

# UNDERSTANDING SMART CITIES

Improving climate resilience in smart cities with open data citizen engagement

Master's Thesis  
Viljam Ahdekivi  
Aalto University School of Business  
Information and Service Management  
Spring 2021



---

**Author** Viljam Ahdekivi

---

**Title of thesis** UNDERSTANDING SMART CITIES: Improving climate resilience in smart cities with open data citizen engagement

---

**Degree** Master of Science in Economics and Business Administration

---

**Degree programme** Information and Service Management

---

**Thesis advisor(s)** Matti Rossi, Hadi Ghanbari

---

**Year of approval** 2021**Number of pages** 76**Language** English

---

Abstract

This thesis studies smart cities, and open data solutions in building climate resilience through citizen engagement in smart cities. The purpose of smart cities is to make life smarter, more efficient, and easier for its inhabitants. Therefore smart cities should both withstand and mitigate climate change impacts, while fostering social inclusion and harnessing the potential of citizens in co-operative governance, and the ever-changing co-creation of the smart city.

This study follows the qualitative research tradition. The philosophical foundations lie in the interpretive and constructionist ontological approaches and the method is exploratory interview analysis. The data set consists of seven semi-structured interviews and existing documents.

This thesis contributes to the relatively new field of smart city research by providing a glimpse into the possible avenues of improving urban climate resilience through effective open data citizen engagement. This thesis builds on previous literature on climate resilience, open data, and citizen engagement, and fills the gap that exists on the topic of improving conditions for more effective climate resilience outcomes by fostering improved open data citizen engagement.

---

**Keywords** smart city, climate resilience, open data, citizen engagement

---

---

**Tekijä** Viljam Ahdekivi

---

**Työn nimi** UNDERSTANDING SMART CITIES: Improving climate resilience in smart cities with open data citizen engagement

---

**Tutkinto** Kauppätieteiden maisteritutkinto

---

**Koulutusohjelma** Information and Service Management

---

**Työn ohjaaja(t)** Matti Rossi, Hadi Ghanbari

---

**Hyväksymisvuosi** 2021

**Sivumäärä** 76

**Kieli** Englanti

---

Tiivistelmä

Tämä pro gradu – tutkielma keskittyy älykaupunkeihin, ja avoin data – ratkaisuihin ympäristöresilienssin kehittämisessä kansalaisia osallistamalla älykaupungeissa. Älykaupunkien tarkoitus on tehdä elämästä älykkäämpää, tehokkaampaa ja helpompaa asukkailleen. Täten älykaupunkien tulisi sekä kestää, että minimoida ympäristömuutoksen seuraamuksia, samalla luoden tilaa sosiaaliselle inklusiivisuudelle ja hyödyttämällä kansalaisten potentiaalia älykaupungin yhteisohjaamisessa, ja -luomisessa.

Tämä tutkielma seuraa laadullista tutkimusperinnettä. Tutkimuksen filosofinen perusta on tulkinnallinen ja konstruktionistinen ja tutkimuksen metodi on eksploratiivinen haastatteluanalyysi. Tutkimusaineisto koostuu seitsemästä puolistrukturoidusta haastattelusta ja olemassa olevista asiakirjoista.

Tämä opinnäytetyö tukee älykaupunkien suhteellisen uutta tutkimusalaan tarjoamalla katsauksen mahdollisiin polkuihin, miten urbaania ympäristöresilienssiä voisi parantaa kansalaisten osallistamisella avoimen datan ratkaisuilla. Tämä tutkimus rakentaa jo olemassa olevan ympäristöresilienssiä, avointa dataa ja kansalaisten osallistamista käsittelevän kirjallisuuden päälle, ja täyttää teoreettisen aukon olosuhteiden parantamiseen tehokkaammille ympäristöresilienssilopputuloksille parantamalla avoimen datan ratkaisuilla tehtyä kansalaisosallistamista.

---

**Avainsanat** älykaupunki, ympäristöresilienssi, avoin data, kansalaisten osallistaminen

---

## Acknowledgements

This thesis was made possible with the collaboration of many different people and organizations. Firstly, I would like to thank FinEst twins for providing me with the opportunity to study such an interesting topic. Second, I would like to extend a heartfelt thankyou to the people who participated in the interviews and made this study possible.

I would also like to thank my parents, who have supported me during this entire project and proof read countless copies of unfinished drafts and fragmented drafts. I would also like to warmly thank my sisters for always being a source of inspiration and support.

Finally, I want to thank my friends who always have encouragement to spare, and especially my dear friend Olga, who patiently answered every one of my million questions, guided me when I felt lost, and without whom I would still be struggling to piece together my research.

# Table of Contents

Acknowledgements.....	iii
<b>1 Introduction.....</b>	<b>1</b>
1.1 Background.....	1
1.2 Research objectives and relevance.....	4
1.3 Definitions.....	5
1.4 Structure of thesis.....	5
<b>2 Literature review.....</b>	<b>6</b>
2.1 Smart cities.....	6
2.2 Social sustainability in smart cities.....	11
2.3 Governing smart cities.....	13
2.4 Open data.....	16
2.5 Climate adaptation.....	20
2.6 Climate vulnerability.....	23
2.7 Climate resilience.....	25
2.8 Building resilience.....	30
2.9 Theoretical framework.....	34
2.10 Summary of reviewed articles.....	36
<b>3 Methodology and methods.....</b>	<b>37</b>
3.1 Research design.....	38
3.2 Research context.....	39
3.3 Data collection.....	40
3.4 Data analysis.....	43
3.5 Ethical considerations and trustworthiness of the study.....	47
<b>4 Findings.....</b>	<b>48</b>

4.1	Smart city sense making.....	50
4.2	Most important aspects according to interviewees.....	51
4.3	Overlap between sense making and most important aspects.....	53
4.4	Citizen engagement, climate resilience and open data.....	57
5	Discussion.....	69
5.1	How do professionals working with smart cities define the term “smart city”? What is the sense making behind the phenomenon?.....	70
5.2	How do we engage citizens in building climate resilience in smart cities using open data?.....	71
6	Conclusions.....	74
6.1	Main findings and theoretical contribution.....	74
6.2	Practical implications.....	75
6.3	Limitations of the study.....	76
6.4	Suggestions for further research.....	76
7	References.....	77
	Appendices.....	82
	Appendix A.....	82
	Appendix B.....	83
	Appendix C.....	84

## List of Tables

Table 1. Primary and secondary smart planning themes.

Table 2. List of interviewees and their backgrounds.

Table 3. Examples of code groups, codes and quotations used in the data analysis process

Table 4. Interview quotes reflecting the sense making of the smart city concept.

Table 5. Interview quotes reflecting the complex elements of citizen engagement.

Table 6. Interview quotes regarding open data solutions for smart cities.

Table 7. Interview quotes regarding climate resilience in smart cities.



## List of Figures

Figure 1. Characteristics and factors of a smart city

Figure 2. Water square XL in Rotterdam.

Figure 3. Framework for urban climate resilience.

Figure 4. Data analysis process visualization.

Figure 5. Network visualization of code group “Tools needed for rapid sustainable change”.

Figure 6. Visual representation of overlap between “Smart city sense making” and “Most important aspects of a smart city”.

# 1 Introduction

## 1.1 Background

When hearing the term "smart city", the first things that come to our mind are usually ICT, big data, interconnected systems, smart sensors and futuristic technological services. The smart city rhetoric was originally launched by IBM. IBM patented the "smarter cities" term and decided to aim at taking over the urban technologies market. The strategy that IBM used was one in which they tell a convincing story about cities and the problems that they are plagued with, while conveniently placing themselves as the central solution to these problems, providing a utopian "one size fits all" solution, for all cities worldwide. (Söderström et al., 2014)

Shortly thereafter cities began competing with each other in "smartness" to attract investment to their cities. In practice this means new ICT infrastructure and investing in increased presence and availability of broadband technology. (Söderström et al., 2014)

However, when designing a smart city, it is important to consider the actual use of the smart technologies, i.e. making sure that they fulfil an actual important purpose rather than simply existing as a technological facelift for the image of the city. From a climate perspective, there is an actual need for updating our cities to the next era. Climate change is an undeniable fact at this point, one which will have serious consequences and tangible impacts on how we live and how our cities operate in the coming decades. Climate change is, as Sir David King put it "*the most severe threat we are facing today*" (BBC NEWS, 2004). One of the many reasons why this climate change is such a difficult challenge is that it can be quite abstract and it requires numerous different solutions, from different fields, at different societal, national and international levels. According to Nobel prize-winner Paul Crutzen, we have entered into a new geological period following the Holocene, the "Anthropocene", in which human activities impact the earth on a scale relatable to that of a force of nature (Urry, 2015). It is crucial that we update the cities we live in to be able to deal with these drastic climate changes, be it intensified rainfall, droughts, floods, intensified storms, heatwaves, sea-level rise, lower air quality, etc. There is a very real necessity to "climate proof" our cities, or in other words, to make our cities climate resilient, and in the process, mitigate the actual consequences of climate change. So, in the context of cities and urban environments, climate adaptation is just as important as climate change mitigation. Climate change is also deeply intertwined with issues of social inequality. Citizen

## Introduction

engagement using open data solutions could birth ways to narrow this social inequality gap, while improving societal climate adaptability. In fact, open data is the key bridging component between citizen engagement and climate resilience. This brings me to the research problems of this thesis.

