Masaryk University
Faculty of Informatics

Adaptation of ITIL for Smart City implementation

Master's Thesis

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Brno, Autumn 2020

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.

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Acknowledgements

I want to thank my advisor Ing. Leonard Walletzký, Ph.D. for giving me the freedom in exploring a field I am interested in. My thanks also belong to consultant Ing. Aleš Studený for his valuable advice regarding the ITIL framework, and to Ing. Michal Bačovský for sharing his knowledge about Žďár nad Sázavou with me. Last but not least, I would like to express my gratitude to my close ones for supporting me throughout the process of writing this thesis.

Abstract

Smart cities are based on and employ information technologies. The information technologies serve as a foundation for smart city services. A smart city has to manage not only these smart city services but also supporting services, software, and hardware. This diploma thesis explores the ITIL framework as a possible approach for managing services in a smart city. This framework is deemed suitable for smart cities due to its flexibility; however, a different perspective is needed. The shift in perspective is examined throughout the thesis by literature review and real-life experience. This thesis uses the newly proposed Smart City Service Management approach on an example of a particular smart city; appropriate starting points of SCSM implementation for the city are discovered through interviews. Smart City Service Management is expected to help the city with systematic management of its services and therefore save resources. To conclude, this thesis adapts the ITIL framework to smart city environment and manifests the initial ways to utilise it in smart cities.

Keywords

Smart City, ITIL, ITSM, IT Service Management, SCSM, Smart City Service Management

Contents

Introduction

Until recently, cities had to cope with and manage limited IT services, usually located only in the municipal authority. With the rise of smart cities, the amount of IT infrastructure has become much higher. Nowadays, IT infrastructure does not only mean personal computers in offices, but also all the hardware and software necessary for smart services, networking in the whole city, and related work like monitoring of multiple smart devices sending data, processing of the data, and much more.

Although it was previously possible to manage IT infrastructure and services ad hoc, with the rapid increase of smart solutions, it will not be sustainable to do so even for smaller cities. A systematic methodology is needed to help smart cities with the management of their services. Such a methodology would be ideally based on the best practices gathered from real life; however, there is a lack of research in this regard. This thesis looks into the ITIL (Information Technology Infrastructure Library) framework, trying to find out if it would be suitable for smart cities.

This diploma thesis is structured into five main chapters. Chapter 1 starts by introducing the terms smart city and smart village. From the growing number of people living in urban areas [1] emerged new problems and challenges for the municipalities. Going 'smart' and changing the way the cities and villages operate could help them with many of the issues that urbanisation brings. However, the process of becoming a smart city or smart village may be complicated without the right know-how. The first obstacle, also described in this chapter, concerns the variety of smart city definitions caused by the multidisciplinarity of the domain. The chapter looks at different types of definitions and specifies one for the purpose of this thesis.

Several sources [2, 3, 4, 5] mention the importance of citizens, or more broadly of stakeholders, and their management as crucial for a successful smart city project. [2, 5] stress out how citizens are often overlooked in smart city debate. Because the primary purpose of cities is to take care of their citizens, and stakeholder management is necessary for a smart city project, chapter 2 is dedicated to their classification. Being conscious of the importance of different stake-

holders' groups may be another obstacle for cities. Therefore, this chapter describes the twelve groups of stakeholders and why they are essential for a city (and vice versa).

Smart cities provide various types of services for their stakeholders. Chapter 3 introduces service-dominant logic to explain the importance of value co-creation approach to services. This approach can help cities in their effort to become smart by guiding them to be more stakeholder-centric. Two structures of services, flat and hierarchical, are described further in the chapter, and their comparison is made regarding stakeholders. Lastly, classification of services according to [6] is briefly described to illustrate the possibility of how to classify services in smart city and how the classification can help with their management.

The main work of the thesis is elaborated in chapters four and five. Chapter 4 introduces IT Service Management and its most utilised approach – the ITIL framework. The framework is further used as an inspiration for the newly proposed Smart City Service Management. Every stage of the ITIL version 3 is described together with the necessary shift of thinking so that it can be extended for smart city services.

The ideas proposed in chapter 4 are applied in the case study of city Žďár nad Sázavou in chapter 5. The introduction of the city is followed by analysis of its processes from the SCSM perspective. The analysis is based on a series of interviews with Smart City Coordinator of the city. Finally, four starting points for SCSM implementation were chosen from this analysis. An appropriate suggestion based on SCSM was made for each of the starting points. These suggestions are meant to help Žďár nad Sázavou with systematic management of provided services.

1 Smart City

The term smart city stems from solving urban problems using technology [7], and even though the term smart city appeared first in 1994 [8], it has become increasingly prevalent in the last few years. Google search statistics suggest keywords 'smart city' started to be searched more frequently in 2014 with peak in 2015, as can be seen in Figure 1.1.

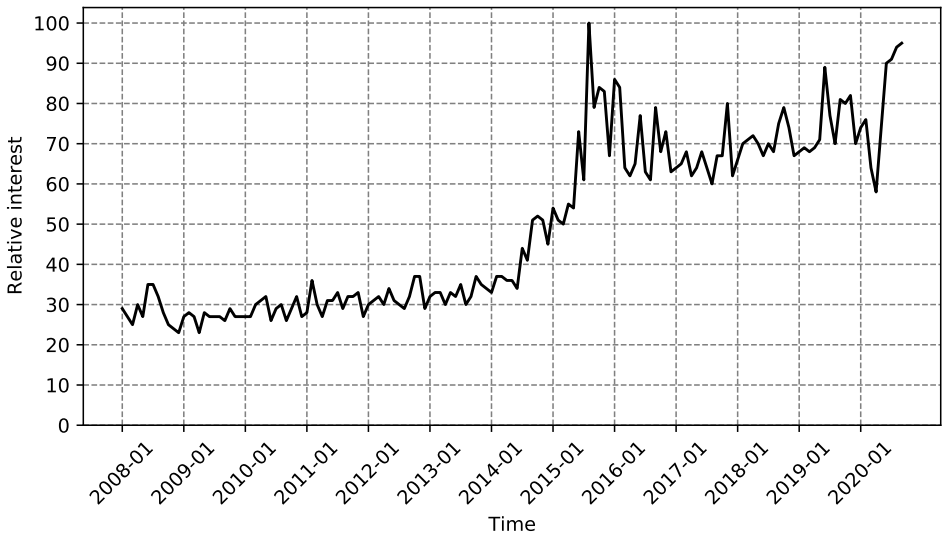

Figure 1.1: The popularity of the search term 'smart city' according to Google. [9]

Often terms other than 'smart' are used regarding a smart city. These can be creative, intelligent, digital, sustainable, or ubiquitous cities. All these concepts are overlapping and may signify different things in different contexts. Even the term digital city used to be utilized as a synonym to a smart city. However, the European Union started to use the term smart city in the year 2010 and the term digital city has become less prominent [8].

Cities, or more broadly urban areas, are becoming more popular in recent years. In 2018, more people lived in urban areas (55%) than in rural ones, while in 1950, only 30% of the population was urban. The estimation for the year 2050 is 68%. Between 1990 and 2018 the av-

erage annual rate of growth for cities with more than 300 000 dwellers was 1.8%. [1]

Higher urbanisation, which is happening, puts pressure on cities and creates new challenges. However, not only cities are affected by this phenomenon. Further in this chapter, a description of smart villages follows.

Cities, especially in Europe, are usually built on old foundations. With the concentration of larger masses of people there, it is necessary to be resilient and adapt to new situations. With more people comes greater consumption of various resources. New apartments need to be built and improvement of infrastructure is inevitable. More roads and buildings may lead to higher air pollution, creation of hot spots, and not enough leisure activities for citizens.

According to [10], the cities and stakeholders are mostly interested in short-term solutions and pilot projects that support business growth. However, larger long-term projects are crucial for further development. User-driven innovation ecosystems, such as living labs, can be the solution for connecting the short-term and long-term projects. Smart cities with a focus on long-term projects could be the bridge needed for achieving sustainability in them. [10]

An analysis of a smart city concept of a particular city from the perspective of long-term and short-term projects is in chapter 5.

1.1 Smart Village

Although the term smart city usually applies only to cities, it is important not to forget about villages, rural areas and whole regions. The terms smart village or smart region are used. The European Union defines smart villages as rural areas and communities that develop added value to existing strengths and assets and where digitalisation, communication technologies, innovations, and better use of knowledge help bring value to inhabitants [11]. Cities and rural areas may face different challenges, but ultimately the process of becoming 'smart' should help both. It is important to note that 'smart' will mean different things for these two populated areas.

Villages in the Czech Republic, especially those far away from bigger cities, are confronted with the problem of depopulation [12]. Tech-

nologies and new (or enhanced) services of a village can help solve or at least slow down this trend. Since the depopulation is happening, with great probability, due to the location not having enough or suitable job positions, the first step could be creating robust Information and Communication Technology (ICT) infrastructure. High speed and low latency internet connection would allow many people to work (at least partially) from home – a trend that has been rising for the past few years and became even more popular as companies had to utilize it during the world pandemic in spring of 2020. Other villages may have the exact opposite problem. Suppose a village is close enough to a significant urban area. New inhabitants may choose to live there due to the proximity to city, financially favourable living conditions, healthier environment, or all of the above. These villages must deal with the influx of new dwellers and expansion of the settlement – creating new living spaces, schools, and services. Another problem villages face, which should not be forgotten, is regarding finances and the size of the municipality. Villages have a naturally lower budget, and they are forced to solve more pressing problems, rather than having the resources to look into the future. The municipal authority is also usually much smaller than in bigger cities and towns, which limits the possibility of reserving a whole department for smart village coordination. It is often not even possible to have a dedicated person for the cause. Because of these reasons, the process of transformation to being smart is slower and substantially more complicated in villages than in cities.

1.2 Definitions of Smart City

[13] mentions that the term smart city pervades into many sectors with no single definition, which leads to confusion among urban policymakers. Overview of the definitions can be found in the same source. Not having one agreed-upon definition can lead to confusion because, from real-life scenarios, cities often try to be 'smart' just as a marketing move without really knowing what steps are necessary to become a real smart city. This can be reflected in their smart city strategies and concepts because while some cities focus on long-term projects and the vision of being a smart city, some focus only on short-

term projects. Moreover, although there is no agreed-upon definition of a smart city, it is undeniably a multidisciplinary field including ICT, economics, management, marketing, waste management, and others.

It follows from multidisciplinarity that being 'smart' is not easily covered by one organisation. In the Czech Republic, three institutions are responsible for different components of smart cities. The subject of smart city as a whole is handled by the Ministry of Regional Development (MMR), Ministry of the Interior takes care of Open Data – a vital part of data management and sharing information in smart cities. Lastly, the process of e-Government and digitalisation falls under the competence of the prime minister. This fragmentation is not ideal and leads to an unnecessary increase of effort one has to invest in finding and checking all the resources provided by these institutions.

1.2.1 Definition of the MMR

In the Czech Republic, the concept of smart city was made into methodology by the MMR in 2015 [14]. The definition of a smart city there is based on the definition of European Comission C(2012) 4701 final [15] and reads as follows:

'[Smart city is a] city, which has a holistic approach to and fulfils with integrity its own long-time strategy of development, and this strategy is expressed by quality and quantity metrics. A city which cultivates its political, social and spatial environment to increase the quality of life and its own attractiveness, and also to reduce the impact on the environment. By employing suitable ICT [the city] enables its citizens to engage in the city's development and use their ideas and suggestions through the community programmes or the economy of sharing, with the goals to improve the communication with the city and to revive the public space. The city supports this transition process to the behaviourally conscious culture by employing suitable organisational and technical tools of 21st century, globally, integrated and by an open way to ensure interoperability of different systems and technologies and their synergistic utilisation. By the quality of life in the concept of a smart city is meant digital, open and cooperative environment of the city, which is healthy, clean and safe for its citizens, as well as economically interesting.' [14]

This definition places emphasis on technologies. Smart cities are expected to employ relevant information and communication technologies and utilise them in many different ways. The cities should take this into consideration when creating their strategies and should not forget interlinking the individual project and areas.

1.2.2 The European Union Definition

Definition of the term smart city can also be found on the website of the European Commission (EC), making it the official definition of the European Union. The definition reads as follows: 'A smart city is a place where traditional networks and services are made more efficient with the use of digital and telecommunication technologies for the benefit of its inhabitants and business.' [16]

A smart city goes beyond the use of information and communication technologies for better resource use and fewer emissions. It means smarter urban transportation networks, upgrading water supply and waste disposal facilities, and more efficient ways to light and heat buildings. It also means a more interactive and responsive city administration, safer public spaces and meeting the needs of an ageing population. [16]

The difference regarding information technology among these two definitions is distinct. While the definition of MMR mentions ICT as a tool to connect with citizens, the definition of EC stresses the importance of going beyond just ICT and that the value is in using the tools everywhere where they can help with efficiency.

