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# THE ANALYSIS OF THE POSSIBLE CHALLENGES OF THE TALLINN SMART CITY PROJECT AND PROPOSALS FOR THE DEVELOPMENT OF A SUCCESSFUL SMART CITY

Master's thesis

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PhD

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TALLINNA TEHNIKAÜLIKOOL
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# TALLINNA TARGA LINNA PROJEKTI POTENTSIAALSETE VEAKOHTADE ANALÜÜS NING PARANDUSETTEPANEKUD EDUKA TARGA LINNA ARENDUSEKS

Magistritöö

Juhendaja: Jaanus Kaugerand
Doktor

Tallinn 2021

# Author’s declaration of originality

I hereby certify that I am the sole author of this thesis. All the used materials, references to the literature and the work of others have been referred to. This thesis has not been presented for examination anywhere else.

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# Abstract

This master's thesis is a thorough analysis of challenging aspects of smart cities' development, focusing mainly on one of the smart city projects in Tallinn. Prior the analysis the term smart city will be introduced to the reader.

Smart cities are being developed around the world and providing scientific means for alleviating or eliminating occurring problems will make it likelier that future projects will be more successful. The topic of this thesis is popular in Estonia as well, where next to Tallinn, other towns are also developing smart cities to improve their citizens' quality of life and currently developments are not as successful as they could be.

Main goals of this master's thesis are the determination of the challenging aspects and of best practices from around the world and in Tallinn, analysis of research finding and stemming from there given suggestions to improve the quality of future smart city developments in Tallinn and around the world.

Using deductive thematic analysis on state-of-the-art articles and cross-case analysis on stakeholders' interviews, this master's thesis sums up many occurring smart city projects' problems, out of which many where related to either any type of resources allocation or general leadership strategies.

The author provides nine suggestions, both organisational/social and technological. All given suggestions are meant to solve problems that have determined from the analysis and are supported by either scientific references or there are provided tools/resources.

This thesis is written in English and is 36 pages long, including 7 chapters, 1 figure and 1 table.

# Annotatsioon

# Tallinna targa linna projekti potentsiaalsete veakohtade analüüs ning parandusettepanekud eduka targa linna arenduseks

Käesolev magistritöö kätkeb endas põhjalikku analüüsi tarkade linnade arendamisel tekkivate probleemsete aspektide kohta, keskendudes peamiselt ühele targa linna projektile Tallinnas. Enne analüüsi tutvustatakse lugejale mõistet tark linn ning sellega kaasnevaid teemasid.

Tarkasid linnasid arendatakse üle kogu maailma ja teaduslikel allikatel ning tegelikul olukorral põhinevate soovituste pakkumine tekkivate probleemide leevendamiseks või kõrvaldamiseks muudab tõenäolisemaks tulevaste projektide edukuse. Selle lõputöö teema on populaarne ka Eestis, kus Tallinna kõrval arendavad tarkasid linnasid ka teised omavalitsused, et parandada oma kodanike elukvaliteeti. Praegusel hetkel ei ole arendused veel piisavalt edukad, kuna targad lahendused ei ole Tallinnas ning laiemalt Eestis väga levinud.

Selle magistritöö põhieesmärkideks on potentsiaalsete veakohtade ja parimate tavade leidmine kogu maailmast ja Tallinnast, leitud tulemuste analüüs ja sealt tulenevad ettepanekud tulevaste targa linna arenduste kvaliteedi parandamiseks Tallinnas ja kogu maailmas.

Nende eesmärkide saavutamiseks kasutati kaht erinevat analüüsimeetodit ning sidusrühmade intervjuusid. Esimene neist on deduktiivne temaatiline analüüs, mille abil analüüsiti teaduslikke artikleid, kuna see meetod aitab teemat piiritleda. Seejärel viidi läbi poolstruktureeritud intervjuud sidusrühmade esindajatega ning nende intervjuude tulemusi analüüsiti juhtumiülese analüüsi abil.

Selles magistritöös esitatakse mitmeid veakohti, mis tavaliselt esinevad targa linna arendamisel, millest paljud on seotud kas mistahes tüüpi ressursside haldamisega või üldiste juhtimisstrateegiatega.

Autor esitab üheksa ettepanekut, nii organisatsioonilist/sotsiaalset kui ka tehnoloogilist. Kõik esitatud ettepanekud on mõeldud probleemide lahendamiseks. Need probleemid on analüüsi põhjal kindlaks tehtud. Probleemide lahendamiseks esitatud ettepanekuid toetavad kas teaduslikud viited või juba erinevate insitiutsioonide ja teadlaste poolt loodud infotehnoloogilised tööriistad või olemasolevad seadustest ja määrustest tulenevad ressursid.

Lõputöö on kirjutatud inglise keeles ning sisaldab teksti 36 leheküljel, 7 peatükki, 1 joonist, 1 tabelit.

# List of abbreviations and terms

| | |
|---|---|
| ICT/IT | *Information (and Communications) Technology.* A term used to describe information technology and its important role of unified communications. |
| ROI | *Return on Investment.* The performance measure that helps evaluate the efficiency of any investment. The ratio or percentage value of the division between the benefit of any investment and the cost of that investment. |
| ProLab | *Laboratory for Proactive Technologies* is one of the stakeholders of the Tallinn Smart City project. |
| GDPR | *The General Data Protection Regulation.* A set of regulations posed by the European Union to protect the privacy of its habitants. |
| CEO | *Chief Executive Officer*. The most senior officer whose jobs is to manage an organization. |
| B2B | *Business-to-Business.* A situation where commercial transactions occur between businesses. |
| CIO | *Chief Information Officer.* The head of information technology of any enterprise. |
| IEEE | *The Institute of Electrical and Electronics Engineers* is a professional association for electronic engineering and electrical engineering, and associated disciplines. |
| API | *Application Programming Interface.* A software intermediary consisting of communications protocols and tools that allow two programs to communicate. |
| GDP | *Gross Domestic Product.* A measure of the market value of all the products and services produced in a certain time, usually measured by a year. |
| BDTI | *Big Data Test Infrastructure* is a tool created by the European Commission to help smart city development be cheaper by providing an infrastructure for big data analysis. |

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# 1 Introduction

The phrase “Smart City” is often used by city officials to promote their cities and make them seem as front runners in the technical field. The truth of the matter is that there is a fundamental difference between a smart city and sensor-filled city that has the technological means to measure different types of data – smart cities start with people and their centre is always the habitants of the city and their needs.

It may seem that the wide use of various high-tech solutions and the effective use of collected data to develop a city is what makes that city smart and with that successful, too. The fact that collecting data with electronical and digital gadgets is no longer science fiction and that it is happening in almost every city within their means is very possibly the basis of this misconception among city officials who eagerly claim to have a smart city in their hands. A smart city, however, needs and insists that the input for its creation came from a variety of people and after analysing this input it is expected from city officials, IT-personnel and business developers to take risks and fully use the high-tech means that are available to support the social, economic and cultural development of the city and its habitants [1].

As the smart city is focused on the needs of its habitants and its solutions are put in place to improve the quality of their lives, smart cities as business models are in theory most prosperous. Even though any new development requires some risks to be taken and resources, in theory, content habitants make any such investment into one with a high ROI (Return on Investment) project.

