for addressing social disparities and enhancing quality of life, as it empowers communities to participate in shaping their digital futures on a level playing field [8].

The essence of SMART management, therefore, is not solely technological but is deeply rooted in the principles of efficiency, inclusivity, and adaptability.

While technology plays a central role, SMART management's success relies on a balanced integration of digital tools with strategic governance principles that prioritize the well-being and engagement of all community members. Efficiency in SMART management involves optimizing the use of resources—whether financial, environmental, or human—by implementing systems that enable data-driven decision-making and reduce waste. This approach allows communities to streamline public services, minimize operational costs, and ensure that resources are allocated effectively to areas where they are needed most. Inclusivity, meanwhile, emphasizes that SMART solutions must be accessible and beneficial to all community members, regardless of socio-economic status, geographic location, or digital literacy. Inclusivity means designing technology and policies that cater to diverse needs and enable citizens to engage with and benefit from digital innovations, fostering a sense of belonging and shared purpose [1].

Adaptability is equally crucial, as it allows SMART management frameworks to remain responsive to emerging challenges and opportunities. In a rapidly changing world, communities must be resilient, able to adapt to new technologies, and prepared to address unforeseen issues like economic shifts, environmental threats, or public health crises. This flexibility is particularly relevant in Ukraine, where territorial communities face a wide array of challenges, from urbanization pressures and infrastructural needs in larger municipalities to economic and social isolation in rural areas. Given these diverse circumstances, a one-size-fits-all approach would likely be ineffective. Instead, SMART management in Ukraine calls for tailored solutions that accommodate the unique needs and capacities of each community while leveraging local strengths [2].

In this context, SMART management offers a powerful pathway for Ukrainian communities to harness digital tools in addressing local challenges and achieving sustainable growth. With decentralization reforms empowering local authorities, communities are increasingly responsible for shaping their own development trajectories. By adopting SMART management principles, they can implement efficient systems for waste management, transportation, energy use, and

more, improving day-to-day life for residents while reducing environmental impact. For rural communities, SMART management might involve digitalizing agricultural practices, using IoT sensors to monitor crop health, or developing platforms for remote healthcare access, thereby overcoming geographical and logistical barriers [3].

Additionally, by fostering citizen participation and utilizing digital platforms for open dialogue and feedback, SMART management promotes transparency and accountability in local governance. Citizens become active contributors to decision-making processes, building a more engaged, informed, and connected society. This collaborative dynamic not only strengthens trust between local authorities and residents but also ensures that community needs are directly reflected in policies and initiatives, leading to more effective governance outcomes [4]. As Ukraine continues to embrace digitalization and decentralization, SMART management offers an adaptive framework for building resilient, inclusive, and resource-efficient territorial communities that prioritize quality of life, social equity, and environmental sustainability [5].

1.2 Principles and Key Elements of SMART Management in Community Governance

SMART management in community governance is built upon core principles and elements that guide how technology, data, and community engagement intersect to foster sustainable, efficient, and responsive local governance. This approach transcends mere technological adoption; it integrates innovative tools with a people-centered governance framework that addresses social, economic, and environmental needs. These principles prioritize not only technological integration but also the foundational values of inclusivity, transparency, and adaptability. Inclusivity ensures that the benefits of SMART management reach all members of the community, regardless of their socio-economic status, age, or geographical location, thereby bridging the digital divide

and fostering social cohesion. Transparency, meanwhile, promotes openness in governance processes by providing citizens with access to information, building trust, and allowing for active citizen participation in decision-making. Adaptability ensures that SMART management systems remain flexible and resilient, enabling communities to evolve with changing circumstances, emerging technologies, and unforeseen challenges such as economic shifts or environmental crises.

Understanding these foundational principles and key elements is essential for effective implementation of SMART management, as they offer a structured framework through which communities can address their unique challenges while maximizing the benefits of digitalization. For instance, data-driven insights allow local governments to make informed decisions that enhance resource efficiency, such as optimizing energy usage, reducing traffic congestion, or improving waste management. Additionally, community engagement platforms provide residents with tools to communicate directly with local officials, fostering a collaborative relationship where community members are active participants in governance. By combining technology with inclusive practices, SMART management not only improves service delivery but also empowers citizens, making them co-creators of their communities' development.

These principles and elements also facilitate a more comprehensive approach to sustainability, allowing communities to adopt practices that minimize environmental impact and support long-term social and economic growth. From enabling public-private partnerships to leveraging predictive analytics for better resource planning, SMART management provides communities with the tools to transform governance into a proactive, data-informed system that can adapt to future needs. As communities navigate the digital age, SMART management offers a holistic governance model that supports resilient, inclusive, and transparent communities capable of thriving amidst the complexities of modern life.

SMART management is founded on several key principles that guide its implementation in community governance, ensuring that technology is used not just effectively, but in ways that serve the community's broader goals. Central to

SMART management is efficiency, which focuses on optimizing resource use and reducing waste through technology. By harnessing data analytics and real-time monitoring, local governments are equipped to streamline processes and eliminate redundancies. For example, data-driven energy management can help communities lower electricity consumption in public spaces, while predictive maintenance for infrastructure prevents costly repairs and service interruptions by addressing issues before they escalate [1].

Inclusivity is another vital principle, aiming to make SMART management accessible to all members of the community. This principle ensures that everyone, regardless of socio-economic background, age, or location, can benefit from digital services and resources. Inclusivity not only calls for the provision of technological infrastructure but also emphasizes the importance of education and training to close the digital divide, especially in rural or underserved areas. This approach fosters social cohesion by ensuring that technological advancements enhance the quality of life for every citizen [2].

Transparency is essential in building trust between local governments and residents, making data and decision-making processes open to the public. Through open data policies and online platforms that display government activities, citizens are empowered to understand, participate in, and hold leaders accountable for their actions. Transparency also supports informed decision-making, as it allows community members to engage meaningfully, knowing that processes are based on accessible and reliable data [3].

Another core principle, adaptability, enables SMART management systems to remain relevant as community needs evolve and as new technologies and environmental conditions emerge. An adaptable framework for SMART management is designed to evolve with trends and challenges, such as population growth, climate change, and economic shifts. This flexibility ensures that community governance stays proactive and resilient, capable of integrating new technologies and adapting practices over time [4].

Finally, sustainability serves as an overarching principle that directs SMART management towards long-term environmental, social, and economic health. By aligning with sustainable development goals, SMART management systems help reduce environmental impact, conserve resources, and support green initiatives like renewable energy and smart waste management. Sustainability in SMART management contributes not only to environmental preservation but also to social equity and economic resilience, benefiting future generations and supporting the community's enduring vitality [5].

Together, these principles form a cohesive foundation for SMART management, ensuring that it is both effective and aligned with the broader goals of community well-being, resilience, and sustainability.

SMART management in community governance relies on several key elements that collectively support the use of technology and data to create responsive, efficient, and sustainable local government systems. Data-driven decision-making stands as a foundational element, emphasizing the importance of using data from various sources—such as IoT devices, public service usage, and community feedback—to inform policies and strategies. By collecting, analyzing, and applying this data, communities can tailor solutions to specific needs. For example, analyzing traffic data can optimize transportation systems, reducing congestion and emissions. This data-centric approach enables local governments to dynamically adjust policies and allocate resources based on real-time insights, promoting responsive and adaptive governance [6].

Effective SMART management also requires robust digital infrastructure, which includes broadband connectivity, IoT networks, and cloud computing platforms. This infrastructure serves as the backbone for key functions like real-time monitoring, automated responses, and enhanced communication. Without sufficient digital infrastructure, implementing SMART management practices would be challenging, as many core functions depend on reliable connectivity and processing capabilities. In addition to supporting various SMART tools and

technologies, digital infrastructure enables efficient service delivery and facilitates seamless communication within the community [7].

Citizen engagement platforms are another essential component of SMART management, as they foster a collaborative relationship between residents and local authorities. These platforms—such as mobile applications, online portals, and social media channels—allow citizens to report issues, access services, and actively participate in decision-making processes. By providing channels for direct communication with local officials, SMART management encourages greater community involvement and ensures that residents play an active role in shaping policies and initiatives that affect their lives [8].

SMART management also emphasizes interdepartmental integration, promoting collaboration across various governmental departments and their functions. By connecting data and processes across departments, communities can address complex, cross-cutting issues, such as public safety, health, and environmental management, more effectively. Interdepartmental integration allows local governments to operate cohesively, reducing duplication of efforts and enabling comprehensive solutions to community challenges [9].

The use of automated services and predictive analytics enhances the efficiency and effectiveness of community services. Automated systems, such as intelligent lighting and optimized waste collection schedules, minimize manual intervention and make resource use more efficient. Predictive analytics, meanwhile, enables local governments to forecast future needs and identify potential issues by analyzing past trends and real-time data. These tools support a proactive rather than reactive approach to governance, helping communities anticipate and prevent problems before they arise [10].

Public-private partnerships (PPPs) are instrumental in advancing SMART management by providing communities with access to cutting-edge technologies, expertise, and funding that may otherwise be unavailable. Through partnerships with private sector companies, local governments can benefit from advanced technological solutions and financial resources necessary for implementing

SMART initiatives. These partnerships are especially valuable for smaller communities with limited capacity to independently develop digital infrastructure, ensuring that they, too, can benefit from innovative SMART solutions [11].

Lastly, sustainability metrics and monitoring are critical to SMART management, as they help communities measure and track their progress toward sustainability goals. Metrics that assess environmental impact, energy consumption, waste production, and carbon emissions enable communities to monitor their sustainability efforts continually. Regular monitoring allows for the early detection of unsustainable practices, guiding local governments to make necessary adjustments to meet environmental and social benchmarks, thereby supporting long-term sustainability [12].

Together, these principles and key elements of SMART management form a cohesive framework that supports effective community governance. By prioritizing efficiency, inclusivity, transparency, adaptability, and sustainability, SMART management enables communities to address their specific challenges and leverage digital tools in ways that foster engagement, resilience, and development. As Ukrainian communities explore and adopt SMART management practices, these principles and elements provide a roadmap for creating governance systems that are both technologically advanced and socially responsive.

1.3 Experience of Foreign Countries in Implementing SMART Management for the Development of Territorial Communities

Countries around the world have pioneered SMART management practices to create more efficient, responsive, and sustainable communities, offering valuable models and insights for others. Each nation has adapted SMART management principles to its unique social, economic, and environmental contexts, highlighting various best practices that Ukrainian communities can learn from as they implement their own SMART management systems.

One leading example is Singapore, globally recognized for its comprehensive "Smart Nation" framework. This initiative integrates digital technologies across government functions to improve public services, stimulate economic growth, and enhance citizens' quality of life. Singapore's approach relies on data-driven governance, employing IoT sensors, data analytics, and artificial intelligence to monitor urban infrastructure, optimize transportation, and manage energy consumption in real time. The government also developed citizen engagement platforms, such as the "OneService" app, enabling residents to report issues directly to authorities and track their resolution. This approach, combined with strong regulatory frameworks for data privacy and cybersecurity, ensures that all citizens benefit from SMART management while maintaining trust in the system. Singapore's model highlights the importance of regulatory support, robust digital infrastructure, and active citizen engagement. For Ukraine, Singapore's experience underscores the need for a strong digital foundation and citizen-government trust as Ukrainian communities explore similar inclusive and adaptive solutions.

In the European Union, SMART management has taken a collaborative approach, particularly through the European Smart Cities program, which promotes sustainable urban development across member states. This program encourages cities and regions to share resources, best practices, and technological solutions, with cities like Copenhagen, Amsterdam, and Barcelona implementing SMART strategies focused on sustainability. Examples include smart energy grids, green mobility solutions, and waste management systems. These cities prioritize sustainability metrics, continually monitoring environmental impact, energy use, and emissions to align with EU climate goals. The EU approach also emphasizes social inclusivity. In Amsterdam, for instance, the "Smart Citizens Lab" involves residents in co-creating solutions for urban issues, such as air quality and noise pollution, allowing them to shape their environment. For Ukraine, the EU's experience demonstrates the importance of community engagement and sustainability-focused governance. Ukrainian communities could benefit from

fostering partnerships across municipalities and adopting standardized sustainability metrics to develop cohesive, environmentally conscious communities.

Japan has approached SMART management with a focus on addressing its aging population and workforce challenges. Cities like Fujisawa and Toyota are pioneering SMART initiatives in healthcare, elder care, and "smart homes" equipped with IoT devices to monitor the health and safety of elderly residents. In addition, Japan's use of robotics and automation in public spaces and healthcare facilities has enhanced service efficiency and promoted independence for older residents. Automated public transportation systems, powered by AI, operate in regions with declining populations, addressing accessibility concerns. For Ukraine, where rural and aging communities face similar challenges, Japan's model illustrates how SMART management can adapt to demographic shifts. By integrating telemedicine, automated public services, and elder-friendly technologies, Ukrainian communities could improve quality of life and social stability in rural areas.

In the United States, SMART management frequently relies on public-private partnerships (PPPs) to develop and implement digital infrastructure projects. Cities like New York, San Francisco, and Chicago have collaborated with tech companies to address urban challenges, from transportation and public safety to environmental sustainability. For example, Chicago's "Array of Things" project—a network of sensors that gather data on temperature, air quality, and noise—was developed in partnership with academic institutions and private companies, providing valuable data for city planning and helping authorities address public health and environmental issues. This model highlights the role of PPPs in advancing SMART management, particularly for communities lacking resources for large-scale technology projects. For Ukraine, adopting a PPP approach could attract private investment and provide communities with expertise and funding, enabling them to build necessary SMART infrastructure cost-effectively.

The experiences of these countries reveal several common themes that are highly relevant for Ukraine as it implements SMART management in its territorial communities. First, robust digital infrastructure is essential, as seen in Singapore and the EU. Ukraine should prioritize reliable broadband and IoT networks to support digital governance, especially in rural areas. Second, citizen-centered approaches, like Singapore's OneService app and the EU's Smart Citizens Lab, are crucial for building trust and collaboration. Ukrainian communities could benefit from similar platforms, allowing residents to report issues, access services, and participate in local governance. Third, a focus on sustainability, as seen in the EU and Japan's elder-care solutions, aligns SMART management with long-term social and environmental goals. Ukrainian communities should adopt sustainability metrics and incorporate elder-friendly technologies to support inclusive, age-responsive development.