1.2.3 Definition Focused on ICT

The term smart city is rooted in many branches, such as ICT, urban planning, or economy. This means a smart city is not just a city employing information technologies but a city using them in every possible way to improve the lives of citizens in many different contexts. According to [17], it is important to identify where can ICT improve the quality of life. However, even though a smart city should go beyond being just about IT (Information Technology), some definitions focus only on that.

An example of definition focusing only on ICT and economy can be the following one: '[Smart cities adapt a] scalable solution that take advantage of information and communications technology (ICT) to increase efficiencies, reduce costs, and enhance quality of life.' [18]

Except with focus on ICT and economics, there are also definitions focused on services, citizens, data-driven definitions, and many more.

1.2.4 Definitions and Stakeholders

The definition of MMR, in contrary to many other definitions, mentions the importance of citizens of the city. Generally, people as a part of a smart city are often overshadowed [2] by the use of technologies. Cities forget that people are an essential part of the urban areas, and a city being smart should be primarily about them and for them. According to [3], there are two foci regarding a smart city: the technology-oriented approach and the people-oriented approach. This is reflected in the definitions.

[3] underlines the importance of 'smart' technologies as not only the means to create more functional physical spaces but also to create more functional people and activities within the spaces. The author suggests that cohesive smart city strategy has to utilise both technology and knowledge to be sustainable (knowledge being the 'human' part of the smart city). The problem mentioned, which can be widely seen in smart city strategies, is that (aspiring) smart cities often fail to take into consideration the people – even though the most successful smart cities are focusing more on needs of their people. The success stems from the people being a vital part of smart cities because they use the services. However, for them to utilize the services to its full potential, the people need to be smart too. [7, 3]

1.3 Formulation of a Definition

Based on definitions not only mentioned above and for purposes of this thesis, the smart city definition was adjusted as follows: Smart cities are cities that employ ICT in a holistic way that ultimately improves the quality of life of the city's stakeholders. ICTs in a smart city are used for collecting data, and the data needs to be processed. The data should

help the city representatives with decision making, and should also serve for creating new services and improving old services to bring more value to the stakeholders.

2 Stakeholders

In an effort to evaluate smart city appropriately, [19] divided it into several components. These components, or characteristics, are smart economy, smart people, smart governance, smart mobility, smart environment and smart living [19]. These characteristics can also be used when creating new projects as a way to help to find contexts and stakeholders. [2] mentions that in projects, smart people are less discussed than other components.

A stakeholder is a person who has an interest in organisation. Every mention of stakeholder in this thesis is related to a smart city unless stated otherwise. Stakeholders of a smart city shape the city through continuous interactions [20].

[4] mentions stakeholder management as being a core activity for creating successful projects. Stakeholders and their needs need to be identified and managed adequately to be able to address the challenges and demands of society. In sustainable development, ecological and social issues must be balanced with economic interests when managing stakeholders by, e.g. focusing on transparency and traceability, fairness, trust, and participation [4]. It is possible to look at a smart city as one big long-term project where stakeholders comprise a crucial part. As was defined above, a smart city should primarily focus on stakeholders and provide them with valuable services.

Stakeholder management is vital for identifying the stakeholders and their needs. Managing the stakeholders helps to create useful services and adequately plan the adaptation of smart city ideas, which leads to their overall successful adaptation. A similar finding was mentioned in [21] regarding project management and how stakeholders affect the whole project management process. Even though stakeholders can differ in different cities depending on their size or location, it is possible to categorise them into several groups. Attempts to understand the points of view of different stakeholder groups in the smart city literature is lacking. However, [2] mentions how incorporating more perspectives of relevant stakeholder groups increases the potential of smart city discussions. [2]

An overview of stakeholders identified in smart city projects can be found in [20]. The stakeholders mentioned in seven different sources,

although not one contained all of them, are: Academia and Research Institutions, Local and regional administrations, Financial supplier/Investors, Energy suppliers, ICT sector representatives, Citizens, Government, Property developers, Non-profit organisations, Planners, Policymakers, Experts and scientists, Political Institutions, and Media.

Because the above list of stakeholders seems on one hand incomplete and, from different perspectives, excessively detailed, below is adapted list of stakeholders suitable for this diploma thesis. The list is based on the one above coupled with knowledge and experience gained in practice.

- Citizens
- Companies (already located in the city and possible new employers)
- Universities, schools, and other educational and research institutions
- Tourists and visitors
- Students
- Self-employed people
- City representatives
- State
- Citizens' associations
- Non-profit organisations
- Financial institutions
- Emergency services

It is important to note that being part of a stakeholder group is only an assignment of a role. One particular person can have multiple roles; therefore, they can be in various stakeholder's groups. Such an example can be a self-employed person, who is also a politician in local municipal government. This person would be in three stakeholder

groups – citizens (assuming the person lives in the city) or visitors (assuming they do not live in the city), self-employed people and city representatives.

2.1 Citizens

Citizens are the largest group of stakeholders; they include people with domicile in the city and anyone who lives there for more extended periods. The findings in [2, 5] show that although citizens are not ignored, they are often under-represented in discussions about smart cities. City representatives may feel like citizens do not have much to bring to the discussion, but the opposite is true. Citizens can see the city from many different perspectives and on a very detailed level. They are the consumers of smart city services (more in chapter 3), and therefore the services have to be tailored to bring them value.

On the one hand, with such a large group comes the problem of communication. In a discussion, some may overshadow the ideas of others only because they voice their opinion louder. Alternatively, an opposite problem may arise – the citizens will not be active enough and will not want to engage in smart city ideas. On the other hand, the city representatives will obtain powerful colleagues by solving these issues. The power of citizens can be utilized by introducing participatory budgeting. Participatory budgeting gives them the ability to share their ideas and suggest a solution, but more importantly, shows them that their voice is heard. The citizens also need to be active to participate in the governance of the city [7].

2.2 Companies

A company is a group defined by law with the objective to acquire money. There can be a variety of companies in a city with many different specializations and many different sizes. A company can be a provider of services for the city, as well as a client/customer.

Every company in a city and the city itself should have a symbiotic relationship. The city can offer the following:

- Space for companies to reside in (buildings, estates)

- Educated and trained citizens who can be employed by the companies
- Citizens who use the services of the companies
- Infrastructure for operations
- Space for offering the company's services (bulletin of the city, trade fair)
- Accessibility (public transport line, roads to the company)

While offering all of the above, the city can also be a client/customer of the company itself.

A company, on the other hand, can offer, e.g. job positions for citizens, taxes, activities for citizens and the city itself (lectures, education), infrastructure (larger companies may help with financing new infrastructure), and sponsorship of local sports teams or citizen's clubs.

It may be interesting to note that a company does not have to be located in a particular city to be a provider or client/customer of a service.

2.2.1 Companies Owned by the City

A city itself can be an owner, or majority owner, of a company. This close relationship may bear advantages as well as the opposite. While the city will have its voices in the committee, it can not order the company what to do because the management of the company is independent. An example could be the obligation to open data of the company – undoubtedly an essential part of a smart city. If the company itself does not want to participate in this, the city has no options to enforce it. Companies may not want to participate in a smart city project if there is no monetary value for them. It is a responsibility of the city to motivate the companies and create solutions to ensure the participation of crucial stakeholders.

2.3 Universities, Schools, and Other Educational and Research Institutions

Although not every village in the Czech Republic has a school, in most of the cities is at least one. Moreover, while universities are usually tied to bigger cities there, research institutions can be found anywhere. For example, in Třeboň (8 217 inhabitants [22]) resides the Institute of Microbiology of the CAS, v. v. i. A research institution in a city draws in people with higher education as they do not have to travel to bigger cities for work and can enjoy the environment of a smaller town. A city profits a lot from any educational and research institution; together they can create educational programmes for the general public. An institution can come up with new ideas and technologies to try in the city and especially important is the cooperation with primary schools and high schools. While lectures are engaging, letting pupils and students work and help in the institutions is far more important. One possibility is to designate workplaces for high schoolers, who would like to participate in Students' Professional Activities[1].

Universities gather large quantities of young people from different parts of a country or even from the whole world. The city and universities should work together to facilitate the adaptation of new students, especially regarding housing and job opportunities. The net of cooperation is becoming bigger since more students means more (and possibly cheaper or more educated) employees for companies. Therefore, support of universities may bring more companies to the city, as well as create numerous start-ups from students' ideas. The city should work together with universities to create innovation centres and facilitate the foundation of such new businesses. While mentioning students, it is important to note that they, as stakeholders, also fall into the visitors' category (unless they have a domicile in the city).

2.4 Tourists and Visitors

The World Tourism Organization defines a visitor as 'traveller taking a trip to a main destination outside his/her usual environment, for less than a year, for any main purpose (business, leisure or other personal

1. In Czech Středoškolská odborná činnost, science contest for high school students.

purpose) other than to be employed by a resident entity in the country or place visited. These trips taken by visitors qualify as tourism trips. Tourism refers to the activity of visitors.' and tourists as follows: 'A visitor (domestic, inbound or outbound) is classified as a tourist (or overnight visitor) if his/her trip includes an overnight stay, or as a same-day visitor (or excursionist) otherwise.' [23]

Local authorities should have an analysis of the possible tourism their city offers. The categories, according to [24] are:

- Cultural Tourism
- Ecotourism
- Rural tourism
- Adventure tourism
- Health tourism
- Wellness tourism
- Medical tourism
- Business tourism
- Gastronomy tourism
- Coastal, maritime and inland water tourism
- Urban/city tourism
- Mountain tourism
- Education tourism
- Sports tourism

Every city has to realise which kind of tourism is possible in its administrative region and focus on them. Focusing means using the right tools to improve the places and activities, and especially communicating it in the language of selected groups of tourists. Regarding IT services, it can mean a counter of people on a bike road, a web camera on a significant place, or thermometers sending current temperature

to a website. It also includes supporting good internet connection in museums, companies, and educational institutions.

For a city, it should be essential to realise what the different categories of visitors/tourists bring as a value. It should then be considered when creating or modifying services. An example of service directly harming a relationship between a city and a group of stakeholders can be a parking system of the city of Brno [25]. Brno created a new parking system with zones and different rules for Residents, Subscribers and Visitors. The system should support residents (people with domicile in zones where the new parking system is established) to be able to park as close to their home as possible. Subscribers are self-employed people or legal persons with an address registered in the area or with a registered office there. Visitors are, from the perspective of the parking system in the city, everybody else. The first two groups can purchase long-term permits to park in the dedicated zones. A visitor has to (in most cases) pay by the hour. Because tourists may be a significant source of finances for the city, this could harm the relationship between tourists and the city. Therefore, when creating a new service, a city should take into consideration all influenced stakeholders and create a plan not to damage any valuable relationships.

2.5 Students

Students are a particular category because the membership is limited by time and everyone in this category of stakeholders also falls into at least one other category. A student can be either a citizen or a visitor, and in addition to that, a self-employed person. The group consists of children and adults, even possibly of senior citizens, if courses from the university of third age are an option in the city. Students bring innovative ideas to the city if the right environment is created. A child can help to design a new park if a contest for elementary schools is created, effectively involving children in life of the city while also marketing the new intended park.

Especially important part of the student body are university students. A city without a university may want to create a programme supporting the return of graduates back to the city. A city with a uni-

versity should focus on the value the university students are bringing to the city and other stakeholders. University students usually work in the city, spend money there, and participate in the city's public life. Harming the relationship the city has built with them could lead to severe consequences for the city (students leaving with their own company to other locations, fewer new students, or limited use of services by the students).

An example of an improperly set service may be the parking system mentioned above. In this system, a problem arises when a university student without domicile but with a company car wants to acquire a parking permit, considering the company has the office registered elsewhere. Willing to pay for the subscriber's permit (which is 20 times more expensive) [25], nevertheless the student is unable to do so without a registered address in the area. Moreover, this is only one student out of many, willing to pay for the permit but being stopped by the current rules. It is important to note that there were 63 054 university students in Brno in 2019, spending in total more than 294 million euros per year [26].

2.6 Self-employed People

Self-employed people develop the economy of a city with their creative ideas and fill the gaps in a market. A city should support self-employed people because they can be the response to high unemployment, or because they may offer niche services to other stakeholders. At the beginning of self-employment, a person may need the city to help them with all the necessary legal administration and support them in their business plan. A city can provide premises at advantageous prices as well as training and education for paperwork and related necessities. Self-employed people are the most flexible component of the labour market – in addition to everything else, they are also a source of innovations for a particular area. While big companies innovate, they often do so from broader perspectives with a narrow focus on their scope of activity. Self-employed people may focus on precisely what they are missing in a municipality. Furthermore, a self-employed person can gradually evolve into a (small) company.