The research problems of this thesis are two. The first one is providing a concrete definition for smart cities, as I will demonstrate in the literature review of this thesis, currently there is little academic consensus on the subject. The second research problem is empowering and engaging citizens and having their voices heard by bridging the gaps between the city and its citizens to address ecological and social issues. The main issue of focus will be that of urban climate resilience. This thesis proposes that open data solutions such as clear digital communication and feedback channels between the city and its citizens, participatory mapping and budgeting, and crowdsourcing could provide ways to bridge this gap, and to build, maintain, and improve climate resilience in cities. It is my hope that not only will the research contribution made in this thesis help to identify ways for cities and the systems they are built upon to withstand the climate impacts, but also to identify ways to address local issues as well and to improve the overall wellbeing of all citizens.

It is the objective of this thesis to illustrate how open data solutions in smart cities can harness the potential of citizens to attain solutions, suggestions, and learning for improved climate resilience in smart cities. Climate resilience is not a one-avenue-solution, or solutions merely from one field. True societal adaptability requires urban planning, green building, novel ideas, technological innovation, policy change, behavioural change, cleaner energy and more efficient uses of energy, among countless others. However, as my field is information services management, in this thesis I will demonstrate how open data has the potential to interlink these solutions and form platforms and processes for creating new solutions in an environment of continuous learning.

This thesis is going to look at open data solutions utilizing citizen engagement to improve climate resilience in smart cities, as well as providing a sensemaking definition of smart cities as a concept, to provide the context for this research.

## Introduction

### 1.1.1 FinEst Twins

The FinEst Twins aims to pair up the scientific and technological prowess of Finland with the highly developed societal use of ICT and innovative entrepreneurial ecosystem in Estonia. The FinEst Twins model will capitalize on these initiatives funnelling and fusing research, innovative services and solutions into integrated service solutions with the potential to create value to users across the globe. (Soe, 2017)

Smart City definitions may vary, but the definition that the FinEst Twins have in mind is that of the 2014 study published by the European Parliament: *"A Smart City is a city seeking to address public issues via ICT-based solutions on the basis of a multi-stakeholder, municipally based partnership."*

One of the key aspects of the FinEst Twins initiative is the Urban OS, which serves as an open ecosystem to provide cross-border joint services. While this serves to benefit both cities, it also provides an innovation hub to scale smart city solutions globally. Additionally, the joint platform works as a knowledge transfer mechanism from a more advanced region (Helsinki) to a catching-up region (Tallin), utilizing open data not only for interaction and knowledge sharing among citizens, but transnationally as well. This type of joint venture could also be possible to replicate in a modified way elsewhere across the globe. (Soe, 2017)

A unique issue that the FinEst Twins initiative seeks to solve is that no matter how big of a city, if smart city solutions are implemented solely within the borders of the region, it is liable to age fast and remained boxed in from the rest of the world, meaning that solutions cannot be scaled elsewhere (Soe, 2017). In the global modern world we live in today, where wicked problems such as climate change are faced by all, it is important to develop solutions which are collaborative in nature between governments and citizens, as well as between nations.

## 1.2 Research objectives and relevance

The objective of this thesis is to determine ways in which Helsinki and Tallin, both coastal cities with a penchant for innovation, can be made more climate resilient by using open data and collaborating with citizens. To elaborate on collaboration: a true smart city includes its citizens in the governance and design of itself (i.e. smart citizens). Collaborative innovation, such as via online platforms usually yields better results than one expert. The FinEst Twins initiative, which uses open data transfers between Helsinki and Tallinn, is a great opportunity to pilot climate resilient urban planning co-created by citizens, academics, experts, governments and companies on online platforms with access to open data.

My research questions for this thesis are:

- 1) *How do professionals working with smart cities define the term "smart city"? What is the sense making behind the phenomenon?*
- 2) *How do we engage citizens in building climate resilience in smart cities using open data?*

The research conducted for this thesis is iterative and exploratory in nature. I will be analysing various literature on smart cities and determining the best practices of the most notable and successful smart city initiatives, what their focuses are and their geographical aspects. I will also be designing a questionnaire on collaborative urban design regarding climate resilience in cities. I will also be defining what Smart Sustainable Cities are by analysing literature and creating a consensus between definitions for the purposes of this thesis, since the term is used rather interchangeably with the term "Smart City" and both terms have various definitions depending on the author. To define the best potential practices for Helsinki and Tallin, I will analyse Smart Sustainable Cities in climates similar to Helsinki and Tallin, to gain a more accurate understanding and provide better recommendations.

## 1.3 Definitions

**Open data:** For this thesis I will use the definition of open data provided by Pereira (2017): "Open data is defined as any data and content that can be freely used, modified, and shared by anyone for any purpose".

**Climate resilience:** Climate resilience will be used synonymously with "urban climate resilience" and with the meaning of improving how urban areas, cities and society cope with climate impacts and climate threats

**Citizen engagement:** In this thesis used synonymously with "citizen participation". The act of passively or actively involving citizens in governance, planning, solution implementation, idea generation, feedback, etc.

**Climate adaptation:** Climate adaptation acts as an umbrella term for "understanding climate vulnerability" and "building climate resilience".

## 1.4 Structure of thesis

This thesis begins with a literature review on smart cities and smart city climate adaptation. At the end of the literature review I will propose a theoretical framework to reflect climate resilience and vulnerability. In the following chapter I will discuss methodology and methods used in the research. I will then discuss the findings of the study in the findings chapter. In the discussion segment I will answer the two main research questions of this thesis, reflecting on the theoretical framework. In the conclusions chapter, findings of the thesis will be summarized along with limitations to the thesis and suggested future research paths.

## 2 Literature review

### 2.1 Smart cities

As the climate change impacts become more intense, diverse and unpredictable, cities inevitably grow more vulnerable to them. According to Hunt & Watkiss (2014) resource availability, water supply, infrastructure, energy production and usage, and general health among others will severely be impacted by climate change, and on a city level air quality, biodiversity, cultural heritage and tourism will also be dealt a devastating blow. To minimize these consequences, cities should strive to adapt to this climatic change and nature's transformation to create a more suitable and pleasant environment for living. *"The need to create adaptive societies is more crucial than ever."* (Fernández & Peek, 2020)

The aim of this literature review is to highlight that need and to provide arguments that support climate resilience for climate adaptation in cities.

According to the UN (United Nations) 55% of the world's population currently live in urban areas and that figure is likely to rise to 68% by 2050. Additionally, according to the European Commission 72% of the European population lives in urban areas. (Fernández & Peek, 2020)

This need for a more adaptive environment does not only exist for the existing population in cities, but as the figures show, with population growth and rural populations flocking to cities, our urban environments must be able to accommodate the growing number of their inhabitants. As population grows, so will the accumulation of waste and resource consumption.

