

ROLE OF DATA IN URBAN PLANNING AND DEVELOPMENT

CASE CITY: LAHTI

Abstract

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Abstract <p>Development of technologies has dramatically changed the way people live. Information and communication technologies (ICT) became the part of our personal lives. At the same time, these technologies affect communities, organisations and even cities – they enable new development capabilities, better-informed decisions and more effective processes. Information technologies create vast amounts of urban data, which carry insights about urban environment and infrastructure.</p> <p>The main objective of the research was to study the role of data in urban planning and development, what are the benefits of data application for urban planning and development, and finally, how data is applied to urban development in Lahti. The study was conducted under the abductive approach, different methods were used to achieve the results. Those include literature review, semi-structured interviews with specialists, existing data analysis.</p> <p>The result of the research showed that urban data is used to study urban environment, analyse processes and objects within it, apply accumulated knowledge to urban planning and development. Benefits of data application include improvements of infrastructures, urban systems, safety and sustainability of urban environment and new social and economic opportunities. The case of Lahti showed that even developing cities can use data to their advantage in order to build resilient and sustainable communities.</p>		
Keywords Urban data, Urban planning, Urban development, Decision-making, Smart cities		

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1 INTRODUCTION

Development of technologies has dramatically changed the way people live. Information and communication technologies (ICT) became the part of our personal lives. At the same time, these technologies affect communities, organisations and even cities – they enable new development capabilities, better-informed decisions and more effective processes. Information technologies create vast amounts of urban data, which carry insights about urban environment and infrastructure.

Urban data change as we live, but it is important to understand what role it can play for urban development and why people should even use it. This research focuses on the field of urban planning and development in general, and, in particular, on the role of urban data in these activities. It studies what urban governance means, how urban planning and development are implemented and how urban data is used and applied.

It then analyses the case city on the basis of the literature review. The literature review supports the search for answers to research questions. It is followed by the case study of Lahti, interviews with local experts supplemented by online materials and presentations. Even as a developed city, Lahti can develop its data infrastructure, introduce new technologies and improve local services. Understanding of urban data capabilities will create new opportunities for the city.

Introductory chapter presents the overview of the research and helps readers to understand the topic. It includes research background, thesis structure and research approach. Thesis structure paragraph describes the thesis in details.

1.1 Research background

Cities have evolved to be centers of development and social life. People move to cities in seek of work and community. The process of rapid urbanisation happens around the world. We can see how share of people living in urban areas changed from 1960 to 2017 (Image 1). Due to urbanisation and population growth, increasing number of challenges occur in urban areas. These challenges exist on various levels: social, economic, environmental, governmental. There are exceptions, but generally cities are expected to spread and grow, so are related problems. (World Economic Forum 2018a.)

On the other hand, cities are key development units of our time – they provide opportunities for social and economic growth, enable creativity and productivity to masses of people (CityLab 2011). Jane Jacobs (1961) noted that cities are engines for innovations. At the same time, cities are systems that should function to make citizens'

lives better. They strongly influence our behaviour, feelings and interactions. (Montgomery 2013.)

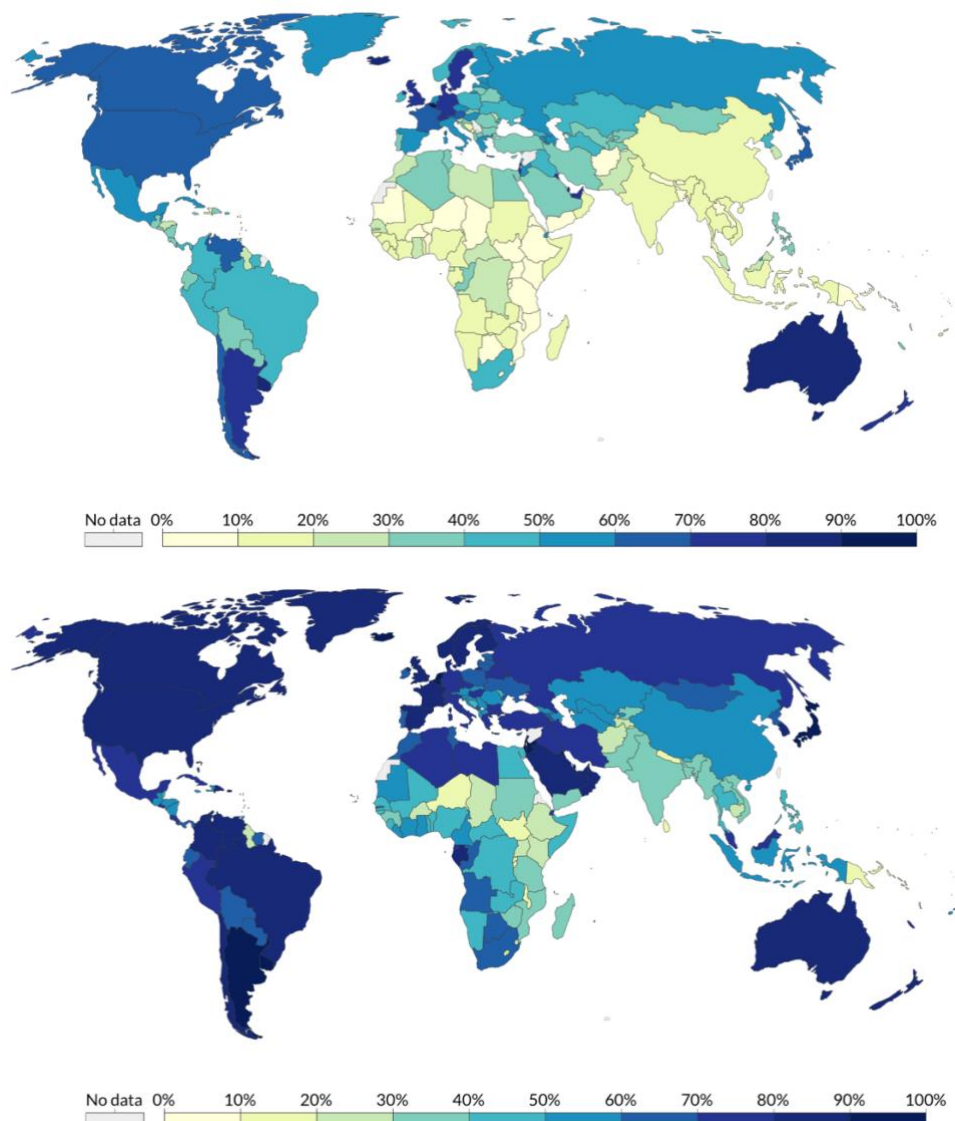


Image 1. Share of people living in urban areas 1960, 2017 (World Bank 2017).

The way we manage and design cities influences welfare of people and shape of society. State governments dictate general regulations in countries. However, they cannot address essential local challenges which lead to global crises. Cities have power and resources to make a big positive impact towards more sustainable and resilient development by applying effective techniques and methods in governance. (World Economic Forum 2018b.)

Effective governance relies on general understanding of a city and capabilities of different participants involved in the development process. Growing complexity of cities demands constant observation over its processes, as well as infrastructure for rapid reaction,

adjustments and improvements. It becomes possible with technological advancement and application of latest methods to urban development.

One of the methods is development and application of data science techniques and technologies within cities. Historically, research and analysis of urban environment relied on statistics, surveys and observation. Today, advancement and expansion of digital technologies produces a wealth of city data. (Glaeser, Kominers, Luca, Naik 2015.)

Growing volumes and availability of data creates new domains for development and new opportunities for growth and innovation. Cities are interested in using data to improve operations and address various challenges more effectively. Implementation of improvements requires participation of all urban stakeholders: government (decision-makers), economic partners, local citizens. (Opendatasoft 2020.)

Development of urban data field is a complex task. There are already some developed cities, such as New-York or Singapore, developing, such as Lahti, and not developed, often smaller or poorer entities. Generally, cities around the world become “smarter”, initiatives on greener and safer urban environment gain popularity, urban services and infrastructure are improved, processes within cities become automated, supported by different technologies, such as internet of things (IoT), information and communication technologies (ICT), geospatial applications. Availability of data and analytics capabilities play an important role in urban management and development. Evolution of technologies changes different parts of urban environment. There are many applications of data in transportation, energy and construction, while many applications are yet to discover. (Mobility 2020.)

There are countless applications of data science in various fields – we see how digital technologies invade and influence our lives. Urban data has the potential to dramatically change the way we understand and develop our cities. However, the science of data in cities is recent and there is still a lot of questions to ask and answer. This thesis is focused on the role of urban data in urban planning and development.

This is essential to understand – how to use urban data for development of cities? How do we extract knowledge from our cities and apply it back? There are many sources and types of data, and there are many ways to use and apply it. Moreover, cities are similar when it comes to technologies and methods of planning and development, but extremely different when it comes to certain solutions and local urban context. But in the era of digital shift, data is the primary resource for innovation and development.

In this thesis, author focuses on the central role of data in urban planning and development as major activities related to urban growth. The word “urban” is used in the meaning of related to a city, town. There is no universal definition for urbanity, but this is enough for the context of this study.

1.2 Thesis structure

In chapter 2, research objectives, questions and limitations, as well as ethical principles of the study are presented. Then, chapter 3 is dedicated to the literature review. It starts with urban governance, its general concepts and objectives. After that, development strategy and urban planning activities and methods are explored and explained. Smart city concept is shortly described to make a transition from urban planning to urban data theory. In the end of the chapter, application areas and role of urban data are discussed. Chapter 4 shows the results of the research, presents the analysis of Lahti’s urban governance activities and data application. Chapter 5 includes the answers to the research questions, analysis of the case study and the ideas for further research.

1.3 Research Approach

There are two basic research approaches: inductive and deductive. While inductive supposes conclusion from an observation, deductive method is used to make a conclusion based on facts or accepted premises. In this study, abduction, combination of two basic approaches, will be used as a method to find the best possible answer to the research questions. (Merriam-Webster 2019.) The thesis begins with a main research question, which leads to literature examination to obtain general understanding of the topic. Then, based on the available literature, a questionnaire for the interview is compiled to study the research case closely.

