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ENHANCING INNOVATION IN SMART CITIES: APPLYING THE QUINTUPLE HELIX MODEL TO THE DEVELOPMENT OF SUSTAINABILITY-ORIENTED SMART CITY SERVICES

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ABSTRACT

Smart cities are increasingly recognized as a key solution for addressing challenges posed by rapid urbanization, climate change, and various political, health, and other crises. They primarily aim to promote sustainable development, mitigate existing climate-change-related and other issues and ensuring good quality of life for citizens. In this process, stakeholders from government, academia, industry, and community need to collaborate effectively. The aim of this study is to explore how sustainability-oriented smart city services are created from the perspectives of multiple stakeholders. Using a qualitative, exploratory approach, we conducted eleven interviews with experts from government, academia, and industry across three countries. Thematic and comparative analysis revealed the emergence of a new system in the innovation creation process, namely the data system. However, stakeholders emphasize that technology alone is insufficient for smart city development, highlighting the need for human-driven decision-making that aligns with residents' needs and city capabilities. This study proposes a thematic map illustrating the varying interpretations of smart city definitions across different stakeholder groups. Additionally, it proposes a framework, grounded in the Quintuple Helix Model, to foster innovation, collaboration, and sustainable development in the creation of sustainability-oriented smart city services and proposes its extension with data systems.

KEYWORDS: *smart cities, smart city services, sustainability, stakeholders, quintuple helix model, innovation*

1. INTRODUCTION

In recent years, a growing share of the global population has been moving from rural to urban areas, with more than half of humanity already living in cities and projections indicating an increase to 68% by 2050 (United Nations, 2018). As urbanization accelerates, ensuring the sustainability of these expanding urban areas has become essential for maintaining a high quality of life for residents, sustaining economic growth, and preserving natural and social resources in the long term (United Nations, 2018). Beyond rapid urbanization, cities worldwide face a convergence of environmental, health, and political crises, ranging from climate change, pollution, and biodiversity loss to global pandemics, geopolitical conflicts, and the unregulated development of emerging technologies (United Nations, 2022). Previous research highlights technology as a crucial component of sustainability-oriented smart city services (SSCSs) (Tura and Ojanen, 2022)

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and as a key enabler in addressing the critical challenges faced by cities (Harrison *et al.*, 2010). However, while technology can be a powerful tool for transformation, the integration of digital solutions alone into everyday life does not necessarily make a city smart (Grybauskas *et al.*, 2022).

Despite a rapidly expanding body of literature, there remains a lack of conceptual clarity and consensus among scholars regarding what constitutes a smart city (Hollands, 2008; Albino *et al.*, 2015; Meijer and Bolívar, 2016; Mora *et al.*, 2017, 2019 a, b; Komninos and Mora, 2018). Hashem *et al.* (2016) define smart cities as those that effectively employ digital solutions to enhance sustainability and improve residents' well-being, while Leydesdorff and Deakin (2011) argue that, for a city to become truly "smart," it must strategically leverage intellectual capital to strengthen creativity, innovation, and civic participation in governance processes by fostering collaboration among policymakers, academic leaders, and industry strategists.

As Leydesdorff and Deakin (2011) further emphasize, smart city development is not a spontaneous outcome of market forces but the result of deliberate policy choices. They highlight the importance of analytical frameworks that guide governance and innovation processes, positioning the Helix models as valuable lenses for examining the knowledge flows and resources that drive smart city service development. The process of value co-creation in complex innovation ecosystems has been widely explored through the Helix models of innovation (Leydesdorff and Etzkowitz, 1998; Carayannis and Campbell, 2009, 2010; Carayannis *et al.*, 2012). Among these, the Quintuple Helix Model identifies the roles of academia, industry, government, the community, and the environment in knowledge-based innovation and sustainable development (Carayannis *et al.*, 2012).

However, recent advances in digital transformation and data-driven governance have revealed the increasing importance of open data systems as mediators of collaboration, transparency, and interoperability among these actors. Building on this insight, the present study applies and extends the Quintuple Helix framework by introducing an additional actor—the open data helix—which represents the infrastructure and digital ecosystems that enable continuous data exchange and innovation among stakeholders. This extended Quintuple Helix Model thus serves as the conceptual foundation for examining how SSCSs emerge through multi-stakeholder collaboration.

Although several cities have begun integrating strategic planning approaches into smart city initiatives, systematic research on this topic remains limited. Comprehensive studies are still lacking on how strategic planning tools and innovation frameworks are applied in the context of smart cities and how they influence governance and co-creation processes (Mora *et al.*, 2019b). Moreover, the United Nations has identified a persistent knowledge gap regarding how cities can facilitate such development, calling for a deeper theoretical and practical understanding of smart city transformation—particularly the role of smart technologies in making cities safer, more inclusive, resilient, and sustainable (United Nations, 2017). Addressing this gap motivated our research question: *How do government, industry, academia, and community stakeholders collaborate in the development of SSCSs?*

Accordingly, the aim of this research is to better understand stakeholders' respective contributions to smart city development and to apply the extended Quintuple Helix Model to explain their roles and interactions in creating innovative SSCSs in countries in the early stages of adoption, such as Slovenia.

The remainder of this paper is organized as follows. The *Literature review* section provides a comprehensive literature review on SSCS definitions, benefits, and risks, their contribution to sustainability, and their development through the lens of Helix models of innovation. Section *Methodology* outlines the research methodology. Section *Results* and *Discussion* present results with their discussion, offering insights into the roles of academia, government, community, industry, environment, and open data in developing SSCSs. Finally, section *Conclusion* summarizes the key findings, outlines limitations, and proposes directions for future research, emphasizing implications for theory and practice.

2. LITERATURE REVIEW

Definitions, benefits and risks of smart city services

There are many definitions of the smart city concept, but most agree that smart cities connect information and communication technologies with physical, social, and business infrastructures to enhance urban intelligence and efficiency (Harrison *et al.*, 2010) and that smart cities aim to use resources effectively while improving economic and social living conditions for their residents (Hashem *et al.*, 2016). The key dimensions commonly identified in the literature include smart mobility, smart living, smart environment, smart people, smart governance, smart economy, smart architecture, and smart technology (Ismagilova *et al.*, 2019). However, Leydesdorff and Deakin (2011) argue that for a city to become truly "smart," it must strategically leverage intellectual capital to strengthen creativity, innovation, and civic participation in governance pro-

cesses by enabling collaboration among policymakers, academic leaders, and industry strategists.

Some of the benefits of digitalization include providing information and tools for measurement and management (D'Amico *et al.*, 2020; Pardo-García *et al.*, 2019), encouraging residents to adopt more sustainable behavior (Kahya *et al.*, 2021), providing innovative solutions to the challenges of sustainability, equity, and economic growth in cities (Haarstad and Wathne, 2019; Pereira *et al.*, 2020), and helping integrate new policies for sustainable urban development (e.g., controlling air quality, land use, and water use) (Pardo-García *et al.*, 2019), among others.