*"Cities generate 80 percent of global GDP on a land space of 3 percent, they also account for 60-80 percent of global greenhouse gas emissions, 50 percent of global waste, and 75 percent of global natural resource consumption."* (United Nations Environment Programme (UNEP), 2013)

Smart cities is a highly debated term and therefore little consensus over the definition itself exists in academic literature (Fernández & Peek, 2020). Literature on smart cities can be divided into two main categories: 1. Studies focusing on technological side, which focus

## Literature review

on questions such as energy efficiency, carbon emissions etc and seeks to develop smart technologies for cities. 2. Approaches smart cities as objects of analysis and attempts to define the smart city as a jumble of technologies such as advanced ICT, smart cards in public transport, e-governance functions aimed at increasing competitiveness, administrative efficiency, and social inclusion. (Söderström et al., 2014)

As we can see, there is somewhat of an absence of climate adaptation in the general smart city rhetoric. Moreover, the label of "smart city" is often self-imposed (Hollands, 2008). Additionally, the term and language of the "smart city" has been criticized as being used to attract economic and political capital without making significant changes otherwise (Sterling, 2018). So, what makes a city "smart"? In some cases, technology-lead cities is considered to be the main factor, but what does this exactly mean? Are smart cities defined by extensive ICT networks, business centeredness, broadband networks, or cutting edge technology? All of these factors play a part in smart cities, but none of them exclusively make cities smart (Hollands, 2008). Even with smart technology and broad ICT networks, smart and skilled people are required to make use of these things. Furthermore, the presence of top-tier tech companies merely make up a statistic of technology generated income, which makes the city a tempting investment target, but hardly makes it smart (Hollands, 2008). According to Hollands (2008), these definitions are all too narrow and often contradict one another.

Smart City definitions may vary, but the definition that the FinEst Twins have in mind is that of the 2014 study published by the European Parliament: *"A Smart City is a city seeking to address public issues via ICT-based solutions on the basis of a multi-stakeholder, municipally based partnership."*

The FinEst Twins initiative focuses on five domains of sustainable smart city development: 1) **Smart mobility**, 2) **smart energy**, 3) **built environment**, 4) **smart city governance**, 5) **urban analytics** and **data**. Leaning on the definition provided by the European Parliament, this thesis regards climate change as a pressing and vital public issue.



Literature review

Griffinger et al. (2007) have created a figure, which highlights six categories and aspects that constitute a smart city. For the purposes of this thesis, this figure provides a benchmark for the reader on the traits of the mainstream smart city agenda.

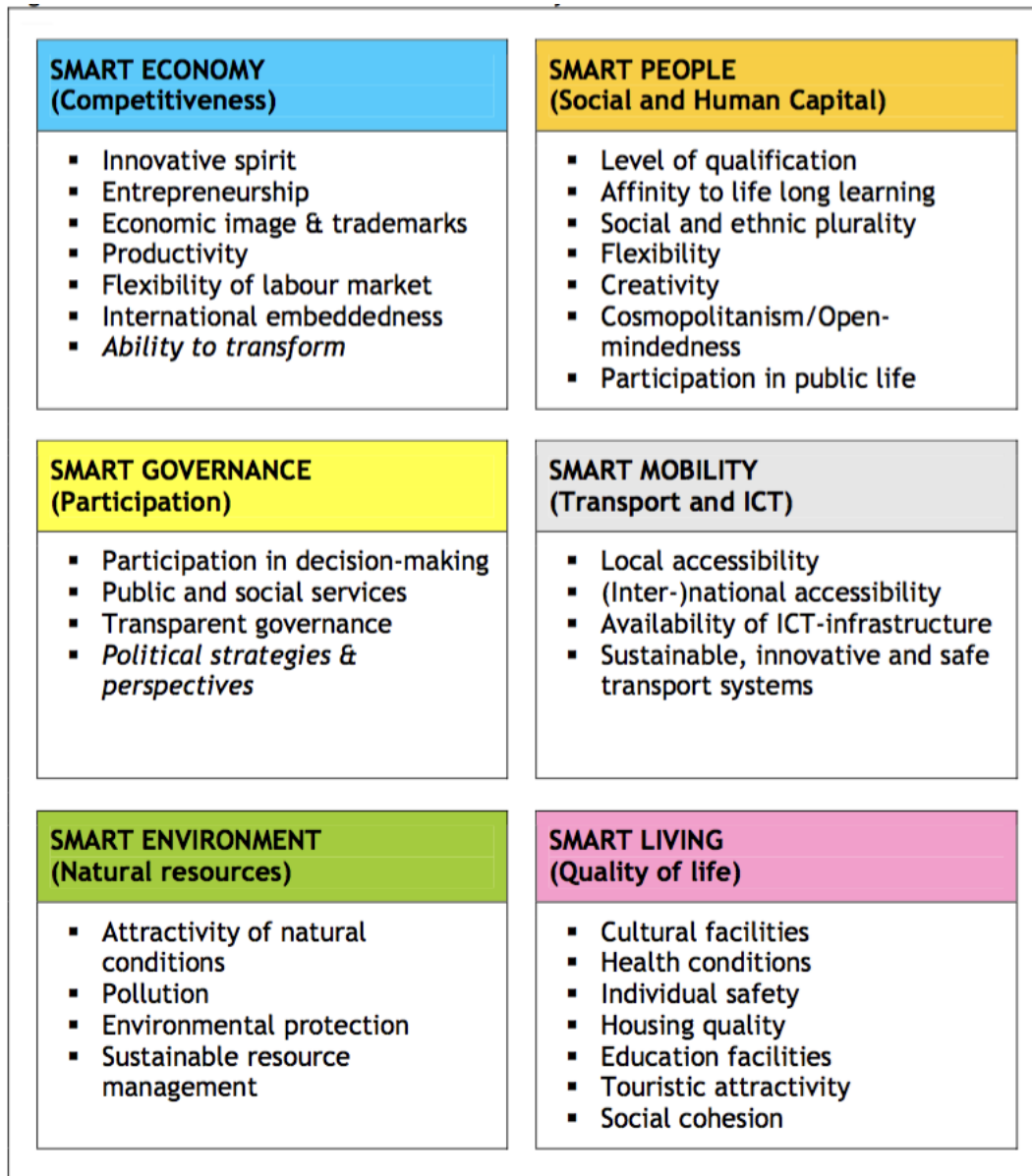


Figure 1: Characteristics and factors of a smart city. Source: Griffinger et al. *Smart Cities - Ranking of European medium-sized cities*. Centre of regional Science, Vienna UT, 2007

## Literature review

In a study conducted by Townsend and Lorimer (2015), various smart city strategies were researched, including cities such as London, Chicago, Barcelona, New York City, Singapore, Hong Kong, Dublin, and San Francisco. According to Townsend and Lorimer (2015) smart city planning varied drastically in each case, but were connected by a few common themes.

*Table 1: Primary and secondary smart city planning themes in Townsend & Lorimer (2015) study*

<b>Primary themes</b>	E-government, IT industry promotion, Citizen engagement, Open data, IT infrastructure, Internet access, IT skills, Urban infrastructure
<b>Secondary themes</b>	Academy-city links, Emergency services, Sensor networks, Government portals, Evaluating success, Civic hacking, Exporting solutions, Cloud computing platforms, Tourist economy, Energy efficiency, Energy generation, Transportation access

Key differences in smart city plans included a broad array of different time scales in which these initiatives are meant to be completed. However, a significant amount of reporting on what has been done and what is being done took up a major part of the smart city initiatives. Furthermore, few of these initiatives specified any regulations and legislations that would need to be changed for these initiatives to succeed. (Townsend & Lorimer 2015)

The cities researched in the Townsend & Lorimer study are all major metropolises and therefore the author of this thesis finds it alarming that the global issue of climate change is barely mentioned in these smart city plans, apart from a passing mention of energy efficiency and energy generation in the secondary themes portion. However, it is unclear as to whether ecological sustainability is a built in criteria of these themes. In any case it does seem that little emphasis is placed on a rather glaring issue of the need for a climate adaptation strategy. In the climate adaptation, vulnerability and resilience segments of this thesis I highlight the importance of a climate strategy for smart cities, and moreover, the need for the climate strategy to take centre stage in smart city planning. It is important to note however, that the Townsend & Lorimer study only reflects the smart city planning of the few cities in question. However, the purpose of showcasing the results of the aforementioned study here is to understand where a lot of the smart city rhetoric resides

## Literature review

thematically and to underline what the need for smart cities truly is, which is adaptation of our urban areas to climate impacts.

Social inclusion and citizen engagement is also a popular theme in the smart city rhetoric, but often lacks substantial evidence and data on who is being left behind and how they will be included and empowered (Townsend & Lorimer, 2015). This leads us to the next segment of this literature review, which discusses social sustainability in smart cities.

## 2.2 Social sustainability in smart cities

Social and environmental sustainability are often also counted as characteristics of a smart city, but give way to business and tech as they often gain the major priority and therefore supersede the goals for environmental and social sustainability in smart cities. Furthermore, cities are great drivers of economic growth, but also huge consumers of resources and contributors to waste. (Hollands, 2008)

In fact, according to Baird (1999), cities consume 75% of the world's resources. This thesis argues that to truly build cities of the future, development plans should fit into the definition of sustainable development, which is:

*"Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs."* (World Commission on Environment and Development, 1987).