Therefore, the primary source of data is the interview with industry specialists. The secondary sources are studies and books by well-established authors, articles and report, related to the topic, interviews and surveys conducted by other parties, freely available statistics and data from governmental and international resources.

2 METHODOLOGY AND RESEARCH DESIGN

This chapter presents the research objectives, questions and limitations. It also describes the chosen research methods which are used to answer the research questions. In the end, research ethics are mentioned in order to respectfully address sensitive points.

2.1 Research Objectives, Questions and Limitations

The main goal of the thesis is to study the role of urban data management in urban planning and development. Author explores the domain of urban data and applications of data management techniques and technologies in urban environment in order to understand the benefits of effective data management for the city.

Another goal is to analyse the case city and compare it to the frameworks expressed in the literature review. The research questions have been thoughtfully formulated to make the research process precise and effective.

The main research question is:

- What is the role of urban data in urban development and planning?

The sub-questions are:

- What are the benefits of urban data application?
- How urban data is applied to urban planning and development in Lahti?

The study is limited by several factors. First one is the complexity of the urban data field – each domain discussion can be elaborated deeper; however, the goal of this thesis is to explore urban data concepts and its relation to urban planning and development, not focusing on particular parts, but on overall process and applications. Secondly, urban environment can vary depending on the size, density and culture aspects, which affects urban data features, availability and applicability. Thirdly, some relevant information about the case city cannot be disclosed by its representatives, However, author's goals is to conduct an objective, precise research to explore the role of urban data in urban planning and development.

Different kinds of data should be used to get valid research results. (Crowe et al. 2011, 4-5). This study utilizes different methods for attaining and analyzing variety of data types.

2.2 Thesis Methodology

First method applied in this study is the literature review. Available field knowledge is analysed and presented to form a background and provide a context for the research. In literature review, several real-life examples are included for a deeper understanding of the urban data domain and a more precise further research.

The study continues with the analysis of Lahti's urban data management through personal observations, information available on the internet and interviews with specialists working in Lahti government. Based on the information obtained from the literature, benchmarks and questions are compiled to evaluate Lahti by common standards. Author compares trends and practices with activity in Lahti city. The case study approach works best for obtaining an in-depth knowledge about the question of interest, in its real-life conditions (Crowe et al. 2011). A case study is a research approach which explores phenomenon in a relevant context using different data sources; it prevents the study from being one-sided, incomprehensive. A case study is usually implemented in four different scenarios:

1. The study is aimed at answering "why" and "how" questions;
2. The behavior of those involved in the study cannot be manipulated;
3. The author believes that the context is important to deepen the understanding of the subject of the study;
4. The studied phenomenon and the context are connected, and it is difficult to differentiate them. (Baxter & Jack 2010, 545.)

This method has been chosen because urban data field is practical and highly dependent on the context, thus cannot be generalized. However, there are widespread issues and challenges which can be analysed and then resolved with common solutions.

In-depth interviews with industry representatives were recorded electronically and later analyzed. Semi-structured conversations are based on the information gathered from literature, list of topics and questions are compiled in advance, although questionnaire is flexible and is adjusted throughout the interview. This approach has been chosen for exploratory case study, author looks for precise and explained answers related to urban data management issues. (Saunders, Lewis and Thornhill 2015, 393-394, 6th edition)

2.3 Research Ethics

While conducting any kind of research, especially the ones involving the third-party participants, it is crucial to provide full clarity to handle the ethical and sensitive points in a

respectful way. (Ethicsguidebook.ac.uk 2018). This thesis is based on carefully chosen and cited information from different sources as well as author's ideas. During the implementation of interviews, the interviewees were informed about the author and the aims of the research which the interviews were done for. In accordance with GDPR interviewees consented to sharing their personal information and took part in the interview voluntarily. The participants have the right to withdraw their consent anytime and the content is being used for the agreed purpose only, which is the writing of the bachelor's thesis. All the conversations were recorded with consent of each party. The participants decided not to put in any sensitive information, therefore none of it was recorded or used. The author is the only person who got access to the tapes, and when the research is ready the tapes are deleted. The interviewees read the final work before anyone else to ensure the information was gathered, presented and analyzed in an ethical way. Personal opinions expressed during the interview are clearly marked to avoid confusing facts and opinions.

3 LITERATURE REVIEW

This chapter presents the background for the research and is based on available scientific studies, articles and public speeches from reliable authors on topics of urban governance, urban development strategy and urban planning, urban data and its applications.

3.1 Urban governance

Throughout the major part of human history cities were ruled by monarchs, who had power to take indisputable decisions. Nowadays, they are managed and planned by professionals and, virtually, should satisfy the needs of its citizens. The process of planning, financing and managing urban areas is called urban governance. It involves different parties and institutions, private and public. Relationships between them and decisions made by them influence urban processes and environments. As illustrated in Figure 1, these parties include: private business, civil society and governmental institutions, individuals and communities. (Devas 2004.)

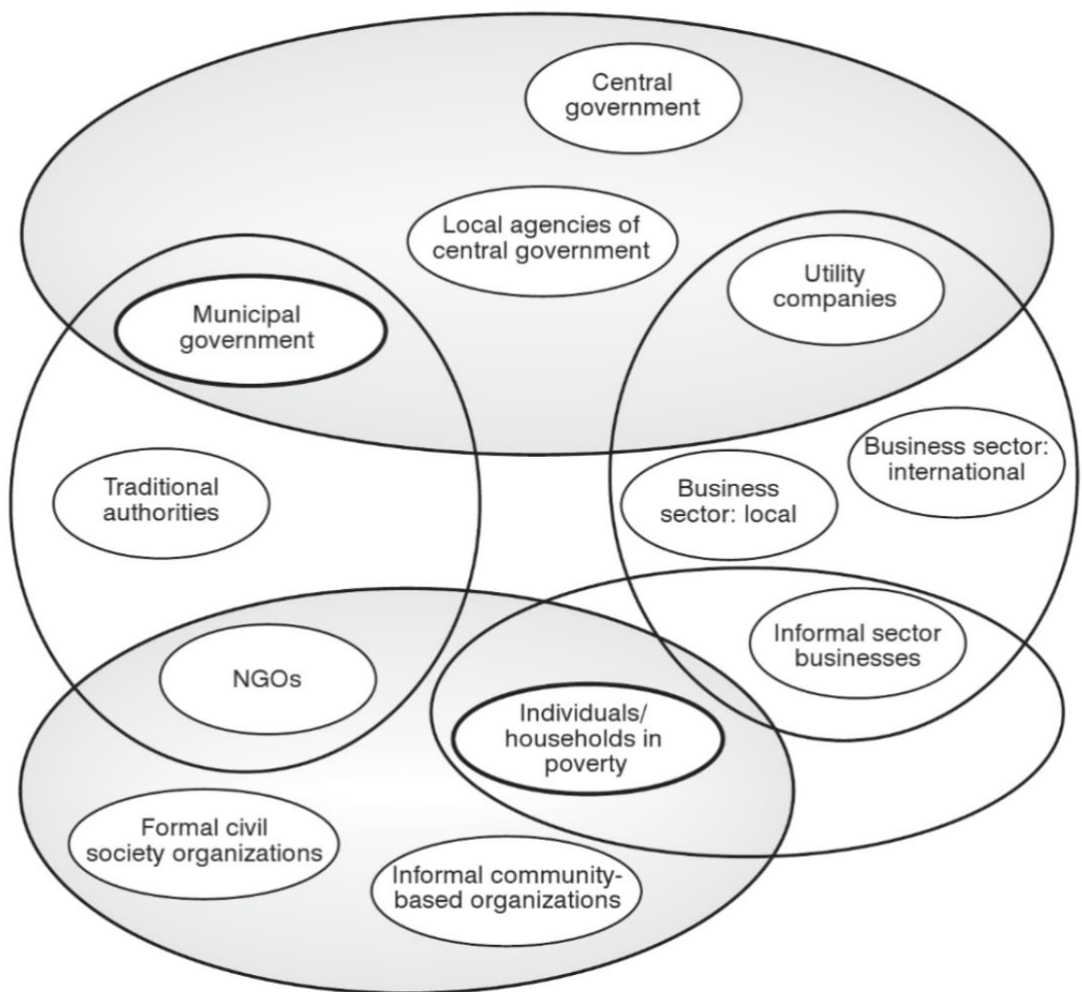


Figure 1. Participants of urban governance process (Devas 2004, 25)

Environment of a city is shaped by private and public parties based on common interests and certain contexts (Figure 2). One of the partakers is a city government, which is usually a central and most powerful element implementing actions. Thus, considering needs and interests of different parties, city government controls and plans urban development. (Devas 2004, 25.)

As we can see from Figure 2, urban governance is a continuous process. Decisions based on relationships between parties produce outcomes which shape a city and enable further development. Elements within urban governance and development processes are profoundly interconnected.

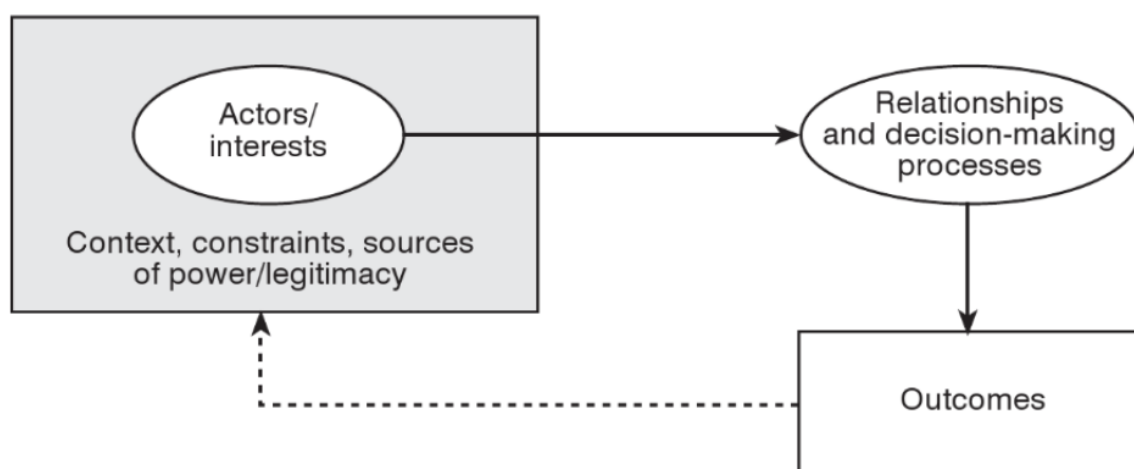


Figure 2. Relationships of participants and outcomes (Devas 2004, 27)

Importance of urban governance

Management of cities and urban development under growth conditions is a key challenge of 21st century. While good comprehensive governance enables social and economic well-being, bad governance and lack of planning contributes to poverty, inequality and conflicts. (Avis 2016.)