Besides the benefits provided by technological innovations, there are also some risks associated with their adoption, such as overly rapid technological development (Cao *et al.*, 2020; Parmentola *et al.*, 2022), which can cause significant e-waste (Das *et al.*, 2019). Moreover, there is a risk of insufficient or improper infrastructure capacity, network security issues, energy efficiency, and high costs, among others (Allam and Jones, 2021).

Data security has also been considered an important risk arising from the use of novel technologies (Budrin *et al.*, 2020), such as autonomous vehicles, real-time monitoring, or cloud computing (Cugurullo *et al.*, 2021; D'Amico *et al.*, 2020). Social acceptance of technologies (e.g., blockchain) may also be an issue (Belli *et al.*, 2020; Mora and Deakin, 2019), as well as the digital divide, which is influenced by socio-demographic factors like age, income, and region (Shin *et al.*, 2021).

Enhancing sustainability through smart city services

Cities are responsible for up to 70 percent of harmful greenhouse gas emissions worldwide while occupying only about 3 percent of the land. Since their actions affect the well-being of the whole planet, they have no other choice but to fight climate change, which is already causing numerous environmental, social, and economic problems (Il and Cooke, 2016). Sustainable development must consider the needs of the present without compromising the ability of future generations to meet their own needs as defined by The World Commission on Environment and Development (1987). To achieve that, a smart sustainable city must be climate-neutral, as well as a place where people are a priority and share the core values of conservation, respect for natural resources, and appreciation of the environment (Il and Cooke, 2016). Literature on sustainable development has previously focused on its potential for economic, environmental, and social benefits, improving organizational performance, increasing safety, and regional development, whereas the effects of digital innovation on sustainability are still under-researched (Parida *et al.*, 2019). Digitalization of smart cities can improve the quality of life for their residents through enhanced information and customer services and improved decision-making (Kyriazis *et al.*, 2013).

Sustainability-oriented innovations in smart cities include new products, services, processes, and business models that drive smart city development (Tura and Ojanen, 2022). SSCSs (and other types of sustainability-oriented innovation) aim to create economic, environmental, and social value. They involve making intentional changes to (an organization's) philosophies and values (Adams *et al.*, 2015). Some examples of SSCSs include open data systems, smart infrastructure, management systems for communal areas, digital platforms, e-government platforms, smart metering systems, smart energy and natural resources systems, smart mobility systems, and mobile apps. They can support urban sustainability in different ways. They support 1) economic sustainability by helping increase the number of local businesses, encouraging new ones, and reducing taxes, 2) environmental sustainability by reducing CO2 emissions through improved mobility efficiency, integrated public transport services, and soft mobility, as well as optimizing the usage of energy and natural resources and encouraging citizens' eco-friendly actions, 3) social sustainability by helping citizens to participate in a larger number of social events and activities and planning novel city activities. Citizens also enjoy simplified digital procedures for completing administrative documents, better mobility, safer streets, and technology capable of improving their skills to help them find a job (Margherita *et al.*, 2023). Approximately 54 % of papers focus on smart city governance and smart environment, while relatively limited attention has been given to community aspects of SSCSs development according to the literature review by Ninčević Pašalić *et al.* (2021).

Developing smart cities through the lens of the Quintuple helix model of innovation

In recent years, scholars have emphasized that smart city development must move beyond a purely technological focus and instead embrace a more holistic and collaborative approach. This shift calls for the adoption of the Helix models of innovation, which recognize that sustainable smart city development depends on the dynamic interaction among multiple stakeholders rather than technology alone. Specifically, Mora *et al.* (2019b) highlight the need to transition from a technology-centred perspective toward a Quadruple Helix model that integrates government, industry, academia, and the community in a shared innovation ecosystem.

Such an approach combines top-down governance driven by strategic public policy and institutional leadership with bottom-up initiatives emerging from community engagement and citizen participation. To operationalize this collaboration, cities are encouraged to develop a comprehensive smart city strategic model, establish innovation accelerators to support smart city development, and implement an integrated intervention logic that aligns technological, social, and environmental objectives within the broader context of sustainable smart city development.

Over time, the roles of smart city stakeholders and the overarching goals of smart city development have evolved. These dynamics are well captured by the Triple Helix model (Leydesdorff and Etzkowitz, 1998), which conceptualizes innovation as a "spiral model of interaction" among three key stakeholders: universities, industry, and government. Through their collaboration, these stakeholders generate synergies that stimulate knowledge creation and economic growth.

The model was later expanded to reflect broader social complexity. The Quadruple Helix model incorporates the culture- and media-based public sphere and civil society, including elements such as art, creative industries, culture, lifestyles, media, and societal values (Carayannis and Campbell, 2009, 2010). This addition acknowledges the influence of the community and the cultural context on innovation processes. Subsequently, the Quintuple Helix model introduced a fifth dimension, *the natural environment* to emphasize the importance of socio-ecological interactions and sustainability in innovation systems (Carayannis *et al.*, 2012).

The Quintuple Helix model represents an interdisciplinary and transdisciplinary framework that illustrates how contemporary challenges, such as climate change and environmental degradation, can be addressed through knowledge exchange across all stakeholders. These stakeholders continuously interact to foster sustainable development and innovation. Academia, supported by financial investment, develops human capital and generates knowledge for sustainable development, which in turn feeds into industry. Industry creates new jobs, develops sustainable products and services, and promotes corporate social responsibility, directly influencing environmental outcomes. A healthier natural environment enables a higher quality of life for the community and inspires new SSCSs. The community, as both a user and co-creator, adopts sustainable lifestyles and communicates its needs and expectations to policymakers in the government. The government integrates knowledge from academia, industry, and the community to formulate legal and policy frameworks that advance sustainability. These, in turn, influence all other stakeholders, completing the circular flow of knowledge and innovation that defines the Quintuple Helix model (Carayannis *et al.*, 2012).

Applications of the Helix Models in Smart City Research and Information Systems

The Helix models have been widely adopted within smart city research in the information systems field to analyse the interdependence of stakeholders in smart cities. Leydesdorff and Deakin (2011) were among the first to apply the Triple Helix model to smart cities. Building on this foundation, Lombardi et al. (2012) developed an analytical model connecting the core stakeholders of the Triple Helix using the Analytic Network Process to evaluate smart city development performance. Their model captures feedback among academia, industry, and government, providing a systemic tool for supporting evidence-based policy and SSCS management. Similarly, Cruickshank (2011) analysed the Smart Cities Regional Academic Network (SCRAN) to illustrate how smart infrastructure and online platforms facilitate collaboration and knowledge sharing across Helix stakeholders.

Later research expanded toward more inclusive models of smart city development. Mora *et al.* (2019b) conducted multiple case studies of European cities (Amsterdam, Barcelona, Helsinki, and Vienna) to test dichotomies in smart city development, such as technology-led versus holistic and double- versus quadruple-helix approaches. Their results underscored the need for integrated, multi-stakeholder strategies that balance top-down coordination with bottom-up community involvement. Similarly, Gebhardt (2020) examined participatory governance in the Brainport Metropolitan Region (Netherlands), revealing how community-driven innovation pathways fit within a Triple Helix model.