In line with the previous statement above, that based on the literature reviewed for this thesis, a true smart city maximizes the economic, physical, and social wellbeing of all of its citizens, while remaining globally competitive and environmentally sustainable. This would cover all three bases of sustainability: environmental, economic, and social. If smart cities are done right, meaning that both smart and sustainable are emphasized, ICT development would be driven by sustainability issues, and not for the sake of pure technical development, where new technical "solutions" do not actually solve any problems (Höjer & Wagnel, 2015).

The focus of this thesis will be on the sustainable smart city development of the FinEst Twins initiative. When addressing environmental sustainability and climate questions, it is important to realise that there can be no climate justice without social justice. In other words, climate issues are inevitably also social issues. Due to this, I will be briefly addressing social sustainability in smart cities below.

Smart city initiatives often emphasise broadband networks, however, broadband networks are only truly smart city characteristics, when all of the citizens of that city have access to the broadband network. Lima is a good example of this, having a large telecommunications system, yet most of the city's inhabitants do not have access to it (Graham, 2002). Continuing on the trend of social sustainability and inclusion in smart cities,

## Literature review

another question that must be asked is how the value generated by technology is divided (Hollands, 2008). The reason this is important is the risk of social and cultural divide as a city becomes increasingly economically polarized, due to the income gap between IT skilled workers and IT illiterate workers (Hollands, 2008). Colding and Barthel (2017) argue that inadequate cyber security is a risk in ensuring citizens access to basic necessities and that the Smart City model has a risk of marginalizing parts of the population. Additionally, the attraction of skilled IT professionals can create gentrified neighbourhoods, which further steepens inequality, excluding traditional communities and poorer residents (Hollands, 2008). Therefore, social quality should be taken into an account in planning and implementing smart city initiatives.

*"Social quality depends on the extent to which economic, social and political citizenship is enjoyed by all citizens"* (Chuev et al., 2016).

As discussed in a previous segment of this thesis, the smart city label can relatively easily be self-imposed by cities. Due to this phenomenon, there is a growing trend of emphasizing positive traits (technological advancements, business-friendliness) in cities for promotional purposes, while simultaneously downplaying negative ones (pollution, waste, etc.). (Hollands, 2008)

Harvey (1989) argues: *"Capitalist investment in urban infrastructure, while necessary, is no guarantee to further capital accumulation. And while such investment may temporarily act to boost an area's profile and create employment, it can also mean diversion of public (welfare) resources to help lure in mobile global capital thereby creating social polarization."*

This should be seen as an incentive for cities to invest in social and ecological sustainability, which would provide a stable environment for capital accumulation in the long term by mitigating risks of environmental disasters and social unrest. This topic will be further elaborated upon in the climate adaptation, vulnerability and resilience segments of this thesis.

## 2.3 Governing smart cities

As with the definition of the smart city, there is no unanimous opinion or theory on how smart cities should be governed. Some researchers state that smart cities should be governed by traditional means, so as to say, like any other city. Other researchers argue that the whole way of governance must be transformed to govern the smart city. This means that different actors, individuals and organizations, need to collaborate to govern the smart city. However, most researchers and publications emphasize post-material outcomes i.e. sustainability or post-material process i.e. enhanced citizen participation. (Bolívar & Meijer, 2016)

To enable this collaboration and evolve into a true e-government, governments need to address citizens demands for the following three issues: **1. Universal access** to e-government services for 100% of citizens. **2. Privacy and confidentiality** for citizens personal information. Citizens need to increasingly provide private information to be granted access to e-government services and confidentiality must be guaranteed to foster citizen trust for successful collaboration. Technical solutions, transparent processes and independent auditing groups can provide solutions to this. **3. Citizens as the focus** of government management. Internally efficiency needs to be the focus, while externally citizens are the focus. In other words, governments need to reorganize in a manner that is convenient for citizens instead of convenient for government to prevent Big Brother-type scenarios. (Layne & Lee, 2001)

Additionally, we must learn how to more effectively govern our infrastructures in order to adapt our infrastructures to climate change (Chappin, 2014). According to Chappin (2014) to do this, we must understand the **different interconnections within and across infrastructures**, of which there are three: **1. Interconnections between technical elements**, **2. Interconnections between social elements**, and **3. Interconnections between social and technical elements**. To make the system adaptable, we must understand the system on the deepest level.

In line with the literature reviewed in this thesis, which places citizens and involving citizens as an important action, I will discuss the role of citizens, in governing the smart city, and as an integral part of the smart city and achieving climate adaptation and resilience both in this segment and in future segments of the thesis. According to Chatterton (2000), there are many groups and individuals in cities whose talents are going to waste and falling into the social problem category, rather than being seen as potential for cultural creativity, while

## Literature review

many alternative political groups such as environmentalists, squatters, third sector groups and urban political movements go unseen or are held in an unfavourable light. There are copious amounts of marginalized, but incredibly talented and passionate individuals, movements, and organizations, which could be harnessed to improve cities. These groups have the potential to bring radical new innovations and improvements, both into the way our cities function, and how our cities are governed, because of their alternative nature. To accomplish this, cities should focus on fostering **smart communities**, meaning involving marginalized groups and fostering and enabling interaction between systems and people (Bolívar & Meijer, 2016).

Paquet (2001) regarding the creation of smart communities:

*“The critical factor in any successful community has to be its people and how they interact. The most important aspect of information technology is not its capacity to automatically create smart communities, but its adaptability to be utilized socially in ways that empower and educate people, and get them involved in a political debate about their own lives and the urban environment that they inhabit.”*

In the context of smart cities, one dimension of smartness is collective intelligence, meaning that with a group of heterogeneous citizens collaborating with each other on a platform is generally more likely to provide smarter solutions than one single expert (Anttiroiko, 2016). Therefore, involving citizens openly in planning, decision making, and governance and thereby harnessing the potential of collective intelligence would seem to play an important role in governing the smart city. Open data systems have the potential to play a remarkable role in this type of collaboration.

Anttiroiko (2016) also sees the true value of harnessing the human aspect of smart cities as he speaks of cities being complex entities, and to truly understand them, we must go beyond concepts such as green buildings, ICT and smart systems. Citizens are an integral and unavoidable part of cities and should therefore be taken into account when discussing, planning and implementing smart city initiatives. (Anttiroiko, 2016)

Jarmo Eskelinen, CEO of Forum Virium Helsinki, on citizen engagement and open data in smart cities:

## Literature review

*“For Helsinki, the making of a smart city signifies advancing the open engagement of citizens and communities, pioneering in open data and transparency, and promoting agile service development”* (Anttiroiko, 2016).

Smart cities should strive to use open governance, which would add transparency in city councils and encourage **active participation of citizens** to collaborate in decision-making processes of the city, thereby increasing trust between citizens and the government (Casini, 2017). According to Anttiroiko (2016), citizens are involved in different roles and their involvement serves different purposes and functions; some initiatives grant citizens a voice, some solidifying their rights as political actors, and others as service users, from which valuable data and feedback can be obtained. This of course requires trust between governments and citizens, which can be achieved by guaranteeing privacy of citizens’ data. Collaboration and shared decision-making between citizens and city councils brings forth the need for increased and careful data privacy and cyber security (Fernández & Peek, 2020).

To summarize this segment of the thesis, smart cities are about more than just advanced infrastructures and technologies, they are about changing the way citizens and visitors interact with the city and vice versa, changing the way the city is governed and decisions are made. In essence, it is about taking the next step in the information technology revolution and unifying the city and its inhabitants into an agile entity that is adaptable, dynamic and inclusive. *“The aim should not be to be the best city in the world, but to be the best city for the world.”* (Bolívar & Meijer, 2016). Most researchers and publications emphasize post-material outcomes i.e. sustainability or post-material process i.e. enhanced citizen participation (Bolívar & Meijer, 2016).



## 2.4 Open data

In this section of the literature review of this thesis, I will be discussing the literature of open data and its different forms such as open government data (ODG), what role open data plays and potentially could play in smart cities and how it ties into citizen engagement. Furthermore, I will broach the various benefits of open data, as well as the different challenges and barriers of open data.