2.7 City Representatives

The representatives of a city are a special type of citizens with potentially more significant power to influence the functioning of the municipality. As they can also be self-employed or owners of a company operating in the city, there may be additional need for monitoring of their actions. Especially important is segregation of duties, which means they should not be in a position from where they could fraudulently introduce advantage for their personal business without detection.

City representatives effectively manage the city through a complex system of proposals, approvals and adjustments. The representatives are usually elected for a certain number of years. Therefore their long-term efforts may be unattainable. This can be especially problematic at the beginning of a smart city project. A change in leadership could stop every preparation or project done so far. In the Czech Republic, the local elections take place every four years (last took place in the year 2018) and is adjusted by act no. 491/2001 Sb [27].

2.8 State

The state lays the foundation of how municipalities should create their smart city strategies – it is responsible for methodologies and manuals. Furthermore, the state establishes rules for the digitalisation of data, which should be presented to the municipalities in a positive light. The state hands over to the cities part of its own responsibilities: to develop infrastructure, issue personal documents to the citizens (identity cards, passports, or driving licenses), administer land registry, and much more.

However, the state not only assigns tasks, but it also redistributes finances from taxes, offers grants, and overall helps with the development of the cities.

2.9 Citizens' Clubs

Citizens' clubs unite people with similar interests and in the Czech Republic are regulated by the act no. 89/2012 Sb subsection 214 – 302 [28].

These associations are often created around hobbies – e.g. sports or gardening.

A city needs such clubs to create activities for its citizens and to enable citizens to share their interests. A city should also support clubs because from some may become tourist's attractions. The participants are knowledgeable in their hobbies, as well as in the city itself. This can be extremely useful when creating projects in the city – before transferring the proposal to fields' experts, the city can make use of the clubs for their inputs. Moreover, a round table can be created for discussion. The clubs are also important because they create a sense of community in the city – a gardening festival can be arranged to bring together not only the members of a gardening club but also other citizens. Especially significant are clubs for senior citizens, creating a community for a group of people that are jeopardised in many ways (physical health due to being sedentary, loneliness influencing mental health, or economically).

A city can help the clubs to organise festivals by offering spaces or helping to distribute marketing materials. A city can also help by offering its services or solely financially.

2.10 Non-profit Organisations

Non-profit organisations (NPOs) are not created to make a profit. Rather, they are very often created with the purpose of helping disadvantaged people (either physically, mentally, or economically). NPOs help cities to take care of people in need, relieving the social and health systems from the workload. Instead of going to the labour office to ask how to fill out an application, one can go to the NPO. Similar relieve can happen for physical rehabilitation and hospitals.

The city can help NPOs by offering spaces to work in or plots to build on. The municipality can also directly financially sponsor a NPO or help mediate sponsors through contacts with businesses. Moreover, it is possible to offer NPOs places at markets and other festivals (e.g., Christmas market) to help them be more visible for the public. If a municipality has a say in creating public transport timetables, it can help with getting through a timetable change that the NPO would benefit from.

2.11 Financial Institutions

[29] defines financial institutions as licenced companies with legal subjectivity regulated by the state, offering products and services in compliance with the licence. There are several types of financial institutions, one of them being banks. Banks are one of the most prominent businesses of the financial systems and therefore are usually heavily regulated. The central bank is superior to other banks. Its role is also different – the two main purposes are ensuring the quality of national currency and ensuring the long-term stability of purchasing power. The central bank is an important partner of state, not only encouraging economic growth and employment but also managing the account of government or handling state debt. Other financial institutions are non-bank savings institution, insurance companies, institutions for collective investments (e.g, investments funds), pension funds, and also stock exchanges and organised off-exchange markets. [29]

The interconnection of financial institution and cities can be shown on an example of banks. It is obvious that banks can loan money to the city and its citizens, but they can also participate in creating business incubators. In these incubators, new entrepreneurs emerge, possibly in need of services from these financial institutions. This cycle can be exciting for banks from a financial perspective. Moreover, the city can provide statistics about the movement of people and information about new building constructions. This information can allow financial institutions to decide where to build new branches or cashpoints. Cities also need insurance companies to secure their assets and actions. Having such financial institutions in the city helps not only to the municipality but also other stakeholders because they do not have to travel far for using their services.

2.12 Emergency Services

Emergency services are the first responders to emergencies, particularly the police, paramedics, and the fire brigade. The presence of these services is vital for a municipality's life and functioning, especially for the more populated ones. Villages in the Czech Republic usually do not have their own emergency services and are using the ones from

bigger municipalities nearby. Quite often a voluntary fire brigade can be located in villages or cities. A city should support these services not only directly, but should also aim to create means for citizens to help. Such means can be participatory budgeting.

A real-life example is the city of Mnichovice – a small municipality with less than 4 000 inhabitants located near Prague, Czech Republic. They introduced participatory budgeting in 2017, and one of the first winning projects was the purchase of two defibrillators for the town's volunteer firefighters. Due to a cycle of workshops for citizens, where the new devices were demonstrated, the citizens decided to support the firefighters in every following participatory budget there was. [30]

3 Services

As was mentioned above, a smart city should use ICT for improving the services it offers and also for creating new services. Service is 'the application of specialised competences (knowledge and skills) through deeds, processes, and performances for the benefit of another entity or the entity itself' [31]. There are two main approaches – product-dominant logic and service-dominant logic (SDL). Service-dominant logic is not focused on short term earnings. Rather, it focuses on customers and on offering them a value proposition. It is based on ten foundational premises that evolved over the years [31, 32, 33].

The system of services in SDL consists of three elements and relationships between them [34]. The elements are:

- Provider: Provider is the entity that performs actions by which a service is provided. The provider works with technology, and/or environment for which they are responsible.
- Client/Customer: Client/Customer is the entity which receives the results of an action. The client/customer owns part of reality and identifies a problem within it.
- Target: Target is a part of reality that should be transformed or operated by the provider. The target is a source of a problem for the client/customer; however, it does not necessarily have to be owned by them (e.g. in the case of renting).

There are different relationships between entities. The position can be seen in Figure 3.1. The relationships are:

- Relationship Provider – Client/Customer: Sharing information and knowledge is the core of the relationship between Provider and Client/Customer. Together they negotiate the responsibility the provider will have/has for the target. Both also balance the value proposition and together they co-create the value for the client/customer.
- Ownership Client/Customer – Target: Client/Customer owns rights to use/change the target. Client/Customer finds the tar-

get has a problem and is also willing to invest in solving it. The target is used by the client/customer to obtain value.

- Responsibility Provider – Target: Provider has the competency and knowledge how to manage the target, is competent to plan the change and improve the Target. The improvement is done in such way, that Client/Customer benefits from it.

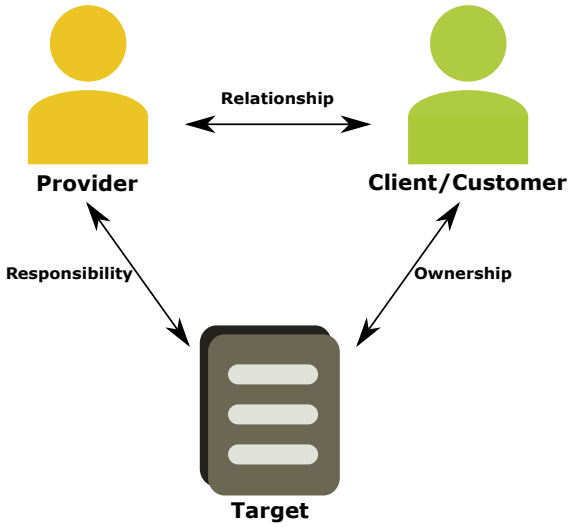

Figure 3.1: Triangle of entities of SDL [34].

It is important to note that this triangle of Provider – Client/Customer – Target is a simplified version with only two parties and one target. However, [33] underlines that value creation is an interaction and exchange of all actors within networks and across them. This statement is important from the smart city perspective, where every stakeholder can be a provider as well as a client/customer. The visualisation of such service environment would be multi-dimensional net. Nevertheless, the principles would be preserved.

The difference between a client and a customer is in the way they pay for a service. Both are the receivers of the service, but while the customer pays for the service with the typical means -– money, the client does not necessarily have to do it the same way. A client can also exchange the service for another service or, e.g. for data and information.

This exchange is very often the case of 'free' services, such as cloud repositories or on-line documents. While seemingly for free, the client is often providing different types of data and personal information to the provider. The provider can then use it, e.g. for machine learning.

According to the service-dominant logic, a value cannot be determined by the provider because only the client/customer can decide the value of a service. The value proposition is the offer from the provider to the client/customer; it describes what the provider is able to do with a client's/customer's target to improve it, from the point of view of the client/customer. Because both the client/customer and the provider determine the value together, the value is co-created. Value co-creation is a win-win strategy where all the parties involved gain something, and the process of co-creation is non-opportunistic with focus on long-term relationships [5]. The value is then acquired by the client/customer by using the service.

In the context of smart city, there are two main approaches to services. IT services focus more on the purely technical part of a smart city while smart city services look at the services a city can provide as a complex system of different interconnected services.

IT services are technical with close-to-no consideration of value from the perspective of the end client/customer. These services may serve, among others, as a technical foundation for smart city services and they are provided by an IT function. IT services define the components for providing a service to end-users. They consist of technology, processes and people.

3.1 Smart City Services

Every service that smart city provides for its stakeholders is considered a smart city service. A smart city service (or feature) can be, for example, Smart Mobility, Smart Infrastructure or Smart Healthcare. Until recently, the smart city services were separated from each other, and a holistic point of view was missing. The services have been designed separately without taking into consideration their connection, relation to existing services or different contexts they may impact [5]. Also, as was mentioned above, focus on people (particularly citizens) is essential; however, often not very prominent in reality [2].

In this section, two main approaches for understanding smart city services will be described, and an article concerning the classification of smart city services will be presented together with benefits of such classification.

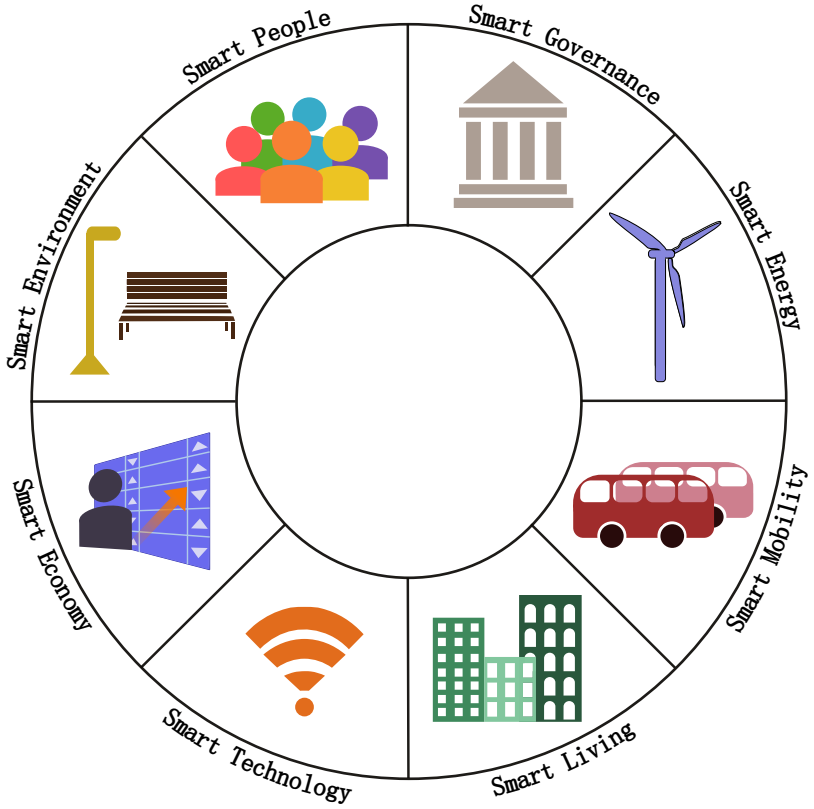

Figure 3.2: Flat structure of smart city services.

3.1.1 Flat (Traditional) Structure

The most common structure of smart city services is depicted as flat, where every service is interconnected with all of the other services. More of a traditional typology of these services is mentioned in chapter 1 – [19] identified six components of a smart city service. This division supports the findings of [6], that smart city services have the same or very similar classification as the structure of a city's government. From this point of view, it is easily understandable why

many structures of smart city services are flat – they copy the different departments of a city's government. Therefore the citizens are on the same level as infrastructure or energy. For the city, it is just another category it has to look after instead of citizens being their partners and clients co-creating the value.

The flat structure model seen in Figure 3.2 is inspired by [19] together with other elements of a city which can be seen in, e.g. [35]. Different approaches need to be taken for developing each of the services, not to mention that smart people are not even a service. Rather, people use the services to bring them value. Moreover, smart people are essential for other services to be smart because smart service without smart users is not smart. According to [5] the explicit dependencies are also not illustrated in the flat structure, even though they should be.

