MASARYK
UNIVERSITY

FACULTY OF INFORMATICS

Methodology of Service Design in the context of Smart City

Master's Thesis

BC. EMA LIPTÁKOVÁ

Brno, Spring 2024

MASARYK UNIVERSITY

FACULTY OF INFORMATICS

Methodology of Service Design in the context of Smart City

Master's Thesis

BC. EMA LIPTÁKOVÁ

Advisor: Ing. Leonard Walletzký, Ph.D.

Department of Computer Systems and Communications

Brno, Spring 2024


FACULTAS ARTIS INFORMATICÆ
UNIVERSITAS MASARYKIANA

Declaration

Hereby I declare that this paper is my original authorial work, which I have worked out on my own. All sources, references, and literature used or excerpted during elaboration of this work are properly cited and listed in complete reference to the due source.
During the preparation of this thesis, I used the following AI tools:

- Grammarly for grammar check,
- Phind for searching new resources and summarizing,
- ChatGPT to improve my writing style.

I declare that I used these tools in accordance with the principles of academic integrity. I checked the content and took full responsibility for it.

Bc. Ema Liptáková

Advisor: Ing. Leonard Walletzký, Ph.D.

Acknowledgements

I would like to express my deepest gratitude to my supervisor, Ing. Leonard Walletzký, Ph.D., and also to Mgr. Zuzana Schwarzová, for their invaluable guidance and insightful feedback throughout the entire process of researching and writing this thesis. Their expertise and encouragement have been important in shaping the direction of this work.

My heartfelt appreciation goes to my family for their unwavering love and understanding throughout my studies.

I sincerely thank all my friends who have supported me emotionally and intellectually during this journey. I am deeply grateful for the encouragement and support from the VSKLJSL friends group, especially Martin, whose belief in my abilities has been a constant source of motivation.

Lastly, I want to thank Slavomíra, her patience and support have been the cornerstone of my academic pursuits.

Abstract

The thesis explores service design in the Smart City context. It first provides a basic understanding of service and service design, focusing on the service design process and Smart City concepts. Then, it focuses on suitable methodologies for designing a service in the Smart City context. It contains recommendations for tools, methods, and approaches to service design that are useful for this chosen context. The thesis aims to summarize these fundamental principles and assist designers in creating better services by utilizing the mentioned methods.

Keywords

Smart City, Smart service, Service Design, SeSlab

Contents

List of Figures

Introduction

In the rapidly evolving landscape of urban development, the concept of Smart Cities has emerged as a pivotal paradigm, promising to redefine how cities operate, interact, and serve their inhabitants. This thesis delves into the complex world of Service Design within the context of Smart Cities, exploring the foundational principles of service, Smart Cities, and Service Design, their evolution, and their application in creating intelligent, responsive urban environments.

The first section of this thesis, titled "Service", lays the groundwork by defining service and value. It further delves into the service-dominant logic, a critical framework for understanding how services drive the economy nowadays.

The thesis then transitions into "Service Design," where Service Design's definition, principles, and stages are examined. Additionally, it explores the different fields of Service Design and the stages involved in the Service Design process.

The third section provides an in-depth exploration of the evolution and definition of Smart Cities, highlighting their components and the role of smart services within these urban environments.

The fourth section, "Service Design for Smart Cities", addresses the challenges and opportunities associated with implementing Service Design in the context of Smart Cities. It discusses the influence of Smart City design on Service Design, the distinction between customer-facing and background services, and the leveraging of data-driven approaches to improve urban services. It presents findings that underscore the potential of Service Design in Smart City context.

In conclusion, this thesis aims to contribute to the discourse on Service Design in Smart Cities by analyzing the principles, challenges, and opportunities associated with this emerging field. Through a detailed examination of service and Service Design, the evolution of Smart Cities, and the application of Service Design principles, this thesis seeks to offer insights that can guide the development of more smart, responsive, and sustainable services in urban environments.

1 Service

In recent years, services have become an important part of modern economies, driving their growth as they play a crucial role in shaping consumer behavior and business strategies. Services have transformed how businesses operate, and consumers interact with the world. By offering convenience, flexibility, and personalized experiences, services have become necessary and a competitive advantage in the global marketplace [1]. This also serves as a motivation for learning about a service and its science. This chapter aims to explain what a service and Service-Dominant logic is.

1.1 Definition of Service

Service, especially in contrast to a product, is intangible and can not be touched or held. A service, particularly in IT services, is defined as delivering value to customers by facilitating outcomes that customers want to achieve without the ownership of specific costs and risks [2]. Service should always be described from a customer's perspective and not defined by any technology used [3].

1.1.1 Value

In the definition, the word value is mentioned. Value refers to the utility or worth that a service provides to customers. This value can be tangible or intangible and is the foundation upon which everything the service offers is built. In the context of this thesis, it is important to identify and define the value of services to better understand what values they bring to the customers [4].

1.1.2 Value proposition

The value proposition is a clear and concise statement about how the service adapts to the needs and expectations of customers. It is a specific advantage or uniqueness that differentiates the service provider from the competition. Defining and communicating the value proposition is key to attracting and retaining customer's loyalty [5].

1.1.3 Value co-creation

Value co-creation is a process where customers actively contribute to creating value in the service. This approach emphasizes that customers are key actors in the value creation process, and their engagement and influence can significantly impact the final value of our service. Integrating value co-creation into our strategy means seeking opportunities for collaboration with our customers in developing new products or services [4].

A good example of a service that most people use every day is the use of smartphone. This service is important to modern life, enabling communication, access to information, entertainment, and many other functionalities. The smartphone is a platform for various applications and services, such as messaging, social media, banking, navigation, and more. In this example, we are not looking at the smartphone as a product but as a tool that provides us with many services.

1.2 Service-dominant logic

With the shift in the economy, many businesses shifted towards a service-dominated logic instead of the Goods-dominated logic they had previously focused on.Service-dominant logic is a new paradigm for understanding economic exchange and the company's role. It represents a shift in the logic, emphasizing service as the fundamental basis of exchange rather than goods. While Goods-dominant logic describes service as one of the types of goods or as something that brings additional value to a product, Service-dominant logic sees service as a process or application of competencies to provide something to the other party, without goods as the main focus but still playing a crucial role. This shift also caused the change from a producer perspective to a customer perspective when describing a service [6, 7, 3].

1.3 Principles of S-D logic

The Service-dominant logic has eleven foundational premises:

1. **Service is the fundamental basis of exchange.**
   The core of economic transactions is the exchange of services as they are the primary means.

2. **Indirect exchange masks the fundamental basis of exchange.**
   As services are not tangible or visible, the exchange service for service is indirect and always apparent.

3. **Goods are distribution mechanisms for service provision.**
   The service is provided by the usage of goods.

4. **Operant resources are the fundamental source of strategic benefit.**
   Skills, knowledge, and abilities are the primary sources which are creating a competitive advantage against competition.

5. **All economies are service economies.**
   All economic activities, regardless of their nature, are centered around the provision and exchange of services

6. **Value is co-created by multiple actors, always including the beneficiary.**
   The value of service is created by multiple parties, which always includes the user/customer.

7. **Actors cannot deliver value but can participate in the creation and offering of value propositions.**
   Actors that are involved in the creation of the service can not deliver the value independently.

8. **A service-centered view is inherently beneficiary-oriented and relational.**
   We are looking at the service from the customer's perspective.

9. **All social and economic actors are resource integrators.**
   Every actor in the economy, whether a business, consumer, or government, plays a role in integrating resources to create and deliver services.

10. **Value is always uniquely and phenomenologically determined by the beneficiary.**
    This underscores that the perception and value of a service are subjective and vary from one customer to another, based on their experiences and needs.

11. **Value co-creation is coordinated through actor-generated institutions and institutional arrangements.**
    The role of social and organizational structures is to facilitate and coordinate the collaborative creation of value through service exchanges.

2 Service Design

As mentioned, the value of the service is determined by the user's usage. A good service is a service that people use. As Marc Fonteijn [8] said, "When you have two coffee shops right next to each other, that each sell the exact same coffee at the exact same price; Service Design is what makes you walk into the one and not the other, come back often and tell your friends about it.". Service Design can help us design a service that users enjoy using. This chapter tries to create an introduction to Service Design as a science.

2.1 Definition of Service Design

Stickdorn [8] said: "If you would ask ten people what Service Design is, you would end up with eleven different answers – at least." Service Design is a multidisciplinary field with various methods and tools from different disciplines. It is not an old field of expertise, primarily developed in the past twenty years, which is not long in comparison to other existing disciplines. However, designers or other professionals have been using Service Design methods for many years and have yet to learn it by this name. It aims to improve user experiences across many sectors by designing systems and processes that provide good services instead of focusing on creating physical or digital products. This approach combines design, management, and process engineering skills, emphasizing the focus on the user's needs.

Additionally, it promotes operational efficiency by streamlining processes and reducing waste, contributing to cost savings. The multidisciplinary Service Design approach encourages collaboration and creativity, leading to more effective and sustainable solutions. These benefits highlight the importance of Service Design in today's competitive market, where the quality of service can be a key differentiator.

Service Design helps to innovate or improve services to make them more useful, usable, desirable for clients, and more efficient and effective for organizations. It tries to find an optimal balance between four factors of services, as shown in Figure 2.1.

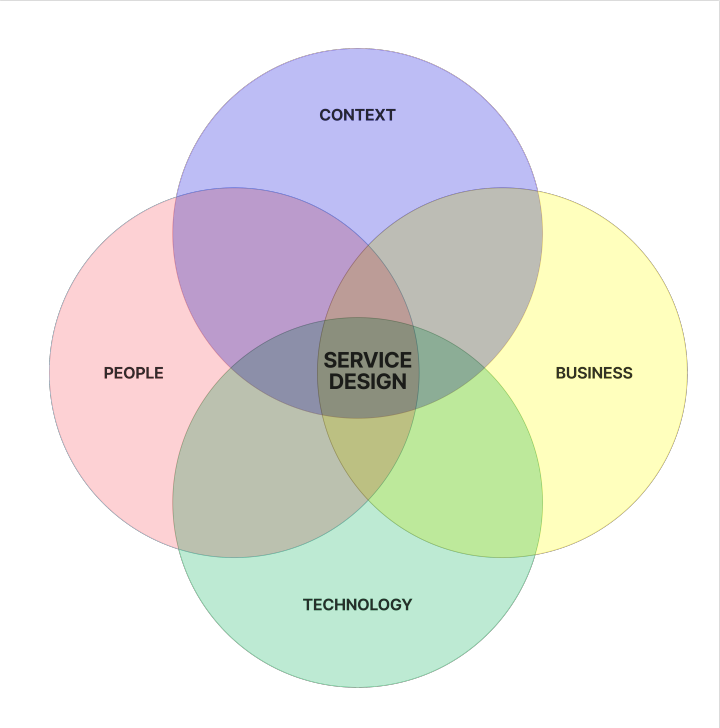


Figure 2.1: Factors of service. Based on [9].