The hypothesis of this master’s thesis is that there is a drift between stakeholders –city officials, business developers, IT-personnel, and the habitants of the city that causes conflicts and lack of trust between the stakeholders and prevents smart cities from either forming or fully blossoming. This master’s thesis focuses mainly on Tallinn and one of its smart city projects.

## 1.1 Background

Tallinn University of Technology and its different institutions: Department of Software Science, especially the research group Laboratory for Proactive Technologies (ProLab), in collaboration with Tallinn City Government and its departments: Urban Environment and Public Works Department, and Transport Department, and Thinnect Inc. are currently developing Tallinn to become a smart city and it is every stakeholders' goal to make this happen with great success. This master's thesis is only concentrating on the smart city project between the previously mentioned stakeholders. The project name in question is SmENeTe 2 [2]. In the rest of the thesis the project is referred as a smart city project. The scientific goal of the research project was to validate applicability of Thinnect OÜ patented mesh networking layer for Smart scalable Environment applications and to recommend changes to the networking layer based on these application requirements. To extend the Proactive Middleware that had been developed at TalTech to offer the functionality required for Smart Environment applications and to develop functionality for in situ diagnostics of wireless network with cloud-based support. Analysis of other projects including Tallinn and smart city development are not included.

The development process included the installation of ca 900 sensors equipped with solar panels to create a network of sensors that can gather data about traffic density and environmental parameters. The installation process of the sensors began in spring 2019. Until now, there has been very little input asked from the citizens of Tallinn, but the representative of Thinnect OÜ has performed at smart city seminars and conferences where possible business clients such as GoSwift, Vaikneri, the Internal Security Service and the Estonian Police and Border Guard Board have approached him. All these business clients feel like they would greatly benefit from the collected data and they could use it as an input for business development. Also, ProLab has been in contact with city officials to work out the best positions for the sensors.

## 1.2 Scope of this Research

This master's thesis' focus lays on the Tallinn Smart City initiative and is supported by other smart city projects from around the world. Smart city developments are huge undertakings and consist of various parts and in that may have issues from different

fields of life. This master's thesis focuses on technological and social issues that hinder the development of smart cities around the world.

Despite privacy and security being very important topics, they are not included in the scope of this master's thesis since the thesis is focused on developing smart cities and the feared lack of privacy and the feeling of being monitored is in my opinion due the anonymity of collected sensor data more a falsely formed opinion about and a by-product of an already functioning smart city.

## 1.3 Research Goals and Questions

The goals of this master's thesis are to prove the posed hypothesis that even though smart cities can potentially be extremely successful business models due to their needs-based nature there seems to be a void between the stakeholders causing the projects to either not succeed or take much longer to succeed. If this hypothesis is proved other goals of this master thesis will be reached. These goals are the following:

1. to determine the possible problematic aspects of previous smart city projects as well as Tallinn Smart city project's ones;

2. to analyse and look for similarities between different projects to determine best practices for the development of smart cities;

3. to provide the Tallinn Smart City project stakeholders the solutions that might help avoid or alleviate possibly occurring problems.

The research question of this master thesis is this: "Why is the profitable usage of the data collected by sensor technology not as widely spread and/or as effective as it could be?" To answer this question is also one of the goals of this master's thesis.

This master's thesis is mainly focused on Tallinn and its smart city project and supported by articles and information about other smart city projects and ideas around the world, but the Tallinn example is the one that led to the understanding that the people and their state of minds are not developing as quickly as the different technologies provided to collect data. This understanding in turn led to this master's thesis' hypothesis and so the expected outcomes of this master's thesis are to determine the factors that are causing smart city projects to fail/not succeed to their full potential.

These problematic aspects could for example be the lack of trust between the stakeholders, the lack of communication between the stakeholders, the misconceptions about smart cities, the overly eager goals and deadlines set by the stakeholders, the lack of business models that need the collected data, the time given to succeed is too short, the technical development is too difficult and the goals of various stakeholders are different and possibly clashing.

The true problematic aspects will be revealed after conducting various interviews of the Tallinn Smart City project's stakeholders and from the articles written about other projects around the globe. If these factors are determined, then they can be analysed.

The analysis of those factors is one of the outcomes of this master's thesis but will also be an input towards finding possible solutions to occurring problems. As smart cities contribute to the economic development of the city and its habitants, they are a tool for earning money [1]. Any tool that helps boost the economy is a tool that needs to be as perfect as possible, so the plausibly most important outcome of this master's thesis is to provide the reader solutions to problems that hinder the development of smart cities and therefore hinder the cities to function in a way that is economically optimal.

These provided solutions could be a communication plan to better the communication and trust between the stakeholders, the educational suggestions to educate business developers to use the data the IT-personnel can provide them with and to educate the city's habitants to know what to ask and to be knowledgeable customers of the city officials. The real provided solutions can only be provided after the analysis is finished.

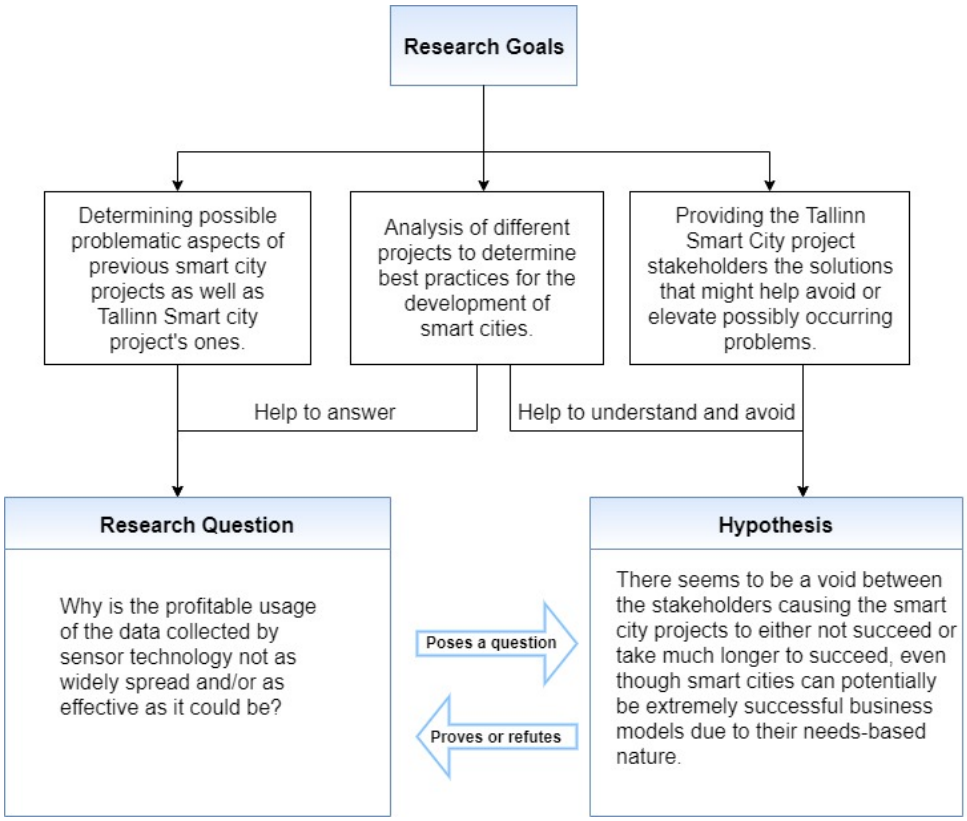


Figure 1 - The structure of the Research Question, Goals, and Hypothesis

Figure 1 shows the scheme how research goals are connected with both the research question and hypothesis.