Urban governance influences many urban aspects:

- physical and social shapes of urban region
- quality and quantity of services and their effectiveness
- distribution of resources between and costs for involved parties
- participants of governance process, decision-making, accountability of the government and satisfaction of local demands (Slack and Côté 2014).

Qualitative urban development, which supports and improves local welfare, require reliable mechanisms of control, planning, coordination and communication. However,

participants of the governance process face various limitations and constraints, one of which is deficiency of relevant data/information about urban environment, social and economic conditions and local population. (Venables 2015)

Principles of good urban governance

Definition of urban governance doesn't include its characteristics. According to UN-Habitat (2010), this is the definition of 'good' urban governance:

“Urban governance is inextricably linked to the welfare of the citizenry. Good urban governance, based on the principle of urban citizenship, affirms that no man, woman or child can be denied access to the necessities of urban life, including adequate shelter, security of tenure, safe water, sanitation, a clean environment, health, education and nutrition, employment and public safety and mobility. Through good urban governance, citizens are provided with the platform which will allow them to use their talents to the full to improve their social and economic conditions.”

- Moreover, there are several principles of good urban governance, which are highly interconnected and mutually reinforcing: civic engagement and citizenship, sustainability, subsidiarity, equity, efficiency, transparency and accountability, and security (UN-Habitat 2010). This vision is considered universal and can be applied by cities in their planning and development activities.

3.2 Development strategy

Urban governance includes multiple activities for development and maintenance of a city. As was mentioned in the previous chapter, urban governance can also influence many important urban domains. However, as any management process, city governance requires a development strategy in addition to common vision.

Development strategy in the context of a city is a goal-oriented activity, which requires participation of interested local parties. Its objective is to facilitate steady, equitable development in cities and suburban areas for well-being of the citizens. A city development strategy is supposed to integrate local development approach with long-term vision and perspectives into urban planning. Well-positioned, strategically prepared society significantly improves its performance in development and is less dependent on political and economic trends. (Cities Alliance 2019.)

Urban development strategy affects several development factors, such as allocation of resources, capital attraction and use, city vision, potential partnerships and projects,

anticipation of growth and shocks, urban planning. These factors vary from city to city, but can be grouped by five common domains:

- Livelihood
- Energy, services and environment
- Infrastructures and spatial form
- Finance
- Governance

In order to successfully develop these domains and ensure quality growth, city development strategy should be implemented with certain rules to include all necessary elements and consider important factors. According to Cities Alliance (2019), the process of urban development strategy design consists of eight steps (Figure 3).

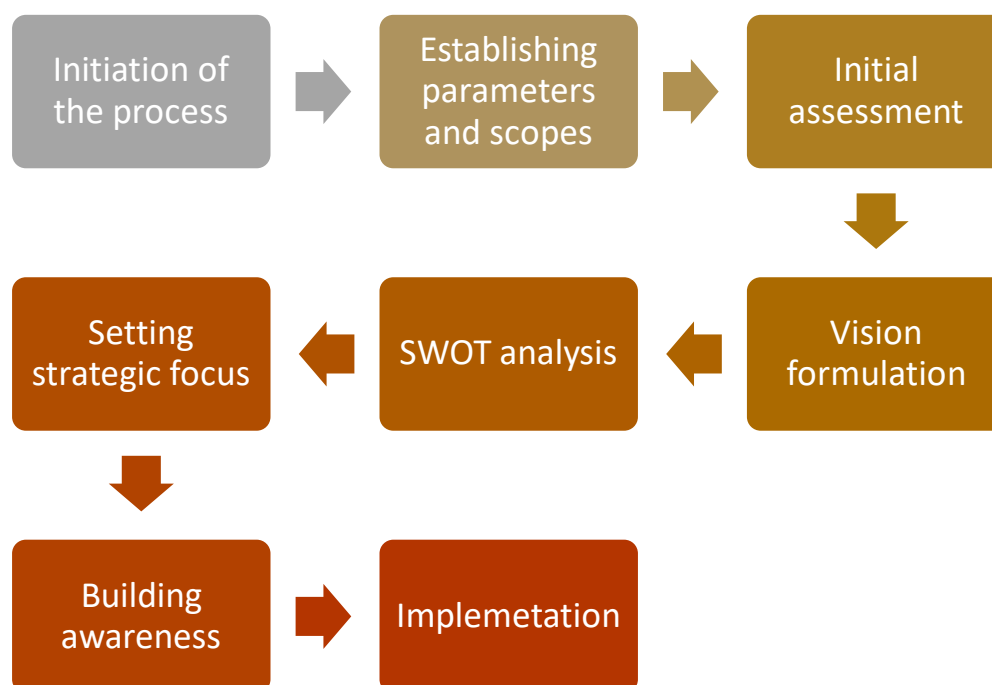


Figure 3. Development strategy design (Cities Alliance 2019).

In today's highly complex and unstable economic and social environment, it is practically impossible to predict and plan for every situation. Therefore, cities and their developers need to be more flexible and strategic. Urban entities, which fail to implement such approach are vulnerable to external threats, and, moreover, barely prepared to take advantage of opportunities. A versatile but focused organisation will be in a better position to manage complexity of urban environment and react to emerging opportunities. Nonetheless, urban analysis and planning are necessary elements of successful application of strategic thinking. (Chartered Management Institute 2019.)

3.3 Urban planning

Development strategy sets a vision for a city. However, it is essential for this study to understand how cities are planned in order to describe the role of urban data during this process. Urban areas are complicated systems, which require thorough and weighted planning and management. Historically, urban planning referred to physical layout design and involved architects and civil engineers. Nowadays, urban planning can be defined as political and technical process of design and development of natural resources' usage and urban infrastructures, such as transportation, communications, and distribution networks related to an urban area. (McGill 2019.)

Urban planning relates to both the development of land and rebuilding or redesigning of existing parts of a city. As any planning process, it supposes goal and strategy setting, forecasting, data analysis and design processes. As very complicated and integrated urban activity, it requires multidisciplinary cooperation and public consultation. (Fainstein 2019.)

The goal of urban planning is development of physical, social and economic environments of a city in order to improve and maintain welfare of current and future residents.

Comprehensive approach is a key feature of urban planning and it explains the complexity of this process. (Harris 2019.)

In-depth research and analysis process is necessary in order to create a plan of urban development. Various issues are considered before actual planning process:

- current residential and commercial land use
- industrial activities of an area
- census information
- economic situation
- public and private opinion

This cumulative knowledge and related strategy are captured in a comprehensive development plan, or a master plan. (Harris 2019.)

3.3.1 Master planning

A master plan (Image 1) is a dynamic long-term document describing an existing community and its future development strategy. It can contain different types of information about local land, systems and population. Master plan can be used by

municipalities of any size – this process can be outsourced to planning firms or implemented by city planners. (Harris 2019.)

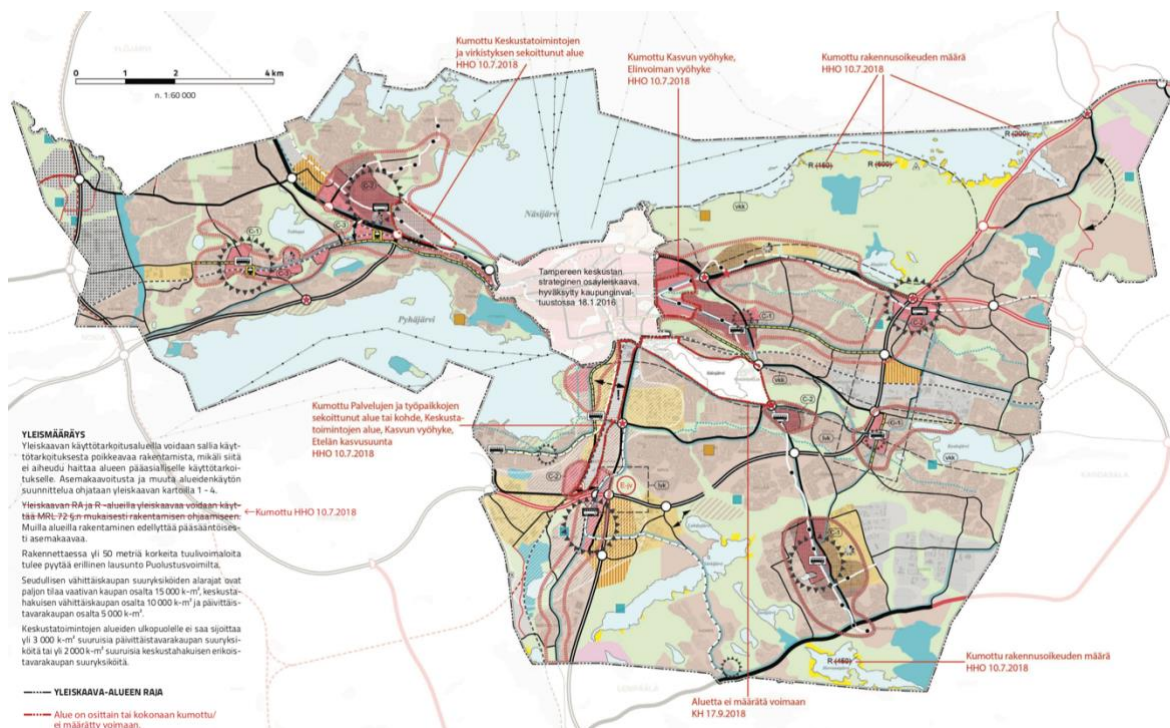


Image 2. Master plan of Tampere, strategic goals, land use and traffic systems (Tampere 2017).