In summary, Service Design is about applying established design processes, design thinking, and skills to improve existing services or create new ones. It is about making the service, which is being delivered, helpful, efficient, and desirable, ensuring that the service interfaces are beneficial from both the client's and the supplier's perspectives.

2.2 Good Services

At the beginning of this chapter, we mentioned that a good service is a service people use. This section of the thesis explores more of the characteristics of a service that would be considered a good service based on the book by Lou Downe [10].

Be easy to find
Ensure that the service is easily discoverable by users by, for example, choosing a correct name.

Clearly explain its purpose
Provide clear and concise information about the purpose of the service.

Set a user's expectations of the service
Establish clear expectations for users regarding what the service offers.

Enable each user to complete the outcome they set out to do
Ensure that the service allows users to achieve their intended goals.

Work in a way that is familiar
Design the service to operate in a manner that users are accustomed to.

Require no prior knowledge to use
Make the service intuitive and easy to use, even for users with no prior experience.

Be agnostic of organisational structures
Design the service to function independently of specific organizational structures.

Require the minimum possible steps to complete
Minimize the number of steps required for users to accomplish tasks.

Be consistent throughout
Maintain consistency in design and functionality across the service.

Have no dead ends
Ensure users can always progress or find their way back within the service.

Be usable by everyone, equally
Design the service to be accessible and usable by all users, regardless of their abilities.

Encourage the right behaviors from users and service providers
The service's design promotes positive behaviors from both users and service providers.

Quickly respond to change
Adapt and respond promptly to changes in user needs or external factors.

Clearly explain why a decision has been made
Provide transparent explanations for decisions made within the service.

Make it easy to get human assistance
Facilitate easy access to human support or assistance for users when needed.

2.3 Principles of Service Design

In this section, we explore the foundational principles of Service Design. These five principles are the cornerstone for understanding, analyzing, and innovating within Service Design. By sticking to these principles, we aim to create functional services deeply connected to user's needs, experiences, and expectations. This chapter contains the theoretical knowledge and insights necessary to ensure that the services developed are user-centered but also co-creative, sequenced, evidenced, and holistic. Through an explanation of these principles, this section seeks to provide a comprehensive understanding of Service Design and clarify why it is crucial.

2.3.1 User-centered

The first principle emphasizes that the design of services should be centered around the needs and experiences of the users. In this principle, we are putting the customer at the center of the design process and trying to imagine the service from their point of view, basically to try to slip into the customer's shoes to better understand what and how the service should be provided. It involves understanding the purpose of the service, the demand for the service, and the ability of

the service provider to deliver that service effectively. Services should be designed based on customer needs rather than the internal needs of the business. This principle also secures the correct communication between service provider and customer, which should be clear and easily understandable on both sides so no misunderstandings are created.

2.3.2 Co-Creative

The Service Design process should involve collaboration with all relevant stakeholders, both external and internal. It includes engaging stakeholders of various backgrounds and functions - from managers across back-office employees to non-human interfaces like vending machines and software systems. Connecting it with principle before - we established clear communication and customer needs in the center. However, the whole service also needs to consider all stakeholders that could be involved. As this process is also creative, we are using the ideas of different stakeholders, which they generate, to build the creativity. The involvement of all stakeholders also helps us later in the service provision as the collaboration ensures that the service meets the needs of all parties involved and fosters a sense of ownership and responsibility. Also, suppose we involve customers in this early stage of the process. In that case, we are likely evoking a sense of co-ownership in them, which increases customer loyalty and engagement in the long term.

2.3.3 Sequencing

The service should be visualized and orchestrated as a sequence of interrelated actions, as the service timeline is crucial. This is because when the service is executed, the customers could be annoyed if it progresses too slowly. The Service Design process deconstructs services into smaller parts - touch points or interactions. The service timeline's interactions are human to human, human to machine, or machine to machine. They could also occur indirectly via third parties. This principle can help us plan the service sequence and examine what will be executed in the background, not seen by the customer. The whole sequence is split into three parts, the first being the pre-service

period, in which the customer is just getting in touch with the service. Next is the actual service period, when the service is provided to the customer. The last one is the post-service period, when customers could, for example, provide a review on an already provided service.

2.3.4 Evidencing

Service is intangible, as was mentioned in the previous chapter. However, we need to make it tangible for the customer so they would be aware of what they are paying for, even for an extended period. For this, we use the help of physical artifacts, which customers can see, touch, hear, or feel. Evidencing can happen in different forms, such as emails, bills, souvenirs, or gifts. All these physical artifacts help customers see the service's value and even prolong the service experience. It adds a tangible component to intangible service. On the other hand, evidence has to be planned or designed according to the service timeline and be manageable for customers so it will not overwhelm them. An excellent example of overwhelming a customer could be sending too many spam emails after the provision of service. We aim to leave a good feeling in a customer in the post-service period to increase their loyalty and probability of recommending our service to others.

2.3.5 Holistic

This principle is about seeing the whole context of the service. Considering all the points of view and every single aspect is impossible in the real world. Nevertheless, in the Service Design process, we should incorporate most of the broader context in which the service takes place. At different levels of service, we should focus on different things. When we talk about the individual touchpoints the customer is in contact with, the focus should be on the environment in which they are taking place. Then, on the sequencing level, different customer jobs should be considered to focus on various perspectives on how the customer's interaction with service could happen and what the experience should be. On the service provider level, the focus is on the internal aspects of the organization providing service. We are talking about the company's culture, employees, and values. Also, we need to

consider structure and establish internal processes and services.

In summary, the Service Design process is fundamentally about creating services that meet users' needs, involving collaboration with all stakeholders, orchestrating the service as a sequence of interrelated actions, making the intangible service tangible through evidence, and considering the holistic context of the service. These principles ensure that services are user-centered, co-creative, sequenced, evidenced, and holistic, aiming to enhance customer loyalty, engagement, and satisfaction [8].

2.4 Fields of Service Design

As a multidisciplinary field, Service Design draws from various disciplines to craft user-centered and effective services. This section explores the significant contributions of different disciplines to the Service Design.

Product Design

Product design principles, traditionally focused on aesthetics, functionality, and usability, are seamlessly integrated into Service Design. Product design enhances the usability and effectiveness of services by ensuring that service delivery mechanisms are user-friendly and align with the overall service experience.

Graphic Design

Graphic design plays a pivotal role in Service Design by facilitating clear communication of concepts and branding. Through the strategic use of graphical elements and mental models, graphic design helps customers navigate services effectively, contributing to a seamless user experience.

Interaction Design

The discipline of interaction design is instrumental in crafting intuitive digital and physical interfaces within service contexts. By prioritizing

user satisfaction and engagement during service interactions, interaction design ensures that services are functional but also enjoyable and efficient for users.

Social Design

Social design focuses on understanding and addressing social dynamics and behaviors to design services that promote positive interactions and community building. By integrating social design principles, service designers can create services that foster user participation, engagement, and a sense of belonging within communities.

Design Ethnography

Design ethnography utilizes qualitative research methods to gain deep insights into user experiences, preferences, and challenges. By immersing designers in the customer's environment, design ethnography informs the creation of empathetic services that resonate with users on a meaningful level.

Marketing

Marketing efforts are essential for promoting services, attracting and retaining customers, and communicating the value proposition effectively. service designers can generate awareness, build brand recognition, and drive service demand by developing comprehensive marketing strategies and communication channels.

In summary, this chapter underscores the interdisciplinary nature of Service Design, where each discipline contributes uniquely to creating functional, user-friendly, and engaging services. By integrating principles and methodologies from diverse fields, service designers can navigate the complexity of Service Design and deliver solutions that meet the evolving needs of users and businesses alike.

2.5 Stages of Service Design

This chapter explains more about the steps or phases of the Service Design process. It provides a rough framework with a fundamental structure, as a Service Design process is very complex and cannot be modeled that easily. In literature, we can find different numbers of steps with different names, but if we take a closer look, we can see that all come from the same principles and contain the same process. It is important to note that this process is iterative, not linear as it could sound. We adapted "The Squiggle" by Damien Newman [1] to Service Design for a good visualization in Figure 2.2. It shows that the Service Design process has four steps - exploration, creation, reflection, and implementation. The first two steps are happening in an uncertain phase and need more clarity. They help us define this clarity to execute the last two steps.

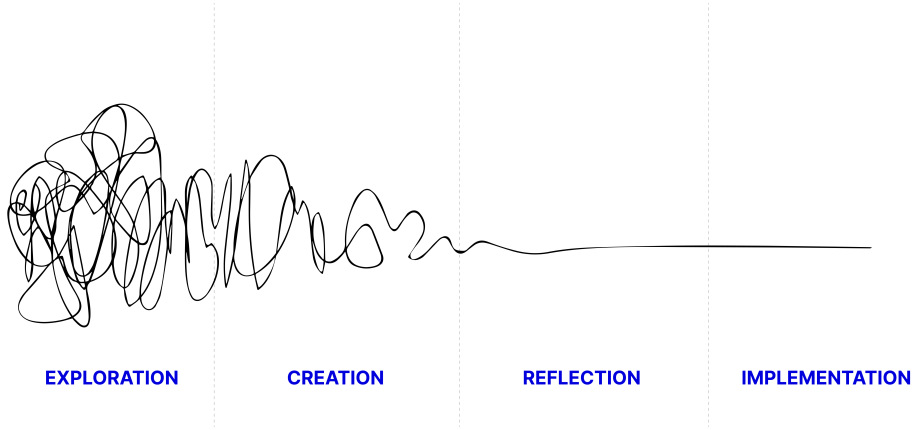


Figure 2.2: Service Design phases [8], adapted by author on squiggle.

2.5.1 Exploration

This initial stage (Figure 2.3) involves understanding the context and goals of the organization or company providing the service. The designer starts by exploring the company's issue or problem and tries to define it correctly. In the previous chapter, we emphasized the importance of the customer's point of view or their centralization. However,

1. https://thedesignsquiggle.com/

the design process starts within the company and understanding their point of view. After the problem is identified, the designer looks at it from a customer's point of view to clearly understand the situation from the perspective of customers - both current and potential. It is a research-driven phase where various methods and tools are used to explore and understand the behavior of everyone involved. The last task in this stage is to visualize findings to simplify complex processes and identify which problems should be handled. In summary, in this stage, we are trying to formulate the problem, not find the solution [8].

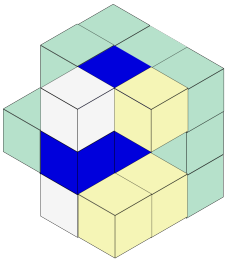


Figure 2.3: Exploration phase. Author, adapted from [8].