3.1.2 Layered Model

[5] suggest a new layered model for smart city services that separates the technical and other supporting services from the functional ones that bring value to the citizens. Figure 3.3 illustrates the hierarchy of the layered model. This concept of layers originates in Software Architecture.

The lowest layer is comprised of Software and Hardware ICT. These are very similar if not the same as IT Services described above. As was mentioned in chapter 1, ICT is an essential part of a smart city, and other services are built upon it. Hardware services can be e.g. sensors, networks, servers, and the whole physical infrastructure. Software services use hardware services. Software IT services create the foundation for other services above this layer to operate. Software services include storage, data collection, or computing power.

Above hardware and software, there is a layer of Supporting Services. The Supporting Services are created by combining the services from the hardware and software layers. Therefore, more complex services are created, which would not exist only on the software layer alone. These Supporting ervices are not able to bring value directly to the stakeholders, hence serve as a carrier of newly created value to the higher layers. Supporting Services can be, e.g. management of transport, control of temperature, or traffic monitoring.

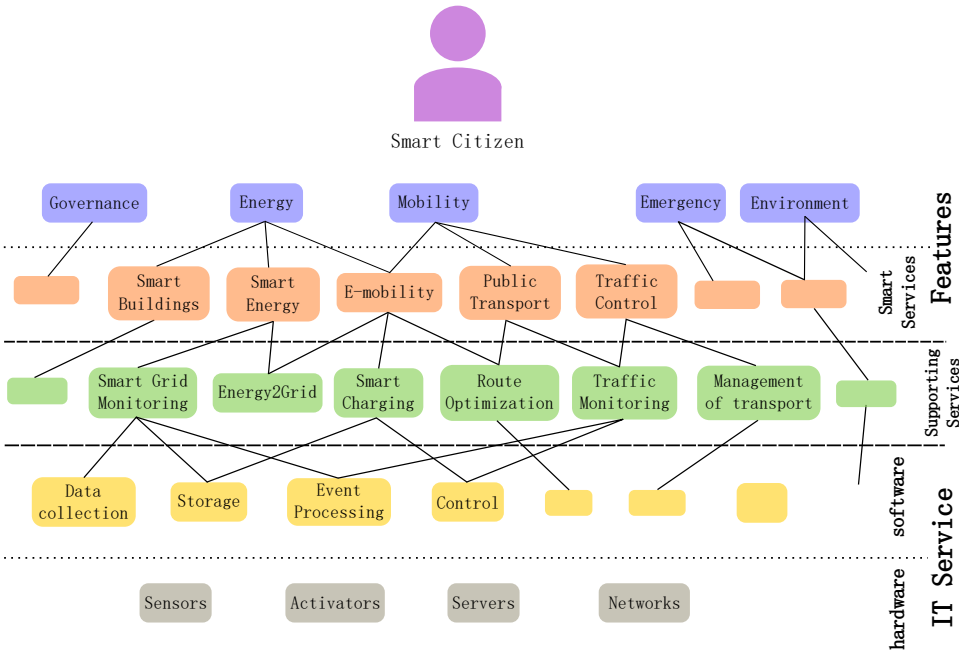

Figure 3.3: Smart city services in hierarchical layers. [5]

The top layer is named Features. These features consist of Smart Features and a sub-layer called Smart Services. Smart Services, similarly to Supporting Services, combine several services from the layer below, creating more complex service in order to create more value for the highest layer to use and provide to the stakeholders. Smart Services are necessary because stakeholders are not motivated enough to use them directly. Also, providing Smart Features would be hard without them. Only smart features can propose value to stakeholders and therefore are directly used by them. The provider of Smart Features is the city alone, or city-designated companies. [5]

3.2 Classification of Smart City Services

Smart city services are defined by [6] as services provided by the city using ICT in city planning and management. Furthermore, in a smart city, citizens may use and access smart city services regardless of time and place. The smart city services are classified by [6] based on four dimensions, and every dimension has two to three categories. Every

service gains one category out of each dimension, and this way, a set of 24 categories is created. This topology is strictly citizen-centric and is based on marketing and service science. Hence they often maintain the perspective of a client/customer.

The first dimension is called Mode of Technology and describes the role of ICT in the service. The categories are Automatic, Informative and Transformative. The second dimension is Service Purpose, sorting the service to either the Hedonic category or the Utilitarian one. Service authority, the third dimension, characterizes if citizens have to use the service or have the option not to. The categories are Voluntary and Mandatory – Mandatory being, e.g. speed enforcement service. The last dimension is called Delivery mode; it represents the relationship between client/customer and providers. The dimension is split into two categories – Passive, when no input from client/customer is needed, or Interactive. The Table 3.1 illustrates the dimensions and their corresponding categories in an organised manner. [6]

This topology of smart city services allows for easy classification from the point of view of citizens/stakeholders. Classification can help to design and create a value proposition. After all, [6] classification is based on marketing. Services in the same categories will have very similar, if not identical, requirements and the classification could enable for more effective and efficient management.

Mode of Technology	Automatic
	Informative
	Transformative
Service Purpose	Hedonic
	Utilitarian
Service Authority	Voluntary
	Mandatory
Delivery Mode	Passive
	Interactive

Table 3.1: Dimensions and their categories for service classification. [6]

This chapter presents a flat structure of smart city services which does not allow for a holistic view, because services with different ability to bring value to stakeholders are arranged next to each other. This non-hierarchical view creates a problem and therefore it is significantly more challenging to sort the services and manage them. The layered model structures the services in a way such that every upper layer is dependent on the lower one and combines several services from there. The value proposition is created on every layer and propagated upwards.

Also, the flat structure is not stakeholder-centric and ultimately makes it hard to design suitable services from stakeholder's perspective. As is written in the introduction of this chapter, the value of service is co-created. Therefore it is important to explain the value proposition to the client/customer in their language. Meaning, the client/customer must understand what value the service can bring them.

Regarding the layered model, the typology from [6] can be used only on the top layer – smart city services. It follows from the fact that the whole typology is done through the perspective of the citizens. The lower layers are not exactly hidden from the citizens but do not bring them value, as is mentioned above. On the other hand, citizens are not the ones who manage the services, and suitably extended topology could help with that.

There are two more points why extending the typology of services could be useful, together with changing the point of view of the layered model. The first point is that citizens are not the only stakeholders in the city. Taking into consideration other stakeholders, it becomes evident that not everyone is working only with the top layer. Stakeholders such as specialised companies, universities, or others may interact with services on lower layers or be providers of some. With this idea in mind, it is apparent that lower layers can bring value to stakeholders, but not necessarily to citizens. Classification of these services would be beneficial from the same reasons the [6] typology is – helping with design and management of these services. The second point is from the perspective of a city. The city is, or should be, the manager and administrator of all the services. For the correct management of these services is necessary to have them classified in all of the layers.

4 IT Service Management

IT Service Management (ITSM) is a strategic approach to designing, delivering, improving, and overall managing IT services with a focus on customers, or more broadly – concerning smart city – on stakeholders [36]. Although many have ITSM connected only to the business environment, every organisation that has to do anything with IT services is performing their management. ITSM contains operation of IT services, budgeting for hardware and software, monitoring the services, educating stakeholders, and much more. This also stands true for smart cities. However, there needs to be a shift in thinking from the business perspective to the city-oriented perspective. While there are many similarities, the main objective of a city is not to make a profit but to serve its citizens. Therefore, while services in ITSM are judged based on the value they bring to the business, in a smart city, the services should be driven by the value they bring to the stakeholders.

Cities could benefit from using a more strategic approach of ITSM because it could help them to understand the value of the services for stakeholders. Furthermore, it could also help manage the risks related to these services, thus making the services more resilient and ensuring value co-creation for stakeholders. ITSM is not only about delivering a service but also about planning, designing, and developing it. When creating a strategy or starting a project, ITSM could help the cities with interconnecting the components. It could also simplify and help with interlinking the new services with existing projects and services from all perspectives (such as stakeholders or hardware and software).

4.1 ITIL and Smart City Services

The most widely adopted and globally recognised approach to ITSM in business is called ITIL [37]. It is a collection of best practices that helps organisations with delivering value to their customers. Therefore, ITIL represents best practices in ITSM. According to [37], service management is 'a set of specialised organisational capabilities for providing value to customers in the form of services'. The standard

for ITSM is ISO/IEC 20000-1:2018, which also works in conjunction with ITIL. The standard describes processes for management of services and their effective delivery. [38]

According to ITIL, ITSM is a strategic way to manage information and communication technologies as well as provide and deliver services to customers. The first version of ITIL was created in 1980s [39] and the newest one is currently version 4 from 2019. Although ITIL and ITSM are prevalent frameworks for the management of IT services, not much is written about using them in relation to smart cities. This lack of publications may be caused by the business nature of the framework. Nevertheless, it does not mean that ITIL cannot be used in smart cities.

ITIL v3 (version 3) divides Service Lifecycle into five stages (as can be seen in Figure 4.1) and every stage is further broken up. The stages are Service Strategy, Service Design, Service Transition, Service Operation, and Continuous Service Improvement. In the centre of the framework is Service Strategy that serves as a basis for Service Design, Transition, and Operation. These four stages are enclosed by Continual Service Improvement.

The following subsections are structured so a comparison can be made quickly. It always starts with an overview of a particular ITIL stage, followed by a description of the stage from a new perspective. The sources for the theoretical information are mainly [40] and [41] unless stated otherwise.

A new perspective on the ITIL framework from the point of view of smart cities follows the ITIL framework theory. The ITIL framework is related to smart cities from a high-level perspective, creating a possibility to use it as a framework for Smart City Service Management (SCSM). [10] suggests that a standardisation of services, together with applications and business models, could significantly reduce the development and maintenance costs of services. This reduction of costs would also be true regarding smart city services. Moreover, standardisation or implementation of suitable framework would help with their management.

The ITIL framework for ITSM is utilised as a baseline, although it is necessary to make adjustments. The inspiration for the management of services in a smart city comes specifically from ITIL v3, even though the fourth version is already in use. It is because ITIL v3 has been em-

ployed since 2011, and there are many successful cases of companies using it to improve their service management. Also, while the foundation of ITIL v3 and ITIL 4 is the same, ITIL 4 underlines the importance of agility. The focus on agility may be a problem for cities, because their financing is very often rigid, being subjected to many controlling mechanisms. Therefore, ITIL v3 is a valid basis for adaptation to smart cities. A significant advantage of a system based on the ITIL framework is that nothing has to be done precisely according to the framework. It is possible to implement only what is important and what will bring value to the city. A suggestion of SCSM implementation is proposed in a selected city; the proposal is further described in chapter 5.

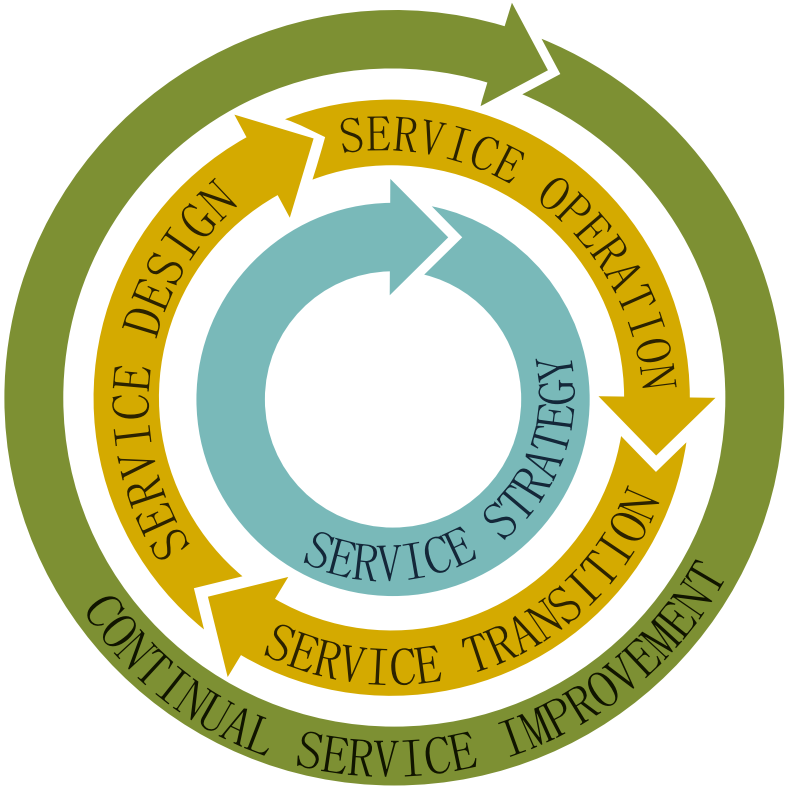

Figure 4.1: Five stages of the ITIL v3 Service Lifecycle. [40]

4.1.1 ITIL Service Strategy

A strategy allows the provider of a service to organise information about the service and have a vision of how the service should look like in the future, ensuring perfect understanding. The strategy states how the management of a service is designed, developed, and implemented. With a clear strategy, the provider should be able to react to changes and improve the service accordingly because they have all the necessary information.