Usually, master plan addresses the following issues:

- transportation and traffic systems
- parks and open spaces
- community facilities
- housing
- economic development
- land use

Creation of a master plan is a complicated activity, it involves numerous factors and is spread between urban domains. Often, the process of master planning is long and iterative – planning steps are repeated until participants are satisfied with results. (Harris 2019.)

3.3.2 Urban planning technologies

Urban planning evolved from a design process into an applied science and then a planning process. Nowadays, urban planners consider not only physical space and

theoretical knowledge they have, but local and personal experience and behaviour. Always this process required certain techniques and methods. The main difference of modern urban planning is that it inevitably involves information and communication technologies (ICT). There are few widely used planning technologies: geographic information systems (GIS), planning support systems (PSS) and the internet. (Klosterman 2015.)

Geographic information Systems

Computer systems for collection, storage and analysis of information about natural and built objects and processes that can be displayed on a map. These systems are useful for various planning activities such as analysing and displaying spatial information, maintenance of inventory and process administration. However, this technology has certain limitations related to incapability for future projecting and long-term implication analysis. (Klosterman 2015.)

Planning Support Systems

Limitations of GIS required new planning technologies, which have customizable features and meet the needs of planners. Some of the most used models in this area are:

- large-scale urban model
- CA model
- agent-based model
- rule-based model

These technologies allow more complex computations of social, economic and development related factors. This creates new opportunities and areas of interest for urban planners. (Klosterman 2015.)

The Internet

Internet and World Wide Web (Web) connect billions of devices into one information and communication system. Urban planners utilize this access to large databases with different types of data in their work. Also, this enables efficient communication, which involves more people into a planning process. Development of web services creates new techniques to capture data and implement urban planning, which seriously affects planners' capabilities. (Klosterman 2015.)

Urban planners apply various techniques and methods during the planning process. This related to collection of data through surveys and observations, data analysis and

assessment of current situation, planning and projections for the future. Urban planning includes vast majority of urban activities and can significantly influence growth, quality of life, economy and safety of citizens. The process of urban planning should be inclusive and engaging for better results – every inhabitant is responsible for well-being of a city and society. (Edsa 2019.)

3.4 Decision-making

Implementation of urban governance and maintenance of urban processes requires complicated decision-making. These decisions are made on daily basis inside local governments in regard to various aspects, from budgeting to infrastructure maintenance and social well-being. In the era of ICT and data-driven development, decision-making shifts towards 'smart' solutions and require increasing number of objective arguments, rather than intuition or personal opinions. (City Lab 2019.)

In general, decision-making is the process of making a choice, which takes several steps and always involves formulation of a problem, gathering of information and assessment of alternatives. This step-by-step activity requires certain deliberation and thoughtfulness for a better result. The goal of decision-making is to make the best possible choice.

According to The University of Massachusetts Dartmouth (2019), decision-making takes seven steps:

1. Necessity for decision – identifying a need to decide
2. Collection of information – gathering relevant information
3. Identifying alternatives – formulating possible courses of action
4. Weighing evidence – comparison of alternatives and arguments
5. Choice – choosing one alternative
6. Implementation – taking action
7. Review and analysis – assessing results and consequences

In urban context, decision-making is related to the governance process, which includes a wide specter of activities, for example: strategy development, planning, innovation, maintenance. This process differ depending on political conditions and social structure, but the objective remains the same – to make the best decisions. In Finnish cities, the highest decision-making body is a city council, which is re-elected every four years.

In 21st century, decision-making in cities is affected by developing technologies and knowledge. City planners are incapable to match the expertise of whole cities. Therefore, city residents should be included in the decision-making process, enabled with choice and power. (Eggers, Greene 2017.) Jane Jacobs, in her book 'The Death and Life of Great American Cities' (1961), wrote:

“Cities have the capability of providing something for everybody, only because, and only when, they are created by everybody.”

According to Eggers W. and Greene M. (2017), smarter cities not only use smart infrastructure and smart services, but leverage technologies to enable citizens with power to decide.

Decision-making in cities is definitely becoming more intelligence-driven. It affects efficiency and quality of decisions, planning, development and, eventually, citizens' lives. Before discussing how data is used in urban governance, we need to define 'smart cities' as an umbrella term for urban data.

3.5 Smart city concept

Concept of a 'smart city' covers wide areas of urban governance and development. There are endless definitions and characteristics of a smart city, but for this research we define smart city as one that uses information and communication technologies (ICT) to improve the quality of urban life and services. Main objectives are similar to conventional:

- Better quality of life
- Attractive economic competitiveness
- Sustainability and resilience

By using various technologies and methods, smart cities enable collection and processing of data related to urban processes and objects. Smart cities enable better decision-making for their stakeholders – public and private organisations, residents. (Eggers, Skowron 2018.)

The shift towards smarter cities has started with Smart city 1.0 – physical urban entities connected via sensor technologies that stream valuable data from “smart” assets. This technology improves performance of physical urban infrastructure and is a key part of a “smart city”. However, advanced cities are entering era of Smart city 2.0 – digital environment is used to improve experience and involve citizens into decision-making. Cities of the future will connect physical, digital and human environments into one intelligent, connected ecosystem. (Eggers, Skowron 2018.)

Technologies and methods of 'smart cities' influence various urban domains. According to Eggers, Skowron (2018), there are six of them: economy, mobility, security, education, living, and environment (Figure 4).

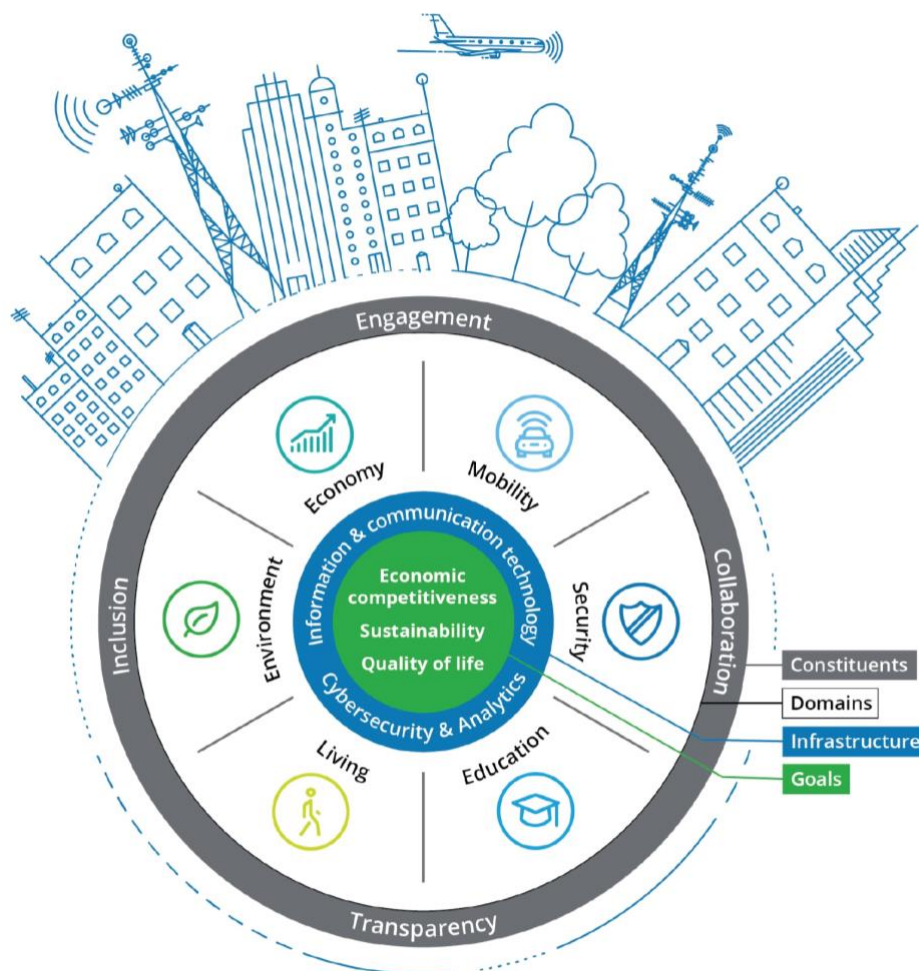


Figure 4. Smart city framework (Eggers, Skowron 2018).

In addition to smart city objectives, infrastructure and related domains, there are four constituents, or principles, by which this framework is implemented: engagement, inclusion, collaboration and transparency.

Modern cities store vast amount of data applicable for different purposes. ICT and analytics enhance availability and usability of this data. Concept of a smart city shortly describes importance of urban data, but doesn't provide necessary details about its nature and applications, which will be done in the next chapter.

3.6 Data

The main goal of this research is to understand the role of data in urban planning and development. In general, data are facts and statistics collected together for reference or

analysis. The word 'data' originates from 17th century, firstly used by philosophers, who defined it as "things known or assumed as facts, making the basis of reasoning or calculation." (Oxford dictionary, 2019.) Therefore, data are raw observations that require actions over them in order to obtain valuable insights.

Information

Another important term for the context of this study is 'information'. Data and information are interrelated but are not interchangeable. Business dictionary defines information as 'data that is accurate and timely, specific and organized for a purpose, presented within a context that gives it meaning and relevance, and can lead to an increase in understanding and decrease in uncertainty' (Business Dictionary, 2019). Information is processed, analysed data which has value and can affect decisions and outcomes.

Data analysis

Data analysis is required in order to transform data into valuable information. Data analysis is a process of studying, cleaning, transforming, and systemizing data with the goal of discovering useful information, informing conclusions and supporting decision-making (Xia & Gong 2014). Data analysis has diverse approaches and is used in various public and private domains of business, science and governance.