2.5.2 Creation

The results are formulated into a concept design and action plan based on the insights gathered during the exploration phase. It is a generative stage where we iterate many times to test and retest ideas and concepts to explore as many mistakes as possible, not avoid them but solve them. As shown in Figure 2.4, in this stage we are starting to build or rebuild based on the information from Exploration phase. The creation stage involves the collaboration of all stakeholders in planning the Service Design. It emphasizes the co-creation principle, involving all stakeholders in planning to ensure the Service Design is aligned with their needs and expectations. The task in this stage is to precisely create solutions to the problems identified in the previous stage. As this is the biggest stage, it is essential to follow all design process principles, not only co-creation. To create a holistic solution,

we need to include everybody in this stage, with the customer still in the center, to follow the user-centered principle, considering the whole sequence and all touchpoints included [8].

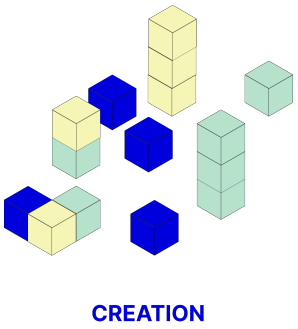
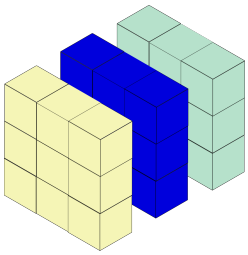


Figure 2.4: Creation phase. Author, adapted from [8].

2.5.3 Reflection

The third stage (Figure 2.5) is also known as prototyping or testing; this stage focuses on iterative prototyping and testing ideas and concepts created in previous stages. It involves converting theoretical research results into solutions that can be evaluated and modified. As the service is intangible, we use different methods than those used in prototyping products, which is the main challenge in this stage. This stage is crucial for generating a mental picture of the future service concept in the mind of customers and incorporating emotionally essential aspects of personal interactions with the service proposition. In this stage, the vision of service is created by comic strips, storyboards, or video sequences. Different staging methods and roleplay are also used. We are trying to be as close to reality as possible, as it is nearly impossible to prototype in a real environment. It is a critical point in the iteration process, where feedback is collected and used to refine the Service Design [8].

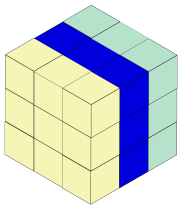


REFLECTION

Figure 2.5: Reflection phase. Author, adapted from [8].

2.5.4 Implementation

The final stage involves designing and implementing the final service based on the feedback and refinements from the Reflection stage - as shown in Figure 2.6. It is a process of change that was formulated in previous stages. Change happens on different levels, and communication between levels is the key to success. Communication has to be clear, so people understand the concept at all levels - customers, employees, and the organizational level. In this stage, the solution is tested in its realistic state, and again, it follows the principle of co-creation, and stakeholders are included. The implementation phase ensures that the service is delivered in a way that meets the needs of the consumers and reflects the brand value associated with it. It is a continuous improvement and development stage. A review of the outcome can lead to a new iteration of the Service Design process [8].



IMPLEMENTATION

Figure 2.6: Implementation phase. Author, adapted from [8].

In conclusion, the stages of Service Design — exploration, creation, reflection, and implementation— form an iterative process. It is important to note as shown in Figure 2.7, in this process, where we are iterating both through the whole process and each stage individually, where we can go back from each stage, in some cases even back to the frist phase. This process is fundamental to developing effective and user-centered services. This chapter has outlined the importance of each stage in understanding the complexity of Service Design and the need for continuous refinement and improvement. By adhering to these stages, service designers can navigate the challenges of creating services that not only meet the needs of consumers but also reflect the values and goals of the organizations providing them.

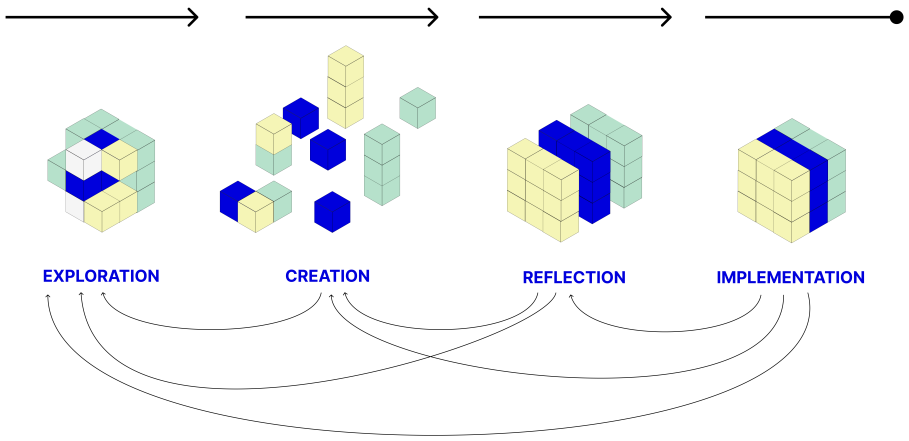


Figure 2.7: Service Design Process [8].

3 Smart City

In the fast-evolving landscape of urban development, the concept of Smart Cities was created, offering a new approach to urban living and governance. As the world changes with the challenges of urbanization, the potential of Smart Cities to enhance the quality of life, support sustainable development, and address issues has become important. This part of the thesis explores the evolution of the Smart City concept and its definition and components. It provides the historical context of the concept and explains the components that define a Smart City. This exploration aims to provide a comprehensive understanding of the Smart City concept and its potential to shape the future of urban development.

3.1 Evolution of Smart City

The history of Smart Cities can help us better understand the purpose of the whole concept. As known, more than half of the population lives in urban areas, not rural ones, according to the United Nations Department of Economic and Social Affairs (UN DESA) [11]. In 2021, approximately 58 percent of the global population lived in urban areas, while 42 percent lived in rural areas. This can bring many positives, such as reducing CO_2 emissions and boasting higher GDP per capita compared to rural areas, but on the other hand, it has also created negatives such as the rise of criminality [12]. To tackle these negative aspects of this change, together with technological evolution and urban planning, as more and more percentage of the population relocated to the cities, cities also started to try to use different technologies or ICT [13, 12].

The concept of Smart Cities emerged with the development of the first computerized urban planning systems in the 1960s. These systems aimed to optimize the use of resources and improve the quality of life in cities [14].

In the 1980s, the term "Smart City" started gaining traction with information technology's introduction in urban planning. Cities began to use computers to manage traffic, utilities, and other services more efficiently. Later, The World Bank and the United Nations began to

explore the concept of Smart Cities, focusing on the use of technology to improve urban living conditions [15, 13].

At the beginning of the 21st century, the term "Smart City" became more widely recognized with the development of smart grids, smart buildings, and smart transportation systems. These technologies aim to make cities more sustainable and efficient. Later, the concept of smart cities expanded to include technological advancements and social and environmental aspects. Cities began to focus on sustainability, citizen engagement, and data-driven decision-making [13].

Lastly, what helped the evolution was the COVID-19 pandemic, which accelerated the development of Smart Cities as governments and organizations worldwide sought to leverage technology to manage public health crises and improve urban services [16].

3.2 Definition of Smart City

As shown above, Smart City is a concept that has not been evolving for a very long time, but even in these short years, different definitions have been created, so Smart City is not a concept with a single definition as expected.

Oliver Gassmann [12] defines a Smart City as follows:
"A Smart City systematically applies digital technologies to reduce resource input, improve its people's quality of life, and increase the competitiveness of the regional economy in a sustainable manner. It uses intelligent solutions for infrastructure, energy, housing, mobility, services, and security, based on integrated sensor technology, connectivity, data analytics, and independently functional value-added processes."

IBM [17] also defined a Smart City: "A Smart City is an urban area where technology and data collection help improve quality of life as well as the sustainability and efficiency of city operations. Smart City technologies used by local governments include information and communication technologies (ICT) and the Internet of Things (IoT)."

If we look at these definitions from the perspective of services, which this thesis focuses on, a Smart City is defined as an urban area that leverages information and communication technologies to

enhance the quality and performance of services such as energy, transportation, and utilities. This enhancement aims to reduce resource consumption, wastage, and overall costs, thereby improving the quality of living for its citizens through smart technology and data analysis.

Another definition is proposed in Lucia Ševanková's diploma thesis, where she defines a Smart City through services: "A Smart City is a set of services that utilize non-trivial ways of information and communication technologies, enabling its management and the entire society to address the challenges of new urban development to increase its efficiency, livability, and sustainability in order to bring its citizens the highest possible value formulated in an understandable value proposition" [18].

The value of a Smart City is determined by what it chooses to do with the technology, not just how much technology it may have [19, 20].

3.3 Components of Smart City

In understanding the architecture of Smart Cities, various models offer different perspectives. For this thesis, a specific model has been selected based on its alignment with the focus of the study. This study adopts the seven-layered Smart City model [21] as it models the Smart City's components from a service-dominant perspective and is designed with Service Design in mind. Importantly, the layers in this model are structured based on their value proposition within the smart city context and the value creation process occurs at each level of the model.

The model represents all components that could be found in a Smart City on seven layers, which are:

Context

Before looking at the layers below, it is essential to establish a context when examining the Smart City's components. The first layer of this model represents the context in which we are examining the chosen Smart City. The context layer is important for designing the services in lower layers as it narrows down other components. In this case, an

example of a context could be Smart mobility or Smart government [21].

Stakeholders

The second layer represents stakeholders important for a given context in the first layer. The word "stakeholders" in the context of Smart Cities refers to individuals, organizations, and entities interested in or actively developing and implementing services in the given context. Their involvement and engagement in decision-making processes are crucial. However, stakeholders often have different visions of services, and narrowing the gap between these visions and implementing projects is essential for effectively developing services in Smart Cities. However, it is important to note that stakeholders can influence multiple contexts, and conversely, a single context can be influenced by various stakeholders. This bidirectional influence underscores the complexity and interconnectedness of Smart City [21].

Smart features

Smart features are defined as key components in the Smart City. This layer includes essential city services such as Transport, Energy, and Healthcare, focusing on providing value directly to the citizens [22].

Smart services

This layer contains the core smart services, which are services with more than one value proposition, in a given context [22]. Building upon the Smart Features, this layer encompasses specific services that contribute to the functionality and efficiency of the city. The design of these services is the main topic of this thesis.

Support services

As Smart services are complex, they require many smaller services to be functional. This layer provides the necessary resources to support the Smart Services. In this layer, we can find Building safety or Energy monitoring for example, as seen in Figure 3.1.

Software

Support services are still quite complex, so the next layer is software, which contains all the needed software solutions for the support services. For example, we can find voice control or monitoring services in this layer. This layer, combined with the layer below, Hardware, creates an infrastructure layer in the Smart city model.

Hardware

The last, seventh layer of the model consists of the physical infrastructure supporting the layers above, including servers, networks, event processing, and control elements such as sensors.