- Financial Management: Finances influence the services from its design to its provision. Financial management covers budgeting for projects, acquiring finances, and also spending. The objective is to manage financial resources in order to be able to achieve the goals of a company. In addition, financial management quantifies the value of a service. [42]

- Return on Investment (ROI): The official ITIL Glossary defines return on investment as a measurement of the expected benefit of an investment [43]. It measures the ability to generate additional value. Because the benefit is described only as a value, it does not necessarily have to be of a financial nature. However, the objective of companies is to make money; therefore, a financial return can be expected as the most important one.

- Service Portfolio Management: Service portfolio collects all possible services the provider can provide with the current assets, together with their description and business value [42]. It includes newly prepared services, running services, as well as retired services and service concepts. Managing this portfolio means to choose the right combination of services to satisfy a client/customer. It also has to consider the costs, necessary investments, and potential ROI.

- Demand Management: It is essential to keep track of demand to ensure business continuity and utilization of services, no matter if it is the demand of the market or the demand of existing customers. Demand management also helps to estimate further developments, can help with creating new services, and

prepare the necessary capacities, therefore lowering the risk of the company's inability to provide services.

4.1.2 SCSM Service Strategy

Smart city strategy is a vital part of any smart city project. Maintaining a vision and interlinking services and corresponding areas or layers is essential for having a general overview. Nevertheless, it is still just an overview, and it does not contain all the necessary information for service management. Elaborating on a smart city vision and creating a detailed collection of services would help cities manage such services in an easier manner. As was mentioned in section 3.2, a suitable classification would be necessary to also help with proposing value to stakeholders.

- Financial Management: The most notable difference between cities and companies in financial management is the fact that cities' primary goal is not to make money. Regardless this fact, cities have to manage their finances carefully. Although services can bring income to cities (by, e.g. providing city infrastructure to a company), it is more likely cities will spend money on the services. Moreover, it may not be only procurement spendings on new infrastructure, but also maintenance or on a salary for administrators of the services. For every IT service or category, these following information should be recorded: cost of operation, maintenance, downtime, repair, possible expansion, and employees. On the other hand, expected or possible earnings should also be logged. Part of financial management should include periodical balance checks of every service and possible grants.

- Return on Investment: Cities may consider ROI as one of the factors when deciding if services are valuable. However, it could be more useful to measure indirect benefits, rather than strictly financial ones. By employing smart city ideas and improving infrastructure, more companies may invest assets in the city, therefore bringing not only money but also additional value. The other non-financial value can be, e.g. the number of people a service brings to the city (tourist, new citizens, companies),

or improvement of the quality of life. These benefits directly depend on the value the service brings to stakeholders. Therefore it is important to look at the services from the point of view of the stakeholders themselves.

Measuring the impact of smart city services on stakeholders is another field which could be the basis for return on investment in smart city. Overall, ROI in a smart city means all the benefits (direct or indirect) a service can bring to the city. The benefits should be taken into consideration when implementing new service or deciding what to employ, and thus should be recorded.

- Service Portfolio Management: Service portfolio in a smart city would collect all services the city can provide with the current assets. It has to be updated when necessary. The complexity of the service portfolio in a smart city is dependent on the dynamics and interconnection of services. While in a company the services are from one provider, the city has to manage services from different providers (e.g. from the city itself, companies, or companies owned by the city) and manage how they fit together.

- Demand Management: Monitoring the demands in smart city is just as crucial as in business. The power of smart solutions is in prediction. With proper knowledge about demand for services, the smart city could predict the necessary IT infrastructure and other resources needed to implement the services at the right time. Demand management should include monitoring of stakeholders and analysis of their needs to create new services, as well as monitoring current services to make sure they still bring value to stakeholders (intended or not). It is essential not to forget that according to the SDL, the value can be only proposed and hence the provider themself cannot decide the value without external inputs.

  In a smart city, it is important to gain and maintain inputs from all the stakeholders. Regarding possible new services, these initiatives must be appraised, and evaluation has to be made of how they fit into the catalogue of currently offered

services. The evaluation of change must take into consideration all stakeholder groups and also the existing and planned infrastructure.

4.1.3 ITIL Service Design

When creating a service, all contexts, connections, and current state of things should be examined. Service Design helps to create and develop services that are in agreement with the strategy of a company.

- Service Catalogue Management: Service catalogue gathers all the consistent information regarding services, mainly in operation, but also in transition or retired. The administrator of the catalogue is responsible for updating and collecting information about services and also making sure it is accurate and up to date. Links, dependencies, and possible benefits should also be described here. [44] stresses the service catalogue as one of the most valuable components of service management.

- Service Level Management: When a subject provides or receives a service, targets of the service and affiliated responsibilities should be known to all parties. These targets and responsibilities may be e.g. when the service is running or how quickly the issues will be resolved. Service level management makes sure agreed level of service is provided. It helps to improve the relationship between the customers and provider because it contains all information about running a service, such as documentation, monitoring, reporting, and reviewing processes. This is done by creating a Service Level Agreement (SLA). SLA is a contract between provider and client/customer, where everything necessary regarding the service and its provisioning should be written and agreed on, therefore ensuring customer satisfaction. This information is based on the service catalogue.

- Capacity Management: Capacity management ensures maximisation of potential activities – the capacity measures how much can a company do within a time period. An example can

be the number of manufactured products in a month. Management of the capacity needs to make sure all parts necessary for the outcome are in harmony – meaning, there are enough resources to maximise activities, including human resources. It is essential for maximisation of profit, but also in case of increased demand.[44] states that even though the capacity across the whole lifecycle must be taken into consideration in the stage of Service Design, the analysis is already being performed in Service Strategy stage.

- Availability Management: Availability management includes every step of availability of IT services or their components. The steps range from design, across measurement and finally to improvement of the service/component, ensuring it complies with the agreement. It assures that a service can be accessed and used.

- IT Service Continuity Management: IT service continuity management helps with the management of IT services and components so the provider will be able to provide at least minimum agreed service levels. The provider can guarantee the minimum service levels by planning and performing recovery when an incident or problem occurs. It ensures the continuation of services, which means the service will never stop. Continuing a service is critical for the business itself. The continuity can be accomplished by minimising the risks and being prepared for recovery. [44]

- Information Security Management: Security is nowadays a critical and very discussed topic. Information security management covers security within services as well as within the business. It ensures the integrity, confidentiality, and authenticity of data, as well as sets the objectives which should be achieved by the business.

- Supplier Management: Hardware, software, and even parts of or complete services can be supplied by an external supplier, the most prominent one being, e.g. internet connection. Supplier management should cover and manage all suppliers

and services (or other components) they provide, while also planning the management in all life stages of a service. In a simplified way, it ensures, besides other things, that there is always someone to call when an issue with an external service arises.

4.1.4 SCSM Service Design

Since smart cities are creating, offering, and managing services, service design is a vital part of already established smart cities. ITIL Service Design can give an idea of what practices should be introduced in smart cities to help them better manage their services.

- Service Catalogue Management: While the service portfolio is about all the possible services a city can provide, the service catalogue is about already implemented and running services. Keeping the information about a service accurate is one way to be sure the service is valuable. Managing the catalogue should also mean changing or completely revoking a running service when evaluation reveals it is not valuable to stakeholders. As described in subsection 4.1.2, similarly to service portfolio, the service catalogue in smart city describes the whole service environment, and it may be difficult to find all possible synergies.

- Service Level Management: Regarding businesses, agreed on and met targets are important for healthy provider-client/customer relationship. Regarding smart city service, the healthy relationship between a smart city and its stakeholders is more based on the knowledge about services and their recipients. A detailed and specific creation of the city's layered model could help with seeing the whole net of links between services and stakeholders. Regarding services that are provided to companies or other stakeholders and are paid for, SLAs should be set and met as is done in the business environment. SLAs should also be set in the opposite situation – if service is provided for the city by company. With services free of charge for larger groups like citizens, SLAs are not only unnecessary but also hard to set. What could be better for these types of ser-

vices may be distinctly stating when the service is available and why and base this on the city's best effort and possibilities.

- Capacity Management: The idea of capacity management ensuring maximisation of profit may feel out of place regarding a smart city, because, as was stated several times above, a city's main purpose is not to make money. Rather than that, smart cities should take into consideration the value their services bring to the stakeholders and manage the capacities to ensure continuous satisfaction. The satisfaction of stakeholders could lead to indirect profit for the city, like the arrival of new citizens or new job vacancies.

- Availability Management: Keeping the services available is vital for stakeholder's satisfaction; therefore, availability management should be part of smart city service management. Since some of the services may have set SLAs, the availability would then be dependent on the city's decision. Availability should take into consideration not only IT services, software and hardware on lower layers, but also the availability of employees and subcontractors maintaining of the service.

  An interesting point of view stems from the fact that a city consists of different locations, and some services may be tied to particular places. Therefore, it is important to make services available where it makes sense. An example can be a bike renting service. The bike renting may be more valuable for stakeholders by being provided in a city centre rather than on the periphery. All of this should be considered when designing a service.

- Service Continuity Management: Planning and performing recovery is a part of the lifecycle of almost every service. Together with the incident and problem management (see below), service continuity management would help the smart city to provide agreed on service levels in a way ensuring stakeholders' satisfaction. Since this is still in the Service Design phase, it means service continuity management is about designing the service the way it would be possible to guarantee the continuity. All of the related services and IT infrastructure

have to be taken into consideration, possibly leading to the procurement of back up assets.

- Information Security Management: The security of information is a vital part of a smart city because cities possess large amounts of sensitive information. Opening their data, providing services, and sharing IT infrastructure has to be strictly monitored and regulated to abide by the laws and protect privacy. A security breach could destroy any relationship a city has built with its stakeholders, potentially halting a smart city project in its beginning.

- Supplier Management: The need to manage suppliers is important in smart cites in the same way it is in the business environment. However, with smart city, it is vital to find synergies among the suppliers, so not only every participant benefits from the relationship but value is also created by interconnecting the different suppliers. The first step for managing suppliers would be to recognise which services and infrastructure are provided by each supplier. Then, the city should analyse which smart city services are dependent on them and how. From there, a smooth running of provided assets should be ensured by a contract between city and supplier. Crisis scenarios with solutions if a problem or incident occurs should be an integral part of the contract.

4.1.5 ITIL Service Transition

Service Transition covers steps for managing all resources for release to ensure the operation of a service. It is focused on the part where service is, figuratively speaking, leaving the provider and starts to bring value to the client/customer. However, this transition is also happening when retiring a service. The Service Transition ensures a service in this stage meets the expectations described in the service strategy. [45]

- Transition Planning and Support: Transition is an immense step for the service provider and client/customer, and it should happen as smoothly as possible. Therefore, planning is necessary. Moreover, the transition planning and support also contains

maintenance of standards and policies, identification and management of risks, and coordination of activities through different projects. [45]

- Change Management: It is important to realise that changes include some risks. These risks should be classified and connected to potential changes. All changes need to be logged (what it was, how it happened, and by whom it was made) to minimise risks and their impact. Changes are not only done to recover service but can also be pre-authorised – e.g. deployment of a new server. All of this belongs to change management.

- Service Asset and Configuration Management: Every service uses several assets for its functioning and operation. This category covers assets and configuration in the transition phase.

- Release and Deployment Management: Release and deployment management proceeds after the Service Design stage. It manages and plans building, testing, and delivering services which have been designed there.

- Service Validation and Testing: Before deployment of a service to the production environment, it is necessary to ensure the service is ready to be published and complies with the intended purpose recorded in Service Design. Testing should verify if the service meets the requirements, while validation confirms if the expectations of the client/customer are met by the service.

- Change Evaluation: Evaluation allows for systematic control of usefulness and guarantee of existing services or changes, taking into consideration the impact it has on the business. Evaluation can be the driving force behind change because often evaluating a service can lead to ideas on how to improve it. Furthermore, if the service does not bring value to any stakeholder group, the evaluation can lead to retiring the service.

- Knowledge Management: Knowledge management contains gathering, categorising, and storing important information regarding services. Managing knowledge about services is espe-

cially significant regarding a change in teams where one person leaving can mean completely losing vital knowledge. With every recorded piece of knowledge, there should be the necessary data, basic information (who, what, when, where), how it was done/resolved and why is it being done this way. This type of detailed entry ensures a better understanding of the process. Regarding knowledge management, it is also essential to transfer knowledge among employees through meetings and workshops.