Open data came into the public sphere of popularity most notably by the declarations of President Obama in 2009, followed by the UK government's transparency initiative in 2011 (Meijer et al., 2014). However, the concept of open data is rooted as far back as the European Enlightenment, and technologically it was both endorsed and promoted by Sir Tim Berners-Lee, in the past few decades (Gurstein, 2011).

Open data could be called a philosophy. It is the encouragement of mostly public organisations to disclose objective data that is accrued through the execution of public services, to anyone, with a possibility of further use, modification, and integration, without copyright restrictions. Open data consists of a variety of different forms of data, including primary, secondary, real-time, offline, location-based, generic, reports, maps, satellite photographs, pictures, paintings, genome, medical data, scientific formula etc. Groups and roles of end users of open data range from organizations, developers, citizens, activists and NGOs. (Grimmelikhuijsen et al., 2017)

In short, open data is publicly disclosed, objectively factual data that can be accessed and used by anyone without any sort of restriction. With the advent of smart cities, open data could provide a valuable tool to bridge the gap between cities and their citizens in governing the smart city, as well as creating value in the form of services, increasing government transparency, and enabling increased citizen participation in the processes and functions of the city. In fact, according to Bakici et al. (2013), smart cities, smart districts, living labs, initiatives and electronic services rely upon open government data as a main driver and component for the creation of new ideas and innovations. Speaking of innovation, according to Grimmelikhuijsen et al. (2017), innovation is the most frequent form of open government data utilization. These innovations range from economic value generating, business-driven innovations to innovations meant to co-produce public services with, and initiated by, citizens. Furthermore, a lack of sharing public data can drastically decrease innovativeness, destabilize entrepreneurial incentives, and thwart the implementation of new businesses and internet-based start-ups (Grimmelikhuijsen et al., 2017). From the perspective of improving

## Literature review

urban management, spatial open data infrastructure is an important open data solution, and according to Chakraborty et al. (2015), a lack of reliable open urban data can even negatively impact urban planning and implementation. Academic research is also an important avenue for open data and open government data use, including, but not limited to unemployment research and ecological research (Grimmelikhuijsen et al., 2017).

Hackathons and competitions are another realm where value can be created from open data. The open innovation strategy holds a significant spot for hackathons to drive up citizen engagement, and to unearth novel ideas and add awareness to the myriad ways in which open government data can be of use. Civic hackathons have been found to have a positive impact on the participation of citizens, but this effect can potentially be decreased or nullified by the limited adoption of the results and solutions obtained in these hackathons, making the follow-through on outcomes extremely important. (Grimmelikhuijsen et al., 2017)

Whilst on the topic of citizen engagement and citizen participation, the 2008 UN World Public Sector Report defines the notion of citizen participation as the participation of citizens in policymaking, and implies a strong correlation to good governance. This policymaking includes levels of service, adjusting government programs towards community requirements and needs, budgeting, and building public support. Furthermore, openness and open data, is considered by the study to have a strong impact on the level of participation by citizens and other stakeholders, which is of paramount importance for public administration practices. (UN World Public Sector Report, 2008)

Releasing public data can minimize the barrier of citizen participation as it can create indirect avenues into government processes, and Janssen et al. (2012) bring up citizen participation as well as empowerment as both a political and a social benefit of open public data (Grimmelikhuijsen et al., 2017).

While the avenues created by open government data empower citizens with tools to challenge the government, public services based on open government data created by citizens improve cooperation between governments and their communities, while simultaneously harnessing citizen engagement in public service creation. Additionally, these public services can bring notable social value to communities by coming up with solutions to social problems in cities for the fields of healthcare, education, transportation etc. Public services utilizing open government data are usually either new innovations or improvements and extensions to already existing public services. (Grimmelikhuijsen et al., 2017)

## Literature review

In addition to the aforementioned benefits and uses of open data and open government data, other benefits include improved big data analytics to create visualizations to understand complex datasets and make more accurate predictions and forecasts based on government data (Grimmelikhuijsen et al., 2017). Data analytics and machine learning also provides tools for environmental impact analyses, improvements in public transportation and decision-making (Grimmelikhuijsen et al., 2017). Power et al. (2015) state that open government data can augment decision-making processes in various ways by having OGD available to key decision-makers and experts. These augmentations and improvement include the significant improvement to participatory decision-making, real-time transparency in decision making, and data-driven decision making (Power et al., 2015).

Finally, releasing government data to the public presents a significant tool in the fight against corruption and the ineffective usage of public resources, as the absence of transparency and information asymmetry has the inherent risk of leading to corruption (Linders, 2013). Furthermore, citizens can take action in policing, by criminal recording and law-enforcement activities such as investigation tasks with the help of open data linking security databases (Hossain et al., 2016)

In this section of the study, I have addressed many of the benefits of open data. For the latter part of this section, I will briefly discuss some of the challenges and barriers of open data.

According to a study by Grimmelikhuijsen et al. (2017), which has gathered findings from numerous open government data studies, the main problem with open government data is rooted in how the data is used, and the lack of use. In practice open government data is used very little, and increase in use requires further study of open government data. Low data quality and legal barriers present frequent hinderances to open government data usage. (Grimmelikhuijsen et al., 2017)

Of course this is merely one of many challenges associated with open data. Another challenge arises with the type of data published by government agencies. For example, with his open government data declaration, President Barack Obama demanded that U.S. agencies publish a minimum of three high-value datasets on the internet. However, many agencies met this request with malicious compliance, publishing datasets of reduced quality, non-reusable, unstructured or otherwise useless datasets. Other nations' agencies could very well follow suit with this type of behaviour. (Hossain et al., 2016)

## Literature review

Reasons for government agencies being unwilling to publish data are many. For example, releasing data to the public could lead to a perceived loss of control over the data, therefore it would be understandable that it is not a priority for many government agencies (Hossain et al., 2016). Additionally, publishing government data requires financial, technical and human resources, while the economic gains are not as readily apparent (Hossain et al., 2016). Some datasets may also pose a threat to organization privacy, business secrets, and even national security (Hossain et al., 2016). These are some of the economic and political barriers to open data from the perspective of the government. Legal barriers such as data ownership issues, contracts, copyright and licensing issues are also readily apparent and would require amendments to intellectual property legislation (Hossain et al., 2016). Additionally, various technological barriers hinder the adoption of open data solutions. These include data anonymisation being a very complex and arduous process, and the possible incompatible dataset formats and platforms used by various parties, which some studies argue should be dealt with by developing a set of common standards for open data publication (Hossain et al., 2016; Linders, 2013).

One of the biggest challenges of open data, for the purposes of this thesis is the possible data divide between groups who have the skills and resources to use open data, and those who do not. These recourses may be financial or educational, and should be addressed in a way that everyone has access to, and the know-how to use open data effectively (Gurstein, 2011). Many studies argue that this would be counter balanced by the value added to society by open data, but these benefits and impacts are not yet very clear (Lassinantti et al., 2014). However, if open data were to be widely adopted in countries such as Finland and Estonia, I expect technological skills to wield such tools to be added to the educational curriculum in schools from an early stage. This may not be the case with other nations though.

To summarize, there is a lot of potential in open data, and many ways in which it could change the way cities are created, by bridging the gap of citizens and government agencies to co-create a vision of the smart city, which ties into what was discussed in the previous chapter on smart city governance. However, there are also numerous challenges that come with open data, how it is used, by who, what kind of datasets are published and what are the end goals and what entity decides upon these end goals. In the next segment of this thesis I will begin the discussion of climate resilience by addressing the literature on climate adaptation.

## 2.5 Climate adaptation

With the oncoming climate threat, and various impacts already etched in stone, no matter what changes we make in our natural resource consumption, it would be sensible to suggest that we design our cities in ways that can cope with climate impacts. This is where climate adaptation comes in.

Moench and Tyler (2012) define climate adaptation as operationalizing the concepts of climate resilience and vulnerability. There are no "one size fits all" strategies when it comes to climate adaptation in smart cities, as each city deals with different environmental impacts according to geographic region and local climate, making each city unique. For example, one city may receive 10 times the amount of rainfall, whereas another city may suffer from increasingly intensified droughts. Solutions should be tailored to fit the unique needs and attributes of each city. However, one commonality is shared: Smart cities should position environment at the core of their development, and **involve citizens and encourage their participation**. (Fernández & Peek, 2020)

In the past, focus has been on climate mitigation efforts. However, as some degree of climate shocks are unavoidable, forerunners in the smart city dominion have started to focus on climate adaptation. For example, Barcelona is implementing a network of green corridors to connect various different green spaces within the city. Additionally, vertical gardens and living rooftops are being introduced. Importantly, not all climate adaptation solutions require ICT, such as Rotterdam's rain gardens. (Fernández & Peek, 2020)

Through extensive analysis, Biesbroek et al. (2013), have identified various barriers that make climate change adaptation more difficult and hinder progress: **1.** The long-term impacts of climate change in contrast to the short-term nature of politics and decision-making. **2.** The need to utilize scientific models to identify, understand and communicate the problem and propose solutions. **3.** The uncertain, vague and ambiguous nature of climate change.