Additionally, public-private partnerships are vital for funding and expertise, as demonstrated in the U.S. By engaging the private sector, Ukrainian communities can advance their SMART initiatives without shouldering the entire financial burden. Lastly, each country's approach is adapted to local needs, which underscores the importance of flexibility. For Ukraine, this means tailoring global best practices to the specific needs of urban, rural, and semi-urban areas, ensuring that each community can address its own unique challenges and opportunities through SMART management.

Conclusion for Chapter 1

1. SMART management integrates technology, data analytics, and community participation to create adaptive and sustainable governance models. Unlike traditional hierarchical systems, it emphasizes efficiency, inclusivity, and adaptability, aligning governance practices with global sustainability goals. This concept forms the foundation for addressing the socio-economic challenges faced by territorial communities, particularly in Ukraine.

2.   The principles of SMART management—efficiency, inclusivity, transparency, adaptability, and sustainability—serve as the foundation for designing governance systems that are both innovative and responsive to community needs. These principles ensure that SMART management practices not only leverage advanced technologies but also promote equitable access, accountability, and resilience within communities. Key elements, including data-driven decision-making, robust digital infrastructure, citizen engagement platforms, public-private partnerships, and sustainability metrics, are essential for operationalizing these principles. Together, they provide a structured roadmap for implementing SMART management systems that address local challenges effectively while fostering long-term environmental, social, and economic well-being. This framework underscores the importance of tailoring SMART initiatives to the unique needs of territorial communities, ensuring that governance systems are both inclusive and adaptable to changing circumstances.

3.   The examination of global case studies, particularly from Singapore and European Union countries, highlights the transformative impact of SMART management on community development. Key lessons include the importance of establishing supportive regulatory frameworks to facilitate digital integration, promoting public-private partnerships to leverage resources and expertise, and ensuring inclusivity by addressing the specific needs of underserved communities. These examples demonstrate that SMART management is most effective when tailored to local contexts while drawing on international best practices. For Ukraine, adapting these successful approaches to its unique infrastructural and socio-economic challenges will be essential in fostering sustainable, equitable, and innovative community development.

CHAPTER 2.
CURRENT STATE OF SMART MANAGEMENT
IMPLEMENTATION FOR TERRITORIAL COMMUNITIES

2.1 State and Challenges of Territorial Community Development in Ukraine

This section provides an in-depth analysis of the current state of SMART management implementation within territorial communities, focusing primarily on Ukraine's evolving landscape. As digital transformation and decentralization become increasingly central to Ukraine's national development strategy, the adoption of SMART management practices across local communities presents a pathway to improved governance, economic growth, and quality of life. However, the extent of this transformation varies significantly between communities, with disparities in resources, digital infrastructure, and expertise presenting both challenges and opportunities.

The discussion begins by examining the unique barriers Ukrainian communities face in adopting SMART management practices. These challenges are particularly pronounced in rural and semi-urban areas, where limited digital infrastructure, insufficient funding, and a lack of technical expertise hinder the adoption of SMART technologies. Additionally, this analysis explores discrepancies in technology access and digital literacy between urban and rural areas, emphasizing how these gaps affect the overall effectiveness of SMART management initiatives. Addressing these foundational issues is essential for creating a level playing field that enables all communities to participate fully in digital governance.

Beyond challenges, this section identifies the potential benefits associated with adopting SMART management practices. Urban centers and resource-rich areas, for instance, can experience enhanced data-driven decision-making, optimized public services, and improved community engagement. Rural

communities, despite their challenges, stand to gain significantly from targeted investments in digital infrastructure and training programs, allowing them to leverage digital tools for local development, agricultural advancements, and improved access to public services. By focusing on these opportunities, this section provides a balanced view of SMART management's potential to empower Ukrainian communities, regardless of their starting point.

Moreover, the readiness of Ukrainian communities for SMART management is assessed, with an evaluation of factors such as technological infrastructure, financial resources, and digital literacy. This readiness assessment reveals which communities are well-positioned to adopt SMART management immediately and which may require foundational support. Through this lens, critical gaps in digital capacity are identified, with recommendations for targeted interventions such as digital literacy programs, increased funding for underserved areas, and infrastructure upgrades, supporting a more equitable approach to SMART management.

In addition, the regulatory and legal support for SMART management initiatives in Ukraine is evaluated. Existing national policies, such as the "Digital Transformation Strategy for Ukraine" and "Digital State 2023," are reviewed to understand how well they align with the specific needs of territorial communities. While these frameworks offer a robust foundation for digital governance, there remains a need for more specific regulations addressing SMART management practices, data privacy, public-private partnerships, and citizen engagement. Developing a comprehensive regulatory framework that balances technological advancement with data security and community trust is essential for sustainable SMART management.

As Ukraine progresses in decentralization and digitalization, understanding this present landscape is crucial for identifying areas of improvement and mapping out potential paths forward. The insights provided here lay the groundwork for targeted investments, policy adjustments, and capacity-building initiatives that can foster an environment conducive to SMART management. By addressing current

challenges and seizing available opportunities, Ukrainian communities can harness the power of digital transformation to enhance governance, promote sustainable development, and improve quality of life for all citizens.

Territorial communities in Ukraine are undergoing a significant transformation as the country continues to pursue decentralization reforms and digital modernization to align with global trends in governance. These communities, which include urban, semi-urban, and rural areas, are navigating a shift toward SMART management practices—a model that leverages technology, data, and citizen engagement to enhance the efficiency, transparency, and sustainability of local governance. The goal of these reforms is to empower local governments, allowing them to independently manage resources, make data-driven decisions, and directly address community needs. However, the path toward implementing SMART management is marked by significant disparities among different types of communities, stemming from variations in resources, infrastructure, technical expertise, and funding availability.

Urban areas, typically more developed and resource-rich, are better positioned to adopt SMART management due to established digital infrastructure, access to diverse funding sources, and a relatively higher concentration of skilled personnel. Cities like Kyiv, Lviv, and Kharkiv have already begun integrating digital tools and data analytics into municipal services, such as public transportation, waste management, and emergency response. However, even in urban areas, scaling SMART initiatives to meet growing demands presents challenges, particularly in terms of workforce development and sustainable funding.

In contrast, semi-urban and rural communities face more pronounced obstacles. These areas often lack the foundational infrastructure required to implement digital systems and struggle with financial constraints that limit their ability to invest in the necessary technologies. Semi-urban areas, though somewhat better positioned than rural communities, frequently encounter a lack of resources and trained personnel, which hinders the effective implementation of SMART

management. Rural communities face the greatest hurdles, with many areas still lacking reliable internet connectivity, digital literacy, and sufficient funding. For these communities, adopting SMART management practices remains aspirational without targeted support and investment.

The uneven landscape of SMART management readiness across Ukraine underscores the need for a tailored approach that considers the specific needs and constraints of each community type. Understanding these disparities is crucial for identifying where interventions—such as infrastructure development, financial support, and technical training—are most needed. Analyzing the unique challenges faced by each type of community provides a clearer path forward for creating a more equitable foundation for SMART management implementation, enabling all communities in Ukraine to participate fully in the country's digital transformation.

Digital infrastructure, encompassing broadband access, IoT (Internet of Things) networks, and cloud computing platforms, forms the backbone of any successful SMART management system. These elements enable local governments to collect, analyze, and utilize real-time data to make informed decisions and improve service delivery across a variety of domains, including transportation, healthcare, energy, and waste management. In well-equipped environments, digital infrastructure supports applications such as traffic monitoring, predictive maintenance of infrastructure, and efficient resource allocation. This foundation allows for a more responsive and adaptive form of governance, tailored to meet the unique needs of each community.

In Ukraine, urban communities, particularly in major cities like Kyiv, Lviv, and Kharkiv, are generally better equipped for SMART management implementation. Approximately 80% of urban areas have access to the necessary infrastructure, allowing them to support advanced SMART technologies. These cities have invested in high-speed broadband, public Wi-Fi, IoT devices, and data storage systems, positioning them to benefit from digital transformation. For instance, IoT networks in these cities facilitate traffic flow optimization, air quality monitoring, and energy management, while cloud computing platforms support the

storage and analysis of vast amounts of data essential for making data-driven decisions. As a result, urban centers are already reaping the benefits of enhanced public services and greater citizen engagement.

However, the digital divide between urban centers and less densely populated areas is stark. In semi-urban and rural communities, infrastructure development is notably lagging, which presents a significant barrier to the deployment of SMART management practices. Semi-urban areas, although more developed than rural ones, often face limitations in terms of network reach and speed, making it challenging to implement continuous data collection and analysis. These areas may have partial broadband coverage but lack the full IoT and cloud infrastructure required for comprehensive SMART management. This limits their ability to provide advanced digital services and hinders the efficiency of their public systems.

The situation is particularly challenging in rural areas, where infrastructure gaps are more pronounced. Many rural communities lack reliable internet access, with some areas relying on outdated or low-speed connections, which significantly limits connectivity and digital interaction. The absence of robust IoT networks in rural areas means that data from critical domains—such as agriculture, public safety, and environmental monitoring—often remains uncollected or underutilized. This shortfall restricts rural communities from harnessing the benefits of data-driven decision-making, making it difficult to monitor and manage essential services effectively. The lack of infrastructure also impacts citizen engagement, as rural residents may have limited access to digital platforms where they can participate in local governance or access government services.

Addressing these disparities in digital infrastructure is essential to creating an inclusive SMART management framework across Ukraine. Investments in broadband expansion, particularly in remote areas, would help bridge the connectivity gap, allowing semi-urban and rural communities to engage in digital governance initiatives more effectively. Developing IoT networks and cloud computing capacity in these areas would further enhance their ability to collect,

process, and utilize data, laying a foundation for responsive and data-informed decision-making. These upgrades are essential not only for deploying SMART technologies but also for ensuring that all communities, regardless of size or location, can participate fully in Ukraine's digital transformation journey. By focusing on closing these infrastructure gaps, Ukraine can move closer to realizing an equitable, connected, and technologically enabled governance model that serves the diverse needs of its territorial communities.

Funding is another central challenge in the implementation of SMART management, as financial resources enable communities to invest in digital infrastructure, hire skilled personnel, and maintain essential services. Urban areas generally have more access to diverse funding sources, such as municipal budgets, public-private partnerships, and, in some cases, international grants. Semi-urban and rural communities face more substantial funding challenges, with limited access to state or regional funding and minimal exposure to alternative funding sources, such as public-private partnerships. This funding gap restricts these communities' ability to develop or sustain SMART management practices.

Another critical barrier to SMART management is the availability of skilled personnel capable of managing and maintaining digital systems. SMART management requires expertise in fields such as data analytics, IoT device management, cybersecurity, and project planning. The availability of such expertise varies widely by community type, with urban areas generally having better access to skilled professionals. Nonetheless, even urban communities report challenges in meeting the demand for skilled labor, while semi-urban and rural areas struggle more significantly due to limited local training programs and career opportunities. For rural areas, the lack of expertise is the most substantial barrier, creating a pressing need for local training initiatives, partnerships with educational institutions, and incentives to attract skilled professionals.
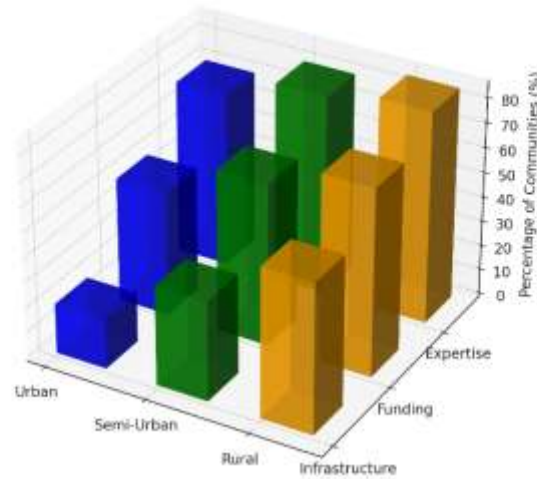
Fig. 2.1 Challenges Facing Urban, Semi-Urban, and Rural Communities in SMART Management Implementation

These disparities across urban, semi-urban, and rural communities are effectively highlighted in figure 2.1, which illustrates the percentage of communities facing infrastructure, funding, and expertise challenges by type. Urban communities report the lowest levels of infrastructure and funding challenges, with around 20% and 40%, respectively, indicating a relatively strong foundation for SMART management. In contrast, semi-urban areas show moderate levels of challenge, with approximately 50% facing infrastructure issues and 65% struggling with funding constraints. Rural areas report the highest levels of difficulty, with 70% experiencing infrastructure challenges, 80% facing funding shortages, and 85% lacking adequate technical expertise. Figure 2.1 underscores the need for a differentiated approach, where each community type receives support aligned with its specific challenges. Rural communities would benefit most from targeted investments in digital infrastructure and funding support, semi-urban communities could prioritize diversified funding sources and training initiatives, and urban communities could focus on talent development and retention to support their expanding SMART management systems.
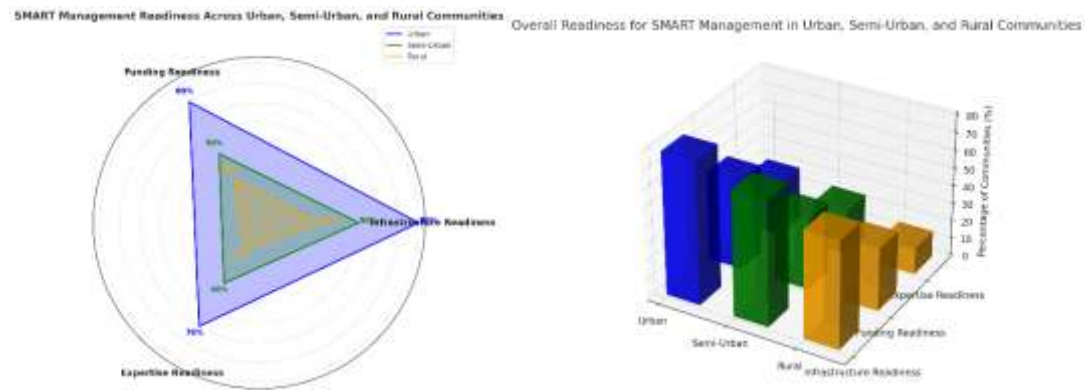
Fig. 2.2 SMART Management Readiness Across Urban, Semi-Urban, and Rural Communities

Figure 2.2 offers a comprehensive view of SMART management readiness across urban, semi-urban, and rural communities in Ukraine, focusing on three critical factors: Infrastructure Readiness, Funding Readiness, and Expertise Readiness. Each visualization emphasizes the disparities in readiness levels among community types, providing insights into where targeted support and resources are most needed to create a more balanced and effective approach to SMART management implementation.