Within information systems and smart city development, Gong *et al.* (2025) applied the Triple Helix framework to explore disaster risk reduction in Shenzhen, China, showing how government, industry, and academia collaborated to create a Smart Emergency Management System that later incorporated community participation. De Oliveira (2024) similarly proposed a digital platform model to enhance communication and integration among Helix stakeholders, emphasizing open data systems as enablers of collaboration.

The Quadruple Helix model further integrates the community and emphasizes inclusivity. Charalabidis *et al.* (2019) and Alexopoulos *et al.* (2022) demonstrated how digital management systems and community co-creation redefine SSCSs development processes, leading to more participatory forms of smart cities 4.0. Zhou *et al.* (2024) applied the model to analyze

how SSCSs can support inclusive cities for people with disabilities, calling for greater socio-technical development.

More recently, the Quintuple Helix model has been used to embed environmental sustainability into innovation systems. Cambra-Fierro *et al.* (2024) examined the #eCity-Sevilla project as a public–private innovation ecosystem and found that environmental sustainability must be a guiding principle across all stakeholders. Streitz *et al.* (2022) also applied the model to transform "smart-only" islands into Lighthouses of Research and Innovation, showing how participatory design and open innovation can produce humane and cooperative hybrid environments.

Other empirical studies, such as Jonek-Kowalska and Wolniak (2021) and Kostko *et al.* (2022), highlight geographical differences in Helix models adoption. While Polish cities remain focused on business-driven Triple Helix collaborations, Russian cities are beginning to adopt quadruple or social variants, signalling a gradual transition toward more holistic models.

In summary, Helix models have proven to be robust frameworks for understanding the multi-level interactions among stakeholders in smart cities. Their integration into information systems research has evolved from measuring performance and governance efficiency to promoting open data-driven, collaborative, and sustainable innovation ecosystems. However, most studies remain conceptual or limited to specific cases. There is still a need for empirical models that operationalize the Quintuple Helix model in developing SSCSs, which is a gap this study seeks to address.

3. METHODOLOGY

Participants

A purposive sampling technique was employed to deliberately select participants based on several criteria. The first criterion was their expertise and involvement in SSCS development initiatives, including holding a job position as the main manager of SSCSs in the industry sector, the main manager of smart city development in the government, or an expert from academia on sustainability and smart city-related issues. This ensured that the sample represented a diverse range of stakeholders from the government, industry, and academia. The community was excluded due to challenges in securing sufficiently representative participants; however, their perspectives were indirectly captured through the views of other stakeholder groups.

Our participants included 2 academia representatives from Slovenia and Croatia, namely a well-renowned physicist and meteorologist and a smart city researcher, 3 industry representatives, who work for the main telecommunication and car sharing companies in Slovenia, 4 government representatives, who work at the Ministry of economy, tourism, and sport in Slovenia, the Ministry of public administration in Slovenia, and local administration departments for smart city development in cities with the main smart city initiatives in Slovenia, and lastly 1 non-governmental organization representative from Slovenia. The interview with the Croatian participant was used only for pilot testing and was excluded from the content analysis to ensure contextual comparability, as differences in administrative structures, cultural context, and levels of smart city development between countries would limit the validity of cross-country interpretation.

Interview Design

This study adopts an exploratory and qualitative research approach aimed at developing a framework for SSCSs in a smart city environment, involving stakeholders from academia, government, industry, and the community. Since the existing literature does not sufficiently cover this topic, this approach allows us to gain a deeper understanding of stakeholders' perspectives. It follows a pragmatist philosophical stance, emphasizing practical solutions and real-world implications for SSCS development. A thematic and comparative analysis approach was employed, with data collected through semi-structured interviews with stakeholders engaged in key smart city initiatives and through a comparison of the proposed thematic map and SSCSs development model with existing ones in the literature.

Potential participants were approached via email or LinkedIn to participate in the study. The interviews were conducted between November 2023 and January 2024. Each interview lasted approximately 45 minutes and was predominantly conducted in person. Before each interview, participants received a written invitation and an informed consent document. The invitation included a concise summary of the research objectives and procedures. Participants were clearly informed of their right to withdraw from the study at any time without facing any negative consequences. Additionally, they were provided with information regarding data use and confidentiality policies related to the interviews.

A semi-structured interview guide was used, which allowed for flexibility in responses while maintaining consistency across interviews. The interview guides are included in Appendix B. They include the main questions for each interviewed stakeholder group (marked as Q), as well as probe questions (marked as P). We also pilot-tested the guide with an expert from

academia. The respondents were allowed to discuss SSCS development and their role in it and were probed when required. Reliability was ensured by using the same interview protocol for each session. Recordings were deleted after the transcripts were prepared.

Data Analysis

Interviews were transcribed using the Online Notes software. After transcription, we conducted a manual thematic analysis of the interviews following the steps outlined by Braun and Clarke (2006). Examples of citations for each identified theme are included in Appendix A. After thematic analysis, we compared the framework of SSCS development with existing ones from the literature using comparative analysis. Data saturation was reached when recurring themes were consistently identified across the interviews, and no new insights or patterns emerged from the responses of the later participants. Furthermore, an iterative approach to data collection and analysis enabled the identification of saturation, as no new themes or insights emerged during the later stages of analysis. To ensure the validity of the findings, peer debriefing was conducted with colleagues who possessed expertise in SSCSs development to review the thematic analysis process and ensure the interpretations were consistent with the data. To further validate the results, the findings were compared with existing literature on SSCSs development. This process of theoretical triangulation helped confirm the consistency of the identified themes with previous research while also highlighting areas of novelty and divergence. By cross-referencing the results with established studies, we ensured that the findings were grounded in the existing body of knowledge and contributed valuable insights to the field.

4. RESULTS

To provide a structured overview of how stakeholders' perspectives align with the Quintuple Helix Model, including the proposed open data helix, the identified themes and their representative codes were organized according to the six helices involved in the development of SSCSs. Table 1 presents the thematic structure, illustrating how each stakeholder contributes to and interacts within the co-creation process of SSCSs.

Government

Digital Technologies

Government representatives emphasized that digitalization within smart cities and communities primarily aims to enhance public services for the community. They underlined the necessity of developing a coherent digital strategy and corresponding action plan to guide smart city development initiatives.

Efficiency

Government representatives emphasized that the efficiency and effectiveness of governance in smart cities are largely enabled by the use of advanced digital technologies. They explained that technological solutions are typically selected after strategic and administrative decisions have been made, ensuring that digitalization supports, rather than dictates, policy goals. This enhanced efficiency was also perceived as a pathway to achieving significant financial savings for municipalities.

In practice, many government representatives reported that their motivation to pursue smart city initiatives stemmed from existing inefficiencies and fragmentation within their administrative systems, both digital and non-digital. The automation of government processes was seen as a means to simplify workflows, improve service delivery, and strengthen interdepartmental coordination. Moreover, representatives acknowledged that cities cannot operate as isolated systems; thus, digital technologies are essential for integrating local government operations within broader regional and national networks.