Somewhat paradoxically, the upgrading and implementing of critical urban infrastructure to fit the smart city approach and combat climate change may in itself contribute to climate change (Fernández & Peek, 2020). Smart growth needs to happen in unison with climate adaptation, due to the fact that increasing amounts of people, infrastructure and economic activity increases climate change impacts (Fernández & Peek,

2020).

Furthermore, according to Joss et al (2019) the environmental discourse in the smart city realm is included namely because of its trendiness, but often tends to be overshadowed by the discourse of economic growth. For the same reason, many aspects of sustainability such as biodiversity, are ignored or left out of the environmental segment of smart cities, which tend to favour climate and energy (Joss et al., 2019).

To enable active participation of citizens, sustainability and the concept of smart sustainable cities need to gain more favour and credibility, especially among environmentalists. To accomplish this focus should be extended to: 1. **Methods to assess** sustainability, 2. **Mitigating measures** to prevent natural resource exploitation and ecosystem devastation by infrastructure, 3. **Intertwining top-down and bottom-up** exploration approaches, 4. **Reinforcing** public sector technological competencies and 5. **Improving** all levels of interconnected governance. (Höjer & Wagnel, 2014)

As mentioned at the beginning of this segment, smart cities should position environment at the core of their model to ensure a true smart sustainable city change (Fernández & Peek, 2020). Simply optimizing and updating urban services through technology is not adequate enough to create more sustainable smart cities (Colding & Barthel, 2019). Fernández & Peek (2020) echo this sentiment by stating: *"Data is meaningless until it fulfils a role in the decision-making process"*.

*"A holistic approach to Smart City frameworks in combination with the active involvement of citizens and its integration with other economic and environmental strategies can definitely enhance the interaction between nature and technology, which will contribute to making our cities more sustainable and resilient."* (Fernández & Peek, 2020)

Frankhauser et al., (1999) suggest three dimensions of strategic adaptation: 1) Reactive adaptation in the face of impacts, and anticipatory adaptation before impacts happen, 2) Planned adaptation are specific adaptations for specific issues, and autonomous options are made without planning, and 3) Substitutes are adaptations which are exchangeable with each other, and complements are adaptation strategies that work together.

It must be remembered, that there is a distinct lack of experience, such as widespread applications of these various initiatives to give us concrete evidence of the efficacy in tackling climate change and climate adaptation, due to the relative newness of the Smart

## Literature review

City model (Fernández & Peek, 2020). This is to say that there is ample theory on climate adaptation, but little results, due to the amount of time needed to observe the effects of climate adaptation implementations, and therefore these initiatives are subject to speculation.

In regards to climate adaptation, this thesis argues on the basis of the literature, that climate resilience is the best course of action to make a city adaptable to climate change. Before discussing climate resilience, it is necessary to elaborate on climate vulnerability. In the upcoming segment, I will examine climate vulnerability.

## 2.6 Climate vulnerability

To address climate adaptation through resilience, we must first address the concept of vulnerability and what makes a particular city or region vulnerable. The vulnerability of a region in social sciences refers to three elements: system exposure to crises, stresses and shocks; insufficient system ability to cope; and consequences and attendant risks of slow or inadequate system recovery (Sherbinin et al., 2007). According to the most vulnerable systems, groups, individuals and places are the most exposed to stresses and shocks, and have the worst capacity to cope and recover from these shocks (Sherbinin et al., 2007). However, while assessing vulnerabilities in cities, it is important to keep in mind that focusing entirely on direct climate impacts leaves cities vulnerable to indirect effects, systemic weaknesses as well as constraints of the institutional dimension (Moench & Tyler, 2012).

For example, according to Sherbinin et al. (2007) when environmental stresses and shocks collide with shocks arising from society, regions face major consequences. Economic depression or social unrest reduces a systems capacity to cope with environmental issues (Sherbinin et al., 2007).

Moench & Tyler (2012) outline three actors in urban resilience: systems, agents and institutions. However, precisely because of this, these actors can also be a source of vulnerability if overlooked. It is the aim of this section of the thesis to highlight that resilience comes from identifying vulnerabilities and enhancing them to create resilience. In essence, a city's strengths can easily become weaknesses. The reason the aforementioned are referred to as actors is that they interact and enable interactions with one another. Depending on how they act or enable interactions either boosts or hinders resilience.

In the context of this thesis **systems** refer to a multitude of interconnected actors that provide cities with different services, some considered essential or critical, such as food and water supply, energy, transport, shelter, communications, as well as support ecosystems for all of the above, without which cities cannot function (Moench & Tyler, 2012). Systems are linked in complex interdependencies and a failure in one area of the system often leads to failure overflowing to other systems, and in the worst case, the collapse of multiple systems. This in turn, can cause drastic consequences that cross regional and international boundaries and disrupt global trade, as well as local life. (Moench & Tyler, 2012)



## Literature review

**Agents** refer to social organizations and individuals (government entities, businesses, community advocates, households and individuals) in relation to socio-ecological systems, and their capacity to adapt, learn and innovate (Moench & Tyler, 2012). Agents are not all equally vulnerable and different factors contribute to how resilient certain agents can be. These different factors include, but are not limited to: poverty, gender, ethnicity, age, quality of housing, location, access to services. These factors lead to different degrees of vulnerability between agents. The basis of an agent's power to act are built on assets. Assets can include financial, physical, natural, social and human assets. Climate vulnerability is linked to the different asset portfolios of agents. (Moser & Satterthwaite, 2010; Peiling, 2003; Satterthwaite, Dodman, & Bicknell, 2009)

**Institutions** in the context of social sciences refers to the formal or informal social rules or conventions that govern human behavior and exchange in social and economic interactions (Hodgson, 2006). Institutions govern how agents and systems interact with one another in response to climate change impacts (Moench & Tyler, 2012). Institutions can create vulnerability in cities if they inhibit agents' access to necessary systems such as food, water supply and housing (Moench & Tyler, 2012). For example, those individuals and groups who are systematically marginalized through institutions that restrict their access to services provided by the government and other urban systems are likely to be in a more precarious position (i.e. more vulnerable) when climate impacts occur (Moser & Satterthwaite, 2010; Pelling, 2003).

Moench & Tyler (2012) encapsulate the nature of vulnerability with the following statement: "*Vulnerability to climate change occurs when fragile, inflexible systems and/or marginalized or low-capacity agents are exposed to increased climate hazards, and their ability to respond or shift strategies is limited by constraining institutions*".

Now that I have provided a brief overview of climate vulnerability in smart cities, I will delve into climate resilience in smart cities.

## 2.7 Climate resilience

In the vulnerability segment of this thesis, I discussed three elements of vulnerability, provided by Sherbinin et al. (2007), which were system exposure to crises, stresses and shocks; insufficient system ability to cope; and consequences and attendant risks of slow or inadequate system recovery. Moraci et al., (2018) elaborate on these three elements to provide the building blocks for urban climate resilience: exposure, sensitivity, and response capacity, the process of responsive action, learning from mistakes, and creating risk minimization capacity. The following are two definitions of resilience and urban climate resilience by the IPCC (Intergovernmental Panel on Climate Change) and the EPA (Environmental Protection Agency) respectively:

*“The ability of a social or ecological system to absorb disturbances while retaining the same basic structure and ways of functioning, the capacity of self-organization, and the capacity to adapt to stress and change”* (IPCC, 2007).

*“A city’s ability to reduce exposure and sensitivity to, and recover and learn from, gradual climatic changes or extreme climate events. This ability comes from a city’s risk reduction and response capacity, and includes retaining or improving physical, social, institutional, environmental, and governance structures within the city.”* (Moraci et al., 2018)

To ensure a smart climate strategy, cities should aim for resilience as one of their main goals (Moraci et al., 2018). This can be interpreted as a comprehensive climate strategy being a requirement of a smart city, of which resilience should be the main goal. Therefore, a smart city is the result of a good climate strategy. Chan (2015) elaborates that defining resilience goals as well as resource efficiency in the context of local constraints is a good initial step; however, in addition to national and international development goals, local grassroots movements should not be underestimated or ignored, as they are quickest to mobilise. Moraci et al. (2018) agree with this notion, stating that improving awareness within the population is important to ensure maximum participation, which can be done by communicating the benefits of contributing to climate adaptation. I have outlined the importance of citizen participation and citizen engagement in the governance portion of this thesis.