Figure 2.2 is a 3D bar chart that illustrates the percentage readiness in each of the three categories for urban, semi-urban, and rural communities. The bars are color-coded by community type—urban (blue), semi-urban (green), and rural (orange)—and the height of each bar represents the percentage of readiness within each category. This chart reveals a distinct hierarchy in preparedness levels, with urban communities consistently showing the highest percentages, followed by semi-urban communities, and then rural communities, which display the lowest readiness across all factors.

In terms of Infrastructure Readiness, urban communities are leading with 80%, reflecting well-established broadband access, IoT networks, and cloud infrastructure that support digital governance. Semi-urban communities, with 50% infrastructure readiness, have a basic but incomplete digital foundation, limiting their ability to fully leverage SMART management tools. Rural communities have

the lowest infrastructure readiness at 30%, indicating substantial gaps in digital connectivity and network resources. This lack of infrastructure poses a significant challenge to adopting SMART systems in rural areas, where foundational digital investments are critical.

Funding Readiness shows a similar pattern. Urban areas score 70% in this category, benefiting from access to a diverse range of funding sources, including municipal budgets, public-private partnerships, and grants. This financial advantage enables urban communities to support the costs of implementing and maintaining SMART systems. Semi-urban communities, with only 40% funding readiness, have more limited access to consistent funding, which restricts their ability to pursue comprehensive SMART initiatives. Rural communities, with a readiness level of just 25%, face the most severe funding constraints, as they often rely heavily on state support and lack the capacity to attract private investment. This funding disparity underscores the need for innovative financial solutions tailored to rural and semi-urban areas to bridge the resource gap.

Expertise Readiness is another critical area where urban communities stand out with a 60% readiness level, although the demand for skilled personnel still exceeds supply. Urban areas typically have access to a larger pool of skilled professionals who can manage and operate SMART systems, though expanding this workforce remains a challenge. Semi-urban communities show a lower expertise readiness at 35%, reflecting a significant skills gap that affects their ability to sustain SMART management initiatives. Rural communities face the largest expertise deficit, with only 15% readiness, due to limited access to training programs and educational resources. This lack of technical expertise hinders the deployment and maintenance of SMART management technologies in rural areas, highlighting a need for targeted skill-building programs to support these communities.

Figure 2.2 also complements this analysis by providing a radar chart that visualizes the same readiness factors across urban, semi-urban, and rural communities. Each community type is represented by a distinct polygon—urban in

blue, semi-urban in green, and rural in orange—and percentage labels for each factor make comparison intuitive. The radar chart clearly shows that urban communities have the largest area, indicating high readiness across all factors. Semi-urban communities occupy a moderate area, with infrastructure and funding slightly lower than urban areas, and a noticeable dip in expertise. Rural communities cover the smallest area, revealing the most significant readiness gaps in all categories.

The radar chart in figure 2.2 provides an at-a-glance comparison that emphasizes how these readiness factors differ between community types. Urban communities demonstrate strong preparedness across the board, which positions them well for effective SMART management. Semi-urban communities, while moderately prepared, still require support, especially in securing funding and expertise. Rural communities, with the lowest readiness in every category, face severe limitations that prevent them from fully participating in digital transformation efforts. This chart highlights the urgent need for tailored support and investments in rural areas to close the readiness gap and foster inclusive SMART management across all types of communities.

The insights from these visualizations suggest a roadmap for policymakers: urban areas can benefit from initiatives focused on expanding technical expertise, semi-urban areas require enhanced funding and skills development, and rural areas need foundational investments in digital infrastructure, funding support, and workforce training. By addressing these specific needs, Ukraine can create a more equitable environment for SMART management, empowering all communities to leverage digital tools for improved governance and quality of life.

This analysis of infrastructure, funding, and expertise challenges reveals a complex and nuanced landscape in which each community type—urban, semi-urban, and rural—faces distinct barriers to implementing SMART management effectively. Urban communities, while relatively well-prepared, still encounter obstacles, particularly in the availability of skilled personnel, that limit their ability to fully realize the potential of SMART systems. Semi-urban areas, though

moderately equipped with some digital infrastructure, funding, and expertise, require significant improvements to reach the level of readiness seen in urban centers. Rural communities, however, are the most disadvantaged, struggling with substantial gaps in digital infrastructure, funding sources, and technical skills, all of which are crucial to support SMART management initiatives.

For Ukraine, achieving equitable SMART management across all territorial communities means addressing these foundational disparities in resources and capacity that currently limit the participation of semi-urban and rural areas. This calls for a tailored approach, recognizing that a one-size-fits-all solution would not adequately address the specific needs of each community type. Urban communities, for example, could benefit from policies focused on enhancing their technical workforce and supporting more advanced digital solutions. Semi-urban areas, on the other hand, would benefit from additional funding resources and targeted programs to build their digital infrastructure and improve technical training for local government staff. Rural communities, which face the most profound barriers, need extensive foundational support in all areas, including infrastructure, funding, and expertise, to make even basic SMART management a feasible reality.

A primary focus on infrastructure investments is essential, especially for rural and semi-urban areas, where connectivity and digital systems are still lacking. Expanding broadband access, installing IoT networks, and establishing reliable cloud computing platforms are fundamental steps that would allow these communities to begin adopting digital tools for managing public services. These infrastructure investments would bridge the digital divide, creating a more level playing field where all communities have the baseline connectivity needed to participate in SMART management initiatives. Improved infrastructure will also facilitate the implementation of basic SMART management practices, such as real-time data collection, automated service management, and digital platforms for citizen engagement, which are vital for modernizing public administration.

Financial innovations are equally important, as the funding disparity between urban, semi-urban, and rural communities creates significant inequality in SMART management readiness. Urban areas benefit from access to municipal budgets, public-private partnerships, and international grants, while rural and semi-urban areas often rely heavily on limited state support. To address this, Ukraine can explore innovative financing models that make resources more accessible to underserved areas. These could include dedicated grants for rural digital transformation, incentives for private companies to invest in semi-urban and rural infrastructure, and flexible loan schemes that help local governments fund their SMART management projects. Creating public-private partnerships specifically designed for rural and semi-urban areas would attract external expertise and resources, facilitating the development and maintenance of SMART systems in places where local governments lack the necessary budgetary capacity.

Lastly, targeted training programs are crucial for building the expertise needed to operate and sustain SMART management systems across all communities. While urban centers may have a higher concentration of skilled personnel, the demand for expertise in data analytics, cybersecurity, and digital governance still outstrips supply. In semi-urban and rural areas, this skills gap is even more pronounced, often preventing communities from effectively implementing or maintaining SMART initiatives. By investing in targeted training and capacity-building programs, Ukraine can empower local officials and staff with the skills they need to manage digital infrastructure and interpret data effectively. Such training should include technical workshops, partnerships with educational institutions to develop relevant curricula, and ongoing support to ensure that local governments can keep pace with evolving technologies. Furthermore, incentivizing skilled professionals to work in rural and semi-urban areas through loan forgiveness, competitive salaries, and career development opportunities could help alleviate the expertise shortages in these regions.

By focusing on infrastructure investments, financial innovations, and targeted training programs, Ukraine can lay the groundwork for a more inclusive

digital transformation. These initiatives will empower communities across the country to leverage the benefits of SMART management, creating a public administration that is more efficient, responsive, and aligned with the needs of its citizens. With a tailored approach, Ukraine can foster an environment in which urban, semi-urban, and rural communities all have the opportunity to modernize and enhance their governance systems, ultimately contributing to a more equitable and sustainable digital future.

2.2 Assessment of Readiness for SMART Management in Ukrainian Communities

Assessing the readiness of Ukrainian communities to adopt SMART management practices is essential to understand where resources and support are most needed. This readiness assessment considers several key factors, including the availability of technological infrastructure, financial resources, digital literacy levels, and the capacity of local governments to implement and sustain SMART systems. These factors vary significantly across urban, semi-urban, and rural areas, creating a landscape in which each community type faces unique opportunities and challenges in adopting SMART management.

The level of technological infrastructure is a foundational element that determines a community's ability to implement SMART management practices. Urban areas in Ukraine, particularly major cities like Kyiv, Lviv, and Kharkiv, are comparatively well-equipped. These cities typically have robust broadband networks, public Wi-Fi access, and basic IoT capabilities [13], [16]. For example, Kyiv has implemented digital monitoring in areas such as transportation and public safety, allowing real-time data collection that enhances urban management [24]. However, while urban areas are generally well-prepared for SMART management, there are still areas where infrastructure needs upgrading, such as expanding IoT networks and enhancing cloud computing capacity for large-scale data processing [1], [5].

In contrast, semi-urban areas have a patchier infrastructure landscape. Many semi-urban communities may have access to broadband but lack the high-speed internet and IoT networks necessary for advanced SMART applications [6], [54]. These areas often struggle with the cost of maintaining and upgrading their existing infrastructure, which can slow down the adoption of new technologies [8]. Without adequate IoT coverage and cloud support, semi-urban areas are limited to basic digital services and are unable to engage in more sophisticated SMART management practices that require real-time data analysis and automation [61].

Rural communities face the most significant technological challenges, with many lacking even basic internet access or stable broadband connectivity [19], [24]. In these areas, limited or non-existent IoT networks prevent the collection of critical data that could be used to improve service delivery and resource management [30]. The absence of reliable digital infrastructure severely limits the potential for SMART management in rural regions, where investments in foundational infrastructure are necessary before more advanced digital services can be introduced [18], [19]. Bridging this infrastructure gap is essential for enabling rural communities to participate in Ukraine's broader digital transformation [14], [24].

Financial readiness is another critical component in assessing a community's ability to adopt and sustain SMART management systems. Urban communities are typically better positioned financially, with access to municipal budgets, partnerships with private enterprises, and, in some cases, international grants and funding programs [6], [13], [54]. This financial advantage allows urban areas to experiment with and invest in SMART technologies [7]. However, even in urban areas, funding is not unlimited, and the long-term sustainability of SMART systems remains a concern [14]. Municipalities may face difficulties in covering ongoing operational costs, especially as they expand their digital systems and face increased demand for digital services [61].

Semi-urban communities face more constraints in accessing funding. Often, these communities rely heavily on regional or state funding and may not have the

same access to private investment as urban centers [11], [19]. This reliance on external funding sources can make financial planning challenging, as it limits the flexibility of semi-urban areas to prioritize their own needs and goals [30]. Many semi-urban areas are not able to attract the private partnerships that urban centers do, creating a financial gap that hinders their ability to establish and sustain SMART management practices [24]. Developing alternative funding models, such as public-private partnerships and dedicated grants for semi-urban digital transformation, would be essential to support these communities in their SMART initiatives [8], [54].

Rural communities are in the most difficult financial position, with limited local revenue and minimal access to private funding. These areas often rely almost entirely on state support for essential services and infrastructure projects, leaving little to no room in the budget for digital investments. For rural communities, the high cost of establishing basic digital infrastructure and maintaining it over time is prohibitive without significant external assistance. This financial limitation means that rural areas require targeted financial interventions, such as government-funded digital infrastructure programs or subsidies to make SMART technologies more affordable.
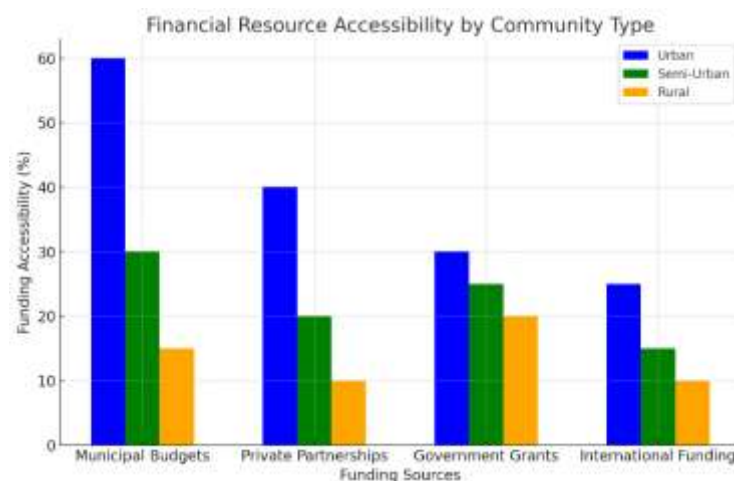

Fig. 2.3 Financial Resource Accessibility by Community Type

Figure 2.3 provides a comparative view of Financial Resource Accessibility across urban, semi-urban, and rural communities in Ukraine, illustrating the

disparities in funding support that each community type experiences. The chart categorizes funding sources into four main types: Municipal Budgets, Private Partnerships, Government Grants, and International Funding, with bars representing the percentage accessibility for each community type.

Urban communities show the highest level of financial resource accessibility across all funding sources. With municipal budgets covering about 60% of their financial needs, urban areas have a solid base for funding SMART management initiatives [13,54]. Additionally, urban areas benefit from private partnerships, which provide around 40% of their financial resources, indicating strong support from the private sector [61]. Government grants offer another layer of support at 30%, and although international funding is lower at 25%, urban communities still receive more diversified financial support compared to semi-urban and rural communities [7]. This diversity in funding sources positions urban areas favorably for sustaining and expanding SMART management practices [24].