## 1.4 Structure

This master's thesis consists of an overview of the current situation in smart city development and its nature in general, a thorough analysis based on the information gotten from the scientific articles and interviews that are conducted with the Tallinn Smart City project stakeholders, and suggestions for the development of a smart city.

In the first chapter, the author gives an overview of the topic chosen and its background, the hypothesis and the research goals. This chapter will introduce the reader the thesis' structure and the scope.

In the second chapter, the author gives an overview of the state-of-the-art, both articles on the theoretical and supportive material about smart cities (such as articles about directives and digital transformation in general) and articles written about other cities that have experiences with developing smart cities.

In the third chapter, the author gives an overview of the different methodologies that will be needed to conduct this research.

In the fourth chapter, the author gives an overview of the interviews, about the questions and how they will support the research goals, and the interviewees and their backgrounds.

In the fifth chapter, the author gives an overview of the analysis of the interviews with the Tallinn smart city project stakeholders. Every interview question will be a new subparagraph.

In the sixth chapter, the author gives an overview of the suggestions for developing smart cities. Suggestions will be divided into two groups. First set of suggestions will stem from previous work of Dutch researchers' key insights and the other set will stem directly from the analysis of the interviews.

The seventh chapter will be the summary where the author summarises the most important findings of this thesis and gives suggestions on how to further the research on this topic.

# 2 State-of-the-art

In this chapter the author is going to write about the state-of-the-art of smart cities. What a smart city is and what it represents. As this master's thesis is a research about the restrictive factors of developing smart cities the focus of the state-of-the-art lies on previous smart city projects and articles written about them to try to find similarities among them. Negative similarities are used as precautionary lessons to avoid and find solutions to and the positives prove the value of the smart city initiative.

As cited in the Introduction section of this thesis, the fundamental necessity in the development of smart cities is being citizen centric. This idea was first mentioned in 2008 [1] but is still relevant more than ten years later and proves to be axiomatic, because it is still the focal point in all the articles and conferences.

An article in the Journal of Science and Technology Policy Management about smart neighbourhoods [3] confirms this statement writing how smart cities should be citizen-centric, and their ideas must be supported by the means provided by modern ICT (Information and communications technology). Smart cities' focuses should be:

1. efficient transport;
2. reducing waste and energy consumption;
3. pollution and crime control;
4. providing sanitary living spaces.

The government's capability and functionality for the sustainable development will be enhanced by the participation of the habitants in planning and decision processes.
This article suggests further research to get more detailed results, as it will be tried to do in this master's thesis by comparing the Tallinn Smart City project to others to determine the most problematic aspects.

GDPR (General Data Protection Regulation) and its possible effects on developing smart cities have been addressed very well in an article [4] by Goran Vojkovič. In his

article it is proved that GDPR will absolutely have an impact on the development of smart cities but that this is not something to be fearful of. The regulations set in place are helpful conditions for the developers because they provide a sense of security for the citizens. As smart cities do use public data collected from real life, it is assuring that there is a set of regulations in place that protect the privacy of habitants whilst providing developers clear guidelines.

Taavi Tammiste the CEO (Chief Executive Officer) of SIFR also shares this opinion and talked about this at the conference Smart City for the Citizens 2019: Data and AI as game changers for the cities in Tartu. SIFR is a B2B (Business-to-Business) company that offers AI solutions to businesses to learn from their data and generate new business cases.

A chapter [5] written in 2019 by Fiona McDermott describes Dublin's experiences with involving citizens to the process of developing cities. The development of a smart city requires input from the citizens, but there are some problems getting and using that information, too. In Dublin, Ireland the city officials noted that there were problems within the system: the amount of bureaucracy was immense and that made it inconvenient and somewhat hard to include new development ideas both from city officials and city's habitants into real development strategies. It was either too time-consuming or the people were not willing to go the extra mile needed to implement change via regular channels.

It was decided to use the guidelines of lean start-ups and create Beta projects. For example, they used the Lean Resourcing method which meant that any new project was in testing only for as long as it took to get an idea whether it would succeed and only using as little resources as possible. This method is a modified version of the Lean Startup method [6].

The chosen projects were based on ideas both from the city officials and its citizens and all the projects followed a concrete process combined of six steps that were guidelines to turn an idea into a solid business model. First step of their system concentrated on finding the issue or opportunity to turn into a business model; this can come from the local community or government. Secondly, it is required to map out the current situation of the chosen idea for the project (e.g. the financial situation). After that starts the brainstorming session to name all the possible ways to solve the issue, prioritisation of all the found ways, and prototyping in the order of prioritisation. The sixth step is to

write a formal report of it all, also thinking about the possibly needed policy arrangements.

In the end, the outcomes of the undertaking in Dublin were very interesting. On one hand, they proved that it is possible to step outside the box and get new ideas for city development in a lean way and the city officials interacted with the habitants of the city more and from that gained valuable knowledge about what could and should be different. On the other hand, they also stumbled across problems. Firstly, even though the Beta projects were all developed whilst fully taking everyone's opinion into consideration, at the end of the day senior city officials sometimes ruled in their own favour and disregarding the habitants' input or needs. This occurring problem calls for a more open and democratic system.

Another negative factor was money. The city officials failed to realise that some projects may need time to really blossom and as the city officials have real life problems to solve, projects that consist of ideas that may one day become successful are more likely to receive less funding than real life problems that need to be solved.

An article [7] by Sam Musa offers a road map to smart city development and the article provides the readers some interesting suggestions for any smart city stakeholder. A way to create smart cities and use the citizens' input for the development is to employ a city CIO (Chief Information Officer) that would have inside information of what the citizens want and need. That way the needs are heard by someone who has the necessary knowledge about information technology and its possibilities. E-government can help create direct contact between the CIO and the citizens, so that trust can be built.

Also, in every development it is important to determine whether the undertaking will be beneficial and necessary. It is very important to evaluate the habitants and surroundings of a city: everyone wants to live comfortably but comfort means different things to different people. Analysing citizens' age, educational backgrounds, hobbies, city's most attractive places, businesses and the capitals of the communities are critical success factors in pre-development of any smart city.

Secondly, any development is easier to manage when certain ground rules are set in place. Before any development even starts, there should be an understanding among all stakeholders what are the roles, responsibilities, strategies, and objectives of a smart city. This document will provide clarity and a sense of responsibility that is needed to

reach the set goals. In the long run documents like these, if developed by the governments, are ways to make city planning more efficient.

The importance of building cities with keeping the people in mind is a very common theme throughout the state-of-the-art. Any developed smart city should also be humane, an article [8] from IEEE (The Institute of Electrical and Electronics Engineers) Internet Computing suggests. Building humane smart cities is all about the people. For example, sensor data will provide city officials the information about the mobility of cars, but the question should be where the people are going. That way the best solutions can be found: it could be new routes of public transportation or the establishment of varying working hours, but these days cars are very important. To alleviate traffic jams, it is more common to build new viaducts than to really dig deeper and realise the real problematic aspects and to try to solve the traffic problem once and for all. Building new roads is expensive, yet up until now not many have questioned that solution or demanded new solutions to even be considered.