Finally, they asserted that smart city development is primarily the responsibility of local municipalities, supported by the state through strategic direction and funding. Industry, in their view, plays a complementary role by designing and implementing individual SSCSs that can be integrated into city systems to enhance overall efficiency and connectivity.

Industry

Digital technologies

Industry representatives emphasized that digitalization represents the primary distinction between a traditional and a smart city.

Efficiency

Industry representatives agreed with the government that smart cities contribute to improving governmental processes. They noted, however, that there are no truly "dumb" cities, as every city operates through some form of organized system. Digitalization, in their view, simply introduces new possibilities for enhancing these existing structures. Industry stakeholders regarded governments as their primary clients and described their role as providers of smart city platforms through which individual SSCSs can be offered to res-

Helix	Themes	Representative codes
Government	Digital technologies; Infrastructure; Efficiency	- digitalization strategy and action plan - digitalization of public services - public-private partnerships - financial savings - collaboration among stakeholders
Industry	Digital technologies; Efficiency	- use of advanced digital technologies - public-private partnerships - optimization of work processes - collaboration among stakeholders
Academia	Digital technologies; Efficiency	- a tool for communication - optimization of work processes
Community	Quality of life; Role of residents; Smart communities	- added value - high quality of life - better user experience - residents' wants and needs - participatory decision-making - residents as drivers of development - personalization and accessibility - behaviour and value change - smart community - universality of smart city services - adjusted solutions for small towns
Environment	Efficiency; Sustainability	- low energy and material footprint - sustainability goals - mitigation of climate change-related issues
Open data	Digital technologies; Infrastructure	- a tool for communication - collection and connection of data - open data - data exchange - sensors - safety and security

FIGURE 1 **Helices, themes, and codes derived from thematic analysis.**

idents. In this sense, they perceived their contribution to smart city development as complementary to that of the government, sharing a common understanding of their respective roles within the system.

Academia

Digital technologies

Academia representatives adopted a more critical stance toward the use of digital technologies in smart city development. While acknowledging their advantages, they emphasized that technological implementation should constitute the final stage of development rather than its foundation. According to their perspective, sustainability must be the primary goal of smart city development, with technology serving merely as a tool to support this objective. They further stressed that prior to digitalization, all stakeholders should demonstrate genuine commitment to sustainability and establish clear policies to guide its implementation.

Efficiency

Academia representatives emphasized the need for sustainable smart city development, arguing that smart cities should be efficient in their use of energy and material resources. Achieving this requires not only the optimization of city operations but also the promotion of sustainable behaviour among community members. Academia thus places greater emphasis on the environmental sustainability dimension of efficiency, while remaining consistent with the perspectives expressed by government and industry stakeholders.

Community

Quality of life

Government representatives emphasized that local municipalities operate primarily for the benefit of the community, aiming to enhance the quality of SSCSs. They highlighted the importance of understanding the community's needs and preferences before making development decisions.

In contrast, industry representatives placed greater emphasis on optimizing the user experience for the community as the end-users of their services. They strive to add value by integrating various SSCSs, ensuring that they are easy to use, convenient, and comfortable. From their perspective, the community is viewed primarily as a group of consumers.

Academia representatives, meanwhile, cautioned that efforts to optimize consumption should not come at the expense of the community's overall quality of life.

The role of the community

Academia representatives, similar to those from government, perceive the community as citizens rather than consumers. They emphasize their active role in shaping a "smart society," where sustainability becomes a core societal value. From their perspective, this transformation does not rely primarily on digital technology but rather on individuals' conscious choices and collective responsibility.

Government representatives focus on participatory decision-making, advocating for the inclusion of the community in planning processes as an expression of democratic governance. They argue that the community should have a meaningful voice in shaping its living environment. Furthermore, they suggest that encouraging the adoption of new SSCSs and sustainable practices is more effective through the provision of appropriate infrastructure and positive incentives rather than coercion. Digital technologies can help by offering the community initial experiences with new SSCSs, motivating their real-world use. Government representatives also view them as potential drivers of smart city development, whose active involvement enhances both sustainability outcomes and quality of life.

Industry representatives concur that developers must consider the community's habits, needs, and expectations. However, they admit that feedback from community members as end-users is rarely collected, as their primary clients are local municipalities rather than the community itself. This reveals a divergence between government and industry stakeholders' perspectives: while government views the community members as participants in city development, industry tends to regard them as indirect consumers of services.

Smart communities

Government representatives emphasized the importance of integrating smart communities into the broader smart city concept. They advocated for the development of universal SSCSs that can be adapted to different community sizes and contexts. In their view, it would be most efficient for larger cities to develop core SSCSs that smaller settlements could subsequently adopt or connect to.

Industry representatives recognized the business potential of developing SSCSs for smaller communities, observing that larger communities, such as larger cities, already offer a wide range of SSCSs to their residents. They stressed that smaller communities require solutions tailored to their specific needs and characteristics. Although achieving profitability in these communities can be challenging, there is strong and growing demand for SSCSs beyond major cities. Their perspective remains more profit-oriented than that of government representatives; however, both sectors agreed that collaboration can lead to the most effective and sustainable outcomes.

Environment

Efficiency

Stakeholders from government, industry, and academia emphasized that, in addition to improving administrative processes, SSCSs should also enhance the efficiency of natural and social resource use. They highlighted the importance of minimizing energy and material consumption as a key component of SSCS development. Greater efficiency in these areas can also generate financial savings for municipalities.

Sustainability

Government representatives agreed with academia that digitalization without a broader objective, such as sustainable development, lacks purpose. However, they emphasized that human nature drives people to continually seek better living conditions, which often entails increased resource consumption. This pursuit, they noted, can conflict with sustainability goals, making it essential to find ways to enhance communities' quality of life while using fewer resources.

Industry representatives asserted that SSCSs should not negatively affect the natural or social environment, though they provided limited detail on how such principles should be practically implemented.

