# Application of context-driven methodology for implementing the smart city concept in Czech republic

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**Abstract.** This paper investigates the significance of context comprehension within the smart city domain by emphasizing the various perspectives of stakeholders such as ministries, municipalities, and citizens. Since the value of service provision depends on the interactions across different service systems within distinct domains and contexts, through an exploration of the value chain and formulation of value propositions, the paper aims to achieve the synergy among diverse service contexts. Using the smart city context of the Czech Republic as a case study, the paper systematically examines the implementation of context-driven methodology and provides insights for the broader development of smart cities. Also, this study highlights the importance of understanding service overlaps and identifies key issues for future service research, with potential applicability in smart city initiatives, particularly in middle and eastern EU countries.

## 1 Introduction

Nowadays, cities face various challenges, including aligning urban development with sustainability and resilience while reducing the carbon footprint. Integrating innovative solutions underpins the "Smart City" concept and includes state-of-the-art technologies such as information and communication technology, the Internet of Things, and 5G networks [1]. One critical issue arises regarding the efficacy of these new technologies and interventions in effectively addressing the urban development paradigms and with the development of service science since 2008, positing that an effective smart city should embrace a service-oriented paradigm that not only considers technological and innovative aspects but also underscores the intrinsic value and value co-creation among citizens and diverse stakeholders [2].

Smart cities may embrace a new methodology to facilitate enhanced communication and presentation of an appropriate value proposition to diverse stakeholders. The new technologies, in this context, function as a tool for the distribution or realization of the value co-creation, rather than constituting the primary goal of urban development. This strategic shift in urban planning points out that how technology plays a role in shaping the trajectory of city development. It emphasizes the importance of effective communication mechanisms and

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the articulation of a value proposition that considers various interests from stakeholders [3]. Thus, it is challenging to develop a service design approach that can be used in practice.

The paper therefore aims to give a brief overview of the smart city methodology used in the Czech Republic, with the specific aim of showing how it reflects the service approach and principles of service science. It can be a good starting point for the broader analysis that could answer the question of the transferability of this methodology to other countries and its possible further development.

The rest of the paper is organized as follows. Section 2 discusses the methodologies in the smart city development. Then section 3 scopes down the smart city concept in Czech Republic and describes the model design and implementation. Next section 4 uses case studies to explain and validate the model design proposed in section 3. Afterwards, section 5 discusses the lessons learned and further research challenges. Finally, section 6 concludes the papers and outlines future research.

## 2 Smart Cities and Methodology

The concept of smart cities has emerged as an important development paradigm in urban planning. It has leveraged up-to-date technologies to increase the efficiency, sustainability, and livability of urban living spaces [4]. As cities are designed towards becoming "smart," it is critical to establish robust methodologies for planning, implementing, and assessing the impact of smart city initiatives [5]. A set of methodological frameworks for smart cities have been proposed. For example, multi-contextual methodologies have been proposed to advance interoperability among various domains, such as urban planning, energy management, and social behaviors. Those methodologies adopt interdisciplinary approaches that facilitate reusability and understanding of various services. This ensures a holistic understanding of the complex dynamics within urban environments. Also, some data-driven methodologies are proposed to address data collection, analysis, and interpretation issues in smart services [2].

Furthermore, ethical considerations and privacy concerns associated with data-driven methodologies are raised to ensure responsible and inclusive urban development. Since smart city initiatives depend on user acceptance and engagement, user-centric methodologies involve citizens in the value co-creation of urban solutions [6]. This increases the effectiveness of smart technologies and facilitates active participation from citizens. In the dynamic landscape of smart cities, the development and application of robust methodologies are crucial for ensuring successful and sustainable evolution for smart cities. Multi-contextual collaboration, data-driven decision-making, and user-centric design are foundational principles that can guide the creation of effective smart city methodologies. Therefore, it is necessary to analyse the value for the service receivers of smart city services, to evaluate its value proposition and its relation to other services, where service science offers a promising methodology on service design in the context of complex systems [7].