As seen in Figure 3.1, services in this model are grouped into two categories: customer-facing services and background services. Background services are located at the bottom of the model and are creating a base for the Customer-facing services build. The end users interact only with the Customer-facing services and Background services are not visible to them. Background services contain the hardware and software layers and the Supporting services layer. On the other hand, the Customer-facing services are visible to users, and in this category, Smart features and Smart services are located [21].

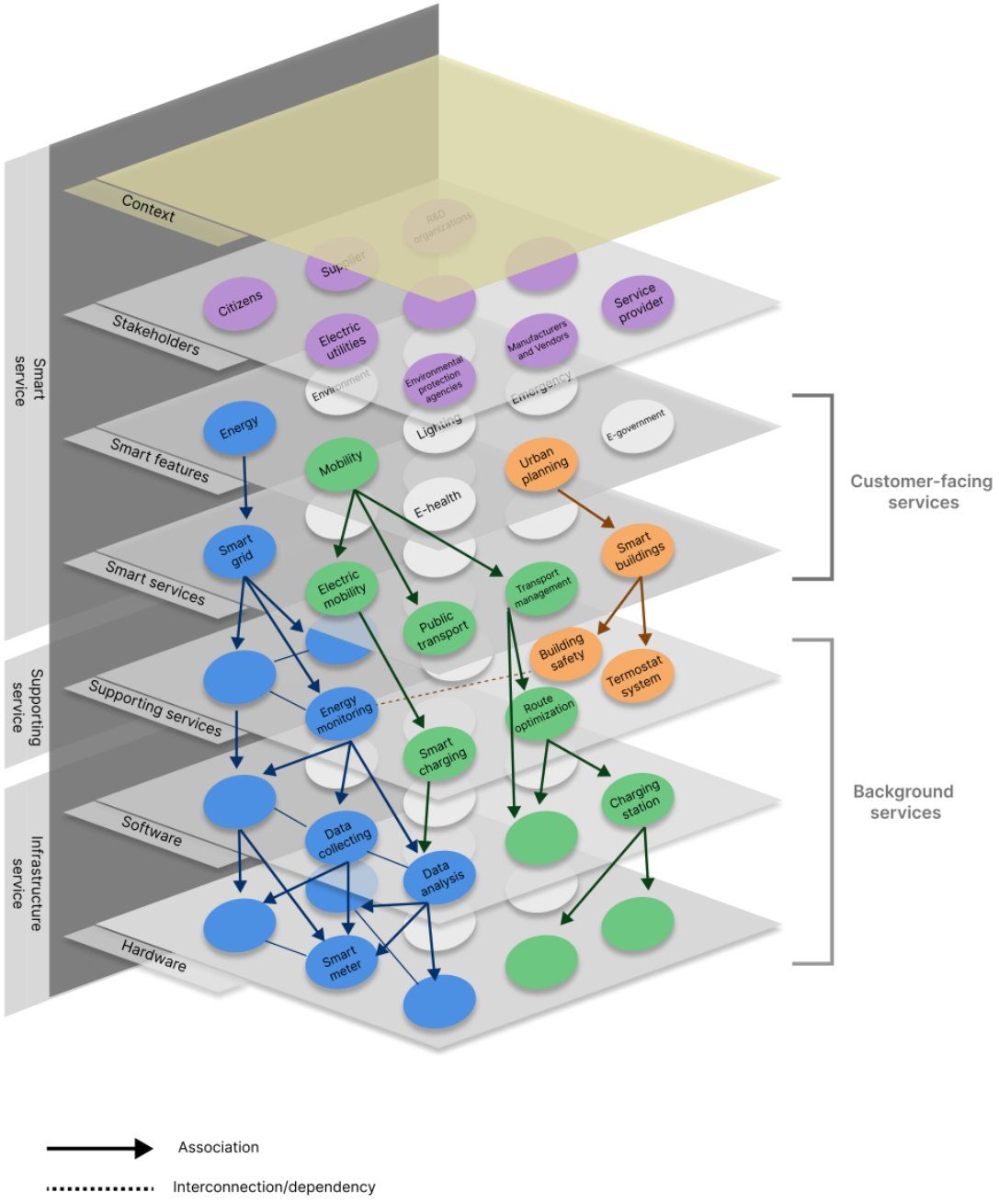


Figure 3.1: Smart City services layered model [21]

For simplification, services from this model can also be viewed in a triangle in Figure 3.2. It consists of four main layers categorized into two groups mentioned above. This model is presented as a triangle, emphasizing the end user's perspective and the role of each layer in creating value for the customer. Each level of this triangle service structure can only be functional with the lower level, so the services are created by combining several services at the previous level. Services on higher layers often use Supporting services from different contexts, meaning many services exist in this multi-contextual environment [23].

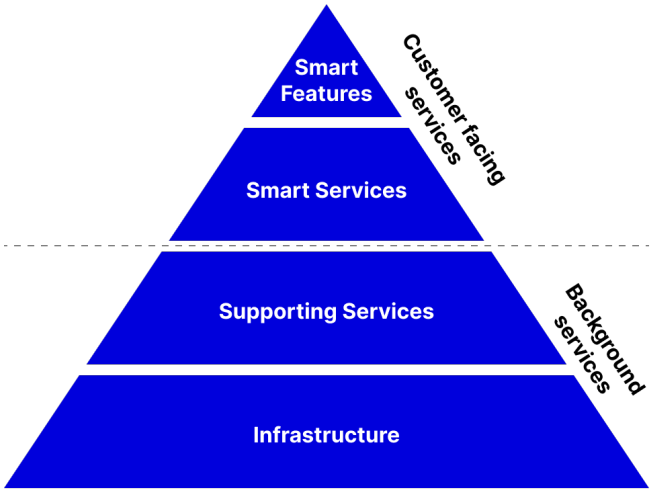


Figure 3.2: Service triangle. Adapted from [21, 23]

3.4 Smart services in Smart Cities

As mentioned above, services are placed in the third and fourth layer of the seven-layered model, with the third layer containing the core smart services and the fourth layer containing services used to support the third layer. Services in Smart Cities are commonly divided into different areas. Terézia Kazičková [24] divided services in Smart Cities into eight areas in her diploma thesis.

Urban Planning involves the use of advanced technologies to optimize the layout and design of cities. Through data-driven insights, urban planners can make informed decisions about land use, infrastructure development, and public spaces, leading to more livable and sustainable cities.

Public Lighting systems use sensors and IoT devices to adjust lighting intensity based on environmental conditions and pedestrian activity.

Energy aims to optimize the use of energy resources, reduce waste, and promote renewable energy sources. This includes smart grids, energy storage solutions, and demand response programs that balance supply and demand dynamically.

Mobility encompasses the integration of various modes of transport, including public transit, cycling, and walking, to create a seamless and efficient mobility network. Smart mobility solutions use data analytics to manage traffic flow, reduce congestion, and improve accessibility.

Environment focuses on monitoring and improving air and water quality, waste management, and green spaces. Sensors and IoT devices collect data on environmental conditions, enabling proactive measures to protect and enhance the natural environment.

Emergency leverage technology to improve response times and coordination during crises.

E-Health involves the use of digital technologies to enhance healthcare services in cities. Smart health solutions include telemedicine, electronic health records, and wearable devices that monitor health parameters.

E-Government streamlines administrative processes, making it easier for citizens to access public services. Online platforms for submitting documents, paying taxes, and accessing information enhance transparency and efficiency in governance, making cities more accessible and responsive to their residents.

It is important to note that these areas of IT services are across all of the bottom five layers of the Smart City model. All of the information mentioned above also highlights how complex the concept of a Smart City is.

4 Service Design for Smart Cities

The advent of Smart Cities presents a significant new opportunity for service designers to tackle emerging challenges and enhance urban living. As cities become increasingly connected and data-driven, the role of service designers is evolving to address the unique needs and complexities of these environments [25].

4.1 Challenges

Municipal officials face significant challenges in delivering services across various domains, including public safety, transportation, water and energy utilities, and city planning.

One challenge comes from managing and utilizing extensive data generated by city infrastructure, public works, and citizen interactions. The influx of structured and unstructured data from sensors, video cameras, mobile apps, and legislative mandates for data retention presents both a challenge and an opportunity for improving service delivery.

Another of the primary challenges is meeting the high demand for services with limited budgets. As urbanization increases and infrastructure ages, government expenses rise, often needing more funding to support new service requirements. This situation necessitates innovative solutions to enhance the value of government services within budget constraints [26].

On the other hand, living in Smart Cities also presents several challenges. Primarily due to the expectation that residents must possess technical skills to interact with the city's smart living options. This is connected to citizen readiness to use a smart services. Based on the research findings by ElBarachi [27], citizens are ready to use smart city services. However, their readiness is influenced by various factors, such as empowerment, optimism, and innovativeness as enablers and insecurity, mistrust, and legal considerations as inhibitors. Therefore, while citizens are generally ready to use smart city services, their satisfaction and discomfort are essential indicators in determining their continued usage.

4.2 Influence of Smart City design

This thesis contemplates a design of service in the Smart City, but the Smart City in question has already been designed, which can bring some constraints for the service designer. When embarking on the design of services within an already established Smart City, service designers face unique challenges and constraints that can influence their approach. These constraints come from the existing infrastructure, technological limitations, regulatory frameworks, and the inherent complexity of integrating new services into an already functioning ecosystem. Understanding these constraints is critical for designing services that meet the city's citizen's needs and align with the Smart City's broader objectives.

4.2.1 Context definition

The context layer is defined as the initial layer of the Smart City model, representing the overarching environment or domain in which the chosen Smart City operates. This context could encompass various aspects, such as Smart Mobility or Smart Government, each with unique challenges, opportunities, and requirements. The selection of a specific context narrows down the scope of other components, focusing the design and implementation efforts on addressing that domain's specific needs and objectives. In Service Design, the context layer is essential in shaping the design process. It influences the choice of Service Design methods, the identification of user needs, and the development of relevant and effective solutions within the defined context. For instance, in the context of Smart Mobility, Service Design methods might emphasize user-centered approaches to understand and address the needs of commuters, focusing on aspects related to mobility issues.

The implications of the context layer on Service Design methods are profound. By narrowing down the focus, the context layer ensures that the Service Design process remains aligned with the objectives of the Smart City initiative, thereby enhancing the likelihood of successful service implementation and user adoption.

In conclusion, the context layer in the Smart City model is not just a theoretical construct but a practical tool for Service Design. By

understanding and defining the context effectively, service designers can ensure that their designs are relevant, effective, and aligned with the broader objectives of the Smart City initiative.

4.3 Customer-facing versus Background service

Customer-facing and background services differ significantly in several aspects, the most important being their purpose, audience and performance requirements. These aspects also affect the Service Design process as we must focus on them differently. This part of the chapter compares these two types of services regarding these aspects.