3.6.1 Big data

Governments and businesses have been always utilizing data for planning and managing cities. For a long time, applied data was limited in volume, origin and variety. New era of technologies open up possibilities for big data – it has increased volume, variety and velocity comparing to conventional urban statistics. It is more thorough, exhaustive, representing entire populations and systems in details. It can be real-time data or data over long periods of time or any kind of massive datasets created within urban environment. (Townsend, Zambrano-Barragan 2019.)

In this paper, terms 'data' and 'big data' are not separated and just referred as 'urban data' – created within cities. Author is interested in value that application of data technologies brings. Big data provides comprehensive insights, while smaller datasets has its benefits and can reflect opinions and actions.

3.7 Urban data

This study is dedicated to urban data, its role and applications in urban planning and development activities. Urban data is static and dynamic data created within urban

environment by facilities, organizations, and individuals. It can be collected and stored by governments, public organisations, enterprises, or individuals with modern information technologies tools and methods. Data can be analysed, shared, integrated or used by people to obtain a better understanding of urban environment, operations and processes. (Engineering 2016, 171-178.) Therefore, urban data are collections of data created by objects within cities. Generation and collection of data require digital technologies which are widely used by private and public parties.

According to Alexandre Gonfalonieri (2018), the workflow of data management can be described with three layers (Figure 5), which include technological networks, smart applications and analytics, adaptation and usage. The big challenge is an effective data integration between different organisations, departments and communities. Massive amounts of data are collected in cities, but most of it is forgotten.

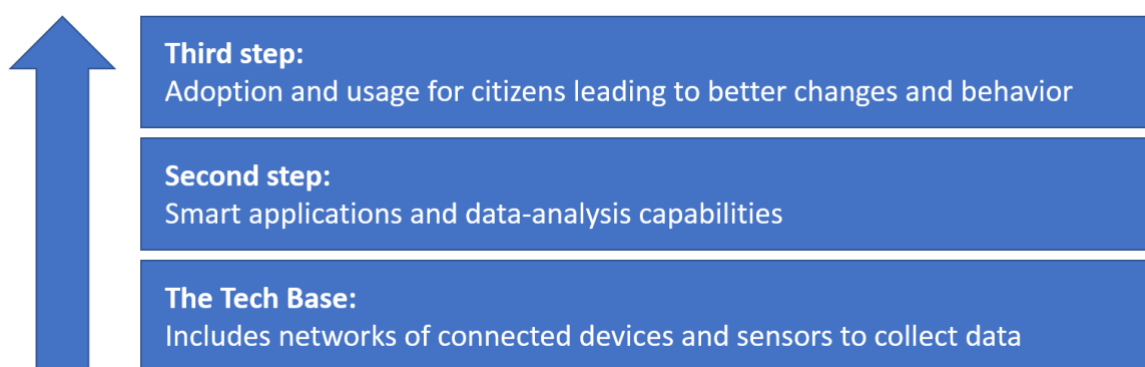


Figure 5. Three layers of data management (Gonfalonieri 2018).

3.7.1 Urban data types

There are different data types in data science and statistics. Practically, all of them can be found in urban context in various forms. Types of urban data are differentiated by the origin and volumes. In addition to geographic data/spatial data, which was discussed earlier, most common sources of data relevant to urban environment can be divided into three broad categories: government data (census data, open data, etc.); personal data (social media, quantified self-data, etc.), and sensor data (transport, surveillance, CCTV, Internet of Things devices, etc.) (Kitchin, Dodge 2011)

Data type	Examples
Geographic / spatial data	Mapping of surfaces and spaces
Government data	Census data, open data

Personal data	Social media, pictures, documents
Sensor data	Sensors, Internet of Things, CCTV

Table 1. Urban data types (Kitchin, Dodge 2011)

Urban data domains

Practically, most of urban processes can be tracked, analysed or observed. Scientists and urbanists divide urban environment into broad categories, or domains, for convenient research implementation and development. Features, applications and distribution of urban data are dependent on respective urban domains. According to Romualdo-Suzuki (2016), there are eight categories of urban domains, which are interconnected, but also separate from one another. All these categories (Figure 1) provide vast amounts and types of data, which have different characteristics, describe different objects and processes and require various techniques and tools for analysis.

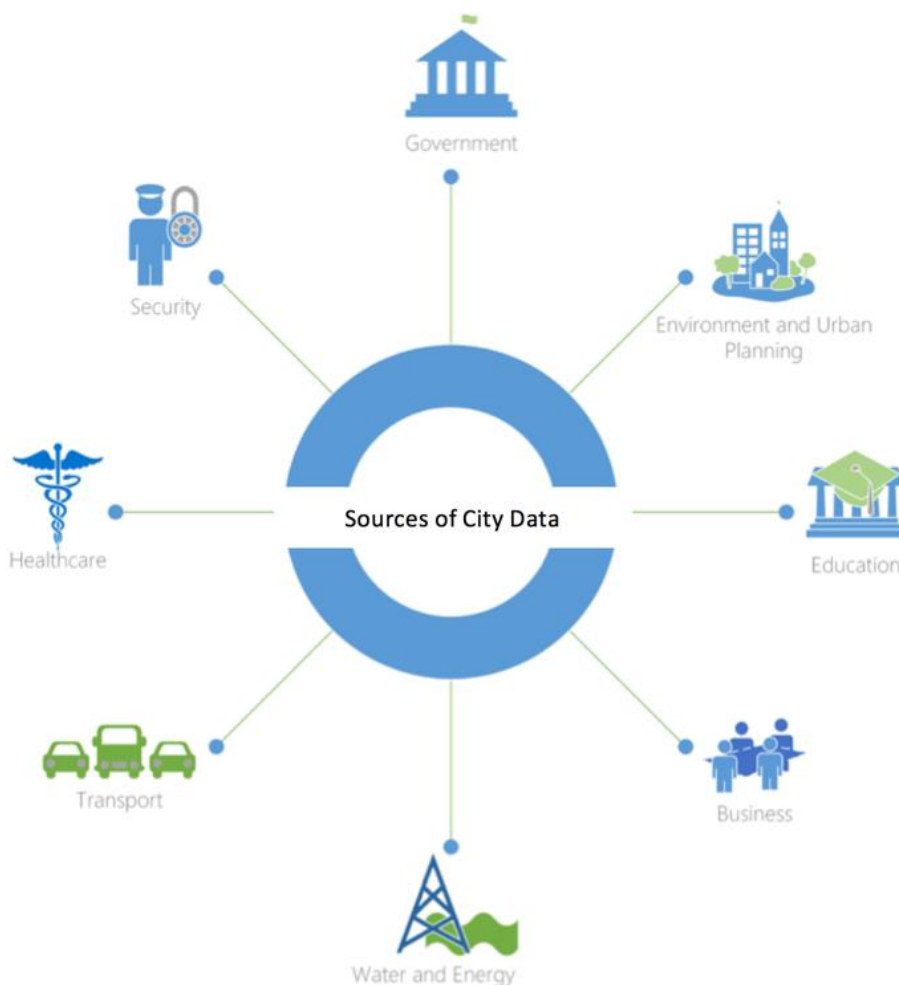


Figure 6. Domains of urban data (Romualdo-Suzuki 2016)

Often, different data sources are controlled by different parties: police forces, local and general governments, private organisations, individuals. Usually, government has the access to wide variety of information, which can even be opened to public. Processes within a city can be tracked and studied to obtain valuable knowledge for development. Every domain has according technologies or digital tools, which produce potent data. Never governments control every aspect of urban environment, but through active integration and inclusion organisations, systems and people can communicate and improve. (Romualdo-Suzuki 2016.)

3.7.2 Application areas

Technologies and processes in cities generate and collect data that can be used and applied. The same way urban data domains are organised, application domains describe areas where data can be integrated to or used in. According to Sen, Eggers (2018), technologies can significantly influence and change these areas:

1. Economy

Urban environment should be conducive for business and economy development. Smart economy can enable joint work and mutual benefits between private sector and government by facilitating technologies' application and intensive networking for resolving real urban and social issues. Smart urban economy can produce data which are valuable for urban economy analysis, prediction and support.

Example: evolving business ecosystems around major areas and communities (healthcare, student societies).

2. Mobility

Traffic data became as important as traffic infrastructure. Moreover, they are interconnected and provide comprehensive data on urban mobility. Digital platforms and services are already widely integrated into urban mobility and provide planning, ticketing and payment for citizens as well as valuable mobility data for governments and private companies.

Example: growing industry of mobility as a service; integration platforms for public and private transport.

3. Security

Public safety and security agencies must adapt to changing realities of urban environment. Data can play a big role in analysis and prevention as well as reacting to

emergencies. Smart policing and surveillance can be applied to improve safety and security. However, private safety and private secrets should be respected and considered. In addition, digital security should be addresses with secure data platforms, clear governance and smart access protocols for preventing and reacting to threat of hacking.

Example: predictive analytics; decentralised technologies for data safety and transparency.

4. Education

Data and analytics can enhance possibilities and varieties of education. Not only the way people learn can be transformed, but what people learn. Real-world cases and experience can replace classroom learning, while information technologies and digital applications can help analyze and track student's progress. Cities should create digital and technological conditions and collaborate with universities to solve urban and societal challenges.

Example: student projects that integrate urban data to resolve local issues.

5. Living

Technological advancement and application of data technologies in living domain involves such areas as healthcare, human services, infrastructure and building. Cities should facilitate tools that support healthcare, improve energy consumption, improve and tailor human services. In sync with data technologies, such as predictive analytics, and behavioral sciences, smart living can improve citizens' lives and help them make better choices, as well as promote and support sustainable way of living.

Example: smart buildings and infrastructure cut CO2 emissions and decrease resource waste.

6. Environment

Environmental and urban issues are serious challenges for cities. Optimization of energy use and resource consumption can benefit economically and socially. Application of sensor technologies which capture and collect data enable effective control and adjustment of urban services. At the same time distributed energy sources allow units produce and consume power at the same time, which leads to sustainable energy management and resolution of environmental issues.