4.1.6 SCSM Service Transition

When a new service is ready to be deployed (or old one retired), many things have to be considered, no matter if it is in a business environment or a city. At this point, the service is designed, and its value proposition is clearly set. It is also introduced in service portfolio and service catalogue.

- Transition Planning and Support: The timing of service deployment may be crucial for its success. It is especially true in the business environment, but cities may benefit from this too. Imagine the service of smart traffic lights to improve traffic in a city. Deploying such service, for example, on the first day of school would be highly risky, and in the case of failure, it could put the service in a bad light for stakeholders. In contrast, deploying the service at the beginning of the summer holidays, together with clear communication of such, would allow operational testing (assuming there is less traffic on summer holidays in the city). Afterwards, at the beginning of the school year, the service would be tested and prepared for increased traffic. Furthermore, compatibility with other services should be ensured.

- Change Management: Every new service is a change to the already running system, and it is important to balance them and record the necessities. A smart city should know what changes are happening and why to maintain stakeholders' satisfaction by thorough communication of these changes. The complexity of interconnections among services can be seen in Fig-

ure 3.3. Besides, as was mentioned above, changes can be pre-authorized, which allows for their proper planning.

- Service Asset and Configuration Management: On an example of a new camera system, it can be shown that none or incorrect asset and configuration management could lead to several incidents. Camera system could use local network for communication, which is naturally used simultaneously by other services like traffic lights and many various sensors. All services on the same network could fail if asset or configuration management, or both, would not be taken into consideration. The cameras could generate more traffic than the network is prepared for; therefore, effectively stopping any communication taking place on the network. This situation could arise from a problem of insufficient capacity of the network (therefore failed asset management) or incorrectly configured cameras, assuming they would, for example, send the video in unnecessarily high quality, hence flooding the network (failed configuration management).

- Release and Deployment Management: As was described above, release and deployment management includes not only delivery but also the building and testing of a service. It is crucial to make sure the service will be integrated into the service environment not only from the point of view of stakeholders but also from the perspective of other IT services. For this, it is essential to know the current IT infrastructure and be ready to procure another, if necessary for the intended service. An important part of release and deployment management is also a training of end-users and employees operating the service. In a smart city, services will be often outsourced by companies, and the contract should cover all this.

- Service Validation and Testing: In a smart city, it is vital to be aware if service is bringing value to the stakeholders. At the beginning of service operation, validation of this should be done with stakeholders (by, e.g. using questionnaires or recording the number of complaints). Testing, on the other hand, is more

of an internal matter, where creators together with smart city coordinator should verify if the service meets requirements stated in the Service Design phase, from technical and (if applicable) non-technical point of view.

- Change Evaluation: To be sure service is continually valuable to stakeholders in a smart city environment, evaluation is necessary. It falls into the Deming cycle of Plan-Do-Check (Evaluate)-Act, which very closely relates to Continual Service Improvement (see below). Especially in a smart city, which should serve its citizens, it is imperative to communicate with them and know their opinion. Therefore, the city should not focus exclusively on the financial advantages of a change. Furthermore, maintaining a service that is not valuable to anyone can be very expensive and wasteful. Besides, for evaluation, it is essential to work with the correct set of metrics and indicators, so the city is not cluttered by useless data.

- Knowledge Management: The same is true in the smart city as is in the business environment regarding knowledge management. In addition, selected knowledge could also be shared with the general public, educating the stakeholders about smart city background. This education would then also serve as an advertisement of the smart city's outcomes. It is important to maintain the knowledge of stakeholders to make sure the services are used to their full potential.

4.1.7 ITIL Service Operation

After transitioning to the production environment, the service is ready to operate and bring value to the client/customer. However, the work of the provider does not end here – it is necessary to comply with the agreed-on SLA and manage the operating service.

- Event Management: Event management is a process of monitoring all events in IT infrastructure, detecting and escalating unexpected occurrences. For successful recognition of an event, the state of infrastructure needs to be known at all times. Event

is a change of state with significance for the service/component and its management; an action of personnel is typically required for the event to be resolved [43].

- Incident Management: Incident management is a process describing dealing with services after an incident (unplanned interruption) and returning them to their normal state, throughout their whole lifecycle. An occurrence of an incident does not have to be reported only by a monitoring tool, but employees, users, and other stakeholders can do so too. Incidents, similarly to changes, must be logged, categorised, and prioritised. The recording is done to ensure either quicker recovery when similar/same incident occurs or to have information for resolving the cause.

- Request Fulfilment: Request fulfilment gathers different demands on a service by users. It is closely related to an incident because both of these may result in a change. However, requests are usually for information or small changes. Therefore, requests are, unlike incidents, considered low risk. [46]

- Access Management: Access management falls under the category of security. It manages accesses to services for authorised users or roles. These users and roles have to be clearly defined.

- Problem Management: Problem is the cause of one or more incidents. Problem management is supposed to minimise the occurrence of problems and incidents and further investigate them throughout the whole service lifecycle [43]. As with changes and incidents, it is necessary to log the arising problems and prioritise them according to their impact.

Service Operation also contains four functions.

- Service Desk: Service desk is a business unit arranging contact with customers/clients. Service desk serves as one point of contact for all, logging the requests/ideas/complaints and either solving them or escalating them to a superior.

- Technical Management: Technical management is responsible for IT infrastructure and related work such as network, servers,

or programming. The activities there consist of planning, implementation and operation of IT infrastructure, so the foundation of services is stable. This function is prominent in different parts of various phases, e.g. in capacity management or release and deployment management.

- IT Operations Management: IT operations management takes care of everyday functioning of services and IT infrastructure. The goal is to keep the services and devices running by maintaining and managing them.

- Application Management: Application Management maintains and supports applications in all phases where it is necessary: ranging from the design of applications to the operation and improvements. The goal is to support business processes.

4.1.8 SCSM Service Operation

Hopefully, every city already has some services running. In a smart city, services may be more based and dependent on IT, and the operation itself may be more demanding to manage. Especially considering the tight interconnection among services described in subsection 3.1.2. Another problem specific to cities is departmentalism, because of which there is a lack of awareness of services throughout the whole municipality. Employees may be often aware only of the services provided by their department. Therefore, overview and interconnection of services must be known and managed for an efficient and value-creating smart city.

- Event Management: For the city to become reactive, it should monitor events and should be able to distinguish between those events that need to be escalated and those that are of a regular and natural occurrence. If increased traffic occurs on the network on Monday at 2 am, the city should know it is not an attack but rather a scheduled event of periodic arrival of new data on the servers.

- Incident Management: Because the services provided by a city are created to bring value to the stakeholders, incident manage-

ment and with that connected returning services to the operational state should be of high importance. The incident can be discovered by the responsible people, e.g. through event management, or by stakeholders themselves. Poorly managed incidents can lead to the loss of trust of citizens and other stakeholders in the smart city project. And while a company can offer compensation in the form of discounts, it is hard to compensate in the scope of a city. Therefore, incident management is crucial for a successful smart city.

- Request Fulfilment: In a smart city, the needs of stakeholders should be the driving force for designing and implementing new services or improving the existing ones. The city should collect requests, systematically evaluate them and use them as a starting point in service design. Sometimes a city may have an idea for a service without knowing if stakeholders would find it valuable; in that case, a process of gathering this information should be started. The city also gives information to stakeholders in cases they have the right to know it, and the information is not yet published. Request fulfilment is solely the responsibility of the city and cannot be covered by any external company.

- Access Management: While service like open data should be accessible to all, other services like citizen's portal should have clearly defined access rights. In a smart city, the smart services need to be categorised for groups of stakeholders, while IT services should be accessible to those who manage them and those services which use them. Secure channels need to be built when allowing access to services on lower layers.

  Part of access management in a city is also identity management. Ideally, the state should take responsibility for creating such a system, and cities should be able to extend it for their own use. However, if there is no central system, the cities (especially more populated ones) are starting to develop their own identity management systems, resulting in every city having a different one. An identity management system would allow expanding provided services by implementing secure and reliable ones.

- Problem Management: Together with incident management, problem management ensures stakeholders' satisfaction regarding the operation of services. The goal is to prevent problems from arising, therefore minimising the number of incidents. Problems in smart cities may have more complex nature than in a company, due to the widespread service environment and dependency of citizens on the city. Resolving such complex problems (e.g. a pandemic or a failure of service essential to life) is related to urban resilience.

Regarding the four functions of Service Operation, it may be helpful to separate the management of them to three categories – for internal purposes, profitable, and non-profitable. This suggestion stems from the fact that there are different SLAs for paid services and free ones. Therefore, the management needs to focus on different things and may employ different processes, even though the same people may provide the functions.

- Service Desk: Although service desk may seem unsuitable for smart cities, the important idea is one point of contact for all. Not only may multiple different places for saving inquiries lead to improper planning of resolving them, but it is also highly inconvenient for stakeholders. In a smart city, every stakeholder can be receiver of a service. If they should spend time finding the right place to report an incident, it is very probable they would not do it at all. A city would benefit from one clearly distinguished form on its website, saving the inquiries in one place. A new system can be developed, or an existing solution (like citizen's portal) can be adjusted. Stakeholders without the ability to access the form should not be forgotten, and an additional channel should be created for them; nevertheless, saving the request or complaint in the same place as others.

- Technical Management: Assuming a city has existing IT devices, it can be expected it also already manages the infrastructure somehow. The increasing number of smart city services may require the purchase of additional IT infrastructure. Consequently, a city may find more systematic approach useful. Part

of technical management is also employee training and testing of services.

Since it was established in section 1.2 that IT plays an important role in a smart city, it is essential to include the IT department in decision making regarding the city's development. Moreover, IT has to be part of the city's strategy. Only this way, a city can design IT tools to support its smart city project.

- IT Operations Management: As with the previous function, IT operations management should have already work somehow in the city, assuming there are IT devices utilised. The increasing complexity of infrastructure may create new processes to keep the operations effective. It can be seen in Figure 3.3 that IT infrastructure occupies a critical role in a smart city because a great number of services depends on it.

- Application Management: While the goal is to support business processes, in a smart city, the goal would be better formulated as to support stakeholders' satisfaction. Nonetheless, it does not mean application management does not support the profitable activities of a city. Supporting stakeholders' satisfaction does not leave out these activities. Application management in a city should cover management of all the communication among applications, irrespective of the application provider because a city should acquire data from the usage of these applications to gain insight into decision-making.

4.1.9 ITIL Continual Service Improvement

The ITIL framework implements a 7-step improvement process. This process helps with improving services, making them desirable and useful for the intended market. It also helps to improve effectiveness, efficiency, and costs of processes. This phase pervades through all of the phases above. It implements measurements from other phases to find opportunities for improvement. The seven steps are:

1. Defining what should be measured

2. Defining what can be measured

3. Gathering the data
4. Processing the data
5. Analysing the data
6. Presenting and using the information
7. Implementing corrective action

After the last step, the cycle begins anew. [47]

4.1.10 SCSM Continual Service Improvement

Data is collected throughout all the stages to give input for the continual service improvement. In cities, the process of improving a service sometimes happens naturally through feedback from stakeholders. However, in later stages of a smart city project, the city needs to strive to be proactive rather than reactive, waiting for stakeholders' requests. Smart city services should be continually improved to propose better value to stakeholders or to maintain the value proposition. Stakeholders will not use a service which does not bring them value; therefore, cities may waste resources. Because the continual service improvement passes through all the other stages, it is essential to decide the metrics in the service's strategy. This decision can be made, and metrics can be prepared, even though the city is not yet ready to process and analyse the data and implement the continual service improvement as is described in the ITIL framework. With the right preparation, it will be easier to begin to do so in the future, when the city has necessary resources. In smart cities, both the subject and methods of measurement are very complicated. Cities can not take inspiration from the business environment because traditional metrics focus on companies, and therefore are not suitable for cities.

5 Case Study: Žďár nad Sázavou

This chapter introduces the city of Žďár nad Sázavou, which serves as a living lab for smart city research for the Faculty of Informatics, Masaryk University. The document Smart City Concept of Žďár nad Sázavou is described further in the chapter to present the smart city initiative in the city.

Later in the chapter follows an analysis of the city from the perspective of SCSM Service Operation and Service Transition. This analysis was done through a series of interviews with the city's Smart City Coordinator. Lastly, improvements to the most burning problems of the city are proposed together with suggestions on how to introduce SCSM gradually.

5.1 Smart City Žďár nad Sázavou

The city Žďár nad Sázavou has 20 717 ihnabitants [22] and is located in the Vysočina Region. The city itself is a capital city of LAU 1 (local administrative unit). It has excellent touristic potential due to the nearby Pilgrimage Church of Saint John of Nepomuk, which the UNESCO declared World Heritage, and also due to being located in nature conservation area Žďárské vrchy [48].