Purpose
While customer-facing service is designed with the purpose of interacting with customers directly, to be seen by them, and to be at the front line of interaction between the business and its customers, the purpose of background services is to act as a support service for the customer-facing one, or to perform tasks in the background, supporting the operations and functions of the organization. These background services are essential for the internal workings of the business but interact with users differently than customer-facing services.

Value creation
Even if it is not visible at first glance, the background services participate in value creation, not individually nor directly, but through supporting customer-facing services as an enabler to create value.

Audience
As the audience of customer-facing services is a customer, they are tailored to meet their needs and expectations. They often require a user-friendly interface to ensure a positive customer experience. Background services are designed for internal use by employees, departments, or other systems within the organization. They may have different priorities, such as reliability, scalability, and security, rather than user-friendliness.

Performance Requirements
Regarding performance requirements, customer-facing services often have stricter requirements to ensure a smooth and responsive user experience. This includes fast response times, high availability, and handling peak loads without degradation. Background services may have different performance requirements, such as the ability to process large volumes of data, support complex business processes, or ensure data integrity and security.

In summary, customer-facing services are designed to directly engage customers, focusing on user experience, performance, and security. Background services, in contrast, are designed to support the organization's internal operations and other services.

4.4 Leveraging data-driven Smart Cities

Before exploring more about different suitable Service Design methods and tools, one Smart City advantage needs to be mentioned. Smart Cities, characterized by their extensive use of technology and data, offer a significant advantage to service designers. These cities generate big amounts of data from various sources, including transportation, energy consumption, environmental sensors, and citizen feedback. This wealth of data provides service designers with unparalleled insights into citizen's needs, behaviors, and preferences without the need for extensive primary research. By leveraging these datasets, designers can identify trends, patterns, and future needs more accurately and efficiently. This data-driven approach enables service designers to create services that are responsive to current demands and anticipate future requirements, thereby enhancing the overall quality of life and sustainability of Smart Cities.

4.4.1 Data Brno

Data Brno [1] (Figure 4.1), a project initiated by the city of Brno, Czech Republic, exemplifies the potential of Smart Cities to provide data for Service Design. Data Brno aims to make Brno an open and innova-

1. https://data.brno.cz/

tive city by making its data freely available to the public, businesses, and researchers. This initiative supports the development of smart services by providing designers with a rich set of data to analyze and fosters a culture of innovation and collaboration. By making data accessible, Data Brno encourages the development of new applications, services, and solutions that can improve the quality of life for its citizens. For service designers, this open data policy presents a unique opportunity to gain deep insights into the city's needs, challenges, and potential for innovation. By analyzing data on transportation, energy use, public services, and citizen feedback, designers can identify areas for improvement, develop innovative solutions, and create services tailored to the Brno community's specific needs and preferences. This approach enhances the effectiveness of Service Design [28].

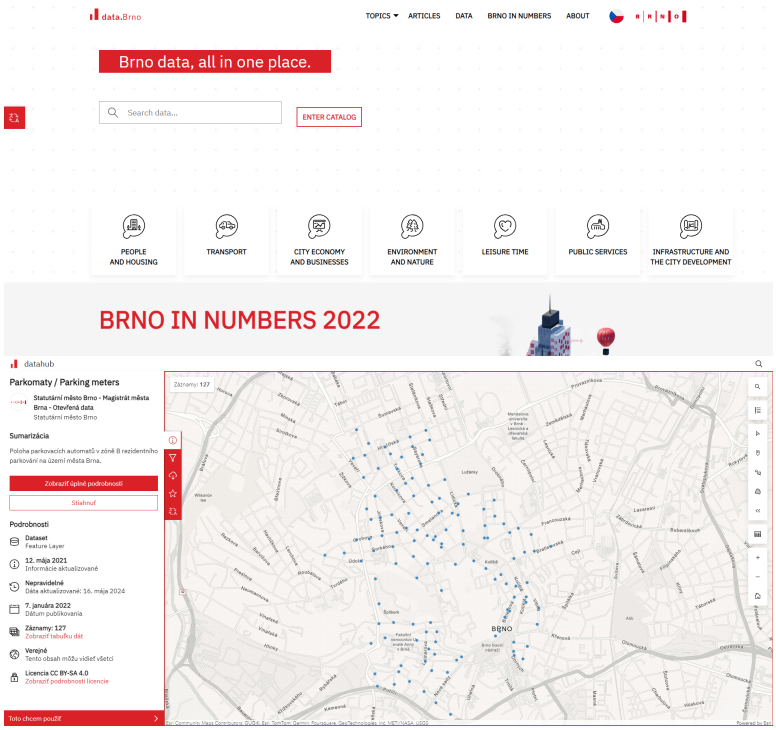


Figure 4.1: Brno Data site. Screenshot by author [29].

4.5 Customer facing services

Customer-facing services play a pivotal role in the urban landscape, particularly within the context of Smart Cities. Customer-facing services encompass a broad spectrum of offerings, ranging from transportation and infrastructure management to public safety and community engagement initiatives. These services are characterized by their user-centric approach, wherein the design and delivery are tailored to meet the diverse needs and preferences of various user groups. By prioritizing customer needs and experiences, Smart Cities can cultivate a more inclusive and responsive urban environment that empowers individuals and enhances collective well-being. Moreover, customer-facing services drive economic growth, foster social cohesion, and promote environmental stewardship within the urban ecosystem. The subsequent sections of this chapter will delve into the complexity of Service Design for Smart Cities, exploring various methodologies, tools, and case studies aimed at creating innovative and impactful solutions that address the evolving needs of communities.

4.5.1 Understanding User Needs and Behaviors

Understanding not only the needs and behavior of customers but also their interaction with service is a crucial aspect of designing any customer-facing service. In order to achieve this, it is important to explore and analyze the user needs, which is in "Exploration" part of the Service Design process. By conducting ethnographic studies, interviews, and surveys, service designers can gain insights into their customers' daily routines, challenges, and aspirations. One of the most valuable tools is the needs map, which was proved by Seyun et al. [30].

Needs map

A needs map is a conceptual framework that categorizes and analyzes the different needs of users. It was developed based on the service-technology-infrastructure-management (STIM) framework to help understand, classify, and interpret the needs of users and citizens in urban spaces. The needs map aims to provide a methodological role in developing services suitable for Smart Cities by identifying concrete

needs from various raw needs of stakeholders. It can help service designers analyze and confront urban issues from various perspectives. This way, they can find insights into sustainable service development. The needs map is structured into four layers, each representing specific service, technology, infrastructure, and management aspects.

First layer is the STIM embedded design model; in Figure 4.2, it is represented by four rectangular sides: Service, Technology, Infrastructure, and Management. Layer 2 contains the functional aspects of the STIM model, each part having two sectors that contain two entities. Entities in Layer 2 are defined as follows:

Contents are a mixture of information and details from the perspective of the software.

The interaction entity provides interaction between the service and the user and executes the user-centered design.

Interface is a communication medium and protocol for Smart City technology. Communication can happen thing-thing or thing-human.

Function provides a way for Infrastructure and Management to have a consistent and efficient role.

The third layer represents practical, not functional, entities. These are used for design and realization in the real space and can serve as goals for the service.

Fourth layer contains data indicators used to draw insights for Smart City service development. Indicators in this layer are statistical social indicators in national annual surveys, but they also serve as the basis for providing practical services for the Smart City. For example, the residential transportation field is a crucial indicator that future housing or urban models should offer as a service for the Smart City.

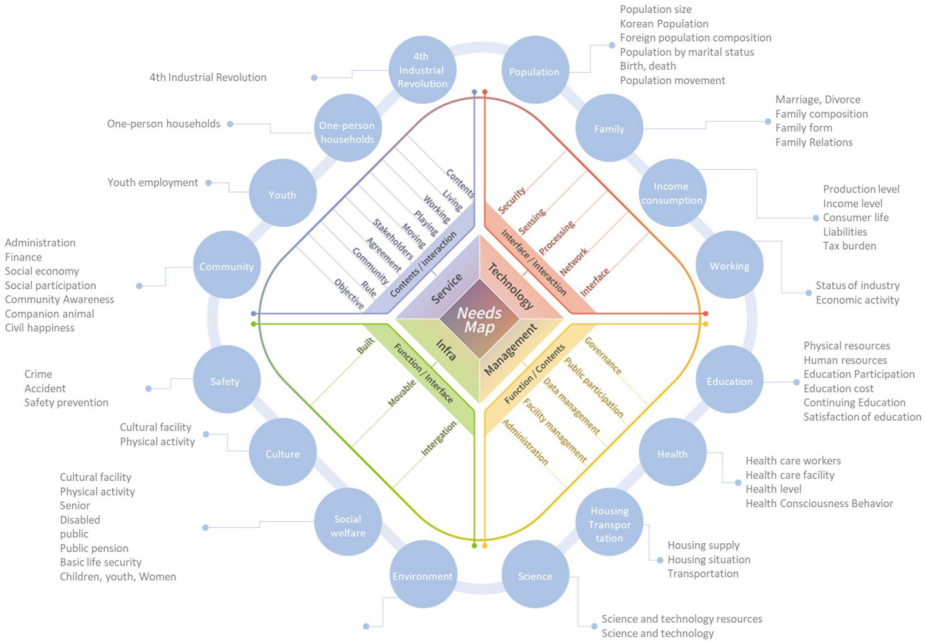


Figure 4.2: Needs map [30].

In the paper [30], Seyun also discusses the application of the needs map to develop a smart service. The steps involved in the application of the needs map include:

1. **Understanding the Experience Zone:** This step involves obtaining overall information related to entities on Layer 4, which helps to understand the current status of the experience zone. This step aims to identify the issues that are visualized as indicators.

2. **Field Investigation at the Experience Zone Through Layer 4:** Based on the information obtained in the first step, the behaviors of users connected are analyzed, which leads to the services helping solve the issue being conceptualized.

3. **Establishment of Services for the Experience Zone:** In this step, the entities on the needs map are utilized to develop the smart service. This involves careful planning of the service to reflect the various needs of user groups, including living, work, entertainment, and mobility.

These steps demonstrate the practical application of the needs map in developing services for Smart City [30]. An example of the result of these steps can be seen in Figure 4.3.