Example: embedded technologies, sensors that track pollution, waste and resource use; improved energy use and new energy resources.

This is not an ultimate list of application areas, but it provides a general understanding of where and how urban data can be integrated and applied. This is important for this study, since the main goal is to explore the role of urban data in planning and development. These areas cover most parts of urban life and can be used as a framework for urban development.

3.8 Benefits of data application

How and for what reasons governments can use urban data may differ from city to city. However, there are some general benefits of urban data application, which are experienced by cities around the world. According to Adam Rujan (2018), government technology consultant, there are several widespread benefits of application of data technologies.

Effective decision-making

A well-designed data analytics infrastructure and strategic thinking gives cities access to massive amount of data – and gain actionable, meaningful knowledge from that. Intuition based decisions are being replaced with data-informed or data-driven decisions.

Enhanced engagement

Digital presence of a city promotes connected, integrated citizens' experience. Various online services, transparency in actions, involvement of locals create closer relationships with people and increase urban engagement of communities.

Safety

Technologies and integrated data flow can decrease criminal activities. CCTVs, detectors, sensors may not only help to interrupt the crime, but to prevent it by analytics and better urban design.

Reduce of environmental footprints

Critical conditions of global environment force cities to apply technologies and analyse data in order to control, identify and decrease sources of pollution. Moreover, data analytics help to understand consequences on citizens' well-being and improve urban environment.

Better transportation

Arguably, transportation is potentially the biggest smart domain of urban environment. Integrated and connected transport systems are significantly more efficient than the

predecessors. Different technologies from simple public transport tracking to real-time control of traffic help to reduce congestion, improve mobility, develop a better urban environment.

Economic and development opportunities

Smart city and urban data investments play an important role in building a competitive urban environment. It attracts businesses, investors and developers to cooperate with governments and improve cities. Innovations always bring growth, and urban areas are not exceptional.

Efficiency of utilities

Data collected from utilities help improve effectiveness of the grid. Data technologies give cities the tools for efficient resource usage and help to avoid waste of water and electricity. Also, these technologies improve communication between clients and providers.

Better infrastructure

Data technologies can provide tools for predictive analytics to maintain infrastructure, avoid failures. Eventually, it saves money and time for other urban challenges.

3.9 Role of urban data

Urban data describes the status and functioning of different urban objects and elements, such as buildings, streets, transport, finance, population. Urban data can be categorized differently, but clearly it gives us a better understanding of urban environment. Also, there are various analysis tools and methods of extracting value out of urban data. (Pan, Tian 2016.)

In the era of informatization, digitalization and global urbanisation, urban data becomes a valuable strategic resource. Growth of available data and analysis capabilities promotes development of integration, collaboration and innovation. For example, big data research and development supports new business models and business solutions, which are used by governments and planners. Use of urban data and big data unveils necessary knowledge and allows urban developers to apply quantitative and qualitative analysis methods in their work. (Engineering 2016, 171-178.)

The process of urbanisation leads to some serious urban challenges such as housing shortage, environmental sustainability, transportation crisis, social inequity. The complexity of modern ecosystems requires a comprehensive approach to different

dimensions of urban infrastructure. One of the requirements for this systematic approach is objective and clear vision of urban processes and urban environment. Conditions of urban environment strongly depend on governmental planning and development decision. One of the functions of urban data – provide the basis for data-informed decision-making and new solutions for complex social challenges. In essence, application of data science in urban environment should enable improvements of urban management, creation of urban knowledge, analysis of urban conditions, involvement of local citizens and effective urban planning and development. (Engineering 2016, 171-178.)

3.10 Literature review outcomes

The goal of the literature review was to explore the urban data field in relation to urban planning and development and build a theoretical base for primary research. Concepts of urban governance and urban development were described, planning technologies, urban data types, sources and applications were explained. The next step of the research is to apply this theoretical knowledge. The interview was implemented based on the frameworks from this literature review. The following chapter presents the case study.

4 RESULTS

This chapter presents the results of the case study. It includes analysis of an interview with the representatives of Lahti: Aija Holopainen and Markku Ukkonen. The interview was complemented by presentation materials related to urban planning and development strategy of Lahti provided by Aija Holopainen. The goal of the case study is to research the role of urban data in urban planning and development of Lahti, explore application areas, employed technologies and strategic vision of the city on the topic.

4.1 Lahti background

The population of Lahti region is approximately one hundred twenty thousand people, including Nastola area. Lahti is highly urbanized, with over 80% of population living in urban areas and over 70% of residents living within 5 kilometres from the urban core. At the same time, most of Lahti's inhabitants have green zones in walking proximity, which describes the city as a 'green' urban area. (Lahti 2020a.)

In 2019, Lahti was awarded European Green Capital 2021 title for their urban environmental activities. Lahti scored the highest points in air quality, governance, waste management and green growth and eco innovation. Lahti has implemented excellent urban solutions and is on the way to build sustainable circular economy. These solutions are offered to other cities to promote resilient urban conditions. Some of these solutions will be discussed below as examples of urban development. (Lahti 2019b.)

In order to understand the achievements of Lahti in urban governance, we are going to analyse local governance, urban planning, development strategy and study how data is managed and applied. The chapters follow the same structure as in the literature review to save the narration logic.

4.2 Urban governance

Finnish governance system is considered one of the most reliable in the world. Urban governance in Lahti is guided by the City Council, which is re-elected every four years. The City Board is in charge of the procurements and finances of Lahti. Mayor Pekka Timonen, working under the City Board, manages the operations and finances of the City and helps with coordinating officeholder preparations and political goals. The City has five boards, three divisions under the City Board and three regulatory committees. The organisation of the City of Lahti is based on a division by service department, and the services of the City are organised by Educational and Cultural Services and Technical and

Environmental Services. Administrative Affairs takes care of the central administration. (Lahti 2019c.)

In partnership with local organisations and citizens the city develops and implements the strategy of development. Urban governance is spread between the city and communities; the goal is to promote sustainable, competitive growth. The city is on the way to become a bold environmental city. (Lahti 2019c.)

Budget

Since urban development is implemented by the City, all operations and financial activities are planned in the budget. The budget approves Lahti's operational objectives, financial transactions and revenue estimates for carrying out the public services and developing the operations. Implementation of the budget is monitored by the City monthly and can be adjusted and changed. (Lahti 2019d.)

4.3 Development strategy

It is necessary to introduce the development strategy and general objectives before discussion about urban data. As was already mentioned, Lahti was named 2021 European Green Capital because of significant environmental solutions. It is strongly related to strategical vision of Lahti city and translates into development plans.

Lahti's vision and analysis of current situation translates into several directive objectives, which are reflected onto the masterplan (Image 5) and which shape city's strategy and policies (Image 3). It includes sustainable growth and development, increasing density of the city center, high-level quality of life in and around the city, development of local services and businesses, protection and promotion of local natural resources.

-  1. Sustainably growing Lahti
-  2. Lahti centre
-  3. Living in Lahti
-  4. Livelihoods of Lahti
-  5. Services and commerce of Lahti
-  6. Natural Lahti

Image 3. Master plan directives (Lahti 2019)

As we can see, development strategy is not precise, it gives general directives for social, economic and environmental areas for the future. These principles are reflected in master planning process, communication between urban stakeholders, physical development.

Moreover, vision of Lahti for 2030 highlights three operational commitments:

- Grow as an entrepreneur-friendly city and create an attractive working and living environment
- Develop operational flexibility by experimenting
- Promote the good life for children and young people with government actions

Lahti is determined to develop its differentiating features, promote sustainability and resilience through experimenting and sharing the solutions. The central focus is on local people and their welfare – thus city can achieve steady and positive growth.

Moreover, very important part of the development strategy is environmental program, which includes objectives for different domains of urban life in 2021, 2030 and 2050 (Table 2).

Key Focus Areas of Lahti Environmental Programme 2018-2030	2021	2030	2050
Comfortable, Safe and Diverse Environment	Noise prevent programme is implemented (80on %)	At least 10% of the municipal area is protected	Blue-green infrastructure of the city is an international attraction
Energy Production and Use	At least 70% of energy is produced using renewable sources	Total emissions 30% from 1990 level	Carbon neutral energy production
Mobility and City Structure	50% of 5 km or shorter travel is done by bicycle or walking	Public transportation only uses electricity and/or biogas	Carbon free mobility with a dense, yet high-quality, environment
Consumption and Circularity	Public procurements function as	Recycling rate of municipality waste is at least 90%	Zero waste: No waste to

	inspirational examples		landfills or incineration
Food	City co-owned field is only rented for organic farming	The majority of lunch food served by the city is vegetarian	No emissions from consumption, global social responsibility is the basis
Water	Good ecological status of all areas in Lake Vesijärvi	All water ecosystems have a good ecological status, at a minimum	No chemically spoiled groundwater anywhere in the Lahti area

Table 2. Environmental program of Lahti (Lahti 2019d)

Many of current and future decisions were made based on the data available for local government which supported their decision-making and planning capabilities.

Development is implemented based on the common strategy that dictates the direction for regional urban development. The massive amount of information and knowledge produced in the planning and development processes makes smart governance possible and creates new opportunities for public and private organisations.

4.3.1 Urban Planning

The development strategy directly affects planning and development activities. The aim of this chapter is to explore tools and methods which are used for urban planning in Lahti. As we learned from the literature review, urban planning involves various technologies and requires deep knowledge of the environment.

City government of Lahti approaches urban planning as one of the key aspects for sustainable and effective development. The planning process is implemented in four-year cycles, with master plan being reviewed during each City Council term. A regular and continuous planning process offers an overall picture of the city's strategic land use, which provides necessary timing and targeting of urban planning and development projects.

(Lahti 2019e.)

Every four years there is a renewal of the master plan (Image 4), one of the main documents defining planning and development strategy for the next term. The master plan (Image 4) is considered a strategic image of the city's future.