Semi-urban communities, however, face more limitations in accessing these financial resources. Municipal budgets account for roughly 30% of their funding, which is significantly lower than in urban areas. Private partnerships and government grants each contribute about 20-25%, reflecting semi-urban communities' limited ability to attract consistent private investment or secure substantial government grants. International funding access is also limited, at only 15%, which further constrains their ability to implement and maintain advanced SMART management systems. This moderate level of funding accessibility indicates that semi-urban communities may struggle to fully realize the benefits of SMART management without additional support.

Rural communities are the most financially constrained, with low accessibility across all funding categories. Municipal budgets provide just 15%, indicating minimal local revenue available for SMART initiatives. Private partnerships are even less accessible, offering only 10%, as rural areas often lack the economic incentives to attract private investment. Government grants provide a slightly higher level of support at 20%, but this is still insufficient to meet the

needs of these communities. International funding is the least accessible source, covering only 10%, which limits the potential for rural areas to access external resources for digital infrastructure and SMART management capabilities. The limited financial resources available to rural communities highlight a significant funding gap that restricts their ability to participate in Ukraine's digital transformation.

Overall, Figure 2.3 illustrates the substantial disparities in financial resource accessibility across community types, underscoring the need for targeted financial support, especially for semi-urban and rural communities. To address these gaps, tailored financial interventions such as dedicated grants, public-private partnerships, and flexible funding models are essential. By providing additional financial resources to underserved communities, Ukraine can create a more equitable foundation for SMART management, allowing all communities to benefit from digital transformation and improved governance.

Another critical factor in readiness assessment is the level of digital literacy among community members and government officials, as well as the technical capacity of local governments to manage SMART systems. In urban areas, digital literacy rates are generally higher, and local governments have a stronger base of skilled personnel familiar with digital tools and processes. Many urban centers have already implemented e-governance platforms, and residents are more accustomed to accessing services online. However, the increasing complexity of SMART management systems requires ongoing training and capacity-building to ensure that government staff can keep up with new technologies and maximize the effectiveness of SMART initiatives.

Semi-urban areas often face a digital literacy gap, both among the public and within local governments. In these communities, fewer residents may be familiar with digital services, limiting the potential for citizen engagement in SMART management practices. Additionally, local government staff in semi-urban areas may lack the technical expertise required to manage and maintain digital infrastructure effectively. This lack of capacity can slow the adoption of SMART

technologies, as these areas may struggle to find or retain skilled personnel. To address this, semi-urban areas would benefit from targeted digital literacy programs for residents and training workshops for government employees, preparing them for more active participation in SMART management.

Rural communities experience the greatest challenges with digital literacy and capacity. Digital literacy levels are often lower in rural areas, where residents may have limited exposure to technology and less familiarity with online services. Local government staff in rural areas may also lack the training needed to operate and maintain SMART systems. This skills gap presents a significant barrier to implementing and sustaining SMART management, as rural communities may not have the human resources required to support these systems. Providing digital literacy programs in rural communities, along with ongoing support and training for government officials, would be essential to build local capacity and ensure successful SMART management adoption.

Citizen engagement is a critical component of SMART management, as it fosters transparency, accountability, and community involvement in decision-making. In urban areas, citizen engagement platforms are more commonly available, allowing residents to interact with local governments, report issues, and access information. However, as these platforms grow, urban areas will also need to address data privacy concerns, as increased data collection raises questions about protecting citizen information. Urban centers must balance the need for data-driven governance with robust data privacy measures to maintain public trust.

Semi-urban and rural areas, in contrast, have limited access to citizen engagement platforms, which restricts their ability to involve residents in governance. Semi-urban communities may have some digital engagement tools but lack the comprehensive systems found in urban areas. Rural areas, where digital infrastructure is minimal, often have no engagement platforms at all, making it difficult for residents to participate in local governance processes. For these communities, establishing basic digital engagement channels is a necessary first

step. Additionally, as engagement grows, data privacy policies will need to be established to ensure that residents feel secure in using these platforms.

The assessment of readiness in Ukrainian communities highlights that urban areas are the most prepared for SMART management, with substantial infrastructure, moderate funding, and a relatively high level of digital literacy and government capacity. However, even urban areas have room for improvement, particularly in maintaining long-term funding for SMART systems and expanding technical expertise among government personnel.

Semi-urban communities show moderate readiness but face challenges in funding, infrastructure, and digital literacy. These areas would benefit from increased financial resources, digital infrastructure investments, and capacity-building programs to support both government staff and residents.

Rural communities have the lowest levels of readiness, with significant barriers in all areas. They lack essential infrastructure, face financial constraints, and experience low levels of digital literacy and government capacity. These communities require comprehensive support, including infrastructure investments, targeted funding, and digital literacy initiatives, to close the readiness gap and enable them to participate fully in Ukraine's SMART management framework.

By addressing these readiness disparities, Ukraine can ensure that SMART management benefits reach all communities, creating a more inclusive and effective digital transformation across the country.

2.3 Regulatory and Legal Framework Supporting SMART Management

The successful implementation of SMART management practices in Ukraine's territorial communities depends not only on technological readiness and financial resources but also on a strong regulatory and legal framework. This framework provides the policies, guidelines, and legal protections necessary for local governments to implement, monitor, and sustain SMART initiatives

effectively [14], [18]. A supportive regulatory environment ensures that SMART management aligns with national priorities, respects citizens' rights, encourages private sector collaboration, and promotes sustainable development across all community types—urban, semi-urban, and rural [30].

Key elements of this framework are grounded in the Constitution of Ukraine, which establishes the foundational principles of transparency, accountability, and the right to access information [31]. These constitutional guarantees are operationalized through specific laws that address critical aspects of SMART management. For instance, the Law "On Local Self-Government in Ukraine" empowers local authorities to independently adopt digital solutions and e-governance platforms to enhance service delivery [18]. Similarly, the Law "On Information" ensures the accuracy, relevance, and security of public information, enabling data-driven decision-making that is essential for SMART management systems [17].

Transparency and accountability are further reinforced by the Law "On Access to Public Information," which mandates that public institutions provide timely and open access to their data [14]. This provision supports citizen engagement and the development of open data initiatives, allowing communities to leverage information for innovation and governance improvements [26]. In tandem, the Law "On Electronic Documents and Electronic Document Workflow" facilitates the transition from paper-based to digital systems, streamlining administrative processes and enabling efficient document management [22].

Critical to the legal infrastructure for SMART management is the Law "On Electronic Trust Services," which ensures the authenticity and security of electronic transactions through services like electronic signatures and time stamps [19]. This law is complemented by the Law "On Personal Data Protection," which aligns with international standards such as GDPR to safeguard individuals' privacy and secure the sensitive data used in SMART systems [16].

Strategic policies like the National Informatization Program, the Concept for the Development of Electronic Governance in Ukraine, and the Strategy for the

Development of the Information Society in Ukraine provide the roadmap for integrating digital technologies into public administration [24]. These initiatives focus on building digital infrastructure, enhancing digital literacy, and fostering collaboration between public and private stakeholders, all of which are integral to scaling SMART management across the country [30].

Finally, the Decree "On Open Governance Partnership" highlights Ukraine's commitment to transparency, innovation, and citizen participation [8]. By promoting open governance practices and encouraging the adoption of digital platforms, this decree aligns with the core principles of SMART management, enabling local governments to engage stakeholders effectively and deliver more responsive services [30].

Despite these robust legal foundations, gaps remain in the regulatory framework. For example, fragmented implementation, inconsistent enforcement, and the need for updates to address emerging technologies hinder the full realization of SMART management's potential [7]. Addressing these gaps through unified guidelines, enhanced capacity-building programs, and alignment with international best practices will ensure that the framework supports equitable and effective SMART management nationwide [1,5].

Ukraine has made strides in recent years toward establishing a digital governance framework, recognizing the importance of digital transformation in modern public administration. Key national policies, such as the "Digital Transformation Strategy for Ukraine" and the "Digital State 2023" initiative, outline ambitious goals for digital infrastructure development, e-governance, and the digital economy. These strategies emphasize the need to integrate digital technologies into various sectors, including public administration, healthcare, education, and transportation. By promoting digitalization at all levels, these policies lay the groundwork for SMART management implementation across Ukraine.

However, while these policies provide a broad vision for digital transformation, they lack specific guidelines tailored to SMART management at

the local level. Much of the focus in national strategies is on high-level objectives, such as expanding broadband access or implementing e-governance platforms, without detailed directives for SMART management practices in territorial communities. This lack of specificity can create challenges for local governments, particularly in semi-urban and rural areas, where resources and expertise may be limited. To bridge this gap, Ukraine would benefit from a more detailed policy framework that addresses the unique needs of SMART management in local governance, with specific standards, benchmarks, and support mechanisms for communities of different sizes and resource levels.

One of the core components of SMART management is the collection, processing, and analysis of large volumes of data to make informed decisions and improve public services. However, the use of data in SMART management raises important concerns regarding data privacy, security, and citizens' rights. In recent years, Ukraine has introduced data protection regulations that align with European Union standards, such as the General Data Protection Regulation (GDPR). These regulations establish rules on how personal data should be collected, stored, and processed, giving citizens control over their personal information and setting limits on data usage.

Despite these regulations, challenges remain in applying data privacy laws effectively at the local level, especially as SMART management initiatives expand. Local governments, particularly in semi-urban and rural areas, may lack the resources and expertise to implement comprehensive data protection measures. Furthermore, as more data is collected through IoT devices, public engagement platforms, and other SMART technologies, the risk of data breaches and misuse increases. To address these challenges, Ukraine needs to strengthen its regulatory framework by establishing specific data privacy guidelines tailored to SMART management. This could include mandatory data protection training for local government staff, protocols for handling citizen data in SMART systems, and penalties for non-compliance, thereby ensuring that data privacy remains a top priority in all SMART management initiatives.

The role of public-private partnerships (PPPs) in SMART management is increasingly important, as private companies provide the technological expertise, infrastructure, and funding needed to implement and sustain SMART solutions. In Ukraine, PPPs are becoming a viable option for local governments seeking to establish digital infrastructure, especially in semi-urban and rural areas where financial and technological resources are limited. Current legislation in Ukraine supports the development of PPPs, but existing regulations are often geared toward large-scale infrastructure projects, such as transportation or energy, rather than the nuanced needs of SMART management.

To fully leverage PPPs for SMART management, Ukraine's regulatory framework should be adjusted to encourage private sector involvement in digital governance projects. This could include tax incentives for companies that invest in rural or underserved areas, streamlined processes for establishing partnerships, and clear guidelines on the roles and responsibilities of private partners in SMART initiatives. Furthermore, creating a legal framework that supports flexible funding models, such as leasing arrangements or subscription-based services, would allow local governments to access SMART technologies without significant upfront costs. By promoting PPPs through regulatory reforms, Ukraine can attract private investment and expertise, making SMART management more accessible and sustainable for communities across the country.

Citizen engagement is a fundamental aspect of SMART management, as it allows residents to participate in local governance, provide feedback on services, and access government information. Effective SMART management requires tools and platforms that enable citizen engagement, such as mobile applications, online portals, and social media channels. In urban areas, these platforms are more commonly available, but in semi-urban and rural communities, access to digital engagement tools remains limited. Current regulations in Ukraine recognize the importance of public participation, but there is little guidance on how local governments can implement digital engagement in SMART management.

To enhance citizen engagement, Ukraine's regulatory framework should include specific provisions that encourage digital participation at the local level. This could involve setting minimum standards for digital accessibility, mandating the creation of online platforms for citizen feedback, and establishing guidelines on transparency and information sharing. Additionally, ensuring that citizens' digital rights are protected is crucial, particularly as SMART management involves extensive data collection. Regulations should outline citizens' rights to access, correct, and control their data, as well as protections against government surveillance. Strengthening digital rights in SMART management would foster trust between citizens and local governments, encouraging greater public participation and making SMART initiatives more responsive to community needs.

As Ukraine advances in SMART management, integrating environmental sustainability into the regulatory framework is essential. SMART technologies offer the potential to improve energy efficiency, reduce waste, and optimize resource use, contributing to Ukraine's broader sustainability goals. Currently, there is limited regulatory guidance on how SMART management can be aligned with environmental initiatives, although sustainability is mentioned in national policies. To maximize the environmental benefits of SMART management, Ukraine's regulatory framework should include specific sustainability requirements, such as the use of energy-efficient technologies, incentives for green innovations, and guidelines on reducing the environmental impact of digital infrastructure.

For example, regulations could mandate that SMART management systems prioritize renewable energy sources for powering IoT devices and data centers, or that local governments implement waste-reduction strategies in conjunction with SMART waste management systems. By embedding environmental considerations into the regulatory framework, Ukraine can ensure that its digital transformation supports sustainable development and contributes to global efforts to combat climate change.
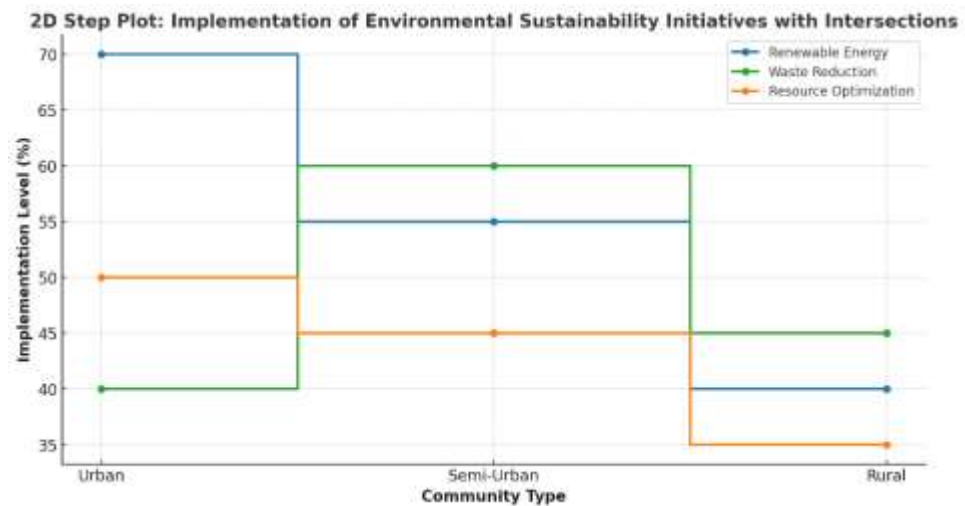
Fig. 2.4 Implementation of Environmental Sustainability Initiatives with Intersections

Figure 2.4 illustrates the implementation levels of Environmental Sustainability Initiatives within SMART management across urban, semi-urban, and rural communities in a 2D step plot. The plot features three intersecting lines, each representing a key initiative—Renewable Energy, Waste Reduction, and Resource Optimization—highlighting how the focus on these initiatives shifts across different community types.