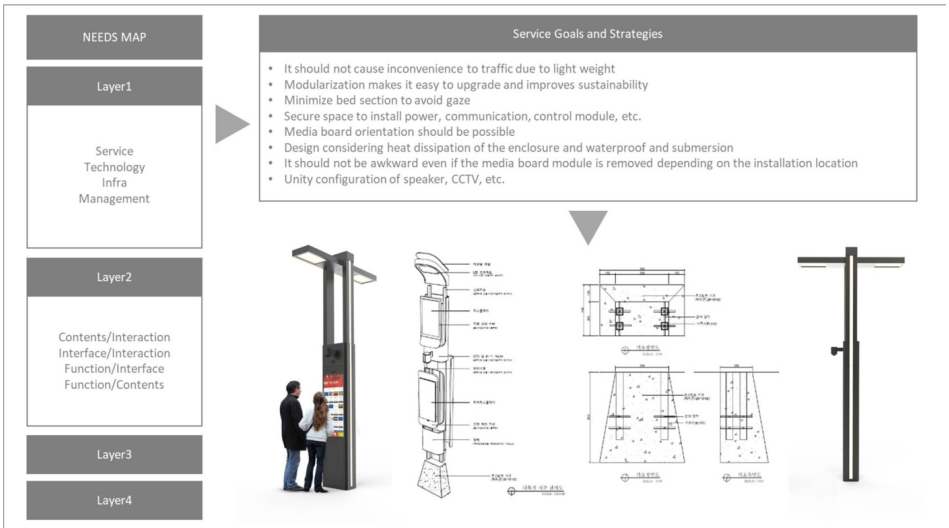


Figure 4.3: Example of designed service by following steps above [30].

Urban planning software

Another concept that can be used to help design services in the context of Smart City is urban planning. Urban planning is a multidisciplinary process focusing on developing and designing urban areas. It also involves strategic planning, infrastructure development, and the implementation of policies to achieve set goals [31].

service designers can use the simulation techniques borrowed from urban planning to anticipate and address customer's future needs. Designers can also gain a foresight into potential challenges and opportunities by simulating various scenarios and urban development projections. These simulation techniques can be adapted and integrated into the exploration phase of Service Design to anticipate evolving user behaviors and preferences [32].

One tool that is commonly used in the context of urban planning for Smart Cities is UrbanSim [2]. UrbanSim is an open-source, regionally-focused urban simulation model that allows for the analysis of urban development scenarios. It is designed to help urban planners, policymakers, and researchers understand the impacts of various urban development projects on the environment, economy, and society.

UrbanSim (Figure 4.4)is a tool that enables planners to create and explore various urban development scenarios. It can simulate the impact of urban development projects on the environment, economy, and society. Additionally, it provides a framework for evaluating the effectiveness of urban policies and interventions [33, 34].

Figure 4.4: UrbanSim example [35].

Mobile ethnography

Ethnography is one of the sciences that are part of Service Design. Mobile ethnography is a research method that collects information using mobile ethnographic technologies, which means it is not dependent on geography. It allows researchers to gather data from participants in real time using modern technology such as smartphones, laptops, and

2. https://www.urbansim.com/

tablets. This method is beneficial for studying customer behaviors and experiences, as it provides direct user information at the time and location of the experience. Mobile ethnography follows the principal ideas and methods of user-centered design, and it contrasts other research approaches through its open manner, where the user structures the research themselves. They document an interaction with a service - a touchpoint. By defining their touchpoints, they provide insights that can be used to improve customer experiences and enhance satisfaction [36, 8].

Mobile ethnography apps are designed with a core feature set centered around facilitating the capture of touchpoints during real-time experiences. These apps offer users a universal platform to document touchpoints using various multimedia formats, including text, audio, photos, or videos. A notable aspect is the ability for users to evaluate these touchpoints and provide feedback. Additionally, these apps often integrate GPS functionality, enabling the creation of detailed maps and visualizations that illustrate the participant's journey within their service experience. Such data is typically uploaded to web-based analysis software, allowing for in-depth exploration and visualization of touchpoint sequences across users [36].

4.5.2 Co-Creation and Participatory Design

In the context of Smart Cities, involving citizens in the design process is essential for creating services that truly address their needs and enhance urban life. This section explores the principles of co-creation and participatory design, along with tools, methods, and examples tailored to Smart City project's unique challenges and opportunities.

As mentioned in Chapter 3.3, stakeholders are defined by the given context as a second layer in the Smart City model. As outlined in this model, the concept of stakeholders emphasizes the importance of engaging individuals, organizations, and entities interested in or actively developing services within a given context. Their involvement and engagement in decision-making processes are crucial for ensuring the relevance and effectiveness of Service Design initiatives.

A separate stakeholder map, a tool often used, is unnecessary as the Smart City model defines the stakeholders in a given context. The stakeholder map typically identifies and visualizes the various indi-

viduals, organizations, and entities involved or impacted by a project or initiative. This can help maintain clarity and avoid redundancy in Service Design.

Participatory Design Workshops

Participatory design workshops are collaborative sessions where stakeholders actively engage in the design process to co-create solutions for complex issues. Facilitated by trained professionals, these workshops include structured activities such as brainstorming, prototyping, and group discussions. Participants contribute their knowledge, experiences, and ideas, generating actionable insights. The workshops produce tangible outputs, such as sketches or action plans, which guide the implementation of design solutions and inform ongoing iterations. Reflection and evaluation after the workshop help identify lessons learned and areas for improvement for the service. Overall, participatory design workshops allow stakeholders to shape the design of services, ensuring that solutions are relevant, inclusive, and responsive to community needs [37].

4.5.3 Prototyping and Testing

Prototyping and testing are integral steps in the Service Design process for Smart Cities, emphasizing the importance of rapid prototyping methods and iterative testing in real-world environments. This approach allows for the development of digital and physical prototypes to gather feedback, ensuring that the final service meets the needs and expectations of its users.

Rapid prototyping is a strategy used in product development, including Smart City services, where a prototype or preliminary product model is quickly constructed, reviewed, and iterated. This method is not limited to tangible objects but equally applies to software or processes. Rapid prototyping empowers teams to understand a product's feasibility better, expose flaws, and gauge user reaction early, ensuring a more robust, well-rounded final product [38]. It embodies the philosophy "fail fast, fail cheap," allowing teams to learn from mistakes without committing to full-scale product development.

Digital Twin Simulations

As mentioned before, Smart City can provide designers with many datasets, which is helpful when using analytics or simulation tools. Digital Twin Simulations are a transformative technology for Smart Cities, offering a virtual replica of a city that mirrors its physical and operational characteristics. These digital twins are created using technologies like the IoT and Artificial Intelligence, enabling cities to simulate real-life environments and scenarios. This simulation capability allows for the testing and optimizing of various city functions, including resource management, predictive analytics, and environmental sustainability, before actual implementation.

Designers can simulate user interactions, service workflows, and environmental factors to assess Service Designs' usability, efficiency, and effectiveness, leading to more user-centric and impactful solutions.

Digital twins offer a dynamic, data-driven approach to Service Design, enabling designers to simulate, analyze, and optimize city services before implementation. This approach can help create and test a high-quality prototype [39, 40].

4.5.4 Implementation of service in Smart City

Service blueprints

Service blueprints are visual representations of the interactions between a service provider and its customers [8]. This tool maps out the steps involved in delivering a service. The steps are mapped from both the customer's and service perspectives, mapping all of the back-end processes. The service blueprint corresponds to a specific customer journey and user goal, allowing the identification of various scenarios that a service can accommodate. For instance, a restaurant might have separate service blueprints for takeout orders versus dining in as it is a different scenario [41].

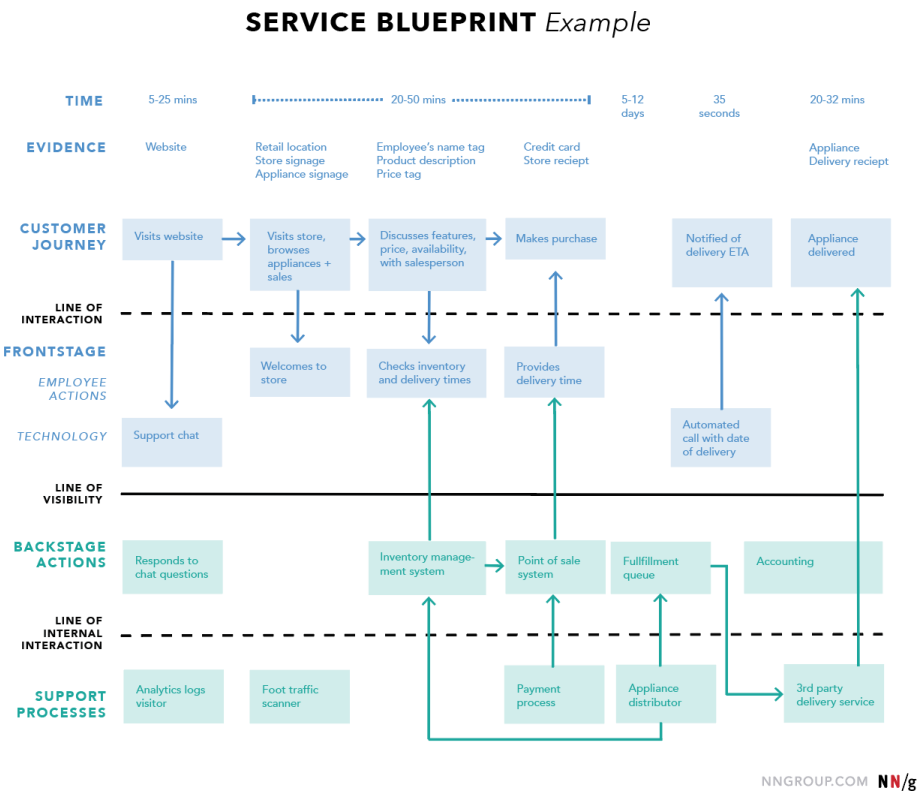


Figure 4.5: Example of Service blueprint [41].

Open Data Platforms

Expanding on the already mentioned concept of the advantage of having data-driven Smart Cities, open data platforms can serve as a building stone for service implementation. Open data platforms are digital infrastructures that provide access to a wide range of data sets, tools, and APIs. These platforms are designed to encourage innovation by making data freely available to anyone who wishes to use it. They facilitate the integration of data from various sources, including government, private enterprises, and citizens. This can lead to easier service implementation as open data platforms enable a more streamlined and effective approach to developing and deploying services.

Smart City Development Kits

A Smart City Development Kit is a collection of tools, resources, and frameworks designed to facilitate the development and deployment of Smart City applications and services. These kits provide developers, city planners, and stakeholders with pre-built software components, APIs, and development tools. The primary goal of these kits is to simplify the integration of smart technologies into existing city infrastructures, thereby reducing the complexity and cost associated with Smart City projects. Also, it makes the production of apps faster, cost-effective, and more dynamic while enabling the creation of cross-linked applications. Additionally, they often come with extensive documentation, support, and training resources to facilitate quick and effective adoption by city officials and developers [42, 43].

One example of a commercial Smart City development kit is KITS [3] by Kimley-Hors, which offers many features and integrations to enhance traffic operations and public safety. KITS provides real-time control and monitoring of Intelligent Transportation Systems devices, including CCTV control, equipment monitoring, and video wall management. It also offers adaptive control solutions to optimize traffic signal timing for safety and efficiency and proactive notifications for potential issues like detector malfunctions or congestion alerts. This kit is designed to integrate with existing infrastructure.