Besides tourist attractions, Žďár nad Sázavou has a long-term tradition in the industrial engineering. The city also offers many activities for its citizens like farmer's market on Saturdays in the centre of the city, sport's activities for summer and winter, museums, and others. Moreover, Žďár nad Sázavou has extended online services for its citizens (e.g. an online form for questions and suggestions or a system to reserve a spot in municipal authority), and offers chosen data as open.

The city started to collaborate with the Laboratory of Service Systems from the Faculty of Informatics, Masaryk University in the 2018 in order to get help with their smart city project. While the representatives of Žďár nad Sázavou had not had complex overview and vision of their smart city efforts, they have already started with individual projects such as electric vehicle charging points. The city became a living lab for the smart city initiative of the Faculty of Informatics,

a place where academic pursuit and real-life are met. In the first quarter of the year 2020, a Smart City Concept [49] was created by an external company with insights from the city's representatives, citizens, and other stakeholders.

The motivation for using a smart city strategy in Žďár nad Sázavou is clear. The strategy serves as a vision for the city – where the city wants to be in the future. It should be the foundation for all the projects, so they fit together and create a complete package of well-defined and interconnected services for stakeholders, not to be in isolation as frequently happens [5]. Often, the individual projects follow the interests of their authors and are focused on a specific technology. The projects may then be connected to a broader smart city concept without specifically defined goals or can be artificially linked to strategic goals. This unsystematic approach does not lead to the smart city project proposing value to the stakeholders. [7]

The strategy should also serve to the city representatives as a functional summary of all the services that are necessary to be implemented. Except for the obvious smart services, it should also be a summary of related IT services and infrastructure. Even though smart services cannot be implemented without proper IT services, IT services are often pushed to the background and come up as a last thought. If IT services are not taken into consideration together with other services in the beginning, it complicates the following implementation of smart city projects. The projects may rely on unrealistic expectations of IT services, and IT resources may be wasted if every service will have its own infrastructure even though they could be combined [5].

Strategy and concept are similar terms; however, strategy is more for a long-term vision, while concept can be more of a set of ideas and projects. Strategies very often do not contain a concrete project (e.g. strategies of the city Vienna [50] and Brno [51]), while the concept of Žďár nad Sázavou contains an analysis of six areas of smart city and from there, particular projects were chosen to be realised. The concept of smart city was realised based on the Development strategy of Žďár nad Sázavou [52]. Moreover, even though it is not a smart city strategy, the Development strategy mentions making a better quality of life for its citizens as one of the global objectives, together with improving technical infrastructure. This objective is according to [3] a good sign that a strategy is cohesive and sustainable. However,

there is no purely smart city strategy in Žďár nad Sázavou. The current Development strategy has been approved until the year 2028, and it is recommended to create the next strategy as solely smart city strategy (combining the concept of smart city and the development strategy into one) because there should be no need to separate them.

The concept itself is divided into five parts, including conclusion and sources. The analytical part forms the main body. Six areas were analysed, copying the traditional flat structure described in subsection 3.1.1 – smart governance, smart people, smart living, smart economy, smart mobility, and smart environment. After the analysis follows a short section dedicated to already finished smart projects of the city. As a result of the analysis, ten projects were chosen to be realised.

5.2 Step 1: Analysing the Initial State

Section 4.1 mentions that the ITIL framework does not need to be implemented as a whole. This is also true for the SCSM variation. Instead, the city can decide to implement what will help them the most. The option of choice is especially useful because it allows the cities to focus on their problems and build a strong foundation for their next steps. The gradual implementation also does not overwhelm the employees of the municipality.

The first step in deciding what could benefit the city Žďár nad Sázavou were interviews with the Smart City Coordinator. Through the interviews, the state of the city's management of services was discussed. At the time of writing this thesis, the city focused predominantly on the stage of Service Operation. Instead of designing how services can look in the future, the city focuses attention to what needs to be repaired. There are little to no resources for planning.

The main problem discussed was public tenders based on the lowest price, where the winners of such tenders are not able to comply with the contract. Problems that arise from this situation are discovered too late. As an example of the problem with these lowest price public tenders was stated a company providing winter maintenance of roads and pavements. When winter came, the company was not able to arrange the pavement sanding, which resulted in several injured citizens. This inconvenience hurt the image of the city

because citizens, rightfully so, saw it as the incompetence of the city. From their point of view, the city is responsible for the pavement sanding, and the citizens do not, and should not, take into consideration any sub-providers – it is a responsibility of the city. Therefore, it is important for the city to pay the public tenders special attention.

Part of the city's focus is aimed at short-term planning. Around July 2020 the city started to use new project planning software. The software contains services in the stages Service Strategy, Service Design, and Service Transition. The warranty period of services is also often tracked there. However, several problems have arisen when using this software. Even though the employees had a training workshop regarding basic project management, estimation and analysis of risks is still an issue. Due to this hindrance, the planned projects are not prepared for any delay. Furthermore, time and finances regarding the projects have to be reported; this new workload creates tension among the employees since they have not been adequately motivated to use the software. More issues contribute to the general aversion, like improper training or inappropriate communication of the advantages of this planning software.

5.3 Step 2: Finding a Starting Point

From the interviews, it was apparent that the city is mostly reactive, dedicating most of its resources to Service Operation. Therefore, the next step was to look further into this stage to summarise the situation. After laying a stable foundation in Service Operation, the city could aim to become more proactive by implementing other suitable and valuable parts of the SCSM framework.

Small part of the city's resources is devoted to Service Transition, mainly planning projects and deployment of services. It seemed from the interviews that the city has started to create processes to work more efficiently with individual projects and services. However, there are several problems in this stage; one was already mentioned above. Therefore, further below is also a subsection describing the current state of Service Transition in the city to find starting points within the stage and connect them to the possible starting points of the Service Operation stage.

5.3.1 Service Operation in Žďár nad Sázavou

Every part of the stage Service Operation is broken down in this subsection, describing the current state of the city according to the interviews.

- Event Management: A sentence repeating throughout most of the interviews was 'different services deserve different intensity of control'. Meaning, for the city, the important services have at least some kind of automation and focus on their control is favoured. The issue of the classification of services will be described further below. One of the well-tracked services is the heat distribution system which is monitored automatically. The services that the city does not consider of the same importance, e.g. street lamps, are examined manually by an employee. Where complaints from stakeholders are expected, these services are controlled more strictly. Stakeholders can use the official website – a special application was created for this purpose – to notify the municipality about a problem. A smartphone application was used briefly, but its support from the city was ceased due to low engagement.

- Incident Management: Similarly to event management, when there is a malfunction of service in Žďár nad Sázavou, the speed of repairs depends on the importance of the service considered by the administrator. The incidents are recorded only with the heat distribution system, but they are not categorised or prioritised.

  Responding to questions of citizens and other stakeholders is also considered a part of incident management. It means something was not correctly communicated, explained, or the information cannot be found or is hard to find. As was mentioned above, stakeholders can utilise the special application [1] on the official website to ask questions. A responsible employee answers the inquiry and publishes it anonymised on the same site. The answers can be filtered only by the department which responded. Questions for the municipal police have a different application in another part of the website.

1. In Czech: Dotazy a náměty – https://www.zdarns.cz/online-sluzby/dotazy-a-namety

- Request Fulfilment: For requests, the stakeholders can utilise the application described in incident management above. Except for this, there are two pages on the website that can serve as a request fulfilment. The first one is a list of links named 'Potřebuji vyřídit', where a stakeholder can find links for more information about, e.g. identity card, passport, or trade licence [2]. The second page, which could be considered a request fulfilment, is a queue management system for reserving consultation slots in chosen departments of the municipality [3]. Interestingly, those pages are not available in English; not even a simplified version.

  More specific inquiries regarding particular projects are usually stored separately and added to the record for the project contractor.

- Access Management: The city has an ultimate vision of making every possible service accessible for all eligible users. However, it is only a vision, and the current state is very different. The administrators of the services know who has the authorisation to access it; nevertheless, there is no central access management system. Moreover, when a citizen requested records from emergency committee meetings formed due to the COVID-19 pandemic in spring 2020, the documents were sent only to the requestor. A better solution would be to publish them on the city's official website to be accessible for everyone. On the other hand, the city has started to work on their open data portal, collaborating with the Faculty of Informatics, Masaryk University [53, 54] together with a way to present the data to the stakeholders in a dashboard form [55].

- Problem Management: It was clear from the interviews that not much is being done in Žďár nad Sázavou as preventive measures. This finding confirms that the city is more reactive than proactive. However, there is a noticeable effort to min-

2. In Czech: Potřebuji vyřídit – https://www.zdarns.cz/mestsky-urad/potrebuji-vyridit/
3. In Czech: Objednávkový systém a stav front – https://www.zdarns.cz/online-sluzby/objednavkovy-system-a-stav-front-na-meu

imalise the origins of problems by performing preventative measures where it is deemed suitable. Such preventative action can be seen when a road is being repaired; the owner of the pipelines below (if it is not the city itself) is contacted about the opportunity to do the maintenance. The decision is then on the owner. The city had an experience when the owner did not want to carry out the maintenance, and in six months, the road had to be closed again due to a pipeline accident. The preventative measures the city performs are very often conditioned by subsidy and again, on how much the service is considered important.

- Service Desk: As was mentioned several times above, Žďár nad Sázavou has a specific application on its website for inquiries. It is, however, not the only point of contact as every representative has their contact information listed on the website. Furthermore, some inquires can be raised in person or on a social media site. The general contacts site also contains a telephone number (without a specification whose it is) and address of an electronic repository [4]. Inquires that arrive by these channels are not stored in a single space or are not stored at all.

- Technical Management: The municipality has its own IT department which is responsible for technical management. However, the interviews suggested that the main focus is on the municipal authority, rather than on maintenance of all the IT services. For example, the new camera system is in the competence of municipal police, and a private company was solving the problems of capacity and interconnectivity. Even though outsourcing is a valid form of IT management, a smart city is based on IT, and therefore IT should be under the control of the city. If outsourcing is done, it has to also be managed appropriately.

- IT Operations Management: Similarly as in the case of technical management, IT operations management and the city's website are handled by the IT department. A problem can be seen in the fact that other employees than those from the IT

4. In Czech: Datová schránka

department are not able to tell if the services of said department are the best possible.

- Application Management: The IT department of the city maintains and creates most of the applications. When in need, the employees extend an existing application to better suit the needs of the city and its stakeholders. On the initiative of stakeholders, they added the option to enclose a photo in the inquiry application form on the website. Another new application was created for comments to the urban transport plan [5]. The stakeholders could express their ideas and suggestions on a map of the city.The city further used those comments in the transport plan [6]. However, this application is not accessible via smartphones. This inconvenience has been criticised by the stakeholders on the social media sites of the city.

As was mentioned above in event management, the city expects that different services deserve a different level of supervision. The issue of how are the services classified and where is the classification stored arose during the discussion. It came to attention that the services are not objectively classified, and the importance is usually based on a personal opinion, knowledge, and experience of the administrator. This empirical approach can fail when the experienced employee leaves their position and is replaced by a new such.

The interviews brought up a concern of the classification of services – who the responsible person should be and how to assure their objectivity regarding the categorisation. To elaborate, the concern is that those who would classify the services would choose the services they maintain as the most important ones. Another talking point was regarding politics and the possible issue of getting across the point why the objectively important service should be classified as one.

5.3.2 Service Transition in Žďár nad Sázavou

The interviews with Smart City Coordinator revealed not only problems connected to Service Transition stage, but also useful information

5. In Czech: Generel dopravy
6. In Czech: Názorová mapa dopravy – https://gis.zdarns.cz/ost/gis-objekty-pro/nazorova-mapa-dopravy

and resources that can be utilised as an advantage for better management. The same structure as in the Service Operation stage above is followed.

- Transition Planning and Support: Several problems are arising from the usage of the planning software; however, when finishing for a better overview of projects. The software contains and therefore checks a workflow that every project has to go through. If a deadline is not met, the administrators are notified. In addition, the software allows to set access rights in such way that others can see the projects. It can be beneficial for creating an overview of all of the projects for the purpose of supervision. In a smart city, the services are usually closely connected, and it is necessary to have an awareness of different projects. Currently, only the city's mayor knows of all projects, albeit only superficially.

- Change Management: The changes directly influencing stakeholders are communicated by the city in advance. The city gathers comments and observations of the stakeholders regarding those changes to use for further improvements. However, evaluation of these opinions is not without difficulties, as is mentioned below.

  The city tries to minimise risks mainly by utilising external sub-providers. From the experience of the city, the sub-providers co-operate very well until they are paid. Afterwards, the municipality noticed unwillingness to resolve issues.

- Service Asset and Configuration Management: The city possesses a geographic information system (GIS) and also its extensions – a very detailed map of vegetation. While the GIS is used as a source for road and pavement sanding in winter, the plan of vegetation is used to tell when the grass needs to be mowed. However, due to the map being very detailed – every tree and bush is noted there – the city has problems to keep it updated.