The Renewable Energy line (in blue) begins with the highest implementation level in urban communities, where infrastructure and funding for renewable projects are most readily available. As we move to semi-urban areas, implementation of renewable energy initiatives decreases but still remains relatively strong compared to rural areas, where implementation is more limited. This steady decline reflects the varying capacity for renewable energy adoption as resources and infrastructure become less accessible outside urban centers.

The Waste Reduction line (in green) intersects with Renewable Energy in semi-urban communities, where its implementation level surpasses both Renewable Energy and Resource Optimization. This shift suggests that waste management is a particular priority in semi-urban areas, likely due to increased local initiatives and accessible waste reduction technologies tailored to these

regions. This focus on waste management indicates a targeted approach to address immediate environmental needs in semi-urban areas.

Resource Optimization (in orange) intersects with both other initiatives, reflecting its fluctuating priority across community types. In urban areas, resource optimization initiatives are moderately implemented but fall behind in rural areas, where limited access to advanced resource management technologies creates a substantial implementation gap. The multiple intersections suggest that resource optimization is prioritized differently depending on local needs and capacities, with urban communities generally leading in the adoption of these practices.

An effective regulatory framework for SMART management should also encourage intergovernmental collaboration and knowledge sharing between different levels of government. Currently, local governments in Ukraine often operate independently, with limited opportunities to share best practices or collaborate on SMART initiatives. Establishing regulatory structures that promote cooperation between national, regional, and local authorities could facilitate the development of more efficient and scalable SMART solutions.

This could include creating a national SMART management task force or a centralized platform where local governments can access resources, share experiences, and learn from successful projects. Regulatory provisions for intergovernmental collaboration would not only streamline the implementation of SMART management but also help less-resourced communities, particularly in rural areas, benefit from the knowledge and experiences of urban centers. By fostering a culture of collaboration, Ukraine can accelerate the adoption of SMART management and ensure that all communities are supported in their digital transformation journey.

The regulatory and legal framework supporting SMART management in Ukraine is progressing, but there remain significant gaps that need to be addressed to create an inclusive, sustainable, and equitable digital governance landscape. Ukraine's current policies, while valuable, are often too general and fail to address the specific needs of SMART management at the local level. By introducing more

targeted regulations on data privacy, public-private partnerships, citizen engagement, environmental sustainability, and intergovernmental collaboration, Ukraine can strengthen the foundation for SMART management across its diverse communities. Such a comprehensive regulatory approach will empower local governments, protect citizens' rights, and ensure that SMART management contributes to a sustainable and efficient public administration system for all Ukrainians.

Conclusions for chapter 2

1. The analysis of technological infrastructure in Ukrainian communities revealed significant disparities between urban, semi-urban, and rural areas. Urban centers, particularly in major cities like Kyiv, Lviv, and Kharkiv, are well-equipped with robust broadband networks, public Wi-Fi access, and basic IoT capabilities, enabling them to implement advanced SMART management practices. In contrast, semi-urban areas face patchier infrastructure, with limited high-speed internet and IoT networks that hinder their ability to adopt sophisticated digital systems. Rural communities face the most challenges, with minimal internet access and non-existent IoT coverage, severely restricting their potential for SMART management. Bridging these infrastructure gaps is essential to ensure equitable access to digital transformation and foster inclusive governance.

2. The financial readiness of Ukrainian communities varies significantly, influencing their ability to adopt and sustain SMART management systems. Urban communities benefit from diverse funding sources, including municipal budgets, private partnerships, and international grants, allowing them to experiment with and invest in SMART technologies. Semi-urban areas, however, rely heavily on regional or state funding and struggle to attract private investment, creating a financial gap that limits their progress. Rural areas are the most constrained, with minimal local revenue and reliance on state support, making it difficult to fund

even basic digital infrastructure. Addressing these financial disparities through targeted interventions such as public-private partnerships, dedicated grants, and flexible funding models is critical to advancing SMART initiatives across all community types.

3.   The regulatory and legal framework for SMART management in Ukraine provides a solid foundation through key laws and policies, such as the Constitution of Ukraine, the Law "On Local Self-Government," and the National Informatization Program. These frameworks establish principles of transparency, accountability, and citizen engagement while facilitating the transition to digital governance. However, challenges such as fragmented implementation, inconsistent enforcement, and the need for regulatory updates to address emerging technologies hinder the full realization of SMART management's potential. Strengthening the regulatory environment through unified guidelines, capacity-building programs, and alignment with international standards will ensure effective and equitable implementation of SMART management across urban, semi-urban, and rural communities.

CHAPTER 3
PROSPECTS AND STRATEGIES FOR IMPLEMENTING SMART MANAGEMENT IN DNIPRO STATE AGRARIAN AND ECONOMIC UNIVERSITY

3.1 Recommendations for Adapting International SMART Management Practices

The role of universities in the development of territorial communities is multifaceted and fundamental. As centers of education, research, and innovation, universities like Dnipro State Agrarian and Economic University (DSAEU) serve as catalysts for economic growth, social cohesion, and technological advancement [10], [11]. They provide skilled professionals, foster pub lic-private partnerships, and conduct research that addresses pressing community challenges. In this context, the integration of SMART management practices further enhances the university's capacity to support territorial communities [12], [14].

SMART management, characterized by its reliance on digital tools, data analytics, and participatory approaches, has become an essential framework for modern governance [13]. It emphasizes efficiency, transparency, and inclusivity, making it particularly relevant for addressing the challenges faced by territorial communities, such as resource limitations, infrastructure disparities, and the need for sustainable development [5,6]. By adopting and adapting international SMART management practices, universities can bridge gaps in technology and governance, empower local communities, and drive innovation in public administration [1,7].

Adapting international SMART management practices to Dnipro State Agrarian and Economic University (DSAEU) offers transformative potential to improve operational efficiency, enhance academic quality, and promote sustainable development [8, 9]. By leveraging global best practices, DSAEU can integrate advanced digital tools and systems tailored to its unique mission and context, bridging the gap between traditional methods and innovative management [2, 3].

These practices provide opportunities to modernize administrative workflows, enhance the teaching and learning environment, and foster sustainability while building stronger collaboration across stakeholders [15, 18].

The digital transformation of administrative processes is a foundational step for implementing SMART management at DSAEU. Globally, universities that embrace digital solutions report significant gains in transparency, efficiency, and cost savings [4, 16]. For DSAEU, tools such as IoT-enabled systems like EnvioCam can optimize energy consumption and monitor campus-wide utility usage in real time, significantly reducing waste and operational costs [17]. Transitioning to cloud-based platforms like Google Workspace or Microsoft SharePoint ensures secure and efficient storage of academic and administrative records, enabling seamless collaboration and reducing reliance on paper-based workflows [13]. Additionally, e-governance platforms like EduTrac allow students and faculty to manage schedules, submit applications, and access academic records digitally, improving communication efficiency and user experience [9], [10].

The integration of SMART technologies into the educational environment is another critical aspect of this transformation. Interactive classrooms can leverage tools such as SMART Boards to facilitate real-time interaction between students and instructors, enhancing engagement and learning outcomes [6]. Virtual reality (VR) platforms like Google Expeditions and augmented reality (AR) applications like Metaverse Studio can create immersive simulations for agriculture and economics courses, allowing students to practice real-world scenarios in a controlled environment [8, 18]. Comprehensive Learning Management Systems (LMS) like Moodle or Blackboard enable hybrid and remote learning with features for course management, assignments, and communication [2,5]. SMART laboratories can benefit from IoT devices like Labster for virtual experiments and AgriTech Sensors for monitoring soil health, crop growth, and environmental conditions in real-time research applications [14, 17].
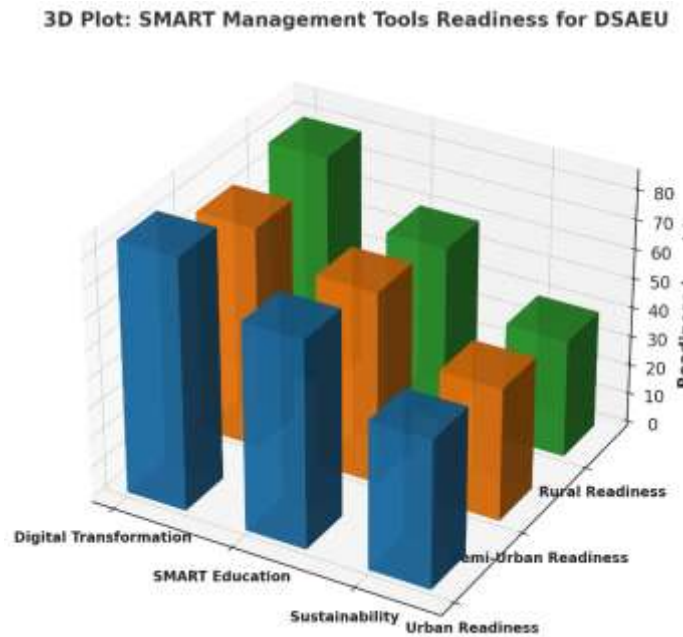
Fig. 3.1 SMART Management Tools Readiness for DSAEU

Figure 3.1 provides a comparative visualization of readiness levels for SMART management tools at Dnipro State Agrarian and Economic University (DSAEU), focusing on three core areas: Digital Transformation, SMART Education, and Sustainability. These categories are analyzed across three scenarios—urban, semi-urban, and rural—to illustrate the varying levels of preparedness and highlight the university's opportunities and challenges in implementing these tools.

Sustainability is a key focus area where DSAEU can leverage its role as an agrarian university to lead in implementing green initiatives. Renewable energy systems such as SolarEdge offer advanced monitoring capabilities for solar panel performance, making them an ideal choice for reducing operational costs and reliance on non-renewable energy sources. For waste management, tools like Enevo can use IoT sensors to track waste levels and optimize collection schedules, ensuring eco-friendly disposal. Environmental monitoring systems such as AirVisual Pro can provide data on air quality, water use, and soil health, which can be integrated into teaching and research activities to strengthen the university's commitment to environmental responsibility.

Collaboration is central to SMART management, and DSAEU can enhance engagement by adopting tools that connect students, faculty, and external stakeholders. Real-time communication platforms like Microsoft Teams or Slack can enable efficient interaction and feedback exchange. Alumni engagement portals powered by platforms like Graduway can strengthen ties between former and current students, offering mentorship opportunities and career guidance. For partnerships with agricultural businesses, policymakers, and international organizations, virtual conferencing tools like Zoom and project management tools like Asana can facilitate joint research projects and collaborative events, enriching the university's academic and professional ecosystem.

For these innovations to succeed, capacity building is essential. Faculty and staff must be equipped to leverage SMART technologies effectively. Training programs can use platforms like Coursera or edX to offer certifications in digital skills, ensuring that faculty and staff remain proficient in emerging technologies. Workshops can familiarize stakeholders with IoT systems, data analytics platforms like Tableau, and digital learning environments. Students can also benefit from tools like Google Classroom to develop competencies aligned with industry needs, preparing them for the demands of a digitally advanced workforce.

By integrating these tools into its operations, DSAEU can achieve transformative improvements across its administrative workflows, academic services, and sustainability initiatives. Modernizing administrative processes with platforms like EnvioCam and EduTrac, enhancing the learning environment with tools like SMART Boards and Labster, and adopting green technologies such as SolarEdge and Enevo create a robust foundation for long-term success. Collaboration platforms and training programs further support these efforts, ensuring that the university community is prepared to engage with advanced systems. These strategies position DSAEU as a model institution for innovation and excellence, setting an example for other universities in Ukraine and beyond.

3.2 Developing a Regulatory Framework for SMART Management

The successful implementation of SMART management practices hinges on the development of a robust and adaptive regulatory framework. Such a framework provides the institutional guidelines, legal protections, and governance structures needed to integrate SMART technologies effectively into the university's operations [14], [17]. Addressing challenges related to data privacy, governance, innovation, funding, and stakeholder engagement, the framework will ensure that the university can embrace digital transformation while maintaining compliance with local, national, and international standards [9], [15].

A fundamental aspect of this regulatory framework is ensuring data privacy and security. As SMART management relies heavily on the collection and analysis of data to enhance decision-making, safeguarding sensitive information is critical [18]. DSAEU must establish clear data governance policies that align with international standards, such as the General Data Protection Regulation (GDPR) [13]. These policies should define how data is collected, stored, and processed while implementing secure technologies like encryption, firewalls, and multi-factor authentication to prevent unauthorized access [8, 16]. Additionally, guidelines on data ownership and access control must ensure that stakeholders, such as students, retain control over their personal information while institutional data remains accessible only to authorized personnel [6, 20]. Prioritizing data security fosters trust among the university community and ensures responsible use of SMART systems [10].

Effective governance structures are another essential element of the framework. DSAEU could establish a dedicated SMART management task force comprising representatives from administration, faculty, IT staff, and students [12, 19]. This task force would oversee the implementation of SMART initiatives, set priorities, monitor progress, and address challenges [7, 15]. Governance structures must align SMART management with the university's broader mission to improve academic quality, foster sustainability, and enhance operational efficiency [11, 14].