Another thematic that is consistent in the state-of-the-art is the lack of trust and this is also discussed in this same article. Authors argue that the lack of trust can be due to mismanagement or ignoring the citizens who want to be heard more than just during the voting of city officials that occurs in every four years, just like in Tallinn. City officials need to understand that they are also the citizens and they too will benefit from any successful developments. The main idea of this article is to look at occurring problems as a case and try to develop a city case-by-case. That is a complex task in today's world of bureaucracy but a task worthy of solving, nevertheless.

An article [9] by Christof Ebert and Carlos Henrique C. Duarte about digital transformation is not directly linked with smart cities but is still a valid and important article as smart city development is in correlation with the development of information technology. It is crucial that societies and IT would harmoniously work together. Digital transformation is a change process within companies and societies in general that is based on technology and is continuous. The keywords are connectivity, flexible value streams, and ubicomp meaning computing that occurs using all the devices, anywhere and anyhow.

The goals of digital transformation are creating and upholding digital infrastructures and to manage their governing, improving data protection, transparency, developing and

improving accessible services for the public, implementing new business models, and changing the education system, so that schools would teach new skills that are needed to excel in today's digital society. Schools should also guide children to want to pursue a career in ICT.

Not only school system and its students are the ones needing to change, software engineering managers and corporate leaders must abandon their roles as controllers and commanders and be more willing to take risks and accept mistakes that may occur in development processes.

Ways to teach these skills are gamification, simulations, and open online courses – everything to make learning more agile and less about classrooms and fear of failure. The human factor in software engineering is increasingly more important, because complexity of systems increases, and software engineers must be ready to handle difficult problems. Digital transformation will require many roles to acquire new skills, but they are needed to use software engineering in all fields of life.

An article [10] published in Computer by the representatives of Digital China, Fudan University, and Peking University presents an idea of a platform for the development of new smart city services. This new crowdsourcing-based platform proposed would allow citizen to be the developers of the services, making these services as citizen-centric as possible. Big IT corporations are not interested in developing public sector services because of their low ROIs, the need for extremely short iteration cycles and broad knowledge base. Small firms, on the other hand, are not able to pay for developments and maintenance.

Crowdsourcing platform provides free-lance developers a chance to develop new products or services while city governments and smart city enterprises create and integrate new APIs (Application programming interface) where collected sensor data and open source software services are available. This platform also ensures a software engineering environment where task organizers and crowd developers can come together and a runtime environment where services can run.

The main challenge of creating such a platform are making it sustainable: reusing developed code and attracting developers, but this platform is bringing the development of human-centric services closer to humans and allows them to use the collected data and environments. This way all the stakeholders collaborate, and the provided outcome is better. Such platforms are currently in use in more than 10 cities in China.

The platform is a great way to validate created services, because everyone develops in a set system and it is very important that the platform involved the latest regulations such as General Data Protection Regulation.

## 2.1 Overview of previous Smart City projects from around the World

During the IEEE International Conference on Technologies for Smart-City Energy Security and Power [11] in Bhubaneswar, 2018 India's smart city initiative was introduced. In India, the population increases with every year, so in 2015 to make the cities function as efficiently as possible the Indian Prime Minister announced that 100 smart cities will be developed all over the country. Smart cities were meant to make life easier and services more accessible for the habitants. Some goals, for example, were to govern cities citizen-friendly and to promote various ways of transportation.

The cities that wanted to become one of those 100 smart cities and get the national funding all went through a three-step evaluation process by the Government of India and a committee of local and international experts. City representatives had to pitch their ideas to different evaluators and those picked projects would each receive capital from a total of 24.5 billion Euros invested by the Government.

The main challenges of developing smart cities were also pointed out in this article including these:

1. the states' and central governments different work cultures;
2. lack of defining the success factors of projects;
3. lack of smart city experts, both project managers and government officials;
4. lack of investments;
5. little knowledge about resource management.

Vinay Kandpal also spoke about smart city developments in India during a conference [12] in Lyon, emphasising how important this initiative is for India. Currently 31% of the population of India lives in cities and they contribute 63% of the GDP (Gross Domestic Product). These numbers are only expected to grow and so as with the first article, this one also focuses on India's smart city developments using SWOT analysis. The analysed cities were Nagpur, Allahabad and Dehradun. Different cities have their strengths and weaknesses and SWOT analysis is a great way to pinpoint every detail. As this master's thesis is focused on lessons, these were the main ones: India's government

is very eager to get private sector included, financial and IT enterprises are considered very important as investors of both money and knowledge by the government and firms such as Cisco and IBM are priorities.
The real challenge according to the author is to build a city for all classes of citizens and the funding due to the very money-consuming and difficult task of smart city development and building self-sustaining cities.

Mila Gascó-Hernandez wrote in her article [13] published in 2018 that there is no clear path on how to develop a smart city, but the city of Barcelona is often thought to be a model to follow. Barcelona was a city of textile production, so its economy was very close to collapsing in the 1980s. That led the city officials to changes and economy was focused on knowledge industries and Barcelona was being developed as a tourist attraction.
Especially during the reign of mayor Xavier Trias (2011-2015) the city underwent many changes. They focused their attention on technology, built infrastructure, economy, the people, and natural environment to reach the two folded goal of using new technologies to improve the economy and the well-being of its citizens. Some of the changes made were building new telecommunication networks with more than 500 kilometres of optical fibre, orthogonal bus network, new LED lighting, and public datasets.
All the different projects were by many viewed as highly successful: 21 000 jobs were created of which 1 870 are directly linked to smart city development and 85 million euros of added GDP impact in 2014. There were also some negatives found in Barcelona: middle-class citizens that could not afford increased living costs of newly created hip areas were forced to move elsewhere. Also, Barcelona's people did not fully understand what it meant to develop a smart city and so without any concrete strategy to manage all the projects and the growing drift between the citizens and city officials, mayor Trias lost the vote of May 2015 even though some improvements were made, and the government supported the cause. The moral of this failed smart city development is that it is important to educate the people whose input one needs.

In the article "Smart City Development with Urban Transfer Learning" [14] the authors pose a question how to develop a smart city with limited data and that city official should really invest into collecting data to enlarge the amount of data. The authors

understand that some data may remain unused, but the more data is collected the more a "cold-start problem" will be decreased.
Resolving or reducing this problem can also help creating more second- and third-tier smart city services. The authors also point out the importance of publishing open data in open data portals for all sides.

During an Indonesian conference [15] on the topic of a smart city framework and development many possible challenges of and ideas for developing a smart city were pointed out. The problems the see are as follows:

1. partial and incidental implementation;
2. compatibility of smart city concept applied to city conditions;
3. too broad of a scope;
4. too focused on developing technology:
    a. forgetting the business needs;
5. lack of evaluation of implementation.

They created a methodology that is an adaptation of the Sun Tzu's Art of War and it has five pillars to it:

1. providing background;
2. setting objectives;
3. having a strategy for the future with current situation considered;
4. implementation;
5. monitoring the project closely.

The authors also think that the public and private sector should work together and that these types of business models could be much more sustainable.