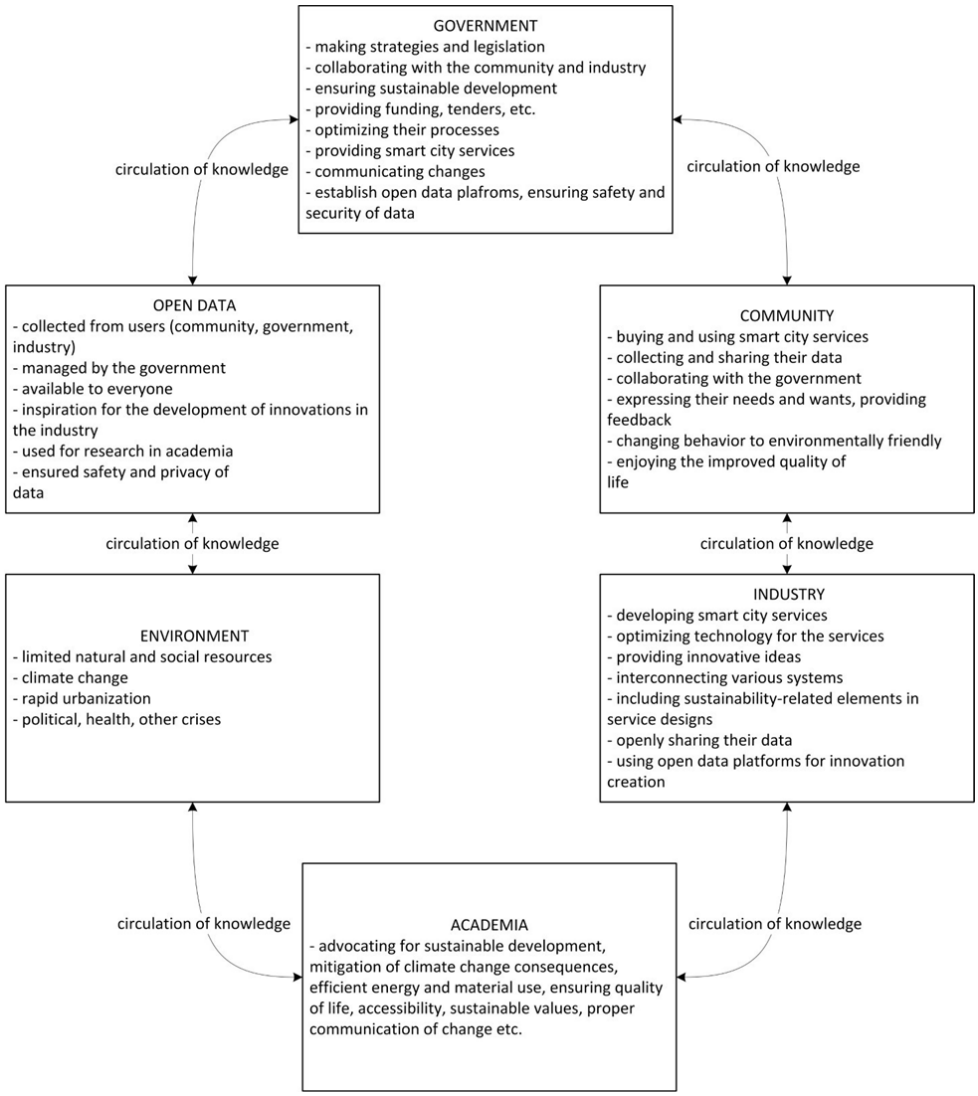
Academia representatives raised awareness of the ongoing consequences of climate change, emphasizing the responsibility of smart cities to mitigate its impacts. They further argued that prior to digitalization, all stakeholders must act with clear intentions and align their actions with well-defined sustainability policies.

Open data

Digital technologies

Government and industry representatives emphasized that digital technologies are primarily used to integrate data from various sources with the goal of digitalizing

TABLE 3 Sustainability-oriented smart city services development framework grounded in the Quintuple Helix Model



government services and connecting the community with local government through open data platforms or clouds.

Academia representatives, however, expressed a more critical perspective on the role of digital technologies in smart city development. While acknowledging their benefits, they argued that technological implementation should constitute the final stage of development rather than the starting point. According to this view, sustainability must remain the principal objective of smart city development initiatives, with technology serving merely as a means to achieve it. They further stressed that before pursuing digitalization, all stakeholders must act with integrity and establish clear, well-defined sustainability policies.

Infrastructure

Government representatives emphasized the critical role of digital infrastructure, such as open data clouds and data lakes, in supporting SSCS development. They highlighted the importance of ensuring that these infrastructures are open and accessible only to authorized users, thereby promoting transparency, interoperability, and collaboration across stakeholders.

5. DISCUSSION

Based on stakeholders' conceptualizations of their roles and the roles of open data, the environment, and the community in smart cities, a comprehensive frame-

work was developed to illustrate their respective roles in creating SSCSs and their interconnections within the broader innovation ecosystem. Figure 1 presents the proposed SSCS development framework, grounded in the Quintuple Helix Model of innovation (Carayannis *et al.*, 2012) and extended with the open data helix. The framework positions government, industry, academia, and the community as the central stakeholders of SSCS development, all embedded within and influenced by the natural environment and the open data system. Each helix contributes distinct knowledge, resources, and capabilities to the co-creation process, while open data systems serve as a mediating infrastructure that enables collaboration, interoperability, and continuous knowledge exchange among stakeholders.

The government acts as the principal driver of SSCS development, setting strategic priorities, formulating legislation, promoting sustainability, and ensuring efficient SSCS development governance. It establishes policy frameworks and financial incentives that guide innovation and foster cooperation with the industry and local community. Prior research indicates that government-led initiatives can provide the institutional and infrastructural foundations needed to integrate physical, social, and business systems through digital technologies (Hashem *et al.*, 2016; Pardo-García *et al.*, 2019). By developing open data systems and digital infrastructure, governments enhance transparency, interoperability, and evidence-based decision-making (Allam and Jones, 2021; Budrin *et al.*, 2020). Nonetheless, both this study and prior literature emphasize that government leadership must balance efficiency with inclusivity; without active participation from academia and the community, policy-driven innovation risks remaining top-down and fragmented.

The industry complements this process by translating governmental objectives and community needs into concrete technological solutions. It develops SSCSs that connect various open data sources to improve efficiency and optimize smart city systems (Harrison *et al.*, 2010; D'Amico *et al.*, 2020). These technologies contribute to energy management, public safety, and the optimization of administrative processes (Allam and Jones, 2021; Margherita *et al.*, 2023). However, industry stakeholders often view local governments primarily as clients rather than partners, which can limit opportunities for collaborative innovation. To ensure sustainable digital transformation, public–private partnerships and shared governance models must align economic incentives with environmental and social objectives (Mayangsari and Novani, 2015; Pardo-García *et al.*, 2019).

Academia, though less frequently acknowledged by other stakeholders in this study, plays a critical role within the Quintuple Helix framework. It provides scientific expertise, critical reflection, and human capital essential for SSCS integration (Carayannis *et al.*, 2012). Academic institutions operationalize sustainability principles within digital transformation by promoting energy-efficient technologies, supporting evidence-based policymaking, and educating professionals capable of managing interdisciplinary SSCSs development initiatives. Their limited involvement in practical collaboration, as observed in this research, reflects a broader challenge of weak knowledge transfer between research and practice, a gap also identified in previous studies (Parida *et al.*, 2019; Adams *et al.*, 2015). Strengthening the academic helix could therefore enhance the capacity of other stakeholders to co-create context-sensitive, inclusive, and sustainable SSCSs.

The community functions as both a user and co-creator of SSCSs. Residents' willingness to adopt SSCSs, openly share data, and participate in decision-making determines the long-term success of SSCS integration. Active community involvement enhances quality of life, environmental awareness, and social cohesion (Il and Cooke, 2016; Kyriazis *et al.*, 2013; Margherita *et al.*, 2023). However, local communities may exhibit resistance to change or distrust toward institutions, limiting their participation (Manfreda *et al.*, 2021; Belli *et al.*, 2020; Mora and Deakin, 2019). Promoting participatory design, transparent communication, and feedback mechanisms can increase community engagement and encourage behavioural shifts toward sustainable lifestyles (Kahya *et al.*, 2021). Furthermore, the findings highlight the importance of spatial and social inclusivity. The concept of smart communities extends smart city principles to smaller towns and rural areas, emphasizing that SSCSs must be adaptable to local capacities and contexts (Schuler, 1996). Such inclusivity ensures that innovation and quality of life improvements are equitably distributed across regions.