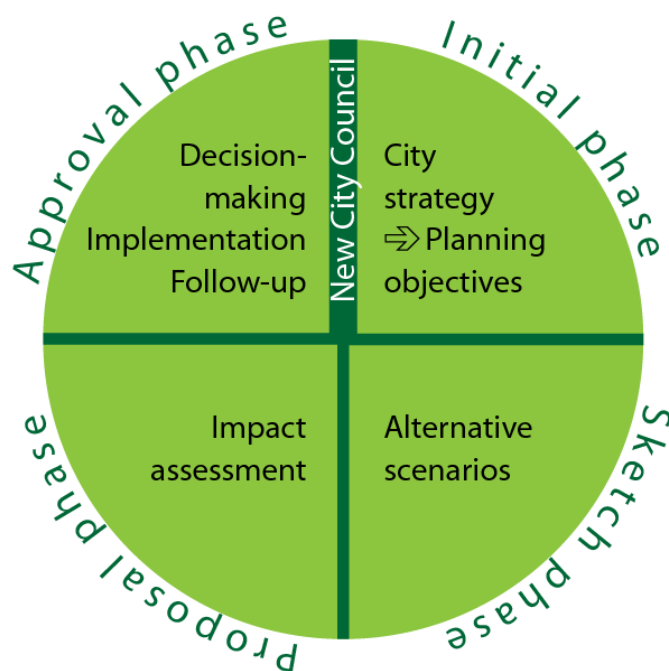


Image 4. Continuous master-planning process, four-year clock (Palomaki 2012).

To form this vision, the city develops and enhances its knowledge about urban environment and different processes within it by studying urban data and cooperating with local citizens. They use all available information resources, such geographic systems, and involve interested urban participants in the process. According to the city of Lahti (2019e):

“When the city plan is being prepared, people who live, work or own real estate in the plan area and areas affected by the plan, as well as others interested in the matter, are given an opportunity to voice their opinion either orally or in writing.”

The main challenge is to create and maintain a comprehensive understanding of urban area of Lahti. Government closely works with local community to build open and responsible relationships in order to support and develop natural urban areas. Aside from that, they use available resources to build up reliable and transparent infrastructure, which will provide necessary resources for community and produce valuable data for governance. In order to achieve this goal, comprehensive urban data management has been introduced into city's strategy.

Many governance activities and decisions can become informal, therefore transparent and inclusive urban planning process is essential for stable people-oriented development. In the next chapter, urban data of Lahti is explained and analysed.

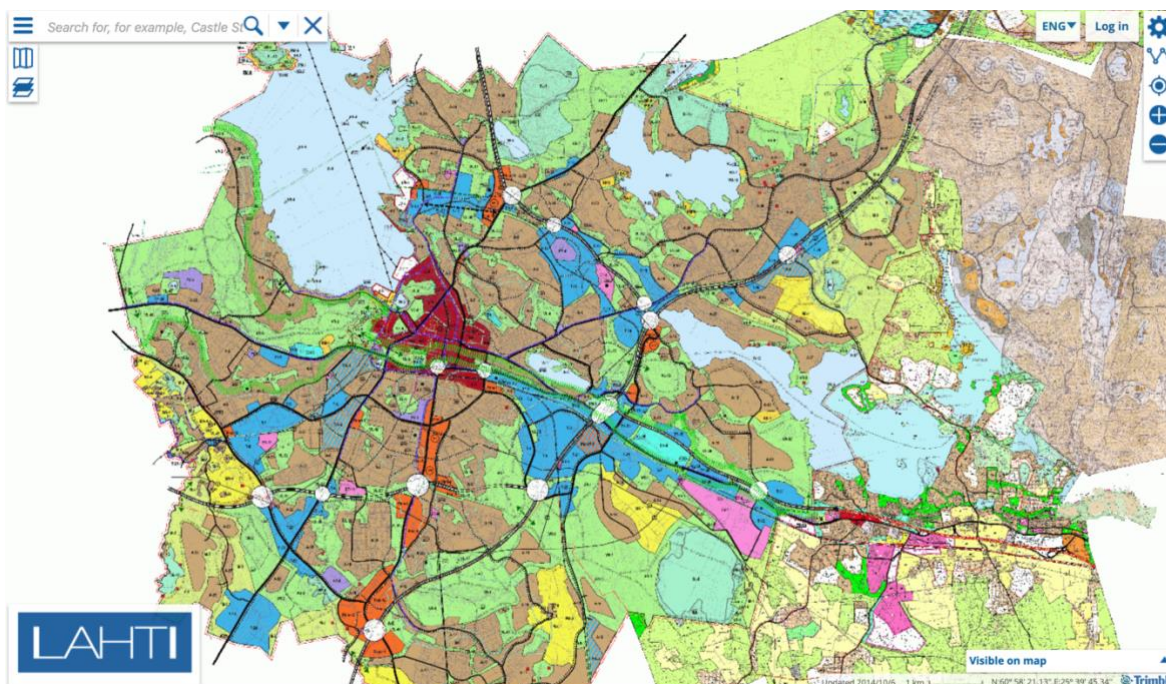


Image 5. Master plan of Lahti. (<https://kartta.lahti.fi/ims>)

4.4 Urban data in Lahti

From analysis of urban planning and development we received a general understanding of the vision and methods of governance. The next step is to see where and what kind of urban data collected and stored by local authorities is applied. There are several ways data can be used for urban planning, in Lahti it is mostly used for decision-making, supporting local services and science, cooperation with citizens.

However, there are certain limitations related to political and social systems in Finland. It affects capabilities of urban data management, particularly, limits regulation, control and development areas.

There are several domains, which can be a source for urban data, and which are fully under city's guidance and control:

- transport system
- census data – population data, economics and registrations
- urban environment (public places, buildings owned by government, streets).

These areas are eligible areas for urban data management and are controlled by city government. Therefore, data collected from them can be directly used for urban planning and development. Besides, there are four internal systems, or departments, which form the basis for governance and development capabilities.

These systems are:

- Geographic Information System – the biggest contributor to the city’s urban planning and development activities. There are more than 450 different layouts for different needs and purposes.
- Education system – system includes data from schools’ and colleges’ which are under city’s jurisdiction. Worth mentioning that universities are not related to cities.
- Economics and human resources – financial and citizens’ data.
- Administration system – internal administrative system of local government.

There are limitations on city’s areas of interest and control, which directly affects possibilities for control, regulation and development. City of Lahti is legally limited in their resources, for example, police data is not under city’s control and general representatives do not have access to it. In some cities, police data is used for preventative actions. It can influence development of public places, streets, services. Also, there are strict rules about privacy issues and sensitive data. Introduction of GDPR made cities remove some sensitive data from open data portals and close it for internal use only, thus limiting access to valuable information, but securing personal data of citizens.

Apparently, there is growing amount of data in Lahti. As a natural urban hub Lahti has technologies and opportunities for data application. However, Lahti is a technologically developing city. Many services and technologies are not integrated, urban data is not managed and applied in a centralised manner.

According to Aija Holopainen (2019):

“Geographic Information System are the main basis for urban planning and development of the city. There more than 450 layouts and we are developing our knowledge about urban environment of Lahti. “

Usually, data collection and application are managed in ‘old-fashioned’ ways through observations, surveys and active involvement of citizens. But technologies related to IoT and ICT quickly penetrate streets and houses of Finnish citizens and minds of the government. These data are actively applied for planning decisions and development strategies.

Application areas for urban data are tightly related to government jurisdiction. Mainly, data analytics are applied for transport development, urban planning, census analytics and development of urban environment – buildings, public spaces. Notwithstanding, city uses every opportunity for environmental screening: sensors, observations, laboratory studies.

Lahti has just taken first steps into smarter processes of urban planning and development. Most of smart city areas hasn't emerged yet, but local government is particularly interested in resolving the most important challenges city faces today. Sustainable urban mobility is one of the strategic directions for 2030 and is already being implemented by CitiCAP project.

CITICAP

In overall, Lahti has just started introducing new data collection technologies, and one of the projects is CitiCAP – citizens' mobility application, which focuses on implementing a Personal Carbon Trading (PCT) idea to reduce traffic emissions in Lahti. Sustainable mobility became a key focus domain for Lahti's government, since 32% of total CO₂ emissions is contributed by traffic sector within the city area. The project was implemented in cooperation with the university and local organisations. (Lahti 2018.)

One of the first steps was to collect comprehensive data about local mobility and traffic area. Simple mobility data platform was created to facilitate a personal carbon trade scheme, which will serve as a planning tool for city's urban planners and open data source for innovators and businesses.

CITICAP's goal is to facilitate a change in local mobility patterns and inspire more people to walk, cycle and use public transport. In the end of the project, smart cycle route will be built as a pilot arena for smart mobility services and physical example of personal carbon trade (PCT) service.

Another, not least important part of the project, is technological approach to sustainable urban planning. Lahti city produces large amounts of mobility and traffic data, which is not fully used and applied because this data is highly segregated and is not publicly available. Connection and opening of this data can improve local mobility area. Moreover, it will create a smarter system, which will be able to react and adjust to changes and demands in real-time. (Urban Innovative Actions 2019.)

Mobility data will be available for three main purposes: data for use of urban authorities, data for personal carbon trading scheme and open mobility data. As a result of the project, other cities, companies and third parties will be able to use the solutions and the collected mobility data for their own development projects. Lahti is involved in active international cooperation and this project is one of the first steps towards smarter urban development. (Urban Innovative Actions 2019.)

4.5 Data management

As was said previously, there are four systems inside a local government, which correspond to urban domains, where they operate. Management of city data is separated between departments – each department is responsible for its area. In addition, there is an IT department, which provides guidelines and frameworks for organised storage of data.

Different sources and types of data are approached differently. For example, road and traffic data is updated regularly, not in real-time, while geographic information systems are updated on demand, whenever new layouts are required for work. Systems within local government are integrated – it means data is shared freely inside the government. Some data is opened to public, for example, statistics and certain geographic data. Some data is private and cannot be published it.

Data management is a service inside a city, the duty of IT departments is to have and organise data for other departments who may need it for their purposes. Statistics play important goal in development.