## 3 Smart City Concept in Czech Republic

The newest methodology for smart city development in the Czech Republic was issued in 2021 by the Ministry of Regional Development of the Czech Republic and it was approved by the Czech government on 10$^{th}$ May 2021, for the purpose of fulfilling the Innovation strategy of Czech Republic for the years 2019-2030: The Country for the Future. *Smart Cities Concept - resilience through SMART solutions for municipalities, cities, and regions* is based on a citizen-centric multi-contextual approach by using service science principles

and applying service-dominant logic. It is focused on raising the citizens' quality of life, the quality of public services, and creating good living conditions regardless of citizens' living area. This concept considers Czechia's unique settlement structure consisting of numerous smaller municipalities and the need to find innovative solutions for different-sized regions and public administration at all levels [8].

### 3.1 Model description

The goal of Czechia's Smart City Concept is to achieve a high quality of life for the citizens, improve the environment, and strengthen the competitiveness of the Czech Republic in an international environment. To accomplish this, the potential of people and territories needs to be efficiently used, mainly through new technological tools, regional cooperation, innovative solutions in municipalities, cities, and regions, and through innovative approaches to interconnection and coordination of problem-solving - this is represented by so-called SMART solutions. These solutions can be described as new technological tools and innovative approaches to interconnect and coordinate the solving of problems. For a solution to become SMART, it must respect the following 7 SMART principles, which are the base of the whole concept [8].

These SMART principles are a way to check if a particular solution can also be considered SMART, and what is the degree of its "SMARTness". The 7 SMART principles, translated from Czech by [9], are:

1. **The principle of direction change** - this means creating the conditions so that, where it is possible and efficient, services are delivered to people, and work and business can be carried out from home or a place close to home.

2. **The principle of resilience** - this is the resilience of people and communities, the local economy, the environment, and cohesion in the territory based on digitization and innovative solutions.

3. **The principle of one solution with multiple effects** - a solution is expected that will bring several significant effects (solving multiple needs at once) with a holistic approach.

4. **The principle of "short distance"** - everything that can be provided locally must be provided locally or at the shortest possible distance (using rule 3E - economy, efficiency, effectiveness).

5. **The principle of cooperation and financial sustainability for the aim of achieving effectiveness of the solution** - it is about cooperation with all partners in the territory, the usage of multi-source financing regarding its long-term sustainability.

6. **The principle of cohesion and complementarity, horizontal and vertical interconnection** - the new solution leads to a leveling of opportunities, reduces tensions, solutions follow each other, cooperation and interconnection at all levels and all levels of public administration is a basic prerequisite for achieving resilience and cohesion.

7. **The principle of evidence-based solutions based on facts, openness and data sharing, transparency, and equal opportunities** - data is generated that is understandable and accessible for innovative applications and the development of people's lives, communities, and businesses (Sharing is caring).

The whole Smart Cities Concept is built as a layered structure (Fig. 1). The aforementioned SMART solutions are on the top, sheltering every other part of the concept. One layer beneath them is a covering cross-sectional area that connects all the solutions together to fulfill the concept's goal. This covering cross-sectional area is linked to the concept's name and the main goal - resilience. These two all-sheltering layers stand on three pillars of sustainable development. These pillars focus on the elements crucial in achieving resilience - people and communities, local economy, and environment - by using the consumers' point of view.