## Literature review

When discussing what aspects of climate change are tackled by resilience, investigating temperature increase, desertification, floods, precipitation changes, energy efficiency issues and soil permeability comprise a non-exhaustive list (Moraci et al., 2018). For smart city climate strategies, cities should outline the main potential climate risks associated with the region.

The ANCI (National Association of Italian Municipalities), have amassed 10 key actions that can improve a city's climate resilience. **1.** Ensuring that an active coordination structure is installed within the local administration to identify and reduce the risk of climate disasters. **2.** Creating economic incentives to households, firms and the community to invest in risk reduction as well as distributing resources for this purpose. **3.** Creating and maintaining real-time databases on assessing local risks and vulnerabilities, which should also be consulted in decisions on urban development. **4.** Ensuring that information and urban resilience plans are openly accessible to, and discussed with the general public. **5.** Investing in resilient, adaptable and sustainable infrastructures, as well as ensuring maintenance of these infrastructures. **6.** Adjusting the safety of all schools and health facilities for climate risks and introducing climate change risk criteria in building regulations and plans of land use. **7.** Identifying safe land to be allocated to low-income citizens and planning new uses for unregulated settlements. **8.** Commencing risk reduction training and education programs; protecting ecosystems and areas that naturally protect against climate threats, minimizing the effects of flooding and other potentially drastic weather events according to the city's vulnerabilities. **9.** Involving citizens in monitoring preventive alert systems and emergency management plans. **10.** Placing victims' needs at the center of reconstruction efforts and involving civil organizations and victims in formulating solutions after each disaster. (Moraci et al., 2018)

*“The prospect of smart cities involves thinking of urban organisms that produce a better management from their own internal capacity, mobilizing technology and behavioral resources, which will make the urban environment more sustainable and more attractive.”* (Moraci et al., 2018)

### 2.7.1 Case: Rotterdam

I will now discuss the smart city case of Rotterdam, which was provided in detail by Moraci et al., (2018). The reason that Rotterdam was chosen as a case for this thesis is because geographically it is relatively close to Helsinki and Tallin, and while Helsinki and Tallin have a colder climate, Rotterdam is a much more apt comparison to the twin smart cities than for example Barcelona or Mumbai.

Rotterdam's main priority in its climate strategy is protecting the city from floods. Particularly, the areas most exposed to risks are placed underlined with importance, such as the port and other important strategic infrastructures. In the most densely populated areas with the most buildings, some projects are implemented on public space, for example the water squares, of which I have included a concept picture below in **Figure 2**. This figure is from an urban design project in Singapore, but also used for Rotterdam. The cities canals will be regulated to increase water storage space, and green space will override paved space to create increased amounts of permeable surface. The added bonus of green space is that it makes the urban environment more enjoyable for citizens. (Moraci et al., 2018)

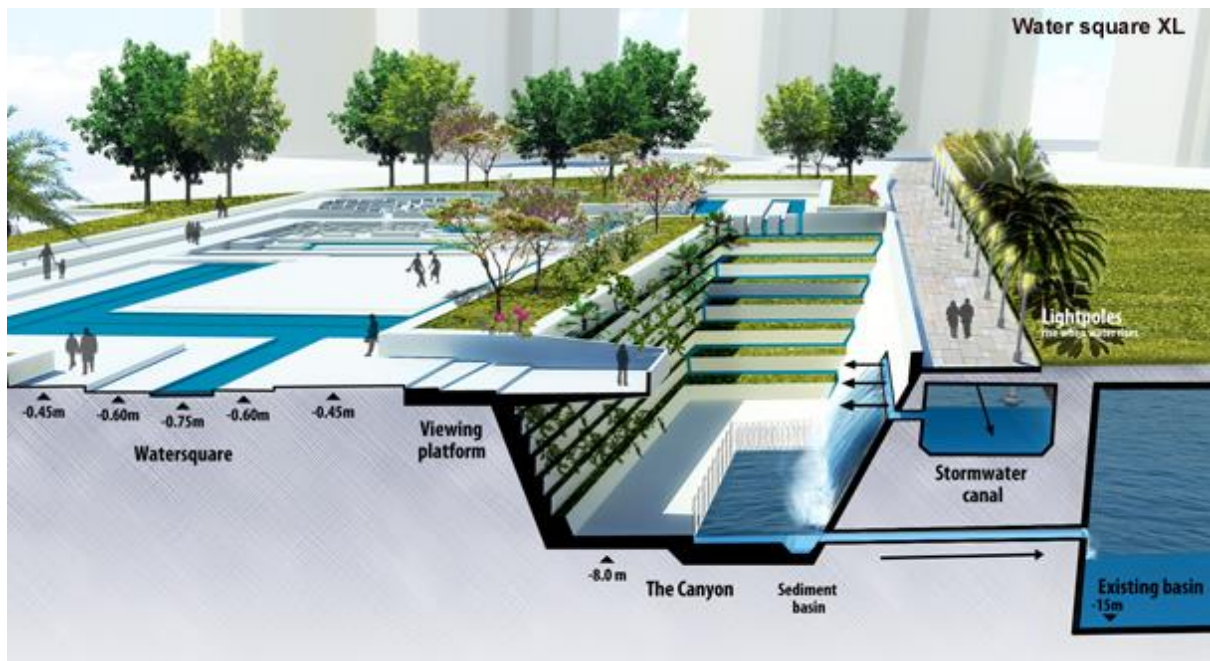


Figure 2: Water square XL in Rotterdam. Resilient Urban Design. Source: City of Rotterdam. Rotterdam Climate Change Adaptation Strategy; Rotterdam Climate Initiative: Rotterdam, The Netherlands, 2013

## Literature review

As you can see from **Figure 2**, the water squares are meant to collect excess rain- and floodwater, irrigate green areas and bring people closer to the water. This creates resilience in the city to deal with flooding and intensified precipitation, while also creating a pleasant urban atmosphere.

### 2.7.2 Case: Barcelona

”A smart city should be able to actively generate smart ideas in an open environment through fostering clusters or Open Data or developing proper living labs while directly involving citizens in the co-creation process of products or services” (Bakıcı, 2013).

The Barcelona Smart City initiative was started to foster competitiveness and harbor innovation as well as boost sustainability. Main pillars of a smart city are human capital, infrastructure and information. (Bakıcı, 2013).

Bakıcı (2013) has identified two important sources of information in regards to the Barcelona Smart City concept, which exist in every city worldwide: 1. Information collected by sensors involving city elements within the city and Open Data, and 2. Information stemming from the city’s inhabitants as digital footprint, social media and crowd sourcing.

In Barcelona, the 22@Barcelona district is used as a functional living lab for new services and infrastructures. This inspires companies to test and develop new innovations and effectively pilot them quickly. 22@Barcelona is far from the only living lab district in the city. (Bakıcı, 2013) This is another aspect which could be replicated in any city, regardless of geographical location.

The FinEst Twins center of excellence is meant as a smart city innovation hub, where projects can be easily piloted. Therefore, the FinEst Twins should set up small living lab districts in Helsinki and Tallin to test new innovations and monitor and compare similarities and differences in progress within both countries.

## 2.8 Building resilience

Moench and Tyler (2012) explain in their article that climate resilience is an important approach due to the fact that traditional and standard approaches such as adjusting policies, practices and plans while relying on predictions to prevent the negative impacts of climate change are quite rigid, have a weakness towards surprise, and may very well not be able to rely on historical data as the effects of climate change become more variable and dynamic.

These are compelling arguments in favor of creating an urban environment which in itself is resilient towards climate impacts, while also analyzing vulnerabilities, both of the systemic and infrastructural variety. This way cities do not need to focus on specific threats, but can instead focus on building overall resilience (Moench & Tyler, 2012). Even with high uncertainty, a climate resilience approach would be able to prepare a city well against climate threats (Moench & Tyler, 2012).

In the vulnerability segment of this thesis, we discussed the three main actors of urban resilience, and we will be revisiting these actors in this portion of the thesis for the sake of comparison and continuity.