  Similarly to project planning, the interconnectivity of services is not holistically addressed. There is a lack of service overview

and general knowledge about different services. Very often, it is the responsibility of a service administrator/provider to think about the relation of their service to other services. Another important issue, which was mentioned already in subsection 4.1.8, is departmentalism. People are not able to see the services they are managing in a bigger picture, nor configure them in relation to services from different departments.

- Release and Deployment Management: The city focuses on communication with stakeholders and does not forget about their communication needs. The representatives employ two channels –– the city's official Facebook site for those who use social media and the local journal for those who do not. In case when finishing project is faulty, it is recorded in handover protocol with expected rectification. The handover protocol serves as a document which officially ends the project and starts the operation of a service. An issue can emerge when cities are pushed to accept the project without reservation for acquiring a subsidy, even though there are objections.

- Service Validation and Testing: According to the interviews, every service in the city is tested before being fully deployed. Currently, the city tests emptying waste containers on a fortnight basis. Before, the new traffic lights were in a test mode to gain feedback from citizens. If a project has an impact on many stakeholders, a detailed analysis is done before deployment, together with testing.

- Change Evaluation: It was evident from the interviews that the evaluation of changes is not a regular step when considering a change. Very prominent was a tendency to prefer evaluation based on financial benefits. While a city has to be frugal, the main task is to take care of citizens, and their well-being should be taken into consideration. The value of a service may not be easily calculated; even though for companies it may be measured in income, for cities it can also be something the city learns or experiences. If the city analyses the comparison of risks and advantages, it is done mainly subjectively because often there are no resources.

Remarks from stakeholders are evaluated similarly; although the city gathers them, the comments and observations are assessed subjectively.

- Knowledge Management: Gathering and transferring knowledge is seen as problematic in the city. It concerns sharing knowledge among employees as well as on the level of services. Since every service is managed by an employee who has the most information about it, it is necessary to record processes and information. However, the city worries employees may not want to participate out of fear of critique of their workflow.

5.4 Step 3: Proposing the Initial Implementation

From the interviews, the most burning issues of the city were chosen, and appropriate recommendations were suggested based on the SCSM introduced in this thesis. In addition to the city's problems, recommendations were made based on the best practices of the ITIL framework. The suggestions and recommendations are described in this section. The city can choose the most valuable ones and implement them.

5.4.1 Regarding Public Tenders

The city perceives the problem of public tenders as a crucial one. There are three suggestions on how to possibly improve the situation.

The first one relates to announcing the tender. The city should change the tenders and base them on the second-lowest price, if possible, or at least do not base the tenders on the lowest price but prefer different criteria. This change forces the applicants to disclose their real price, and in case of preferring different criteria, the tender is not focused on price at all. Therefore, the city could partially solve the problem with companies which do not have the resources to realise the contracted service. Another possible suggestion regarding announcing the tender is to employ two providers instead of only one. On the example of winter maintenance, the system could be as follows. The primary provider would be responsible for 80% of the city's quarters, while the secondary providers would be responsible for the rest.

Correctly set SLAs, which is the second point of how to improve the public tenders, would allow for quick replacement of providers if one would not be able to carry out the service. Furthermore, the city could compare the service quality of those providers, gaining valuable information. Ambiguous SLAs do not guarantee customer's satisfaction, thus paying the agreements special attention could help the city with this problem. SLAs are part of Service Design's service level management.

The last point is a general suggestion regarding processes and methods in the city. In general, it could be beneficial to take inspiration from other cities; in this case, how they arrange their agreements. The correct settings of processes seems to be especially useful. If the processes are set appropriately, it should be easier to change a provider. The city should also expand their know-how by owning every procedure of a service; the provider would serve only as the executor of the service.

The problem of external providers was also mentioned in the interviews regarding deploying a new service, mainly when there are shortcomings. While the city has no problems when the tender is not yet paid, the exaction of repairs is difficult after the end of the project. A suggestion is to keep retention for the duration of the warranty and pay it out gradually. This procedure would have to be, of course, put in the contract.

5.4.2 Regarding Short-Term Planning

Generally, to motivate the employees, their work performance has to be measured. However, employees of the municipality of Žďár nad Sázavou need to be motivated to use the planning software. Only based on the measurements, the city can tell if the operational performance is appropriate or if motivation is needed. Furthermore, the action of measuring itself serves as a motivation. Employees may tend to base their working habits on the measurement, which makes the measuring process and related communication of the measuring important. With this knowledge, it is imperative to vary the metric when the employer is satisfied with the outcome of the previous one. Suitable metrics could help with the motivation of employees regarding the usage of the new

planning software. This proposal relates to SCSM Continuous Service Improvement and SCSM Service Transition's change management.

Related to short-term planning is also risk management with which the city experiences problems. The problem of proper risk analysis is followed by the problem of evaluating the risks. It is recommended to identify risks at the beginning of a project when a service enters into service catalogue or portfolio. Afterwards, it is necessary to record any emerging risks, what steps have been undertaken, and evaluate the process. It is important to start with risk analysis and recording of the emerged ones even though the city does not think it has the required skills and knowledge for evaluation. The collection of analysed risks will serve in the future for learning the evaluation and finding patterns and similarities. If the initial analyses are not done at all, there would be no space for progressive learning and gaining knowledge. It is vital to let the employees try and explore it before it is a required practice, if possible.

5.4.3 Regarding Categorisation of Services

The most significant obstacle in the implementation of SCSM in Žďár nad Sázavou is the absence of a list of services with categorisation. Possible problems mentioned in the interviews concerning the categorisation are mostly political.

Smart city projects and related services should be ideally stripped of any politics. That is why the role of a smart city coordinator should be outside the municipality's politics. A smart city coordinator appears to be a suitable guarantor responsible for the classification of services, of course with help and insight from specialists and stakeholders. Stakeholders should play an important role in the classification because ultimately, the provided services are meant to bring them value. Another suggestion is to classify services of critical importance without the input from stakeholders, asking for their input on the rest of the services. If the city has a problem with gaining insight from stakeholders, being it from unsuitable communication techniques or other reasons, the classification could be based on the utilisation of the services by stakeholders. The assumption is that important services will be used the most (or regularly). However, there may be a problem with acquiring this data, or the data would not be available immedi-

ately. Other two suggestions on how to choose the most important services are:

- According to the structure of the municipality office: Where is the most employees?
- According to the budget of the services: What services have the biggest budget?

The classification of [6] described in section 3.2 could be used in Žďár nad Sázavou to help with the overall management of services, not only regarding Service Operation but across the whole SCSM framework. The classification should be done objectively with insight from stakeholders and specialists.

Creating a service catalogue should be one of the first steps in implementing SCSM. [44] considers the service catalogue to be crucial for management. Without the catalogue of services, it is difficult not only to make decisions but more importantly, to be aware of all the services the city actively provides. When creating the service catalogue, a suggestion is to start from the most critical services and gradually add the rest rather than earmark resources to create the complete catalogue at the beginning. Every service in the service catalogue should have the following attributes: name, unique identification, description, categories, administrator, interconnection with other services, influenced stakeholders, metrics, and risks. However, detailed analysis and research need to be done to design a proper and suitable form of the smart city service catalogue.

A service catalogue would also help with an overview of services and their projects. While in Žďár nad Sázavou only the mayor knows of all of the projects, it might be better to involve the smart city coordinator more. They do not need to be involved in every project in detail; it should be enough to be present when a strategy is created and when a service is recorded into the service catalogue. Because the knowledge of smart city coordinator would not be only superficial, they would be able to find synergies and interconnections among services and projects. Interconnections of services could be visualised in the layered model; however, currently, there is no software for such activity.

Finding the synergies and interconnections should not be solely the responsibility of the smart city coordinator. A process of creating round table discussions should be set up. These discussions could also help with the departmentalism, which was mentioned several times in the interviews. Representatives of different departments, together with representatives of external organisations, could discuss the ways their services or projects are interconnecting, creating the proper smart city service environment.

5.4.4 Regarding Service Desk

Žďár nad Sázavou has many different communication channels leading to different people. While service desk is considered more as a department taking care of stakeholders, the main benefit for the city could be a single point of contact, or more precisely, a system where all the inquiries would be saved. It means that questions from web applications, the electronic repository, the phone calls, social sites, and inquired in person should all be stored in a single space. Although some of this could be done automatically, several channels would require rewriting inquiries manually. The main benefit is clear – having all the inquires at one place allows for transparency in the municipality office. Superiors could see how many inquiries are left to be resolved, are unresolved, or which department has the most work with the questions. More data could be collected, and new applications could result from recurrent inquiries. Furthermore, understaffing can be discovered and confirmed by using such a system.

6 Conclusion

The goal of this diploma thesis was to introduce the ITIL framework for ITSM and find if it is possible to adapt it to a smart city environment. Furthermore, this thesis suggested and demonstrated the first steps for implementing the management system on the example of a particular smart city. This thesis fulfilled its goal, especially throughout chapters 4 and 5.

The first chapter looked into the problem of smart city definitions. Because the smart city is a multidisciplinary initiative, there is no one agreed-on definition. Every field creates its own, focusing on the specific domain; the chapter explored several different definitions. However, not one of the explored definitions mentioned the connection of smart city and data. Therefore, own definition for the purpose of this thesis was drafted. This definition emphasises ICT as a tool for collecting data that can be further used in the city. Follow-up research should explore the data collection and usage of them concerning the maturity of a smart city.

The definition did not leave out stakeholders as a crucial part of any smart city. However, the literature on stakeholders seems to have gaps. While in total twelve stakeholder groups were identified in chapter 2, detailed research may be needed to help cities with the identification. Every smart city should have clearly identified stakeholder groups to ensure their satisfaction and manage the services effectively. Because the vital idea of service-dominant logic is value co-creation, the services should be created to bring value to stakeholders. Without proper knowledge, a city can create services that are not useful for anyone, therefore wasting resources. Moreover, in order to manage the services accordingly and effectively, they must be classified from points of view of all stakeholders and the city itself.

The next step for the newly proposed SCSM is its implementation in cities. The approach needs to be tested and, depending on the observations, changed accordingly. The inputs and observations should be collected from cities of different types (e.g. size, location, or stakeholder groups) to evolve the approach into the most useful as possible. A website for gathering the inquiries and use cases should be created to keep it compact, well-arranged, and transparent for all. There are

currently no cases of implementation except the suggested first steps described in chapter 5. Nevertheless, even now it is expected that employing SCSM will be valuable for smart cities due to the systematic approach to service management.

In order to propose the initial implementation of SCSM, chapter 5 introduced the living lab Žďár nad Sázavou. The current situation of the city was analysed through a series of interviews with the city's Smart City Coordinator. The analysis revealed that the city does not have a systematic approach to services and there is room for improvement. SCSM Service Operation and SCSM Service Transition were deemed as suitable starting stages for the implementation of SCSM. Finally, four concrete starting points were derived, and appropriate suggestions were made. The starting points are the following.

Regarding public tenders, it is recommended to focus on setting correct SLAs. In the case of short-term planning, the chapter suggests motivating the employees and utilising measuring processes. The most significant proposal is concerning the categorisation of services. As was mentioned in [44], the service catalogue is considered as one of the most critical parts of the ITIL framework, and it is viewed the same in SCSM. It was surprising to learn that Žďár nad Sázavou does not have its services classified nor written at one place. It is highly recommended for Žďár nad Sázavou to create a service catalogue which would help the city's representatives with the overall management of services and their interconnections. It is believed that Žďár nad Sázavou would greatly benefit from creating such a catalogue. The last suggestion is regarding service desk, or more specifically a single point of contact. The city currently does not gather requests and inquiries in a single space; however, doing so would help them with efficient management. Furthermore, the data acquired by this practice can lead to improvement of processes in the whole municipality.

It was expected that the city does not use much of a systematic approach to service management. However, the extent of such was surprising. In order to successfully continue with the smart city project in the city, the representatives of Žďár nad Sázavou should focus on the suggestions made in this thesis and gradually implement them. The recommended first step is to start with the service catalogue.

6.1 Further work

This thesis revealed a considerable amount of further work that needs to be done. First of all, the theory needs to be translated into practice because the practice of SCSM will create new inputs for the approach. The inputs can serve as a source for new methods and processes for SCSM. This cycle ensures that SCSM continues to create value for cities.

The next necessary steps regarding SCSM should focus on analysis and research of the service catalogue. Furthermore, an implementation of the layered model could be created to help visualise the services and their interconnections. This visualisation would help cities with creating new services and with the management of these services. Moreover, such a filled in layered model could ultimately serve as a service catalogue for a city.

This thesis only briefly introduced a classification of smart city services. Extending this classification further on all of the layers of the layered model could simplify the management of services. Last but not least, it could also be interesting to examine the relation between SCSM and maturity models of smart cities. It is expected that implementing SCSM would help with their maturity.

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