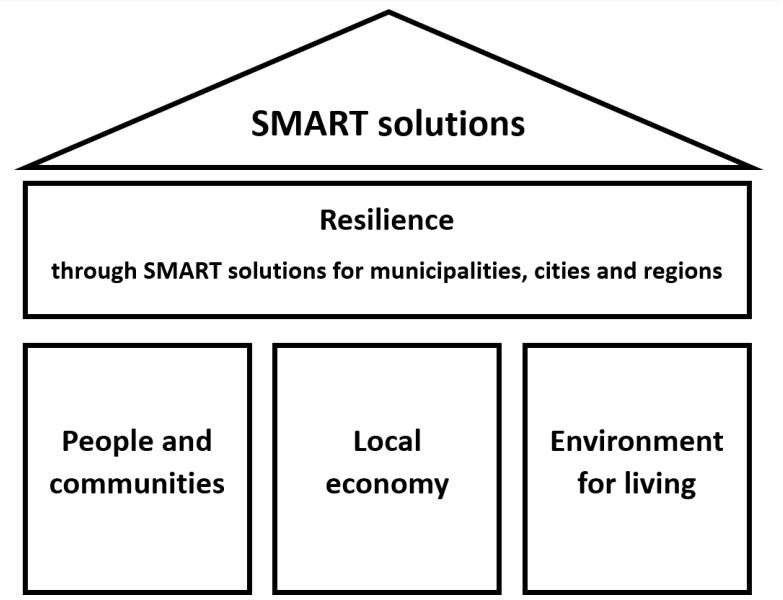


**Figure 1.** Smart Cities Concept's layered structure [8, 9]

### 3.2 The implementation

Czechia's Smart Cities Concept is tied with its implementation plan, titled *Implementation Plan of the Smart Cities Concept until 2030*, which supports the concept by taking specific measures that should be implemented by the year 2030. It was approved by the government of Czech Republic on 11$^{th}$ May 2022. The implementation plan introduces two equally important views, two basic contexts, crucial for successfully implementing the Smart concept. The first view, the resort view, represents the government with its ministries and other central authorities. Important activities done in this view are, for example, managing the implementation, monitoring the SMARTness of proposed solutions or introducing potential financial sources. The main goal here is to apply state policy and achieve the goals directly defined by the central government. The second view belongs to the local municipalities, cities, and regions. They are solving different problems related to the people (citizens, entrepreneurs, tourists, etc.). They can act independently of the central government to solve local problems and issues. We have here two different perspectives that must be merged:

· Government - the aim is to achieve long-term objectives specified in the central urban policy documents, to enable the development of the whole state, and to improve the well-

being of the inhabitants. The government manages the funds and must ensure their effective distribution.

- Municipalities and regions - they want to ensure their local development and solve primarily their problems. On the other hand, they need government support to achieve many goals. It is the only way the government can influence the behavior of municipalities.

The emphasis of the implementation is on the projects that are being realized by the Czech municipalities, in order to better understand the needs of the municipalities and to be able to guide and support them in sustainable development. The goal is for the municipalities to create solutions that are beneficial in multiple contexts [10, 11].

These two contexts, crucial for implementing the Smart Cities Concept, are interconnected through the concept's goals and inner structure and will be managed by a tool called the Smart Service Catalogue (Fig. 2). It contains the typical formulation of the activities that must be performed to achieve a particular goal. They are related to:

- the specific solutions already applied in the municipalities = projects, and
- the general specification of the state policy, describing how the state, represented by the ministry or state organization, will support the successful fulfillment of the particular activity = specification of activity.