Regular audits and evaluations of SMART systems should also be conducted to identify areas for improvement, ensure compliance with policies, and measure the impact of these initiatives [17]. By embedding accountability, transparency, and inclusivity into its governance structures, DSAEU can manage the complexities of SMART management effectively [5, 20].

Encouraging innovation is critical to advancing SMART management at DSAEU. The regulatory framework should provide incentives for faculty, students, and external partners to contribute to the university's digital transformation. Internal grant programs could fund faculty and student-led projects exploring innovative applications of SMART technologies in education and research. Recognizing and rewarding contributions to SMART initiatives through awards or career advancement opportunities can further inspire creativity and engagement. Collaborations with technology providers, agricultural enterprises, and international organizations can bring additional expertise and resources to the university, fostering a culture of continuous innovation.

Partnerships and sustainable funding mechanisms also play a vital role in the regulatory framework. Public-private partnerships (PPPs) with technology companies could support the development of SMART infrastructure, such as IoT networks, renewable energy systems, and digital classrooms, while reducing initial investment costs. DSAEU could also seek government and international grants to finance SMART initiatives, particularly those focused on digital transformation and education. Introducing flexible funding models, such as subscription-based services or leasing arrangements for SMART technologies, can further reduce financial strain and make advanced tools more accessible. These diverse funding mechanisms ensure the financial sustainability of SMART management practices.

Engaging stakeholders is equally important for the success of SMART initiatives. The regulatory framework should promote collaborative decision-making by involving students, faculty, staff, and external partners in shaping SMART management policies. Establishing forums or committees for stakeholder input ensures that decisions reflect diverse perspectives and priorities. Workshops

and training programs can build the skills needed to use SMART technologies effectively, while online platforms for feedback help identify issues and areas for improvement. An engaged and informed community is essential for the success and sustainability of SMART management at DSAEU.

In conclusion, developing a comprehensive regulatory framework is essential for the successful implementation of SMART management practices at DSAEU. By prioritizing data privacy, establishing governance structures, incentivizing innovation, fostering partnerships, and engaging stakeholders, the university can create an environment that supports the seamless integration of SMART technologies. This framework will not only ensure compliance with best practices but also position DSAEU as a leader in digital transformation within the educational sector. Through strategic planning and collaboration, the regulatory framework will serve as the foundation for achieving operational efficiency, academic excellence, and sustainable development at the university.

Below is a proposed step-by-step timeline for implementing the regulatory framework outlined in Section 3.2. The timeline spans 24 months and includes clear milestones for data privacy, governance structures, innovation incentives, funding mechanisms, and stakeholder engagement.

The implementation of SMART management practices at Dnipro State Agrarian and Economic University (DSAEU) requires a structured, phased approach to ensure effective adoption and sustainability. The first step involves establishing the foundation for the regulatory framework through the formation of a SMART Management Task Force. This team, comprising representatives from administration, faculty, IT staff, and students, will define roles, responsibilities, and objectives for overseeing the initiative. Concurrently, a comprehensive needs assessment will evaluate existing policies and infrastructure at DSAEU, identifying gaps in data privacy, governance, funding, and stakeholder engagement. These findings will inform the creation of a regulatory framework blueprint, outlining proposed policies, priorities, and timelines, which will then be refined based on stakeholder feedback.

To secure robust data governance, the next phase focuses on data privacy and security implementation. Policies for data collection, storage, and processing will be developed in compliance with GDPR and other international standards. Advanced security technologies, including encryption, firewalls, and multi-factor authentication, will be deployed to safeguard digital platforms. Additionally, policies defining data ownership for students and faculty and access control permissions for sensitive information will be established. Faculty and staff will participate in workshops to enhance their understanding of data handling best practices and ensure compliance with privacy regulations.

The development of governance structures follows, aimed at creating mechanisms to oversee SMART initiatives effectively. The SMART Management Task Force will be formalized and integrated into the university's governance hierarchy, ensuring alignment with DSAEU's strategic priorities such as academic excellence and sustainability. Metrics for evaluating the effectiveness of SMART initiatives will be defined, and periodic audits and reviews will be conducted to monitor progress and make necessary adjustments.

Encouraging innovation is a critical component of the plan. Internal grant programs will be launched, providing funding for SMART projects led by faculty and students, with clearly defined application processes and evaluation criteria. Contributions to SMART management will be recognized through awards and professional development opportunities, motivating staff and students to actively participate. Additionally, partnerships with technology providers and agricultural enterprises will facilitate the co-development of SMART solutions and joint research initiatives, fostering innovation and collaboration.

To ensure long-term sustainability, building partnerships and securing funding mechanisms are essential. Public-private partnerships with technology companies will be initiated to fund and implement SMART infrastructure, with mutually agreed roles and benefits. Applications for government and international grants will focus on projects promoting digital transformation and education. Flexible funding models, such as subscription-based services and scalable payment

structures, will be introduced to reduce upfront costs and enhance financial sustainability.

The final stage emphasizes stakeholder engagement and integration of the regulatory framework. Collaborative forums will enable students, faculty, and staff to provide input on SMART initiatives, ensuring that policies address diverse needs. Comprehensive training sessions will prepare stakeholders to effectively use new technologies and systems, with ongoing support for professional development. Feedback mechanisms, including online platforms, will facilitate continuous improvement by allowing stakeholders to report issues and suggest enhancements. Finally, all policies, guidelines, and protocols will be compiled into a comprehensive regulatory document, which will be reviewed, approved by university leadership, and formally implemented.

This detailed approach ensures the seamless integration of SMART management practices at DSAEU, promoting operational efficiency, data security, and innovation while fostering a collaborative and sustainable institutional ecosystem.
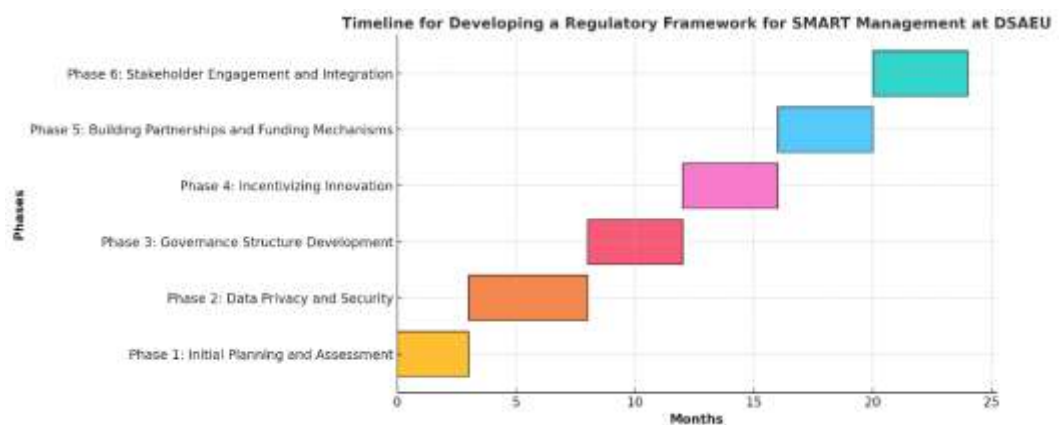

Fig. 3.2 Timeline for Developing a Regulatory Framework for SMART Management at DSAEU

This Gantt-style bar chart illustrates the timeline for developing a regulatory framework for SMART management at DSAEU, broken down into six distinct

phases. Each phase is represented by a horizontal bar, indicating its duration and starting point within the overall 24-month timeline.

To develop a comprehensive regulatory framework for SMART management at Dnipro State Agrarian and Economic University (DSAEU), a series of essential documents and policies must be created. These documents are critical for ensuring effective governance, operational efficiency, and compliance with national and international standards.

The SMART Management Strategy Document will establish the university's vision, goals, and objectives for implementing SMART management. It will outline key phases, milestones, and expected outcomes, ensuring alignment with DSAEU's institutional priorities and strategic plans. This foundational document will serve as a roadmap for the successful integration of SMART management practices.

A Data Privacy and Protection Policy will be crucial for regulating the collection, storage, processing, and sharing of data. It will define protocols that comply with international standards, such as GDPR, and Ukrainian data protection laws, while specifying the responsibilities of stakeholders in maintaining data security and privacy.

To support technological enhancements, a Digital Infrastructure Development Plan will detail the technical requirements, timelines, and budgets for upgrading infrastructure. This includes IoT integration, cloud systems, and cybersecurity measures, along with identifying opportunities for public-private partnerships to optimize resources and reduce costs.

A Governance Structure Guidelines document will define the organizational framework for managing SMART initiatives. This will include roles, responsibilities, and decision-making mechanisms for task forces and committees, ensuring accountability and smooth operation of the SMART management system.

Sustainability will be a core focus, outlined in the Sustainability and Green Practices Policy. This policy will promote initiatives such as energy efficiency,

waste management, and renewable energy adoption, providing metrics to monitor environmental impact and aligning with global sustainability standards.

A Training and Capacity-Building Plan will provide a framework for developing digital literacy and SMART management skills among faculty, staff, and students. This plan will include schedules for workshops, certifications, and continuous professional development to build a competent workforce capable of managing advanced technologies.

To ensure collaboration and inclusivity, the Stakeholder Engagement and Feedback Framework will outline processes for collecting input from students, faculty, alumni, and external partners. It will establish platforms for communication and adaptive feedback mechanisms, ensuring that SMART systems address the needs of all stakeholders.

Monitoring and continuous improvement will be guided by a Monitoring and Evaluation Protocol, which will define key performance indicators (KPIs) to assess the effectiveness of SMART management initiatives. It will set schedules for audits and evaluations and provide templates for reporting progress and suggesting improvements.

To address compliance and mitigate risks, a Legal Compliance and Risk Mitigation Policy will identify regulatory requirements relevant to higher education and SMART technologies. It will also outline procedures for managing risks such as data breaches or system failures, ensuring alignment with legal standards at both national and international levels.

Finally, Collaboration Agreements and Partnership Guidelines will formalize the terms of engagement with technology providers, governmental bodies, and international organizations. These agreements will define shared responsibilities, funding structures, and mutual benefits, encouraging joint research and development initiatives.

3.3 Designing an Implementation Plan for SMART Management in DSAEU

To successfully integrate SMART management practices at Dnipro State Agrarian and Economic University (DSAEU), a comprehensive and phased implementation plan is essential. This plan ensures a structured, sustainable approach to adopting advanced digital tools, engaging stakeholders, and aligning initiatives with the university's strategic goals [10], [13]. Each phase of the plan—Infrastructure Development, Training and Capacity Building, Pilot Projects, Full-Scale Implementation, and Monitoring and Evaluation—addresses specific objectives and challenges, creating a robust pathway to achieving operational efficiency, educational enhancement, and sustainability [7, 15].

The first phase, Infrastructure Development, focuses on establishing the technological foundation required for SMART management. High-speed internet connectivity will be installed across the campus to support digital platforms, IoT networks, and other SMART systems [18, 20]. IoT sensors will monitor real-time resource usage, such as energy, water, and environmental conditions, ensuring optimized resource management [16]. SMART classrooms will be equipped with interactive boards, multimedia systems, and VR/AR tools to enable immersive learning experiences [12, 19]. Administrative workflows will transition from paper-based processes to cloud-based platforms like Microsoft SharePoint, enabling efficient data storage, collaboration, and accessibility [9, 17]. Additionally, energy-efficient systems will be integrated into campus operations, aligning with DSAEU's commitment to sustainability [8]. This foundational infrastructure ensures the university is prepared to support advanced SMART technologies [11].

In the second phase, Training and Capacity Building, the focus shifts to equipping stakeholders—faculty, staff, and students—with the necessary skills to utilize SMART systems effectively [13, 14]. Workshops will be conducted to train faculty on using interactive classroom tools, IoT devices, and data analytics

platforms, while staff will receive guidance on managing digital administrative systems [5]. Collaborations with platforms like Coursera or Udemy will offer certifications in digital competencies, ensuring stakeholders are equipped with up-to-date knowledge [7]. For students, digital literacy modules and practical applications of tools like LMS platforms and IoT-based agricultural technologies will be integrated into the curriculum [15, 18]. Dedicated IT support teams will be established to assist with troubleshooting and provide ongoing guidance, ensuringsmooth adoption and operation of the new systems [10, 19].

The third phase, Pilot Projects, allows for the testing of SMART systems on a smaller scale, enabling the university to identify challenges and refine processes before full-scale implementation. IoT-based energy monitoring systems will be deployed in select buildings to track consumption patterns, identify inefficiencies, and optimize energy use. SMART waste management initiatives will introduce sensor-enabled bins to monitor waste levels and optimize collection schedules, promoting recycling. Digital administrative platforms will be piloted in specific departments to assess functionality and scalability. Additionally, select laboratories will be equipped with IoT devices to enable real-time monitoring of agricultural experiments, providing valuable insights into the practical application of SMART tools. These pilot projects serve as a critical testing ground, ensuring readiness for broader deployment.

Following the pilot phase, Full-Scale Implementation will focus on expanding SMART systems across all university operations. SMART classrooms, labs, and administrative tools will be deployed campus-wide, ensuring all students and faculty benefit from these advanced technologies. IoT sensors will be installed across buildings to monitor energy, water, and environmental conditions comprehensively, allowing for real-time data analysis and decision-making. Renewable energy solutions, such as solar panels, will be scaled to power university operations sustainably, reducing the institution's carbon footprint. SMART waste management systems will be expanded to cover the entire campus,

enhancing sustainability efforts. By integrating these systems fully, DSAEU will transform into a SMART-enabled institution with cutting-edge capabilities.

The final phase, Monitoring and Evaluation, focuses on assessing the performance and impact of the implemented SMART systems to ensure their long-term success and sustainability. Key performance indicators (KPIs) will be established to measure the effectiveness of initiatives, such as energy savings, system uptime, and user satisfaction. Feedback mechanisms will be introduced through online platforms, allowing students, faculty, and staff to share their experiences and suggest improvements. Data collected from IoT devices, LMS platforms, and administrative systems will be analyzed to identify inefficiencies and refine processes. Iterative improvements will ensure the systems remain relevant and effective as technology evolves. A long-term strategy for maintaining and upgrading SMART systems will be developed, securing their sustainability.