During another smart city conference [16] held in Zurich many policy changes were suggested:

1. encouraging the creation of smart city strategies and implementation plans to provide motivation and implement acknowledgment;
2. innovative funding models that join existing public and private funding sources with new kinds of subsidizing;
3. creating innovation zones in cities to test and assess the impact of modernized policies and regulations.

These policy changes are intended to give cities developmental freedom but also to steer them in the mindset of the new age of innovation and help create business models that support local economy.

# 3 Research methodology

In this chapter the author will introduce the reader the research methodology used in this master's thesis. It will also be explained why these methods were chosen and how they contribute to reaching the goal of answering posed research questions. The thesis also contains references to scientific publications that were used to provide the reader objective material to support the claims made in this master's thesis.

By citing many current scientific articles about smart cities, the term itself is being opened and with that many supporting topics, such as smart cities and GDPR. Besides explaining the theoretical background of this subject, many articles being cited have been written about various smart city projects around the world for two reasons: to find out what has been done very well and should be taken into consideration whilst giving suggestions for the successful development of a smart city, but also to determine the real errors that smart city developers and/or scientists have been faced with. These errors will be used as an input for the interview questions that will therefore be more precise and data-driven because of that input.
The analysis will be conducted on the interviews' answers and will give an objective outlook on the Tallinn Smart City project and its possible strengths and weaknesses. All main stakeholders' representatives are being interviewed to ensure the objectiveness of the outcome.
Based on the analysis, suggestions for improvement are given to provide Tallinn Smart City developers a data-driven input to better the development process.

There was an obvious need for two different type of analysis methods. To research the topic of smart cities and the work done by others in the field, the author firstly used deductive thematic analysis to analyse the findings from the state-of-the-art articles. This method allowed to stay in scope and analyse the material with the set hypothesis in mind. The outcome of this analysis were the interview questions where it was important to form objective questions and relying on the work of others helped to reach this goal.

Cross-case analysis was used when analysing the interview answers because the interviewees all answered the exact same questions and therefore analysis similar cases was possible. Cross-case analysis allowed this thesis to be Tallinn-centric.

## 3.1 Deductive thematic analysis

This master's thesis is first and foremost based on the Tallinn Smart City project's stakeholders' opinions and ideas collected through direct communication, so the main research method used is deductive thematic analysis. This method is chosen because it is theory-driven and limited to preconceived frames that are the posed hypothesis and the general idea that all smart city projects have similar tendencies [17].

These similar tendencies are also to be found through conducting deductive thematic analysis on scientific publications on previous smart city projects. The main reason to analyse previous projects is to find negative tendencies that have caused the previous projects to fail or not to succeed completely. Having determined these factors, it is possible to find solutions to the occurring problems and avoid these problems to become success-hindering factors in Tallinn Smart City project.

## 3.2 Interviews

This master's thesis is focused on the smart city development in Tallinn and to get the best insight about the current situation, interviews with the various stakeholders are being conducted. Interviews offer a valuable opportunity to see the bigger picture and understand what the interests and motives of the different stakeholders are and, in that find, the best solutions to problems that may have been overlooked in the past.

Interviews conducted for this master's thesis will be qualitative because it is more important for the execution of the end goal to get well-structured and thought out answers rather than very many but superficial ones. Interviews are structured meaning all interviewees answer the same questions and all questions are derived from the problems found from studying the state-of-the-art articles.

## 3.3 Bracketing

Because of the use of interviews and the need for the interviews and analysis to remain objective, bracketing method is also used in this master's thesis to lessen the subjective opinions or preconceptions of the author [18]. Before the interviews a lot of work went into reading and analysing the state-of-the-art articles that on one hand allowed the author to familiarize themselves with the research topic, but on the other hand also created some preconceived ideas and an understanding of the research topic and possible problems that may be present in Tallinn.

## 3.4 Cross-case analysis

Cross-case analysis is chosen because of its nature of comparing different cases to produce new knowledge [19]. This new knowledge will be objective because the cases chosen for comparison, are from all around the world and there will be many of them. With studying multiple projects from around the world and the one in Tallinn, there is going to be a possibility to find patterns, both good and bad. Cross-case analysis is also used while analysing the answers from interviews. The discovered patterns will help to determine the best practices of a smart city development and in that help to reach one of the main goals of this master's thesis. Cross-case analysis is used together with deductive thematic analysis, which is the main analysis method in this thesis.

# 4 Interviews

In this chapter the author will introduce the reader the interview questions and the interviewees. The interviews will be conducted with the stakeholders of the Tallinn Smart City project and the interviews will be recorded and transcripted by an artificial intelligence based app [20]. The transcripts will not be included as appendices for privacy reasons but will exist as a proof for the validity of the analysis and will be distributed when needed. Interviews will be conducted in Estonian as all the parties it.

## 4.1 Interview questions

All these questions are derived from the scientific articles written about the challenges and general developments of smart cities around the world. Every question will be asked from all the interviewees to ensure the possibility to conduct a thorough analysis using deductive method.

| **Question block** | **Interview Questions** |
|---|---|
| Introductory questions | What is your position in the Tallinn Smart City project? |
| | How long have you been a participant of the project? |
| | How long have you been active in the information technology field? |
| Determining the possible problematic aspects of previous smart city projects as well as Tallinn Smart city project's ones. | What do you think makes a city be a good candidate for a smart city? |
| | What are the main challenges of developing a smart city? |
| | How do the different educational statuses of city's |

| Question block | Interview Questions |
|---|---|
| | habitants influence the development process? |
| | How do the different social statuses of city's habitants influence the development process? |
| | How do the different financial statuses of city's habitants influence the development process? |
| Providing the Tallinn Smart City project stakeholders the solutions that might help avoid or elevate possibly occurring problems. | What are the most important tasks for the development of a smart city? |
| | What do you think about including the private sector in the development and which areas would be most important for this type of collaboration? |

Table 1 - Interview Questions according to Research Goals

These questions are open-ended questions and the answers are going to be individual and reflect the interviewees' personal opinions but the fact that all the interviewees are directly involved with the given project makes the answers legitimate and all of the answers are given having the Tallinn project in mind and therefore the answers reflect the real-life situation.

## 4.2 Interviewees

Interviewees are chosen from Tallinn City Council, Prolab, and Thinnect because these three business entities are the three main partners in the smart city project. Tallinn City Council is the consumer and Prolab and Thinnect are the providers of service. For their anonymity the names are not presented in this thesis but from every stakeholder group two people were interviewed who have all leading positions and been involved with this project for at least over a year, mostly two years. Besides that, they have all been in the IT sector for over ten years minimum, so they are all knowledgeable both in IT in general but also in developing smart cities. From the providers' sides the interviewees were soft- and hardware developers with some having project management tasks and

from the consumer’s side both people had the advantage to have IT knowledge as well as management skills.

# 5 Analysis

In this chapter the author will introduce the reader the answers given during the interviews and the analysis based on them. Because one of the methods was cross-case analysis, the transcribed answers were compared next to each other question by question using Excel but because of anonymity this file will not be included as an annex in this master's thesis. Questions' answers and analysis will be conducted per question in separate subparagraphs and then together in one summary subparagraph.