Another concern is general data protection regulation – new European standards of data protection and privacy related to citizens of the European Union (EU) and the European Economic Area (EEA). Some of publicly available data was closed due to new regulations and some data transfers between public and private organisations became more complicated. With GDPR, individuals gained control over their personal data, which makes it harder for governments to use it, even for right purposes.

Evolving data technologies bring new opportunities and new challenges for local government. Fortunately, constant cooperation with academics and local organisations drives application of data technologies to urban development.

4.6 Role of urban data in Lahti

Based on conversation with Aija Holopainen and Markku Ukkonen and study of open materials and presentation documents the value of urban data in Lahti is clear. As a small digitally and technologically developing city, but at the same time, historical regional centre, Lahti makes necessary efforts towards application of urban technologies. This is essential for reaching the strategic goals of sustainable growth, dense and resilient urban development and well-being of local citizens.

Urban data provides government with valuable knowledge about urban environment, processes and objects inside this environment. Data is positioned as a valuable resource

and government is determined to develop technologies to work with it and develop sources of the data to have more precise and objective database. According to Markku Ukkonen (2019):

“Data is still collected in “old-fashioned” ways, but the city is determined to change it.”

As we found out, urban domains are partly closed for security reasons. Government can develop and analyse only certain areas of city life: transportation, urban environment, finances and population, geographic systems and urban administration. Data is not served a central role, because some processes are yet to be developed, digitalized and automated. Another role of data is communication mean between people and a city. Public issues and common problems are approached in smarter ways.

5 DISCUSSION (ANALYSIS)

This study's objective is to explore the role of data in urban planning and development. During the case study, some concepts discussed in the literature review were not applicable, therefore, not discussed, because of the local features and context of Finland. Worth saying, that Finland is a highly developed country, but also very conservative and careful with application of ICT and IoT technologies due to the risks and specialties of management of such systems.

Finnish governance system cannot be judged in this study, but it is considered one of the most successful in the world. Obviously, it applies to urban governance discussed in the beginning section of the case study. Government is interested in citizens' involvement and cooperation with local businesses and organisations. This is a good trend and most progressive economies and cities of the world do the same thing. Also, as mentioned in the literature review, urban governance and especially planning activities are iterative in its nature. In Lahti elections take place every 4 years and adjustments are made regularly to ensure stable, guided development.

From the literature review, we know that development strategy is extremely important in the context of cities. Lahti has a bold strategy that translates into several directives and common vision for development. Goals, which government of Lahti sets, are aimed at the well-being of local citizens and resilience of urban environment. The strategy is formed based on available knowledge and constant maintenance of local entities and services. Through urban data government collects insights, manages the environment. The life cycle of urban data is not perfect yet, but available and produced knowledge is applied back to urban development.

We can see, that urban planning is tightly connected with data technologies in general, and geographic information systems in particular. Master planning is the most important tool of urban planning, and the city of Lahti has a rich database of GIS projects. In some places of Lahti, technologies are used for visualisation and automation for the comfort of local inhabitants. Urban planning involves many professionals from various fields, as well as local citizens, who are interested in shaping the urban environment. Integrated efforts formulate the master plan, data from all kinds of departments, especially transportation and urban environment data, are applied to formulate the best alternatives for urban development.

The most important part of the case study, in author's opinion, is application methods and areas. From the literature review we learned that all urban domains can be described from

the data point of view. Interestingly, that in the case of Lahti, some urban domains cannot be developed or accessed by the government. Police, healthcare data – these areas are protected by the law and separated from the urban governance system. There are some obvious benefits to that, such as security, but there are some drawbacks as well, such as lack of information, integration and cooperation.

Available application areas are in priority for data-informed or even data-driven development. Transportation is the focus area for this term, there are projects around this domain and strong public conversation about the needs for changing current situation. Urban environment is another area to develop. Surprisingly, streets, buildings, parks are barely used in data infrastructure. Evolution of urban environment is inevitable, but government takes it slowly, with necessary intelligence and awareness.

In conclusion, there are many barriers and lack of integration between organisations and inside the government for avoiding privacy issues. These are big factors when it comes to transparent and sustainable development. There are many areas for development in Lahti and opportunities for cooperation and growth. Another expressed idea was lack of collaboration between universities and city governments, which is also a case in Lahti. This study doesn't have enough evidences to support that, but university system is private and there are the same communication and integration problems. Fortunately, many academic projects find support from the government. This inspires students to participate in open discussion and development activities.

Data analytics and data application is young in the city of Lahti. Both Aija and Markku agreed, that urban data is highly potential. However, urban environment is not digitalized yet, therefore, there are no constant sources of urban data, big data, which is so valuable in the modern world. Urban planning and development activities are strongly supported by available data resources, mostly GIS and census system. Data systems are managed in a solid, sustainable way and are applied to governance. The role of urban data is more informative, than practical. Few things are automated or digitalised, but insights from urban data analytics are actively used in planning and development. Knowledge about the city environment is valuable for city government, therefore, slowly but surely old-fashioned ways of data collection will be replaced by advanced technologies and analytics. Lahti is developing, available data is used in urban planning and development, but there are opportunities for new data sources and data-driven domains.

6 CONCLUSIONS

This thesis gives a wide explanation of the role of urban data in urban planning and development and answer the research questions and sub questions stated in the second chapter.

The main research question is:

- What is the role of urban data in urban planning and development?

The sub questions are:

- What are the benefits of urban data application in urban planning and development?
- How urban data is applied to urban planning and development in Lahti?

The literature review starts with exploration of urban governance, which is an umbrella term for urban planning, urban development and other city management related activities. This is important for the research since the study is focused on data application in these areas.

Also, the literature review includes knowledge about urban data. It presents possible types and sources of urban data, which are essential for understanding of use cases and opportunities for building data infrastructure. The sources are divided between big urban domains: transportation, urban environment, energy, healthcare, security, business and government. Frameworks may differ depending on the context, as we see from the case study, but development of urban data corresponds to development of certain areas within cities.

Application of urban data in urban planning and development is divided between urban domains as well. The difference is in processing of data – how urban data is manipulated; thus, it can be applied. There are many ways how governments can use information and knowledge gathered from urban environment. Mostly, it depends on local needs and technological capabilities. In the end of the literature review, author presented possible benefits and the role of urban data. Urban data provides knowledge about urban environment. Effective data application can improve administrative, social and economic domains of urban life, enables better communication and cooperation of urban participants.

For the case study of Lahti author interviewed two professionals from Lahti city government: Aija Holopainen and Markku Ukkonen. During the discussion, they explained

urban governance of Lahti, shared their view on current situation of urban data and discussed further development opportunities.

Even though urban data is used in “old-fashioned” ways, urban planning and development are designed to engage local citizens and apply the knowledge about urban environment. The origin of this knowledge is available data, which carefully collected and designed from the needs of the city by different systems and departments. Development of data infrastructure will be inevitable under the smart governance strategy, which is implemented by the Lahti city government.

6.1 Answers to the Research Questions

This subchapter gives final answers to the questions formulated in Chapter 2 based on theoretical and interview findings.

6.1.1 What is the role of urban data in urban planning and development?

Urban data plays an important role in urban planning and development. It allows us to study urban environment, analyse objects and processes within it, tackle complicated urban challenges with knowledge gained through integration and collaboration. Urban data provides environmental (geographical, architectural) and societal (economic, social) information for urban planning and development. Moreover, urban data enhances city’s common intelligence – it provides applications for healthcare, transport, housing and social life. It helps to build sustainable and resilient urban environment and design efficient public services for the well-being of citizens.

6.1.2 What are the benefits of urban data application in urban planning and development?

It is necessary to understand the benefits of urban data application in order to justify its role in urban planning and development. Besides improving urban intelligence and decision-making, urban data enables improvements in various urban domains. It enhances capabilities of security organizations, improves effectiveness of infrastructures. Data helps reduce the footprints through analytics and development, it can create new economic opportunities. Open data improves communication between urban participants and helps not only the government, but local businesses and citizens.

6.1.3 How urban data is applied to urban planning and development in Lahti?

In Lahti, urban data plays a key role in urban planning and development. However, methods used to collect and apply data are still developing to create a fully digital urban environment. There are legal limitations in data access for local government and cultural context, which prevents some technologies to penetrate urban environment. However, local government is determined to develop data infrastructure and apply new technologies to urban planning and development in order to improve citizens' lives and deliver qualitative urban services.

6.2 Strengths and weaknesses

This research is limited in discussing details of data application – methods and technologies used, full benefits and circumstances for cities. Moreover, case study is limited in detail about the city, especially different internal systems. Markku and Aija couldn't thoroughly explain every domain of urban environment of Lahti, since they are responsible for their own departments.

This study would be stronger given more and better conducted interviews with local professionals. Urban data and urban planning and development are extremely practical sciences; therefore, practical experience is significant in this context.

Overall, the goals of the study were reached, and all research questions were answered. Importance of urban data research is great, since this field is developing, and new technologies are penetrating urban environments.

6.3 Suggestions for further research

This research focused on the role of urban data, barely discussing technological layer. To gain a better understanding of data development opportunities it is recommended to conduct a study about development of data infrastructure: sources of data, technologies and methods used for collection, storage and application.

In addition, citizens' perception and engagement can be studied: their level of involvement into urban planning process, awareness of urban data and technologies used in cities.

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APPENDICES

APPENDIX 1. Interview questionnaire.

1. How does Lahti approach urban planning and urban development?
2. Is Lahti positioned as a 'smart city'?
 - a. How widely spread information and communication technologies are in Lahti?
 - b. What are these technologies used?
3. How does Lahti approach urban data?
4. What is the role of urban data in urban planning and development?
5. What are the sources of urban data?
6. What are the main areas of urban data development?
7. How data is applied?
 - a. What are the main domains and applications of urban data?
 - b. How does it support decision-making? How much decision-making is affected by it?
 - c. How does it support urban planning and development?
8. What are the benefits of urban data application?
9. How quality of life, economic competitiveness, and sustainability are affected or supported by urban data application?