4.6 Background services

Background services in Smart Cities refer to the underlying systems and processes that support various smart city applications and services. These services are essential for the seamless operation of smart city infrastructure, ensuring that utilities, transportation, public safety, and other essential services run efficiently and reliably. Their importance lies in supporting the overall quality of life in urban areas, enhancing efficiency, and promoting sustainability.

service designers need to understand the role and importance of background services in supporting the delivery of customer-facing

3. https://www.kimley-horn.com/solutions/smart-cities/kits

services. Additionally, service designers must acknowledge that background services are inherently more technical. Different from customer-facing services, they may not be designed in the traditional sense. Instead, the focus lies on their seamless integration into the broader ecosystem of smart city infrastructure. By recognizing the foundational nature of these services, designers can ensure that they are integrated service ecosystems and contribute to a cohesive and efficient urban experience.

This integration involves understanding the technical complexity of these services and their interactions with other components of the smart city ecosystem. Moreover, service designers play a vital role in ensuring that background services align with enhancing efficiency, promoting sustainability, and improving the quality of life in urban areas.

In summary, background services in Smart Cities are more about integration and standards than traditional design processes and methods.

4.6.1 Standards

Standards play a crucial role in developing and implementing Smart Cities, serving as the foundation for interoperability, efficiency, and innovation. When designing a service, we need to think about them and plan the design accordingly to fulfill them. International organizations such as International Organization for Standardization (ISO), International Electrotechnical Commission (IEC) develop and maintain these standards.

As an example, ISO 37122:2019 offers a comprehensive set of metrics to assess smart city progress across various domains, such as education, energy, economy, environment and climate change and many more. The World Council on City Data is a prominent initiative that employs standardized city data to establish Smart Cities. It has created ISO 37120 (Sustainable Development of Communities: Indicators for City Services and Quality of Life).

IEC acknowledges more than 1800 standards that already impact Smart Cities. SyC Smart Cities facilitates the coordination of standards initiatives from various IEC committees and other organizations to achieve integration and interoperability of city systems [44].

4.6.2 Regulations

When a Service Designer is tasked with designing a background service in a Smart City, understanding the regulatory characteristics is important. Incorporating these aspects into the Service Design ensures compliance with legal requirements.

One of the characteristics is lawful interception. The Service Designer must ensure that the background service architecture allows for lawful interception as national legislation requires. This may involve implementing protocols or mechanisms for authorized access to data traffic.

Another one is service dependability. Designing a dependable background service involves architecting systems resilient to failures. Redundancy, fault tolerance, and monitoring mechanisms should be incorporated to minimize service disruptions.

In the past years, emphasis has been placed on personal data protection. Compliance with data protection regulations such as GDPR is non-negotiable. To safeguard user's data, the Service Designer must implement robust data privacy measures, including encryption, access controls, and anonymization techniques.

Security considerations should be at the forefront of the background Service Design. Implementing authentication, authorization, encryption, and intrusion detection mechanisms helps mitigate cybersecurity risks and protect against unauthorized access or data breaches.

The designer should also account for roaming regulations and fair usage policies if the background service involves IoT devices that may roam across different networks or jurisdictions. This may involve optimizing data usage and considering alternative communication channels to minimize roaming charges [45].

4.6.3 System Thinking and Integration

Integrating several solutions is crucial for achieving true "smartness" in a city. This involves increasing the number of sensors and the number of functions they can perform. For instance, integrating a traffic management solution with a smart air quality monitoring solution allows for dynamic control over traffic and air quality. This cross-

solution integration requires careful planning and consideration of how different systems can work together seamlessly.

Moreover, building on existing infrastructure is essential for cost-effectiveness and sustainability. Leveraging the infrastructure already in place, such as communication networks, data centers, and IoT frameworks, can reduce implementation costs and minimize disruption to urban environments. Additionally, it ensures compatibility and interoperability between new and existing systems, facilitating smoother integration and seamless operation of background services. By building upon established infrastructure, cities can maximize their investments and accelerate the deployment of innovative solutions that enhance urban environments' overall efficiency, resilience, and livability [46, 47].

4.7 Multilayered services

In the Smart city, the situation can happen that one service is considered a customer-facing service, but in a different context, it can be just a supporting background service. The Service Designer needs to keep this in mind when designing a service.

Consider a service that manages user profiles in a smart city application. In one context, it serves as a customer-facing service, allowing users to update their personal information through a web interface. In another context, it acts as a background service, processing user data to generate personalized recommendations based on usage patterns.

To handle this dual role, the service should be designed with a clear separation of concerns, with distinct modules for handling user interface interactions and data processing. Dynamic configuration could be used to switch between these modes based on the incoming request type. An API gateway could route profile update requests to the customer-facing module and usage analysis requests to the background processing module.

This example underlines the importance of adopting a flexible and modular approach to service architecture, allowing a single service to fulfill different roles across various contexts by designing the service with a clear separation of concerns; distinct modules for handling user interface interactions and data processing are created, ensuring

focused functionality and easier maintenance. Embracing a modular design approach ensures that the service is composed of reusable and interchangeable components, promoting flexibility, agility, and reusability. Leveraging API gateways facilitates efficient and secure communication between clients and services, directing requests to the appropriate modules based on their context, ultimately enhancing the overall service experience for users in Smart Cities [48].

5 Findings

The previous chapter's findings emphasize Service Design's role in shaping relevant, inclusive, and responsive services to community needs. The mentioned tools and approaches have proven effective in ensuring that the services developed are tailored to meet the community's needs.

Municipalities need help delivering services across diverse domains such as public safety, transportation, and utilities. Accumulating data from various sources poses both challenges and opportunities, necessitating innovative approaches to improve service delivery.

Citizen readiness and satisfaction play pivotal roles in the adoption and success of smart city services. Empowerment and mistrust influence citizen's willingness to engage with these services, highlighting the importance of user-centric design principles.

Service designers must navigate the unique constraints that come with Smart City contexts, understanding the complexity of existing infrastructure, technological limitations, and regulatory frameworks.

Customer-facing services are essential in Smart Cities. They prioritize user needs and experiences. Understanding user needs and behaviors is crucial and often achieved through ethnographic studies, interviews, and surveys. The needs map, a conceptual framework, is valuable in this process. It categorizes and analyzes user needs across service, technology, infrastructure, and management aspects, aiding in sustainable service development.

Integrating services in Smart Cities is enhanced through tools such as service blueprints and open data platforms. Service blueprints provide visual representations of service interactions, facilitating the identification of bottlenecks and optimization opportunities. Open data platforms offer access to a wealth of data sets, empowering designers to gain insights into citizens' needs and preferences and fostering a culture of innovation and collaboration.

Urban planning techniques, such as needs mapping and mobile ethnography, offer valuable insights into user behaviors and experiences, guiding the development of sustainable services tailored to community needs.

Background services form the backbone of smart city infrastructure, supporting various applications and ensuring seamless operation. Designers must understand the technical complexity of these services and prioritize their integration into the broader ecosystem. Compliance with standards and regulations, including data protection and cybersecurity measures, is essential for designing robust background services.

Lastly, the previous chapter reveals the necessity of designing services with a clear separation of relations to accommodate their dual roles as customer-facing and background services.

By addressing these challenges, leveraging design principles, and employing diverse tools and methods, service designers play a pivotal role in shaping the future of urban environments. Their efforts contribute to developing innovative, user-centric solutions that enhance urban living and foster sustainable growth in Smart Cities.

6 Conclusions

In conclusion, this thesis has explored the Service design within the context of Smart Cities. Examining and analyzing different sources has identified key differences and unique challenges associated with designing services for Smart Cities. The thesis has highlighted the importance of adapting existing service design principles to accommodate the technological advancements and interconnectedness of Smart Cities.

First, the thesis provides a fundamental understanding of services and Smart Cities. It explains what these concepts mean and breaks down the different parts of a Smart City to make it easier to understand its components. These parts also help define what smart services are. Next, it explains the principles and stages of Service Design science. It also fulfills its goal by recommending specific tools, methods, and approaches tailored for Smart City contexts, offering practical guidance for designers.

Ultimately, this research continues to build on the Laboratory of Service Systems research at the Faculty of Informatics, Masaryk University. It can serve as a foundational resource for designers and policymakers involved in shaping the future of Smart City services.

This work provides foundations for further practical research and application in the rapidly evolving field of Smart City and Service Design, encouraging continued innovation and improvement in how we design and deliver services in urban environments.

Bibliography

1. COMPANY, McKinsey. *Delivering value to customers*. 2023. Available also from: https://www.mckinsey.com/capabilities/strategy-and-corporate-finance/our-insights/delivering-value-to-customers.
2. CRONHOLM, Stefan; GÖBEL, Hannes; ÅKESSON, Maria. ITIL Compliance with Service-Dominant Logic. *e-Service Journal* [online]. 2020, vol. 11, no. 2, pp. 74–97 [visited on 2024-03-24]. Available from: https://www.jstor.org/stable/10.2979/eservicej.11.2.03.
3. LUSCH, Robert F.; VARGO, Stephen L. *Service-dominant logic: premises, perspectives, possibilities*. Cambridge University Press, 2014. ISBN 978-0-521-12432-4. Available also from: https://search.ebscohost.com/login.aspx?authtype=ip&custid=s8431878&profile=eds.
4. VARGO, Stephen L.; MAGLIO, Paul P.; AKAKA, Melissa Archpru. On value and value co-creation: A service systems and service logic perspective. *European Management Journal*. 2008, vol. 26, no. 3, pp. 145–152. ISSN 0263-2373. Available from DOI: https://doi.org/10.1016/j.emj.2008.04.003.
5. FROW, Pennie; MCCOLL-KENNEDY, Janet R.; HILTON, Toni; DAVIDSON, Anthony; PAYNE, Adrian; BROZOVIC, Danilo. Value propositions: A service ecosystems perspective. *Marketing Theory*. 2014, vol. 14, no. 3, pp. 327–351. Available from DOI: 10.1177/1470593114534346.
6. SPOHRER, Jim; VARGO, Stephen L.; CASWELL, Nathan; MAGLIO, Paul P. The Service System Is the Basic Abstraction of Service Science. In: *Proceedings of the 41st Annual Hawaii International Conference on System Sciences (HICSS 2008)*. 2008, pp. 104–104. Available from DOI: 10.1109/HICSS.2008.451.
7. SPOHRER, Jim; ANDERSON, Laura; PASS, Norm; AGER, Tryg. Service science and SD logic. In: *Proceedings of the Otago Forum*. 2008, pp. 214–237.