The environment constitutes both the context and the ultimate beneficiary of smart city innovation. Environmental constraints such as pollution, climate change, and resource scarcity define the boundaries within which technological and social innovation unfold. Smart cities thus aim to minimize their ecological footprint while maintaining social and economic resilience (Il and Cooke, 2016; Hashem *et al.*, 2016). SSCSs enable real-time environmental monitoring and resource management, offering solutions for sustainable energy use, waste reduction, and pollution control (Haarstad and Wathne, 2019; Pereira *et al.*, 2020; Tura and Ojanen, 2022). Yet, these advances introduce new risks, such as e-waste generation, digital inequality, and overreliance on technology, that must be carefully managed (Cao *et al.*, 2020; Parmentola *et al.*, 2022; Das *et al.*, 2019; Shin *et al.*, 2021). Balancing technolog-

ical innovation with ecological stewardship remains a key challenge for SSCS development.

Overall, the findings reaffirm the central principles of the Quintuple Helix model: innovation in SSCSs arises from the dynamic interaction among government, industry, academia, the community, and the environment. Nevertheless, the results also reveal systemic imbalances, particularly the underrepresentation of academia and the limited operationalization of environmental considerations. To address these gaps, the proposed framework in Figure 1 introduces open data systems as a cross-cutting enabler of collaboration, transparency, and mutual learning among stakeholders. Open data facilitates continuous knowledge circulation, strengthens feedback loops, and ensures that innovation processes remain both evidence-based and socially inclusive. Stakeholders expressed uncertainty regarding which actor should be responsible for providing and maintaining the necessary digital infrastructure, such as data clouds or data lakes, for open and shared use. This ambiguity underscores the rationale for treating open data as a distinct helix within the framework.

6. CONCLUSION

This study explored how stakeholders from government, industry, and academia, together with the environment, community, and open data, conceptualize and contribute to the development of SSCSs, applying and extending the Quintuple Helix Model. The results highlight that while stakeholders broadly align with scholarly definitions of smart cities as systems integrating digital technologies, infrastructure, and governance to enhance efficiency, sustainability, and quality of life, they differ in how they prioritize and operationalize these dimensions.

Across all stakeholder groups, SSCSs are seen as key enablers of efficiency and decision-making, yet not sufficient on their own. Stakeholders emphasized that human-centred governance, strategic planning, and sustainability-oriented policies must guide their implementation. Similarly, both scholars and practitioners recognize the importance of robust infrastructure; however, government representatives focus primarily on the role of open data systems and digital connectivity, whereas academia stresses the integration of social, physical, and institutional infrastructures as prerequisites for sustainable development.

The concept of efficiency is central to all groups, yet its meaning varies. Government and industry stakeholders emphasize administrative efficiency and financial savings, while academia links efficiency to the sustainable use of natural and social resources. Regarding quality of life, both scholars and industry representatives view it as the ultimate goal of SSCS development but acknowledge tensions between technological progress, sustainability, and affordability. The role of the community emerged as critical: stakeholders and scholars alike agree that community participation and their behavioural change underpin successful SSCSs implementation initiatives. Nonetheless, while government and academia see the community as active co-creators, industry tends to regard it as an end-user rather than a partner in innovation.

Sustainability remains the unifying principle across all stakeholders. Together with scholars, they concur that SSCSs must mitigate climate change and promote sustainable consumption patterns, although scholars further warn against unintended consequences such as e-waste and digital exclusion. The inclusion of smart communities reflects a growing recognition that sustainable digital transformation must be inclusive and adaptable to diverse local contexts.

Theoretical contributions and practical implications

The findings of this research hold both practical and theoretical significance. Practically, they provide a comprehensive overview of how various stakeholders perceive SSCS development, identifying key areas where each stakeholder can contribute to value creation within the innovation process. These roles are encapsulated in the SSCSs development framework, which offers actionable insights for local governments developing smart city strategies. Beyond the Slovenian context, the framework can also inform policy design in small and medium-sized municipalities across Europe and other regions with comparable socio-economic and institutional characteristics. For these municipalities, which often face constraints in financial and human resources, the framework highlights the importance of intersectoral collaboration, open data sharing, and joint innovation initiatives among the government, industry, academia, and community.

Theoretically, this research offers a novel perspective on SSCSs development by uncovering differences in stakeholders' viewpoints and examining the impact of SSCSs on sustainability, thereby addressing a critical gap in the existing literature (Papa *et al.*, 2020; Parida *et al.*, 2019). Additionally, the study situates the Quintuple Helix Model by Carayannis and Campbell (2010) within a smart city context and extends it by integrating an open data system. This integration highlights the importance of data accessibility and interoperability as foundational elements for building innovative SSCSs.

Limitations and recommendations for future research

This study is not without limitations. First, the qualitative study was restricted to a small set of experts from one country. This decision to focus on Slovenia was guided by the fact that each country has a distinct cultural context, urban structure, legal environment, and level of digital maturity, all of which shape how SSCSs are developed. Moreover, given that Slovenia is still in the early stages of SSCSs adoption, the number of experts directly involved in this field is limited. The selected participants thus represented the most influential and information-rich individuals in the national smart city ecosystem. Furthermore, after analysing interview transcripts, thematic saturation was reached, indicating that additional interviews would likely not have generated new insights. However, further studies could extend the number of experts interviewed and include cross-country comparisons.

Second, further theoretical validation of the Quintuple Helix model extended with the open data helix could be achieved by conducting additional in-depth interviews with a larger number of experts representing each stakeholder group, both within Slovenia and across other Central European and Balkan countries, as well as in regions sharing similar cultural, legal, and being in the early adoption phase of SSCSs integration. In addition, the proposed framework could be further tested and refined through focus groups or Delphi studies with domain experts to assess its applicability and robustness in diverse settings. It could also be examined in real-world contexts by integrating it into ongoing SSCS development initiatives, where government institutions should take the leading role in collaboration with other stakeholders. Such practical testing would allow verification of whether the roles, needs, and expectations of each stakeholder group have been appropriately identified and would help uncover potential misalignments or gaps within the framework.

Third, the current study could be extended with research on SSCS adoption by the community, as well as studies on encouraging sustainable behaviour change within smart city communities related to their adoption of SSCSs.

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APPENDICES

Appendix A: Citations

Appendix A.1. Digital technologies

Government

- A smart community, or smart city, is one that uses technologies, especially advanced digital technologies.
- If we're already wondering what we're seeing in practice, it's often just that for a certain [technological] solution of a particular company that comes up, then they say, oh, and now we have a smart place, right? It's not that, it's not a smart place. /.../ ... A smart city must also be based on a digitalization strategy, i.e. how you will use digital tools to support goals that you otherwise want to achieve.
- We lacked [technical] tools. /.../ In Dubai, they had all these processes where the citizen has contact with the state digitized. /.../ That's what I imagine a smart city would do. Now, since we're talking about smart cities, it's about municipal services.
- You use data to make decisions for cities and also provide users with what smart cities essentially are. It's not that we were stupid until now and now we are smart, but we have sensors that are connected to the web, the user is connected to the web or to the cloud...