This phased implementation plan provides a clear and detailed roadmap for DSAEU's transition into a SMART university. Each phase builds on the previous one, ensuring a seamless progression from infrastructure development to full-scale deployment and continuous improvement. By following this structured plan, DSAEU can modernize its operations, enhance educational outcomes, and establish itself as a leader in sustainable and innovative university management, setting a benchmark for other institutions in the region and beyond.
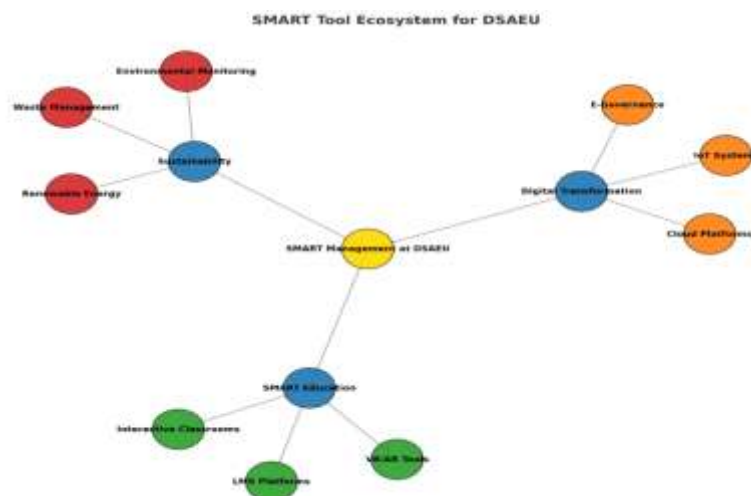

Fig 3.3 SMART Tool Ecosystem for DSAEU

Figure 3.3 represents the SMART Tool Ecosystem for Dnipro State Agrarian and Economic University (DSAEU). It showcases the relationship between the core components of SMART management—Digital Transformation, SMART Education, and Sustainability—and their associated tools.

SMART management tools are the backbone of modernizing operations, improving efficiency, and fostering innovation within institutions like Dnipro State Agrarian and Economic University (DSAEU). These tools integrate advanced technologies, data-driven decision-making, and digital platforms to create a cohesive, dynamic management ecosystem. Below is an in-depth exploration of key SMART management tools, categorized by their applications in Digital Transformation, SMART Education, and Sustainability.

The integration of SMART management tools at Dnipro State Agrarian and Economic University (DSAEU) represents a transformative step toward enhancing operational efficiency, improving educational outcomes, and fostering sustainability. Beyond institutional benefits, this integration serves as a bridge between DSAEU and territorial communities, highlighting the university's role in training specialists and contributing to local governance innovation. By aligning higher education with community needs, SMART management creates a mutually beneficial ecosystem that supports digital transformation and sustainable development.

Digital transformation tools at DSAEU streamline workflows and optimize resource allocation, benefiting both the university and its surrounding communities. Internet of Things (IoT) systems, such as EnvioCam, enable real-time monitoring of energy consumption, water usage, and environmental conditions. These insights can be shared with local authorities to support sustainable urban planning and agricultural development. Similarly, cloud platforms like Microsoft Azure and AWS provide scalable solutions for storing and analyzing data critical to regional planning, economic modeling, and community governance.

E-governance platforms like EduTrac and Ellucian Banner streamline internal university processes, including enrollment, scheduling, and reporting. These systems also serve as practical examples for students learning to apply similar tools in community governance. Data analytics platforms, such as Power BI and Tableau, enhance decision-making by providing actionable insights into attendance, resource management, and operational efficiency, equipping students with skills directly applicable to community needs.

SMART education tools play a pivotal role in preparing students at DSAEU to address challenges faced by territorial communities. Learning Management Systems (LMS) like Moodle and Blackboard enable hybrid and online learning environments, fostering digital literacy and technical expertise. Interactive technologies such as SMART Boards and immersive platforms like Google Expeditions simulate real-world scenarios, allowing students to explore solutions for sustainable farming, resource allocation, and economic development.

IoT-enabled SMART labs, including platforms like Labster and Arduino Kits, facilitate research with direct applications in territorial communities. For instance, students can analyze soil quality or water usage data, providing insights that benefit local farmers and policymakers. These practical experiences ensure that graduates are well-equipped to contribute to community development initiatives.

Sustainability tools are central to SMART management at DSAEU and align closely with the goals of territorial communities. Renewable energy management systems, such as SolarEdge, optimize the use of clean energy sources like solar panels, reducing reliance on non-renewable resources. These systems demonstrate scalable solutions that graduates can implement in local projects.

SMART waste management systems like Enevo use IoT sensors to optimize waste collection, offering efficient and eco-friendly disposal models for communities. Environmental monitoring tools, including AirVisual Pro and soil sensors, support both campus sustainability and community-led agricultural

projects. This integrated approach ensures that DSAEU and territorial communities work collaboratively toward achieving global sustainability goals.

Effective collaboration tools foster strong relationships between DSAEU, its students, and territorial communities. Platforms like Microsoft Teams and Zoom enable seamless communication for joint projects, while tools such as Qualtrics and Google Forms collect valuable feedback from stakeholders to refine SMART initiatives. Alumni engagement platforms like Graduway connect graduates with current students and community leaders, creating mentorship opportunities and fostering a sense of shared purpose.

Public-private partnership tools, such as Asana and Monday.com, facilitate collaboration between the university and local authorities. These tools streamline the planning and execution of joint initiatives, such as infrastructure development and resource optimization, ensuring that projects address the specific needs of communities.

As DSAEU integrates SMART tools into its operations, safeguarding data privacy and security is critical, particularly for collaborative projects with communities. Encryption software like VeraCrypt ensures secure storage and transmission of data, while access control platforms such as Okta regulate permissions for both university and community stakeholders. Comprehensive cybersecurity platforms like Cisco SecureX protect the digital infrastructure, fostering trust and ensuring the integrity of interconnected systems. The integration of SMART tools positions DSAEU as a hub for innovation and sustainability, directly supporting territorial communities through research, education, and collaborative initiatives. This symbiotic relationship emphasizes the university's role in training specialists equipped to address community challenges while using local needs to inform research and curriculum development.

By aligning higher education with the demands of territorial communities, SMART management creates an interconnected ecosystem that fosters mutual growth and resilience. This collaborative framework not only enhances institutional capabilities and community well-being but also ensures that DSAEU

and its partners remain at the forefront of global trends in digital governance and sustainable development.

Conclusions for chapter 3

1. Adapting international SMART management practices at DSAEU presents a transformative opportunity to modernize university operations, improve academic quality, and foster sustainability. Lessons from global examples emphasize the importance of aligning SMART initiatives with institutional goals while addressing local challenges. Key recommendations include the adoption of IoT-based systems for resource optimization, cloud platforms for efficient administrative workflows, and interactive tools to enhance the learning environment. By leveraging international best practices and tailoring them to the university's unique context, DSAEU can bridge the gap between traditional methods and innovative management.

2. The establishment of a robust regulatory framework is critical for the successful implementation of SMART management at DSAEU. This framework must prioritize data privacy, governance structures, and stakeholder engagement to align SMART initiatives with institutional goals and compliance standards. By introducing policies that safeguard sensitive information, create governance task forces, and foster inclusivity, the university can navigate the complexities of digital transformation effectively. Additionally, aligning with international regulations, such as GDPR, ensures that DSAEU's SMART systems are secure and trusted by the university community. This framework serves as the foundation for sustainable and transparent management practices.

3. A phased implementation plan provides a structured roadmap for integrating SMART management practices at DSAEU. The plan includes key phases: Infrastructure Development, Training and Capacity Building, Pilot Projects, Full-Scale Implementation, and Monitoring and Evaluation. Each phase addresses specific objectives, such as establishing digital infrastructure, equipping

stakeholders with necessary skills, and refining systems through feedback. The comprehensive approach ensures that SMART management systems are scalable, sustainable, and aligned with DSAEU's mission. By following this roadmap, the university can achieve operational efficiency, enhance the educational environment, and strengthen its role in supporting territorial communities.

CONCLUSIONS

1.   Investigate the essence and concept of SMART management as a foundation for its practical implementation. The study established that SMART management is a forward-looking governance framework designed to integrate technology and data into decision-making processes. Its essence lies in creating systems that are not only efficient but also adaptive to changing conditions and inclusive of diverse stakeholders. SMART management extends beyond technology, emphasizing collaboration, sustainability, and innovation as foundational principles. These elements make it a vital approach for modernizing governance in both urban and rural settings, where traditional methods often fall short in addressing complex challenges.

2.   Identify the principles and key elements of SMART management and their relevance to community governance. The principles of transparency, adaptability, sustainability, and inclusivity emerged as central to SMART management. Transparency fosters trust and accountability by making data and decision-making processes accessible to all stakeholders. Adaptability ensures that systems can evolve to meet emerging challenges, such as climate change or economic shifts. Sustainability prioritizes environmental stewardship and long-term resource efficiency, while inclusivity guarantees that all community members benefit from SMART initiatives. Key elements such as IoT systems, data analytics platforms, and citizen engagement tools empower local authorities to manage resources effectively, improve service delivery, and enhance public participation in governance.

3.   Analyze international practices in SMART management for insights into best practices and potential adaptations. International examples, including Singapore, Estonia, and EU member states, demonstrated the transformative potential of SMART management. These regions have successfully implemented policies that prioritize digital infrastructure, open data initiatives, and collaborative governance. Key insights include the importance of public-private partnerships in

funding and technology adoption, the role of robust legal frameworks in ensuring compliance and sustainability, and the value of citizen-centric platforms for improving transparency and engagement. Adapting these practices to the Ukrainian context involves addressing local challenges, such as limited funding and uneven digital literacy, while leveraging proven strategies from global leaders.

4. Assess the current state and challenges of territorial community development in Ukraine, emphasizing disparities in digital infrastructure and readiness. Territorial communities in Ukraine exhibit significant disparities in their ability to adopt SMART management practices. Urban areas, equipped with more advanced digital infrastructure and funding sources, are better positioned to integrate these systems. Conversely, semi-urban and rural communities face challenges such as limited broadband access, inadequate technological infrastructure, and a lack of local expertise. These disparities underscore the need for targeted investments and strategies to bridge the gap between urban centers and underserved regions, ensuring equitable development across all community types.

5. Evaluate the readiness of Ukrainian communities for SMART management, focusing on technological, financial, and human resource aspects. The study revealed uneven levels of readiness among Ukrainian communities. Urban areas demonstrate higher technological and financial readiness due to greater access to infrastructure, funding, and skilled personnel. Semi-urban and rural areas, however, lack these resources, resulting in slower adoption of SMART management practices. Key barriers include limited access to funding, low levels of digital literacy, and insufficient human resource capacity to manage and sustain SMART systems. Addressing these issues requires a multi-faceted approach involving capacity-building programs, equitable resource allocation, and strategic partnerships.

6. Examine the regulatory and legal framework in Ukraine supporting SMART management, identifying gaps and areas for improvement. Ukraine's regulatory framework provides a foundational structure for SMART management, with key laws addressing data protection, e-governance, and open information.

However, the study identified significant gaps, such as the lack of comprehensive guidelines for implementing SMART initiatives and inconsistencies in enforcement across different regions. Emerging technologies and international best practices are not fully addressed in existing laws, leaving room for ambiguity and inefficiencies. Strengthening this framework requires updating policies to reflect technological advancements, harmonizing regulations across levels of governance, and ensuring alignment with global standards.

7. Develop tailored recommendations for adapting international experience in SMART management to Dnipro State Agrarian and Economic University (DSAEU). Tailored recommendations for DSAEU include adopting proven international practices such as interdisciplinary research programs, specialized training in digital tools, and the establishment of collaborative partnerships. The university can serve as a model for integrating SMART systems by creating knowledge hubs, deploying IoT-enabled technologies for campus management, and fostering collaboration with territorial communities. These efforts will enhance DSAEU's role in regional development while ensuring its alignment with global trends in digital governance and education.

8. Propose ways to enhance the regulatory framework to support SMART management within DSAEU. Enhancing the regulatory framework at DSAEU requires the development of clear guidelines for data governance, stakeholder engagement, and infrastructure development. The study recommends drafting policies that prioritize transparency, security, and sustainability while ensuring compliance with international and national standards. Creating mechanisms for continuous feedback and periodic reviews of policies will ensure the framework remains relevant and adaptive to emerging challenges and opportunities.

9. Design a phased implementation plan for SMART management at DSAEU, emphasizing infrastructure development, capacity building, and sustainable practices. The proposed phased implementation plan ensures a systematic and scalable approach to adopting SMART management. Initial phases

focus on assessing current infrastructure and developing regulatory guidelines, followed by capacity-building initiatives for faculty, staff, and students. Subsequent phases emphasize the deployment of SMART tools, integration with community governance systems, and the promotion of sustainability through renewable energy solutions and waste management systems. This structured approach ensures that DSAEU can implement and maintain SMART management effectively, serving as a benchmark for other institutions.

REFERENCES

1.   Ahvenniemi, H., Pinto-Seppä, I., & Airaksinen, M. (2020). Smart and sustainable cities: Towards innovative frameworks for urban planning. *Sustainable Cities and Society*, 54. DOI: https://doi.org/10.1016/j.scs.2020.101951

2.   Allam, Z., & Jones, D. S. (2021). Future (post-COVID) digitalization strategies for smart cities: Insights and recommendations. *Cities*, 120, DOI: https://doi.org/10.1016/j.cities.2021.103279

3.   Alizadeh, T. (2019). A policy review of smart resilience for cities. *Urban Policy and Research*, 37(2), 212–224. DOI: https://doi.org/10.1080/08111146.2019.1579620

4.   Angelidou, M., & Psaltoglou, A. (2019). An empirical investigation of social innovation initiatives for sustainable urban development. *Sustainable Cities and Society*, 44, 133–143. DOI: https://doi.org/10.1016/j.scs.2018.09.025

5.   Bibri, S. E., & Krogstie, J. (2020). Smart sustainable cities of the future: An analytical framework for sustainable urban planning and development. *Journal of Urban Technology*, 27(1), 1–27. DOI: https://doi.org/10.1080/10630732.2018.1563368

6.   Bolivar, M. P. R. (2021). Governance models for smart cities: Exploring the role of public-private partnerships. *International Review of Administrative Sciences*, 87(4), 826–843. DOI: https://doi.org/10.1177/0020852319893445

7.   Bondarchuk N.V., Onopriienko O.D. "Implementation of the SMART System of Management of the Development of Territorial Communities: Experience and Perspectives." *Scientific Perspectives* (Series "Public Administration"). Issue № 11(53), 2024. DOI: 10.52058/2708-7530-2024-11(53)-19-32.