8. STICKDORN, Marc; SCHNEIDER, Jakob. *This is Service Design Thinking: Basics, Tools, Cases*. Wiley, 2012. ISBN 9781118156308.
9. CUREDALE, Robert. *Service Design: 250 Essential Methods*. Los Angeles: Design Community College, 2013. ISBN 978-0-9892468-6-6.
10. DOWNE, L. *Good Services: How to Design Services that Work*. BIS Publishers, 2020. ISBN 9789063695989. Available also from: https://books.google.cz/books?id=HcipzQEACAAJ.
11. ECONOMIC, United Nations Department of; AFFAIRS, Social. *World Population Prospects 2019* [online]. New York, 2019 [visited on 2023-04-01]. Available from: https://population.un.org/wpp/Download/Standard/Population/.
12. OLIVER, Gassmann; JONAS, Böhm; MAXIMILIAN, Palmié. *Smart Cities: Introducing Digital Innovation to Cities*. Emerald Publishing Limited, 2019. ISBN 9781787696143. Available also from: https://search.ebscohost.com/login.aspx?authtype=ip&custid=s8431878&profile=eds.
13. KIM, Hyun Myung; SABRI, Sami; KENT, Anthony. Smart cities as a platform for technological and social innovation in productivity, sustainability, and livability: A conceptual framework. In: *Smart Cities for Technological and Social Innovation*. 2021, pp. 9–28. Available from DOI: 10.1016/B978-0-12-818886-6.00002-2.
14. BROWN, Will. The Origins of the Smart City. *Medium*. 2021. Available also from: https://will-brown.medium.com/the-origins-of-the-smart-city-85acfd5b7715.
15. MONTES, Jose. A Historical View of Smart Cities: Definitions, Features and Tipping Points. 2020. Available also from: https://ssrn.com/abstract=3637617.
16. GOLUBCHIKOV, Oleg. *People-Smart Sustainable Cities*. 2020. ISBN 978-92-1-117256-0.
17. GOMSTYN, Alice; JONKER, Alexandra. *What is a smart city?* 2023. Available also from: https://www.ibm.com/topics/smart-city. Accessed: 2024-03-23.

18. ŠTEVANKOVÁ, Lucia. *Analýza Smart City z pohledu IT managementu*. 2018. Available also from: https://is.muni.cz/th/lbwle/. Diplomová práce. Masarykova univerzita, Fakulta informatiky, Brno.

19. AMMARA, Umme; RASHEED, Khansa; MANSOOR, Athar; AL-FUQAHA, Ala; QADIR, Junaid. Smart Cities from the Perspective of Systems. *Systems*. 2022, vol. 10, no. 3. ISSN 2079-8954. Available from DOI: 10.3390/systems10030077.

20. GRACIAS, Jose Sanchez; PARNELL, Gregory S.; SPECKING, Eric; POHL, Edward A.; BUCHANAN, Randy. Smart Cities—A Structured Literature Review. *Smart Cities*. 2023, vol. 6, no. 4, pp. 1719–1743. ISSN 2624-6511. Available from DOI: 10.3390/smartcities6040080.

21. WALLETZKÝ, Leonard; BAYARSAIKHAN, Otgonbayar; GE, Mingyue; SCHWARZOVÁ, Zuzana. An Evaluation of Smart City Models Towards a New Service Design Model. In: *Smart Cities, Green Technologies, and Intelligent Transport Systems*. Cham: Springer, 2023, vol. 1843. Communications in Computer and Information Science. Available from DOI: 10.1007/978-3-031-37470-8_3.

22. WALLETZKY, Leonard; BUHNOVA, Barbora; CARRUBBO, Luca. Value-Driven Conceptualization of Services in the Smart City: A Layered Approach. In: BARILE, Sergio; PELLICANO, Marco; POLESE, Francesco (eds.). *Social Dynamics in a Systems Perspective*. New York: Springer Nature, 2018, pp. 85–98. New Economic Windows series.

23. WALLETZKÝ, Leonard; NENCKOVÁ, Lucie; SCHWARZOVÁ, Zuzana. MANAGEMENT OF SMART CITY SERVICES FROM THE PERSPECTIVE OF QUADRUPLE HELIX. In: 2022, pp. 3158–3163. Available from DOI: 10.21125/iceri.2022.0792.

24. KAZIČKOVÁ, Terézia. *IT Services of the Smart City* [*online*]. 2017. Available also from: https://is.muni.cz/th/kigls/. MA thesis. Masarykova univerzita, Fakulta informatiky, Brno. Supervised by Barbora BÜHNOVÁ. Accessed: 2024-03-21.

25. SLATER, Steven J. *Smart Cities: Opportunities for Service Designers*. 2024. Available also from: https://medium.com/service-design-insight/smart-cities-opportunities-for-service-designers-64200720bf2b. Accessed: 05-10-2024.

26. COTTON, Brian. Smart City as a Service: Using Analytics to Equip Communities. 2015. Available also from: https://sanjose.granicus.com/MetaViewer.php?view_id=51&clip_id=8760&meta_id=557613.

27. EL BARACHI, May; SALIM, Taghreed Abu; NYADZAYO, Munyaradzi W.; MATHEW, Sujith; BADEWI, Amgad; AMANKWAH-AMOAH, Joseph. Citizens' technology readiness in the context of smart city services: An empirical investigation. *Technology in Society*. 2022, vol. 71. Available from DOI: 10.1016/j.techsoc.2022.102115.

28. SPAL, Robert. How open data standards make Brno a better city. *Red Hat Research Quarterly*. 2022, vol. 4, no. 2. Available also from: https://research.redhat.com/wp-content/uploads/2022/08/RedHatQuarterlyResearchMagazine_4.2Q32022_Web_rh.pdf. Accessed: 2024-05-01.

29. BRNO, Data. *Main page*. 2024. Available also from: https://data.brno.cz/.

30. SEYUN, An; SUNGWHAN, Kim; SOYEON, Kim. Necessity of the Needs Map in the Service Design for Smart Cities. *Frontiers in Psychology*. 2020, vol. 11. Available from DOI: 10.3389/fpsyg.2020.00202.

31. *Urban Planning* [https://www.sciencedirect.com/topics/social-sciences/urban-planning]. [N.d.]. Accessed: 2024-05-02.

32. PAPA, Rocco; GARGIULO, Carmela; GALDERISI, Adriana. Towards an Urban Planners' Perspective on Smart City. *Tema Journal of Land Use, Mobility and Environment*. 2013, vol. Vol. 6, pp. 5–17. Available from DOI: 10.6092/1970-9870/1536.

33. WADDELL, Paul. UrbanSim: Modeling Urban Development for Land Use, Transportation, and Environmental Planning. *Journal of the American Planning Association*. 2002, vol. 68, no. 3, pp. 297–314. Available from DOI: 10.1080/01944360208976274.

34. DAVIS, J.; LIN, Peyina; BORNING, A.; FRIEDMAN, B.; KAHN, P.H.; WADDELL, P.A. Simulations for Urban Planning: Designing for Human Values. *Computer*. 2006, vol. 39, no. 9, pp. 66–72. Available from DOI: 10.1109/MC.2006.324.

35. INC., UrbanSim. *Workshops and Courses - UrbanSim Cloud Platform Documentation*. 2023. Available also from: https://cloud.urbansim.com/docs/general/documentation/workshops-courses.html.

36. MUSKAT, M.; MUSKAT, B.; ZEHRER, A.; JOHNS, R. Generation Y: evaluating services experiences through mobile ethnography. *Tourism Review*. 2013, vol. 68, no. 3, pp. 55–71. Available from DOI: 10.1108/TR-02-2013-0007.

37. FINN KENSING, Jesper Simonsen; BODKER, Keld. MUST: A Method for Participatory Design. *Human–Computer Interaction*. 1998, vol. 13, no. 2, pp. 167–198. Available from DOI: 10.1207/s15327051hci1302_3.

38. FIGMA. *What is Rapid Prototyping?* 2023. Available also from: https://www.figma.com/resource-library/what-is-rapid-prototyping/. Accessed: 2024-05-01.

39. HALÚSKOVÁ, Bronislava. Digital Twin in Smart City. *Transportation Research Procedia*. 2023, vol. 74, pp. 1471–1478. ISSN 2352-1465. Available from DOI: https://doi.org/10.1016/j.trpro.2023.11.308. TRANSCOM 2023: 15th International Scientific Conference on Sustainable, Modern and Safe Transport.

40. PWC. *How digital twins can make smart cities better*. Available also from: https://www.pwc.com/m1/en/publications/how-digital-twins-can-make-smart-cities-better.html. Accessed: 2024-05-03.

41. GIBBONS, Sarah. *Service Blueprints: Definition* [Nielsen Norman Group]. 2017. Available also from: https://www.nngroup.com/articles/service-blueprints-definition/.

42. BELLINI, P.; BRUNO, I.; NESI, P.; RAUCH, N. Graph Databases Methodology and Tool Supporting Index/Store Versioning. *Journal of Visual Languages and Computing*. 2015, vol. JVLC, p. 19. Available also from: `http://www.datex2.eu/sites/www.datex2.eu/files/Datex_Brochure_2011.pdf`.

43. YASAR, Kinza; ROSENCRANCE, Linda. *Software Development Kit (SDK)*. 2022. Available also from: `https://www.techtarget.com/whatis/definition/software-developers-kit-SDK`. Accessed: 2024-05-04.

44. LAI, Chun Sing; JIA, Youwei; DONG, Zhekang; WANG, Dongxiao; TAO, Yingshan; LAI, Qi Hong; WONG, Richard T. K.; ZOBAA, Ahmed F.; WU, Ruiheng; LAI, Loi Lei. A Review of Technical Standards for Smart Cities. *Clean Technologies*. 2020, vol. 2, no. 3, pp. 290–310. ISSN 2571-8797. Available from DOI: `10.3390/cleantechnol2030019`.

45. WEBER, Mario; PODNAR ŽARKO, Ivana. A Regulatory View on Smart City Services. *Sensors*. 2019, vol. 19, no. 2. ISSN 1424-8220. Available from DOI: `10.3390/s19020415`.

46. ALANAZI, Fayez; ALENEZI, Mamdouh. Interoperability for intelligent traffic management systems in smart cities. *International Journal of Electrical and Computer Engineering (IJECE)*. 2024, vol. 14, pp. 1864–1874. Available from DOI: `10.11591/ijece.v14i2.pp1864-1874`.

47. BISWAS, Sujit; YAO, Zigang; YAN, Lin; ALQHATANI, Abdulmajeed; BAIRAGI, Anupam Kumar; ASIRI, Fatima; MASUD, Mehedi. Interoperability Benefits and Challenges in Smart City Services: Blockchain as a Solution. *Electronics*. 2023, vol. 12, no. 4. Available from DOI: `10.3390/electronics12041036`.

48. ANAND, Sruthy; RAMESH, Maneesha Vinodini. Multi-Layer Architecture and Routing for Internet of Everything (IoE) in Smart Cities. In: *2021 Sixth International Conference on Wireless Communications, Signal Processing and Networking (WiSPNET)*. 2021, pp. 411–416. Available from DOI: `10.1109/WiSPNET51692.2021.9419428`.