Industry

- Environments become smart, or they start to become smart, when data from one field is combined with data from another field and we create new information from it that didn't exist before, and then we use that information in some way to either prevent something, something bad, say what would happen, or predict something.
- Smarter cities are digital cities that use digital solutions.
- [Smart mobility] is about digital mobility.

Academia

- Technology is absolutely not going to hurt, but it is overrated in itself and I absolutely do not see it as what we need to start with. It is for in the end. /.../ If we do not have policies that will make the city work sustainably, we will not be successful. Digitization is just a technique of how you tell someone something.
- I don't think digital technologies solve much if we don't have good intentions at the base. If we don't have policies that make the city work sustainably, there will be no success. Digitalization is just a technique of saying something to someone. Digitalization will absolutely do no harm, but it is overrated in itself and I absolutely do not see it as what we need to start with. This is at the last stage of development.

Appendix A.2. Infrastructure

Government

- A smart city identifies, collects and makes, for example, liquid data assets, i.e., data that lie in different systems, in different services, with different providers is made available /.../ for example, in the form of a central data lake /.../ the point is that the data from everyone is accessible to everyone, of course, in accordance with the right of insight and access /.../ A smart city must also have some infrastructure. That is, I don't know, digital control of traffic, lights, parking lots, I don't know, public transport, which will exchange data with each other.

Appendix A.3. Efficiency

Government

- Uses advanced digital technologies as a tool to become more efficient in management /.../ In short, the better the way you manage, the greater the savings are realized.
- How you're going to manage a smart city, that's the point. Then, technical solutions are selected according to the offer on the market, and according to the needs.
- We had trouble using [the technical tool] and then we came up with the way how we would optimize our work. /.../ now it is not such a burden for a particular employee. What can be automated is essentially automated.
- A smart city has processes that are happening in the city interconnected. These are the processes of municipal administration, the processes of contractors, public services, I don't know, different departments, etc. As a rule, these processes are usually very fragmented /.../ a smart city is not an entity that operates independently but will always be connected with other systems between cities.
- Smart cities are a matter that concerns the public sector to a greater extent, that is, mainly local communities, but of course also the state, while companies, and here they cooperate with many, are primarily service providers, but not those who would offer smart city solutions.
- For me, a city is smart when it has someone in place who takes care of the coordinated digital development of all city services (first you have to have an organized organization, data and infrastructure, and in the end you choose the technology. By no means is the technological component alone enough).

Industry

- There are no stupid cities, /…/ Smart cities improve processes.
- Municipalities are our clients, so they are the ones who manage the project.
- Technological platforms have begun to take shape, where standalone solutions are connected.

Academia

- A smart city has a very small energy footprint, meaning it consumes little energy, as well as has a small material footprint. That means a low consumption of water, materials etc. We must have a very good utilization, little garbage, so to speak…/…/ everything we do in the city must be very, very optimized, that is, mobility, housing conditions, people's behavior, if you will, etc.

Appendix A.4. Quality of life

Government

- This gives us a better quality of life for people in cities.
- I can see that this can be useful to the citizens. /…/ we are a municipality, we work for the citizen. Meaning, employees are there to provide the best possible service to the citizen.

Industry

- We focus on technological solutions, without asking what people need, whether it's useful at all or not. Smart cities must create added value /…/ all these smart things, but for people who are connected to each other /…/ a smart city results in a better user experience of living in cities.
- Smart cities improve the quality of life in the municipality.
- [smart mobility] is very convenient for the user, it provides him with great comfort, he is not extra burdened I don't know, with parking, so that he can go from point A to point B at the time he wants, /…/ more comfortably than if he drives alone [with his car].

Academia

- [A smart city provides] a quality of life, which shouldn't be much lower [because of optimization].

Appendix A.5. The role of residents

Government

- [A smart city enables] participatory decision-making, etc., which is also a component of democracy, or democratic participation of community members.
- You can forbid people to do something or allow them to do something else. And /…/ what is a carrot works more, that is, this carrot effect, and it is with this city card that we want to reward good practices and change habits for the better.
- The use of advanced digital technologies is also very important for the social part of sustainability. We need to develop the right indicators to be able to address the relevant needs of the people. For example, the accessibility of mobility, healthcare, etc. is important. For the consumer, it is very important that the services are personalized. We can give the consumer the opportunity to co-design individual services and in this way achieve the involvement of the individual in the community, the use of his creative or innovative ideas that he can contribute to the community and that he has the possibility of democratic decision-making. Advanced technologies, such as blockchain, for example, can enable equality in the way of decision-making, as they allow equal access to information and, of course, participatory decision-making, which means that those involved can influence decisions. If people are actively involved in decision-making, budget planning, development planning, etc., the quality of life of individuals can be significantly increased. Digital technologies such as the metaverse, for example, also allow the city to offer residents experiences through the metaverse, such as concerts, where they can evaluate these experiences and this encourages them to become real-world consumers and also receive personalized service, which increases their quality of life.
- Covid has been great for people to also get used to digital technologies, or to the fact that technology allows you to survive at all despite some major crises. That is, you can work remotely, but on the other hand, there is also this expensive thing now, that is, higher prices of electricity, gas and other things, and salaries are not rising accordingly, and then every euro counts for many people.
- I think that in the final phase, users will also start to force us to develop smart cities, because when one city establishes something that is very nice for citizens, in other cities citizens will demand it. Users will force cities to start producing these services, offering them to citizens and to start connecting them with each other, because citizens will be dissatisfied if things are not connected, because the user experience will be poor. A smart city must necessarily include a component of cooperation with users. It has to take into account what their suggestions are, present to them what the city is planning, users have to tell the city what they want, what bothers them, what they like, etc.

Industry

- Let's look at people, let's look at habits, needs and actually address this /…/ there is not a lot of

feedback from end users on what is what they consider useful and what is not.

Academia

- We need to create a smart social climate, which digitalisation cannot do, it must be done by the people who have to take the reins.
- With a smart city, digital is the very last thing we need.

Appendix A.6. Sustainability

Government

- Digitalization itself does not serve anything but must always serve some higher purpose.
- All of us humans are a bit of an economical being, but we want to live better than we have done so far. The problem is that we are spending more and more resources, which is the problem of humanity and is basically the idea [of smart cities], to live as well as we do now or even better, but with fewer resources and that can be used here with technology can help us.
- Slovenia is making great strides. Three cities (Kranj, Velenje, Ljubljana) are in the mission of one hundred carbon-neutral cities.

Industry

- [Smart Mobility] is a nuisance to the environment. That is, both for people and for nature, it is sustainable.

Academia

- Cities are already victims of climate change. Cities are suffering from this and will have to be smart, even if they want to adapt to the climate. A city has to be smart to mitigate climate change, but it also has to be smart to survive floods, droughts and things like that.