8.   Concept of Digital Transformation of Education and Science of Ukraine. Ministry of Education and Science of Ukraine. (2020). *Concept of Digital*

Transformation of Education and Science of Ukraine. Approved by the Ministry of Education and Science, dated 22 December 2020. Available at: https://mon.gov.ua/

9. Doytsher, Y., & Kohelet, P. (2021). The evolution of smart cities and their adaptation to global challenges. *International Journal of Geographical Information Science*, 35(4), 720–740. DOI: https://doi.org/10.1080/13658816.2021.1905521

10. Fotino, F., Greco, L., & Carrozzi, A. (2020). The role of universities in smart territorial development: Evidence from case studies. *Regional Studies*, 54(12), 1740–1755. https://doi.org/10.1080/00343404.2020.1712641

11. Galati, F., Sorrentino, M., & Vecchiato, R. (2020). Leveraging digital platforms for social inclusion in higher education. *International Journal of Educational Technology in Higher Education*, 17, 45. https://doi.org/10.1186/s41239-020-00221-8

12. Godfrey, M., & Johnson, D. (2019). Data-driven sustainability practices: Realizing the potential of big data in smart campuses. *Journal of Cleaner Production*, 229, 640–652. https://doi.org/10.1016/j.jclepro.2019.05.021

13. Kitchin, R., Coletta, C., & Evans, L. (2021). Smart urbanism and sustainable development: Critiquing the relationship between technology and urban equity. *Urban Studies*, 58(4), 771–785. https://doi.org/10.1177/0042098020925356

14. Law of Ukraine on Access to Public Information. Verkhovna Rada of Ukraine. (2011). *Law of Ukraine on Access to Public Information*. No. 2939-VI, dated 13 January 2011. Available at: https://zakon.rada.gov.ua/laws/show/2939-17

15. Law of Ukraine on Energy Efficiency. Verkhovna Rada of Ukraine. (2021). *Law of Ukraine on Energy Efficiency*. No. 1818-IX, dated 21 October 2021. Available at: https://zakon.rada.gov.ua/laws/show/1818-20

16. Law of Ukraine on Higher Education. Verkhovna Rada of Ukraine. (2014). *Law of Ukraine on Higher Education*. No. 1556-VII, dated 1 July 2014. Available at: https://zakon.rada.gov.ua/laws/show/1556-18

17. Law of Ukraine on Information Protection. Verkhovna Rada of Ukraine. (1994). *Law of Ukraine on Information Protection*. №. 2135-XII, dated 2 October 1994. Available at: https://zakon.rada.gov.ua/laws/show/2135-12

18. Law of Ukraine on Local Self-Government in Ukraine. Verkhovna Rada of Ukraine. (1997). *Law of Ukraine on Local Self-Government in Ukraine*. №. 280/97-ВР, dated 21 May 1997. Available at: https://zakon.rada.gov.ua/laws/show/280/97-вр

19. Law of Ukraine on Public-Private Partnership Verkhovna Rada of Ukraine. (2010). *Law of Ukraine on Public-Private Partnership*. №. 2404-VI, dated 1 July 2010. Available at: https://zakon.rada.gov.ua/laws/show/2404-17

20. Luque-Ayala, A., & Marvin, S. (2020). Urban ecologies and digital platforms: Opportunities and risks of smart city integration. *Cities*, 103, DOI:https://doi.org/10.1016/j.cities.2020.102774

21. McArthur, J. L., & Robin, E. (2020). Smart campuses and the role of higher education in addressing the climate emergency. *Sustainability*, 12(3), DOI: https://doi.org/10.3390/su122310083

22. Meijer, A., & Bolívar, M. P. R. (2020). Governing the smart city: The need for governance beyond technology. *International Review of Administrative Sciences*, 86(3), 635–648. DOI: https://doi.org/10.1177/0020852318819032

23. Nam, T. (2020). Smart city technologies and policies: Digital innovations for urban sustainability. *Technological Forecasting and Social Change*, 153, DOI: . https://doi.org/10.1016/j.techfore.2020.119217

24. National Digital Transformation Strategy of Ukraine. Ministry of Digital Transformation of Ukraine. (2021). *National Digital Transformation Strategy of Ukraine*. Approved by the Cabinet of Ministers, dated 17 February 2021. Available at: https://thedigital.gov.ua/

25. Onopriienko O. Implementing foreign experience of smart management in the development of territorial communities in Ukraine. Розвиток

форм і методів сучасного менеджменту в умовах глобалізації: Матеріали 12-ї Всеукраїнської наук.-практ. конф. – Дніпро, 8-9.11.2024: тези доповідей. – Дніпро: Поліграфічний відділ ДДАЕУ, 2024. С. 105-106

26. Ojo, A., Curry, E., & Janowski, T. (2020). Designing inclusive digital public services for smart cities. *Government Information Quarterly*, 37(4), DOI: https://doi.org/10.1016/j.giq.2020.101460

27. Peng, G. C. A., & Nunes, M. B. (2021). Smart technologies for territorial sustainability: Lessons from the COVID-19 pandemic. *Journal of Environmental Planning and Management*, 64(8), 1415–1434. DOI: https://doi.org/10.1080/09640568.2020.1864773

28. Rodríguez Bolívar, M. P., & Meijer, A. (2020). Smart city governance: Reconciling technology with social equity. *Sustainability*, 12(3), 964. DOI: https://doi.org/10.3390/su12030964

29. Sadowski, J., & Bendor, R. (2019). Selling smartness: Corporate discourses and the social shaping of smart cities. *Technology in Society*, 56, 93–100. DOI: https://doi.org/10.1016/j.techsoc.2018.09.001

30. Strategy for Sustainable Development "Ukraine 2020". President of Ukraine. (2015). *Strategy for Sustainable Development "Ukraine 2020"*. Presidential Decree No. 5/2015, dated 12 January 2015. Available at: https://zakon.rada.gov.ua/laws/show/5/2015

31. The Constitution of Ukraine. Verkhovna Rada of Ukraine. (1996). *The Constitution of Ukraine*. Adopted at the fifth session of the Verkhovna Rada of Ukraine on 28 June 1996. Available at: https://zakon.rada.gov.ua/laws/show/254к/96-вр

32. Vinuesa, R., Azizpour, H., Leite, I., et al. (2020). The role of artificial intelligence in achieving the Sustainable Development Goals. *Nature Communications*, 11, 233. DOI: https://doi.org/10.1038/s41467-019-14108-y

33. Angelidou, M., & Gountaras, N. (2021). Smart cities and higher education: Challenges and opportunities in creating sustainable campuses.

Sustainable Cities and Society, 64, DOI: . https://doi.org/10.1016/j.scs.2020.102491

34. Bifulco, F., Tregua, M., & Amitrano, C. C. (2020). Digital platforms and collaborative innovation: Smart cities in the age of AI. *Technological Forecasting and Social Change*, 151, DOI: https://doi.org/10.1016/j.techfore.2019.119862

35. Bibri, S. E. (2019). A comprehensive framework for smart sustainable cities: Advancing integrated urban systems. *Sustainable Development*, 27(4), 496–511. DOI: https://doi.org/10.1002/sd.1913

36. Bolivar, M. P. R., & Muñoz, L. A. (2020). The role of universities in fostering smart territorial innovation. *Sustainability*, 12(7), DOI: https://doi.org/10.3390/su12073025

37. Cao, X., Zhen, F., & Zhao, X. (2021). Data-driven smart urban governance: A review of strategies and challenges. *Sustainability*, 13(2), DOI: https://doi.org/10.3390/su13020658

38. Caragliu, A., Del Bo, C., & Nijkamp, P. (2020). Smart cities in Europe revisited: Digital transformation meets inclusivity. *Journal of Urban Technology*, 27(2), 1–20. DOI: https://doi.org/10.1080/10630732.2020.1748380

39. Chen, Y., & Bryer, T. (2019). Investigating citizen engagement in smart cities through participatory platforms. *Government Information Quarterly*, 36(4), DOI: https://doi.org/10.1016/j.giq.2019.07.003

40. Cooke, F. L., & Jiang, L. (2021). Sustainable human resource management in the digital age. *Asia Pacific Journal of Human Resources*, 59(1), 26–48. DOI: https://doi.org/10.1111/1744-7941.12293

41. Davoudi, S., & Madanipour, A. (2019). Resilient cities and smart technologies: Toward inclusive planning. *Urban Studies*, 56(5), 919–935. DOI: https://doi.org/10.1177/0042098018775432

42. Dastbaz, M., Gorse, C., & Moncaster, A. (2019). *Sustainable cities and communities design handbook: Planning, building, and improving resilience*. Butterworth-Heinemann. DOI: https://doi.org/10.1016/C2017-0-01964-8

43. Floridi, L. (2021). The ethics of artificial intelligence in higher education: Opportunities and risks for smart campus initiatives. *AI & Society*, 36(3), 613–621. DOI: https://doi.org/10.1007/s00146-020-01189-9

44. Franzoni, S., & Resnati, D. (2021). The digital twin in smart city applications: Bridging gaps between planning and implementation. *Journal of Urban Planning and Development*, 147(4), DOI: https://doi.org/10.1061/(ASCE)UP.1943-5444.0000712

45. Gehl, J., & Svarre, B. (2020). *How to study public life in smart cities: Data-driven methods for urban studies*. Island Press. DOI: https://doi.org/10.5822/978-1-61091-937-6

46. Giffinger, R., & Gudrun, H. (2020). Smart city ranking: Assessing urban sustainability in the context of digital transition. *Cities*, 108, DOI: https://doi.org/10.1016/j.cities.2020.103031

47. Guo, R., Yang, Z., & Jin, L. (2021). Green growth strategies for higher education institutions in smart cities. *Journal of Cleaner Production*, 316, DOI: https://doi.org/10.1016/j.jclepro.2021.128144

48. Jin, L., & Lusch, R. F. (2020). Strategic smart city frameworks: Fostering innovation and sustainability. *Journal of Urban Technology*, 27(3), 59–78. DOI: https://doi.org/10.1080/10630732.2020.1748395

49. Kleibert, J. M., & van der Wende, M. (2019). The rise of smart campuses: Higher education and the digital divide. *European Journal of Higher Education*, 9(2), 189–208. DOI: https://doi.org/10.1080/21568235.2018.1542246

50. Lin, W., & Liao, S. (2021). The role of big data analytics in smart campus development: Applications and challenges. *Computers in Human Behavior*, 119, DOI: https://doi.org/10.1016/j.chb.2021.106688

51. Mellouli, S., Luna-Reyes, L. F., & Zhang, J. (2019). Leveraging open data for smart urban governance: Lessons from case studies. *Information Polity*, 24(1), 69–84. DOI: https://doi.org/10.3233/IP-190122

52. Mora, L., Bolici, R., & Deakin, M. (2021). Smart innovation ecosystems: Designing environments for inclusive innovation. *Sustainable Cities and Society*, 70, DOI: https://doi.org/10.1016/j.scs.2021.102943

53. Moreno, C., Allam, Z., Chabaud, D., Gall, C., & Pratlong, F. (2021). Introducing the "15-minute city": Sustainability, resilience, and place-based planning in urban design. *Smart Cities*, 4(1), 93–111. DOI: https://doi.org/10.3390/smartcities4010006

54. Napolitano, P., & Blasi, S. (2021). The role of smart contracts in sustainability-focused public-private partnerships. *Journal of Cleaner Production*, 284. DOI: https://doi.org/10.1016/j.jclepro.2020.124778

55. Nazari, H., Vial, G., & Aubert, B. (2020). Leveraging digital platforms for smart territorial governance. *Technological Forecasting and Social Change*, 151, DOI: https://doi.org/10.1016/j.techfore.2020.119875

56. Nguyen, H. T., & Hoang, L. M. (2021). Data analytics in smart universities: Opportunities and challenges for higher education. *International Journal of Educational Technology in Higher Education*, 18, 47. DOI: https://doi.org/10.1186/s41239-021-00287-5

57. Nikolic, V., et al. (2020). Exploring the potential of IoT for smart cities: Applications and barriers. *Sustainable Cities and Society*, 61, DOI: https://doi.org/10.1016/j.scs.2020.102385

58. Pawlowski, J. M., & Struck, D. (2021). Inclusive digital transformation for rural areas: Best practices from the EU. *European Journal of Development Research*, 33(5), 1287–1304. DOI: https://doi.org/10.1057/s41287-021-00364-4

59. Sanchez, D. G., & Miller, K. (2021). Smart city standards for sustainability: A global perspective. *IEEE Access*, 9, 36749–36765. DOI: https://doi.org/10.1109/ACCESS.2021.3062387

60. Sarwar, S., & Tarar, M. (2020). AI-driven governance for smarter urban ecosystems. *Government Information Quarterly*, 37(4), DOI: https://doi.org/10.1016/j.giq.2020.101486

61.   Sun, Y., & Lee, J. (2021). Public-private partnerships in smart urban energy systems. *Renewable and Sustainable Energy Reviews*, 146, DOI: https://doi.org/10.1016/j.rser.2021.111207

62.   Zhang, J., & Li, Y. (2021). Designing resilient smart education systems: The role of digital platforms and collaboration. *Journal of Educational Technology Development and Exchange*, 14(2), 45–59. DOI: https://doi.org/10.18785/jetde.1402.04