## 5.1 Analysis of the Question "What do you think makes a city be a good candidate for a smart city?"

With every IT project where there are at least two different organisations in play with them both having goals of their own, it is very important that the communication between all of the stakeholders would be as easy as possible – meaning there's synergy and all the participants understand what the end goal is. Surely, some basic knowledge of IT is more than a plus but more importantly, all the people involved must want to achieve results and think of the solutions not the problem. Someone from the city council may not have the newest information about the leading technology but it is still important that they would be involved in the thought process because they see the bigger picture and can help either the scientists or the private sector to develop technologies that are actually useful and needed by the city.

It is, however, not good enough when a few city officials have – maybe because of their own initiative – involved with the private or third sector representatives to develop new solutions. The will to want to move forward and be innovative must be ingrained into the city and its leaders in all levels and all subunits. The goal for a city should never be becoming a smart city, it should be providing great services to its citizens. To improve services means to be always ready to innovate services and this is an ongoing process that requires resources. A leader, be it the mayor or a subunit's manager, must understand that and allow resources to be allocated for business process design. That in turn will lead the services to being more human-centric.

A city that is a good candidate has either the necessary and timely regulations already in place or the capability to change regulations *ad hoc*. All new ways of providing a service are great but especially when dealing with the public sector following regulations when providing public services to the citizens is a must. However, seen as smart city solutions are innovative it is almost certain that regulations have not taken account the innovative new ways of providing a service that may even have not been technologically possible when the regulation was written.

As with every project, the most important thing is the resources. If a city wants to become a smart city, it must find the people and capita. Educated people are hard to come by and in a smart city project many skills are needed: IT, legal, management, and communication. These skills need to be found within the project organisation but should not be limited with it. Also, supportive skills from all branches of city officials that know their field and its problems. Although people are most important because they lead the project, capita is a necessity as well – ideas do not cost much themselves but to create a functioning service or product money is needed and managing money flows can make or break the project.

The last point of needing capita can be alleviated when there's a good infrastructure in place in the city already. In this context infrastructure can be viewed in many ways: from sensors to lamp posts in the city. The more advanced and high-tech the infrastructure the better. In the case of Tallinn where sensors are already in place every new project that exploits the same sensors will need smaller investment.

## 5.2 Analysis of the Question "What are the main challenges of developing a smart city?"

The main challenges pointed out by almost everyone were time and resources – developing smart city solutions takes a lot of time and is a process. Patience and trust between the stakeholders are needed to mitigate the tension and confusion when results may not happen as soon as expected.

By resources it was not so much project funding that was lacking but the people as already mentioned before. In terms of bringing new people in, providers are already struggling to compete with other developed countries. When there is not enough

university students, scientists and developers, it is very challenging to build our own custom solutions and bought-in technologies is reality what Estonian cities must wait for and get by with. The very limited financing of the Estonian academia is also seen as a problem – as it causes people not to choose to stay in the academic field this in turn leaves less innovators in Estonian academia.

A few interviewees from both sides mentioned the fact that real problem is the lack of real value products and services. Most of the smart city solutions are not must-have but more nice-to-have solutions. Everybody accepts smart city solutions can change our lives as any city's habitants for the better but no actually valuable and life-changing solutions are yet in the market because no one has really identified the needs of the customer and found a smart city solution to them. As a solution to this, some of the interviewees suggested more collaboration between the public and private sector.

Every city that wants to become a smart city must have leaders in every sub-unit all the way to the mayor that have a data-driven mentality and a clear leadership strategy where business product design is most important. These two aspects are needed for two reasons: firstly, no city where the leaders are not interested in making data-driven decisions and do not want to improve services will not invest in new technologies or will do so only partially and not sufficiently. Secondly, having all the decision-makers on board will also help with bureaucracy when new sensors must be added to the city and for that a signed document is needed. There will be no halt and no need to explain the need for sensors. In addition to leadership strategy, city officials in Tallinn also see the need for set technological standards, such as cloud-first, to follow when developing new services. These standards need to be developed to have an understanding and a vision for the technological elements.

## 5.3 Analysis of the Questions "How do the different educational/social/financial statuses of city's habitants influence the development process?"

These three questions are combined into one because of their intertwined origins. All the providers' side stakeholders saw it as a bigger influencer than the city officials but all in all everyone recognised that it does make a difference. It may not create difficulties for the development process but people with worse financial, social and

educational statuses may not be able to consume the smart services because they do not have the know-how nor willingness nor gadgets needed to use the innovative services. That in turn means that there must always remain an analogue service next to the digital (e.g. paper forms).

It was also suggested that city's habitants with a higher level of education and in that better social standing are more accepting and supportive about the new technological solutions – they are less likely to be paranoid about being monitored. Having some knowledge about the technological possibilities of sensors may even mean that the city's habitants can help develop new services by asking for them. They might also have more incentives to improve the quality of living around them e.g. be more aware of the surroundings thanks to sensor data.

## 5.4 Analysis of the Question "What are the most important tasks for the development of a smart city?"

Different tasks from different areas were pointed out by the interviewees. Many of them said it is vital to, before the start of actual development, understand and agree upon an actual problem that is meant to be solved. This may seem obvious but seen as most developments are more nice-to-have ones, suggests that development up until now is not entirely human-centric and more just trial projects to either test the technology or to just have some type of data being collected.

Before starting any type of collaboration or development between outside stakeholders the communication channels and contact persons of every stakeholder must be clear to all the participants. Because of the city officials' different sub-units and agencies, it is important to have communication channels and contacts outside the project organization in place before the start of the development as well to mitigate time spent on bureaucratic tasks.

As with every project, it is of upmost importance to manage resources and with a project where the technology and solutions are innovative, it is difficult to evaluate the capita and time needed. City officials in Tallinn happily work with other cities to share experiences but cities still have their differences and what may have worked in Tartu can be hard to implement in Tallinn.

Smart city development is, as it has been mentioned many times before, a long process. However, development projects in Tallinn are often short-period projects with a definitive end goal and date. This is something city officials should keep in mind: having to manage short-time projects that may still have an end date but that their end goals would correlate with the tasks set in the long-time smart city development road map. This would make procurement based short-time projects more useful and effective. Smaller scale also allows faster results that are needed to communicate to higher officials and the public.

Following the idea of having a long-term strategy, it is also needed to have legal aspects under control and not facing any type of vendor lock. Both these tasks are important for the city officials. Regulations are what dictate how and why public services are provided and any change in the how needs to be mirrored in the regulations. This means it is of upmost importance to work closely with the city's legal team and have them familiarised with the strategic goals. To ensure that no vendor lock occurs, a strong architectural strategy and vision needs to exist. It may happen that the city has procured services from many different providers who all have their standards and preferred platforms which may not work together. Therefore, the city needs to be the one to set the standards and look for great matches to the already existing platforms. As a supportive task, city officials pointed out that it helps to be in the know about what the tech giants are doing because this is an indicator of the coming trends in the field of technology.

## 5.5 Analysis of the Question "What do you think about including the private sector in the development and which areas would be most important for this type of collaboration?"

All interviewees agreed that it is a good idea to work together with the private sector for different reason: they have more thrive for innovation, they have no bureaucracy, they may have more money, the public sector will never employ enough developers to work for them nor do they see the need to do so. Given that this project was also started by the private sector, such an answer was not surprising. The private sector can be a great partner for the public sector in a different way than mentioned before as well – they can be the educators. The private sector technological experts such as developers and

innovators can educate public sector official on the newest technologies in the field and it would be most useful to the private sector to get clear input from the public sector what is needed in the market. This way private sector companies can truly develop products and services that they can sell, and public sector would have some of their problems solved.