Appendix A.7. Smart communities

Government

- That is why I am very reluctant to use the term smart city and I always say smart community, where community can mean: One block in which residents have a common system. It can be a city, it can be a village, it can be a region, it can be a country, it can be Europe, it can be the world... that is, you don't have to be a city to be smart. Even municipalities that do not even have a settlement that would be declared as a city can take very nice steps forward in this direction, establish services, and sooner or later these services will have to be universal. /.../ In the end, it will grow into a single city, but services will be built and suburban environments, which is only logical, will not build their own systems, but will be connected to city systems. /.../ In the end, it will grow into a single city, but services will be built and suburban environments, which is only logical, will not build their own systems, but will be connected to city systems.

Industry

- Indeed, large cities already have smart city services. Now smaller cities also see, not that they will no longer be able to grow in this way, and that if they want to meet the needs of their citizens and the transition to sustainable mobility, they will not be able to go the way of large cities, but of course they will have to find their own formula. Very concretely, this means that city authorities need to promote the development of alternative types of mobility, for example, in a much more structured and active way, which then actually enable the user to switch from owning a car to using mobility as a service. Now the smaller the city, but of course the more challenges there are, but that doesn't mean the right formula can't be found. We actually see a great opportunity in the fact that existing technology companies have developed the technology and processes, and we actually start purely from this operational one, so we can very optimally set up all processes in a way that is adapted to smaller cities. Each city is really specific for itself, firstly because of the topography, secondly, how the city lives, that is, what are the traffic flows, migrations and, of course, the approach of the city authorities to this topic. You have to analyze each city very wisely and then go about implementing the establishment of these services in a very, very customized way so that you can provide these services profitably. In smaller towns, of course, profitability is difficult to achieve due to population density, and for this reason, some co-financing by the state or cities will be needed in a similar way as the already existing public transport in these cities.

Appendix B. Interview guides

(Q1) How would you describe a SC? What makes a city smart from your perspective? (GOVERNMENT, ACADEMIA, INDUSTRY)

(P1) What lies at the heart of smart cities? What is the main goal of SC development? Who are the relevant stakeholders for SC development? How do you see the role of citizens in it? What are some areas/dimensions of SC development? How do you see the role of sustainable development in smart cities?

(Q2) What are the key issues in a city and local community that you are faced with which can be

addressed by implementing smart services? (GOVERNMENT) / What are the key issues in a city and local community that can be addressed by implementing smart services? (ACADEMIA) / Which solutions are you providing for the city? Are you familiar with the key issues in a city and local community? How are your smart solutions addressing these issues? (INDUSTRY)

(P2) How are rapid urbanisation, climate crisis, political crisis, and digitalisation affecting your city's development and the quality of life of the local community?

(Q3) What are the benefits of using smart services? (GOVERNMENT, ACADEMIA, INDUSTRY)

(P3) What are the benefits of using digital technologies for public and private organisations? How does it impact the lives of citizens?

(Q4) What are your current issues regarding the use of smart services? (GOVERNMENT) / What are some possible risks regarding the use of smart services? (ACADEMIA, INDUSTRY)

(P4) What are the risks of using digital technologies for public and private organisations? How can they negatively impact the lives of citizens?

(Q5) How do you currently manage electricity and water consumption, land use, waste, and GHG emissions as some of the important factors for ensuring environmental sustainability in cities? (GOVERNMENT) / How are electricity and water consumption, land use, waste, and GHG emissions as some of the important factors for ensuring environmental sustainability in cities currently managed? What are some guidelines for their management? (ACADEMIA) / How can electricity and water consumption, land use, waste, and GHG emissions as some of the important factors for ensuring environmental sustainability in cities be managed by your smart solutions? (INDUSTRY)

(P5) Are you using open data platforms, smart infrastructure, digital management systems, digital platforms, e-government systems, smart metering systems, smart mobility systems, smart energy and natural resources systems, mobile applications, or any other smart technologies to manage the sustainability of the city?

(Q6) How do you perceive the role of sustainability in SC development? (GOVERNMENT, ACADEMIA) / How do you perceive the role of sustainability in SC development in general and the development of your smart solutions? (INDUSTRY)

(P6) How can smart cities impact natural and social environments?

(Q7) What are some examples of SCSs that you use or would like to use to improve the environmental or social sustainability of your city? (GOVERNMENT) / What are some examples of SCSs to improve the environmental or social sustainability of urban environments? (ACADEMIA) / What are some examples of SCSs that you provide or plan to provide to improve the environmental or social sustainability of your city? (INDUSTRY)

(P7) Do you track the electricity, water and energy consumption and waste production of the citizens/households? If yes, how? (GOVERNMENT) / How can the electricity, water and energy consumption and waste production of citizens/households be controlled with smart services? (ACADEMIA) / How can the electricity, water and energy consumption and waste production of the citizens/households be controlled with the use of your smart solutions? (INDUSTRY)

(Q8) Do you use smart services to promote the sustainable behaviour of citizens? If yes, how? (GOVERNMENT, INDUSTRY) / How can smart services be used to promote sustainable behaviour in citizens? (ACADEMIA)

(P8) What can a citizen do to improve their environmental footprint?

UNAPRJEĐENJE INOVACIJA U PAMETNIM GRADOVIMA: PRIMJENA MODELA PETEROSTRUKE SPIRALE U RAZVOJU USLUGA PAMETNIH GRADOVA USMJERENIH NA ODRŽIVOST

SAŽETAK

Pametni gradovi sve se više prepoznaju kao ključno rješenje za izazove koje donose ubrzana urbanizacija, klimatske promjene te različite političke, zdravstvene i druge krize. Njihova je primarna svrha promicanje održivog razvoja, ublažavanje postojećih problema povezanih s klimatskim promjenama te osiguranje kvalitetnog života građana. U tom procesu nužna je učinkovita suradnja dionika iz javnog sektora, akademske zajednice, industrije i šire zajednice. Cilj ovog istraživanja je istražiti kako se razvijaju usluge pametnih gradova usmjerene na održivost iz perspektive više skupina dionika. Korišten je kvalitativni, eksplorativni pristup, a provedeno je jedanaest intervjua s ekspertima iz javnog sektora, akademske zajednice i industrije u tri zemlje. Tematskom i komparativnom analizom utvrđena je pojava novog sustava u procesu stvaranja inovacija - podatkovnog sustava. Međutim, dionici naglašavaju kako tehnologija sama po sebi nije dovoljna za razvoj pametnih gradova, već ističu potrebu za donošenjem odluka temeljenih na ljudskim vrijednostima koje su usklađene s potrebama građana i mogućnostima gradova. U radu se predlaže tematska mapa koja prikazuje različita tumačenja definicija pametnih gradova među različitim skupinama dionika. Također, predlaže se okvir temeljen na modelu peterostruke spirale za poticanje inovacija, suradnje i održivog razvoja u stvaranju usluga pametnih gradova usmjerenih na održivost, uz prijedlog proširenja tog modela uključivanjem podatkovnih sustava.

KLJUČNE RIJEČI: *pametni gradovi, usluge pametnih gradova, održivost, dionici, model peterostruke spirale, inovacija*