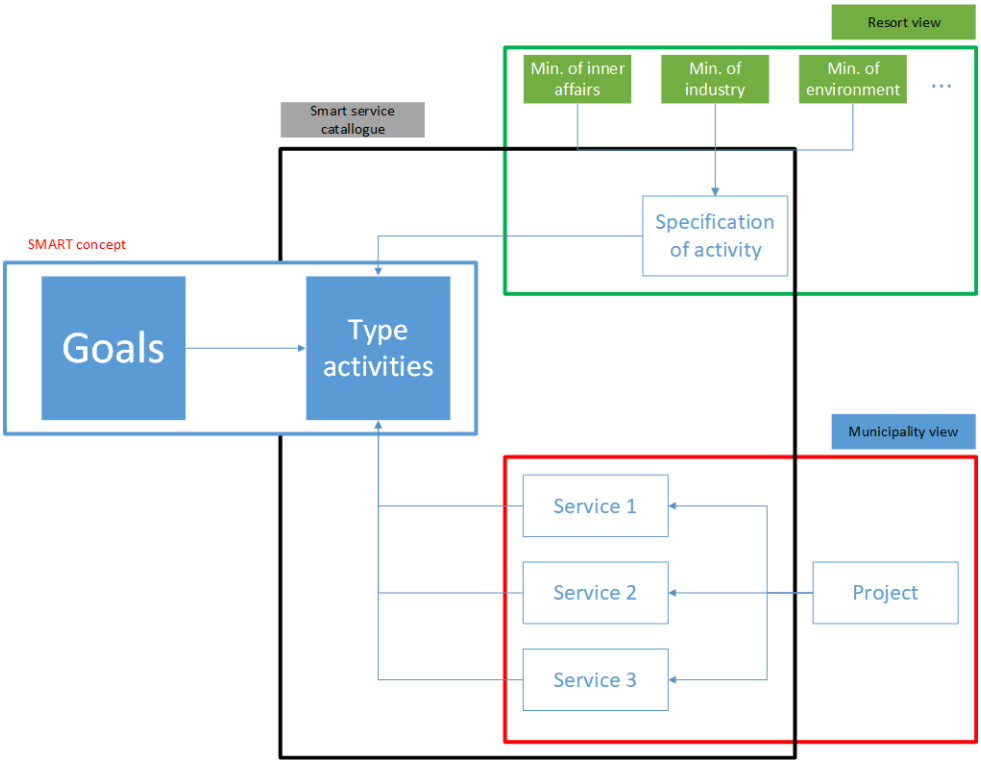


**Figure 2.** Smart Service Catalogue structure [10, 12]

The principle of service science is applied here. The whole environment of the implementation is based on several value propositions:

- Proposition from the government to municipalities - by using this Smart concept, you can develop faster and more effectively, with an easier way to get the funds.
- Proposition from municipalities to government - by using this Smart Concept, you can present your priorities of development to the government faster, and the government can then react more efficiently to the requirements from the municipalities.
- Proposition for other smart city stakeholders - by using this concept, you can effectively participate in the concept development. There is one, general platform, used for the Smart City (and urban) agenda.

### 3.3 Limitations

The implementation is facing challenging issues in both of the mentioned contexts. The specific distribution of municipalities in the Czech Republic brings the challenge of creating a method or tool that would be beneficial for all municipalities regardless of their size or population. The new methodology addresses this problem and explicitly aims to support the smaller municipalities. However, it is still being determined if the methodology will be truly useful for them because of how smaller municipalities perceive the whole complex idea of smart city, smart solutions, and holistic solutions for multiple contexts. Smaller municipalities usually focus on something other than the long-term benefits of implementing solutions that would bring value in multiple contexts at once or that would help prevent possible future problems. For the most part, these municipalities solve their problems ad-hoc, rather focusing on the straightforwardness and simplicity of the solution, and how much money it will cost or save the municipality. They often see Smart City as a useless construct from the government that has no additional value for them, and they want to stay independent [11, 13].

In the second context, ministries and government officials face problems with management and supervision of the ongoing implementation. The people responsible for the smart agenda at the Ministry of Regional Development need to communicate with all the other stakeholders involved in the implementation of the Smart Cities Concept, such as other ministries' officials, representatives of the resorts, or other entities cooperating on the concept in the role of gestors or handlers that are responsible for their assigned part of the concept. All of these stakeholders need to understand the principle of the Smart Cities Concept and why is the multi-contextual approach necessary, which can become an overlong process. Another issue is that since the methodology for implementation of Smart City in the Czech Republic is an official government document and approach, every decision regarding this topic needs to go through a long and tedious process before it is approved, and every minor change needs to be approved.

## 4 Case studies

### 4.1 Ministries

The whole concept is built on SMART solutions, and each solution is linked to a specific pillar of the concept or the cross-sectional area. The solutions also have many other attributes that need to be tracked and updated (e.g., responsible person, relevant funding, goals, connection to other solutions, current state, and much more). According to the implementation plan, a tool to manage these solutions and the whole concept will be created. There is no such tool yet. All the starting data about the overview of the smart concept and solutions were kept in an MS Excel sheets, generating 16 tables, each with approximately 130 rows and 14 columns. From these tables, a card was generated for each solution, and these cards are stored

in an MS Word document. Effective working with data in this form is highly impractical and challenging. Also, the ministries need to be able to monitor the smartness of the solutions, the distribution of the SMART solutions in the three pillars, and the distribution of SMART solutions in the cross-sectional area of the concept. There is no process in place to enable this on a regular basis with the data in this form. And because the specifications for the management and analysis of the whole concept are highly specific, until the creation of the Smart Service Catalogue (Fig. 2) there is currently no suitable tool for this. [10, 14, 15]

The second issue from the actual implementation of the concept in the Czech Republic is the changes in government. Shortly after the government approved the concept, regular Czech parliamentary elections were held. This led to changes in many government officials, including the people responsible for the smart city agenda at the Ministry of Regional Development. This, combined with the fact that numerous stakeholders from the government are involved and all the processes in the government body take a long time, leads to a situation where effective communication between all the stakeholders needs to be reestablished before the development of a smart agenda can continue.