Even though the collaboration was agreeable to everyone, there are some things that were pointed out that are possible negatives. Firstly, city officials must be very careful about not ending up in a vendor lock where they are completely bound to one company's solution and it is difficult to switch service providers. Secondly, known and trustworthy companies with enough manpower and capita are often not interested in small trial projects and are not too innovative. They are not the ones to act as educators or partners during the project planning stages or in a project proposal when there are no reassurances that the project will be funded. Start-ups are usually very eager to work with the public sector and gladly share their ideas with the public sector and given their still developing products and services can agilely change it in the way their public sector client needs. The downside of start-ups is inevitably that public sector officials cannot always rely on them. Start-ups are young developing companies that may end up going bankrupt or just decide to close their business. Entering a contract with an unreliable partner for many years – because smart city projects are long projects – can be difficult for a public sector official to explain to their executive leader.

# 6 Suggestions

In this chapter the author will make suggestions that can improve the Tallinn smart city development and because of the recurring obstacles within every smart city development, these suggestions may alleviate problems of other cities. Suggestions given stem from problems that were evident from the interviews and are backed by academic articles, if possible.

## 6.1 State-of-the-art suggestions

Although articles focusing on the mistakes and/or problematic aspects faced with developing smart cities are not too popular, there are some that can be partially used within the scope of this master's thesis and in author's view coincide with the situation in Tallinn and could improve the state of future developments.

### 6.1.1 Suggestions based on key insights from Amsterdam

There were some key insights pointed out by researchers at the Amsterdam University of Applied Sciences [21] where they analysed smart city projects in Amsterdam. Although, the key insights given are Amsterdam-based and not actual suggestions and some of the key insights are not scalable for the Estonian scene, many are still included to this master's thesis with added suggestions by the author. The Dutch researchers also presented a great set of questions based on the key insights that are helpful for everyone who starts developing a smart city solution that can be accessed online. The researchers in Amsterdam point of the following:

1. city officials do not need to be included in the development process and they can just be the consumer of a provided service or product, but there lies a risk that it could be harder to get them on board with such a project. So, it is in this master's thesis' author's view better for both actors from the civil society or

private sector and the public sector to work together from the start when development idea comes not from the public sector.

2. when a smart city solution is being developed in a multi-stakeholder project, it is of upmost importance that there is trust and unambiguousness between all the stakeholders about their motives for involvement in the project. It is also proved more successful when a project has one partner that has clear gains from the project because that partner will be extremely motivated to make sure the project is moving along. Taking this given suggestion further, the author of this master's thesis suggests that this transparency can be achieved with all stakeholders assigning project managers to establish a steering committee where one person is leading that committee. In that it is insured that there exists someone that will steer the project and when problems occur there is someone to turn to for further instructions. One of the main tasks of such a steering committee is alleviating any risks for the project before major problems can occur.

3. the project scope is necessary to define before the start and communicate it to all the stakeholders, however the scope can be changed when needed and that, when communicated in time to all the stakeholders, is not a bad thing.

4. often smart city solutions do not succeed because the people or organisations that these solutions are meant for do not want to use them because of their own way of doing things and it is uncomfortable for them to make the change for something new. As smart cities need to be human-centric, working closer with citizens is advised. This is not entirely scalable to the COVID-19 tracking app in Estonia, HOIA, and its relatively low download rate of 16,2% (the application has been downloaded 215 833 times [22] and there are 1 328 976 people living in Estonia [23].)

5. it is a great idea to share knowledge and experiences between different cities who are all trying to develop smart cities. This needs to be systematic and structured. In the view of this master's thesis' author, Tallinn should create a format for this task force under Tallinn Entrepreneurship Day (*Tallinna Ettevõtluspäev*) or as a completely new format. This new task force could be for cities what Digital Nations is for countries. Digital Nations, of what Estonia is

one of the founding members, is an organisation that combines 10 countries around the world who are leaders in digital government [24]. This task force would also be a good way to communicate to the public of plans and aspirations of Tallinn, thus explaining the vision and in a way creating a safe net where to fall if some project may not succeed.

## 6.2 Suggestions based on interviews

Based on the problems identified from interviews, the author gives additional suggestions to the Amsterdam key insights and added suggestions to those insights.

### 6.2.1 Technological tools

With smart cities becoming more popular and reusable software components being developed, there are many tools out there, some open source, that enable saving money by not having to build everything from scratch and using same tools helps to create a network.

Some tools for smart cities have been developed by the European Commission's programme Connecting Europe Facility [25] that they see public sector can greatly benefit. Some examples of such tools are Context broker, Big Data Test Infrastructure (BDTI) and eARchiving. Context broker is meant for understanding city's data by centralising raw data, BDTI for analysing it, and they also offer their eArchiving service for maintaining it. Using Connecting Europe Facility's tools will mean that these tools will help cross-border data sharing and are built using reliable and trustworthy standards.

Tallinn and other smart city candidates should develop smart city sandboxes where ideas and products could be tested out with little to no extra investments. This idea mainly familiar to cybersecurity specialists and software developers can be used in smart city development as well – smart city developers may need regulatory or technological sandboxes. As legal fields can differ quite drastically, it makes sense to create one for Estonian cities. One of the technological sandboxes around the world is Helix SandBox [26]. Every city has their own technological architecture in place and not all may need a sandbox type of solution, however if they do, Helix Sandbox has

already been developed and will be updated, and it has been implemented with a few smart city projects, so it could be beneficial to try it out.

### 6.2.2 Educating the public

In addition to a task force connecting different cities that develop smart city solutions, it will be beneficial to have other communication schemes to advertise city officials' efforts in developing new solutions. Tallinn Entrepreneurship Day (*Tallinna Ettevõtluspäev*) is a great example of such a scheme.

Another way to reach more people is content marketing which is now an integral part of online marketing campaigns [27]. Going digital with marketing campaigns are great because they allow the target groups to be reached wherever they are whenever they want to consume content.

Smart city solutions should be human-centric and solve actual problems of given city's habitants. City officials have the best overview of habitants' problems, whereas businesses that want to develop new services and products would greatly benefit from as precise input about what is needed. Due to for example political and reputational reasons cities do not want to advertise their problems to the public and thus giving the opposition a chance to attack current government. However honest data about the situation will help to solve the problems. As a good example of this, the Estonian government organises regular deep dives and hackathons with different public sector agencies and development firms. Many problems have been solved and public sector has only benefitted from honestly advertising their shortcomings. It is worth to try regularly to have deep dives and hackathons concerning smart city solutions.

### 6.2.3 Continuous and risk-free resources

Smart city development undoubtedly requires a certain amount of resources, both monetary and personnel. To ensure money for smart city development projects, city officials in charge of budgets and funding should create funding means for proof-of-concept types of projects that are not as expensive as real developments but allow ideas to be tested out. Such a funding mean has worked for the state where actual developments are substituted with analyses and proof-of-concept trial projects.

To ensure that projects are well thought-out, it is useful to use a rating system or guidelines that validate new ideas. Two of them have been mentioned in this master's thesis already. One of them is the Dublin A-F process [5] that offers a six-step methodology for describing the needs, current situation, and solutions of projects. Another methodology is the one that the researchers from Amsterdam [21] have created. It lists 10 questions that should be thought through before starting any smart city project. Topics of these questions range from finances to impact and upscaling.