### 4.2 Municipalities

Obtaining the cooperation of municipalities in implementing the new smart cities concept methodology is challenging due to the varying perceptions of the smart city agenda, which differ from town to town and village to village. For example, we can take a look at two municipalities with the size of 6000-7000 inhabitants. The first of these towns, Slavičín, has a proactive approach to using smart solutions. They have multiple smart solutions already working, and they have developed their smart strategy for the following years. Their strategic document analyzes the city's problems and potential in multiple areas - smart governance, smart people, smart economy, smart mobility, smart environment and smart living. Based on the analysis, they proposed a strategic plan for the city's next years alongside with the implementation plan for this strategy. This city wouldn't have problem catching up to the official government's methodology, the Smart Cities Concept, and using the advantages it provides in full [16].

On the opposite side, we present an unnamed municipality of approximately the same size. This city's strategic plan is focused mainly on completing the basic public infrastructure, such as sewage, water pipes, and a few buildings. They have very few smart solutions implemented, mostly simple, such as a digital office board installed in front of the municipal office, and a basic digital Citizen's Portal. The mayor is positively inclined for smart solutions, however they don't see the same enthusiasm in the citizens. When they started with the Citizen's Portal, the citizens had an option to register and see how much money or if they owe something on the municipality fees - only two people from the whole municipality have registered. The municipality faces a financial challenge in implementing smart solutions as they do not allocate funds for such initiatives in their budget. Consequently, if they decide to implement any smart solution, the funding would have to come from government funds or European Union grants. For the future, the municipality is considering adding the option to pay municipal fees online through the Citizen's Portal. However, it is uncertain whether the citizens would actually use this service [17].

## 5 Discussion and Further Challenges

Establishing a regulatory framework is important to guide the implementation of smart city technologies. Integrating different technologies such as IoT, AI algorithms, and data analytics

may create impact on privacy, security, and other city functionalities. Thus, adapting existing regulations to accommodate emerging technologies while ensuring ethical and legal standards is a significant challenge. Since the rapid development of smart city technologies introduces complexities to traditional regulatory structures, smart cities face the challenge of making regulations that are not only resilient but also flexible to accommodate the new technologies.

As smart cities depend on interconnected digital systems, the risk of cyber threats may also increase during smart server design. Therefore, developing cybersecurity measures in smart cities is a critical challenge to protect critical infrastructure and sensitive data. Given the interconnected nature of smart city services, smart city services such as sensors and data centers may increase potential attacks, specially to sensitive data. Preserving sensitive data is a significant challenge in the smart city research. It is important to balance new data-driven methodology and privacy protections. Thus, incorporating privacy-by-design principles are essential in a smart city ecosystem.

Furthermore, prioritizing sustainability to minimize environmental impact is a challenge that smart city initiatives are facing. It is important to balance technological advancements and eco-friendly practices in smart cities. Smart city initiatives are often combined with an environmental footprint, for example, the deployment of interconnected technologies, and energy-efficient infrastructure would create an ecological impact. Thus, while offering increased efficiency and improved quality of life, mitigating ecological effects and prioritizing sustainability are critical for smart city planning and implementation.

## 6 Conclusion

In this paper, we have showed how the different stakeholders can perceive the implementation of smart cities. The main issue is the problem of synchronizing those perspectives and achieving a valuable environment, and this is usually ignored by many countries.

While the challenges between government and municipalities are the most evident, similar issues can arise between regions and municipalities, or government and regions. Hence, it is essential to address the problem of scalability in services and consider potential responses to evolving contexts.

The paper has also highlighted the major challenges in smart city development, and their impact on various aspects of urban development. A significant issue that the cities are facing now is the complexity of the problem, where the situations are affecting each other in many ways, where it is difficult to reveal all those interactions. Thus, this paper has suggested one of the possible solutions to deal with this situation.

As future works, we plan to include more experiments and contexts to validate the context-driven methodology in smart city implementation. Also, we plan to extend the smart service model by considering regulatory structures, data privacy and sustainability.

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