### 6.2.4 Business process design

It was clear from interviews with city officials that smart city solutions are more a tool than the goal, and the goal should be better services and business processes. Cities do not face the same competition with other cities like businesses do for customers and because of that it is possible that functioning processes are left as they are and not improved regularly which is not sustainable.

One way the Estonian cities and towns can re-evaluate and redesign their business processes and provided services, understand the need behind these activities, and get the help and funds for it, is described in the statute [28] of the Department of Information Society Services Development of the Ministry of Economic Affairs and Communications of Estonia. The main tasks described in the statute include:

1. developing, publishing and updating the documents concerning the development of public services, coordinating the development of public services in the information society, ensuring quality and managing the relevant supervision by the Ministry;

2. developing, managing, and maintaining the quality of public services' evaluation system to ensure the unified quality of public services information society, and consideration of usability and user-friendliness;

3. organizes the compilation and publication of reviews of the quality of public services;

4. analyzing the policies of existing public services, including legal, technical or organizational;

5. compilating proposals for the improvement of specific public services;
6. organizing the compilation of concepts of the renewable public services, considering legal, organizational and technological factors;
7. organizing co-operation for the renewal of public services with interested parties;
8. compilating and managing projects for the implementation of innovations of public services;
9. making proposals for the state budget for funding within their field of activity.

# 7 Summary

Smart city as a term has many definitions, however the author finds the most accurate and all-inclusive definition: a smart city is a city where public services are comfortable to consume, and overall quality of life is elevated thanks to the input from the citizens and technological advancements. Chapter 1 has been dedicated to introducing the reader the topic and its background.
This master's thesis includes two different analyses of smart city developments and their occurred problems. It is focused on Tallinn's one smart city project called SmENeTe 2 [2] which is one of the projects that will be analyzed. The methodologies used to carry out this research have been introduced to the reader in Chapter 3.

Many projects from around the world will be researched and analyzed to find out which are the main problems that keep occurring. The research has been detailed in Chapter 2. Research was necessary because based on these problems, questions to ask Tallinn smart city project's stakeholders were formed. Main categories of problems that were found from the state-of-the-art's analysis were the following:

1. resources: either lack thereof or wrongful allocation. The main types of resources are time, money and the people.
2. insufficient collaboration between sectors (e.g. public and private.)
3. different project management problems (e.g. too broad scope, not focusing on the business needs.)
4. city's habitants' different classes (e.g. different educational levels.)

Having analyzed different state-of-the-art articles, out of which many were articles written about development processes around the world and understanding which problems were actual smart city problems, questions for the stakeholder interviews were formed. Chapter 4 has been dedicated to the questions alongside with background information of interviewees of the Tallinn smart city project's stakeholders.

Chapter 5 has been dedicated to the analysis of the interviews. Main categories of problems that were found from the interviews' analysis were the following:

1. insufficient knowledge sharing between sectors. Although there is communication and projects being done cross sector, there is not enough valuable input shared between them making development not as precise and human-centric.
2. insufficient sharing between public sector officials around the world, even around the closer region.
3. organization's culture. Public sector is not at a point yet where human centeredness is the end goal.
4. human resource issues. Estonia is a small country where it is rather difficult to bring students/researches in. This is mainly creating technological problems that in turn affect social aspects – no real innovation/delayed innovation that make it harder to reach deadlines.
5. not having defined the actual business need. Mainly still in trial stages with solutions that are nice-to-have not must-have.
6. legislative requirements. They often need changing when new way of providing services is introduced.
7. defining scopes. Usually in Estonia, projects are short-term with the requirement of having actual product at the end of it. Smart cities are, in turn, ongoing developments.
8. city's technological architecture. It must be clear and not be subjected to vendor locks or not compatible parts.
9. finding partners to trust.

In Chapter 6 different suggestions have been given by the author that should alleviate these problems. These suggestions were intended for Tallinn's projects but because generally problems occurring in Tallinn are the same ones that also occurred everywhere else, so these suggestions may be used for other cities as well. They will probably help the European Union's member states the most.
Suggestions summarized were the following:

1. establishing project steering committees across project stakeholders.
2. establishing working groups with other cities that develop smart cities around the world.

3. working alongside the Ministry of Economic Affairs and Communication to design human-centric services.
4. using technological open-source tools already developed (e.g., by the European Commission.)
5. including the citizens with content marketing campaigns and by organizing more events like Tallinn Entrepreneurship Day (*Tallinna Ettevõtluspäev*).
6. create or use already existing and provided in this master thesis' rating systems for different smart city projects.

To further this research, the author finds it would be useful to analyze the cybersecurity problems that occur with the development of smart cities. The need for it is going to be more evident with each day as more and more cities have many smart city solutions in place and the cyber threats are going to be their everyday problems.

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# Appendix 1 – Answers for Bracketing

What is your position in the Tallinn Smart City project? – I am writing this master's thesis on the project and have read a lot of articles and taken part in some of the meetings between stakeholders.

How long have you been a participant of the project? – Since Spring 2019.

How long have you been active in the information technology field? – Since Autumn 2015.

What do you think makes a city be a good candidate for a smart city? – I think a good smart city has set its goals and strategies so that they support the development. The money is important and cities with bigger means have higher possibilities to develop more, but with a great strategy and set ideas it is possible to find third sector partners and other means. Also, money does not solve anything in itself and so cities with bigger means can fall victim to poor leadership and wrongful investments.

What are the main challenges of developing a smart city? – Smart cities are relatively new and the way to govern them may be unknown by city officials because they are not that technical people and have unrealistic ideas. Also, smart city as just that must never be a goal but rather a tool to solve real issues or weaknesses.

Different cities do not work together resulting cities having to deal with the same issues and finding solutions to them themselves and in that losing valuable resources. There should be a great community in place that is based on trust. Right now, there is not nearly enough articles that honestly include the negative aspects and errors faced by the different city officials/developers etc.

How do the different educational statuses of city's habitants influence the development process? – People with higher level of education are usually more knowledgeable in IT, so they know what to ask from the city council members regarding IT solutions. Also,

they usually are paid more and can therefore buy different gadgets and smart phones that are more compatible with smart city apps and services.

How do the different social statuses of city's habitants influence the development process? – People who have a higher social standing are usually more inclined to care about the city they live in and have more knowledge and means to contact the city council for changes, there might also exist prejudice against lower class members and their opinions might not be taken account.

How do the different financial statuses of city's habitants influence the development process? – As written before, mainly I see the issue there with people with lower incomes not having the means to pay for the smart phones, cellular data/Internet to reap the benefits of the created services.

What are the most important tasks for the development of a smart city? – I think planning and managing are the key tasks because every smart city project has multiple stakeholder groups and the processes are multifaceted ranging from the technical to legal to social etc. A lot of various resources need to be managed and it is very important to stay current and in the know about the latest technologies. Also, the most important is to analyse what are the core issues that smart city solutions can fix.

What do you think about including the private sector in the development and which areas would be most important for this type of collaboration? – I think the more knowledge and different viewpoints the better but the private sector has to be managed and they can not own any of the data, owning the technology and the solution is fine but the data must be public sector owned.