### 2.8.1 Systems

Ensuring that systems can withstand disruptions is of paramount importance. According to Moench & Tyler's (2012) research in urban climate resilience, system resilience attributes consist of:

**Flexibility and diversity:** Being able to manage and perform tasks in a variety of circumstances and conditions, and to modify processes to achieve new ways of perform these tasks should the need arise. Key assets and functions are organized in a way that any one given shock or event does not affect the entire system, and the system has many ways of performing any single task.

**Redundancy, modularity:** Extra available capacity for sudden increases in demand, and having many replacements available if one or many parts of the process should suddenly fail.

**Safe failure:** This is the capacity and ability to withstand extreme shocks without

## Literature review

the entire system failing completely. This also refers to the failure of one structure not spilling over into the failure of another, despite these systems being interdependent or interlinked.

It is important to understand that these characteristics of resilient systems are not exclusive and may often overlap, for example with flexibility and modularity manifesting in the same way (Moench & Tyler, 2012).

### 2.8.2 Agents

Agents interact with systems and institutions according to their own opportunities, constraints, incentives and where they stand in society. Agents behavior can be changed and influenced by using the correct incentives. (Moench & Tyler, 2012)

The role of other agents such as governments and organizations is of paramount importance, as they are the primary contributor to planning, prevention and response services, which make up a massive part of urban resilience and climate adaptation. Additionally, a large part of urban climate resilience is the capacity for collective effort to access knowledge to assess risk. (Satterthwaite et al., 2009; Berkes, 2007)

Characteristics of climate resilience in agents can be organized as follows (Gunderson & Holling, 2002; Twigg, 2007):

**Responsiveness:** The ability to organize, identify and anticipate problems and respond in the aftermath of a significant event or shock.

**Resourcefulness:** The capacity and ability to access various assets and resources, including those of systems and other agents, by collaborating, to take affirmative action.

**Learning capacity:** Ability to learn from mistakes and gain insights from past events to improve performance, innovate, and acquire new skills.



### 2.8.3 Institutions

*“Institutions may enable and support, or constrain and inhibit, the capacities of vulnerable urban groups”* (Moench & Tyler, 2012).

Public information contributes to a positive institutional environment, as citizens who have access to timely information regarding climate hazards are likely to be able to respond more effectively and are therefore more resilient (Moser & Satterthwaite, 2010). This is a brilliant argument in favor of open data. If citizens have access to open data on weather and other climate information, they have the opportunity to take action more efficiently and create preventative measures.

The most important characteristics of institutions linking agents and systems when considering resilience enhancement or constraint are the following (Huntjens et al., 2012):

**Rights and entitlements linked to system access:** Institutions that grant different degrees of rights and entitlements to different portions of the population reduce climate resilience for marginalized groups.

**Decision-making processes:** Particularly those processes in urban development and urban systems management should be transparent, accountable and responsive (United Nations Development Programme, 1997). Recognition and inclusiveness of the most vulnerable groups in decision making should also be included in the aforementioned processes (Huntjens et al., 2012).

**Information flows:** Information regarding risk and vulnerability should be readily available to all agents, including households and individuals, to ensure that decision making can be made on meaningful evidence (Huntjens et al., 2012).

**Application of new knowledge:** Institutions that enable, encourage, and guide the creation, use and exchange of new and useful knowledge are a cornerstone of resilience.

Additionally, rights to self-organize and engage in collective choice can enhance resilience in the face of climate hazards (Huntjens et al., 2012). In contrast, institutions that inhibit these practices can greatly hinder climate resilience.

In the vulnerability segment of this thesis, I highlighted a quote by Moench & Tyler

## Literature review

(2012) on how vulnerable systems and agents are prevented by inflexible systems to cope with climate threats. In contrast, “*resilience is high where robust and flexible systems can be accessed by high-capacity agents and where that access is enabled by supportive institutions*” (Moench & Tyler, 2012).

The framework that Moench & Tyler (2012) discuss in the article consists of two major actions regarding the three elements mentioned above: **understanding vulnerability** and **building resilience**. Understanding which aspects of the systems, which agents and which institutions are vulnerable and how, is crucial to being able to build resilience and therefore adapt to climate change. Building resilience is a cycle of identifying actions, prioritizing, designing, implementing and monitoring, again in the realms of these three aforementioned resilience actors. Both understanding vulnerability and building resilience are iterative and overlap in knowledge sharing activities, exchanging both scientific and local knowledge to constantly improve both resilience practices and vulnerability assessment. (Moench & Tyler, 2012)

## 2.9 Theoretical framework

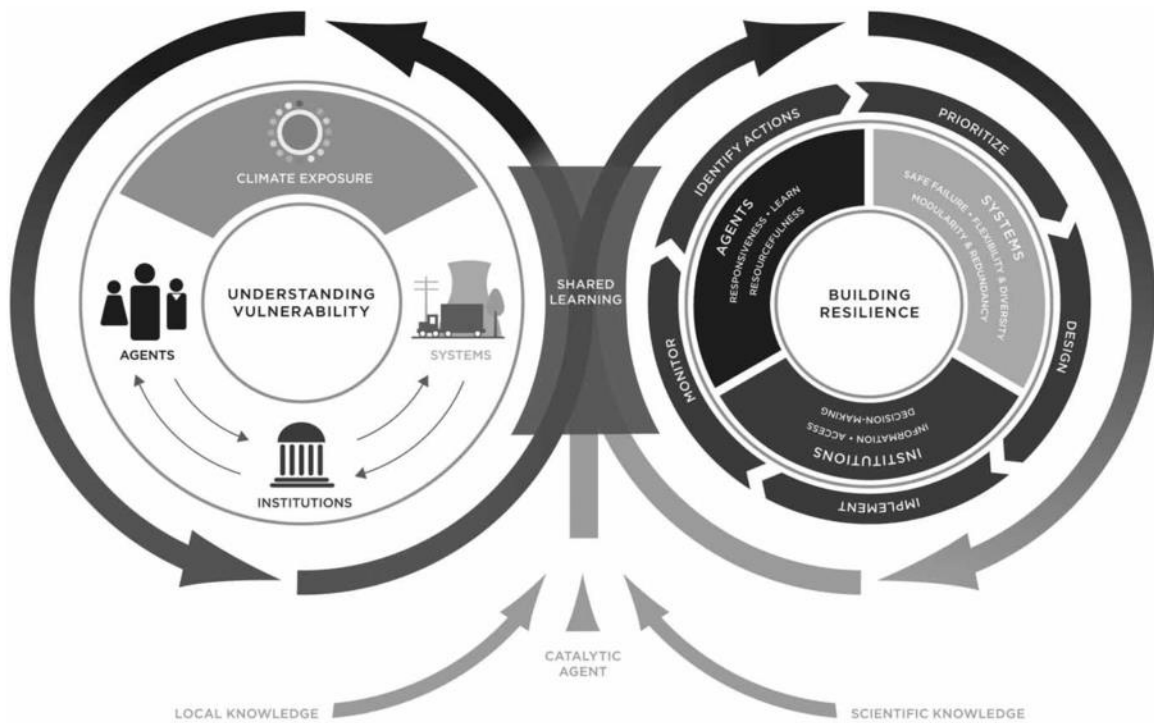


Figure 3: Framework for urban climate resilience, Institute of Social and Environmental Transition-International, 2012

The theoretical framework for this study is presented in Figure 3. The framework was designed by Moench & Tyler (2012) and provides a broader scope for building urban climate resilience through shared learning to create societal adaptability. The framework was in no way tweaked or changed by the author of this thesis, but it has been reapplied for this study to reflect on the relationships between the smart city and its citizens, with open data as the key linking component to produce improved climate resilience outcomes. The author of this thesis argues that this theoretical framework is suitable for the field of information services management, due to the fact that applying the theoretical framework to the smart city context and adding open data as an enabler of the interplay between the framework components, does not alter the theoretical processes of this framework, and the product of this process in relation to the empirical evidence of this thesis is an increasingly climate resilient smart city, which is an application of the framework's original product: the shared learning achieved in understanding climate vulnerability and building climate resilience. In fact, the theoretical framework provides an optimal tool in understanding how open data solutions can bridge the gaps between citizen engagement and increased climate resilience.

This framework was chosen through abductive reasoning, as the empirical research was conducted first and then a theoretical framework was chosen that best suited the empirical evidence and how that evidence was collected and analysed from the research material. In the methodology chapters and subchapters of this thesis I explain how I divided urban climate resilience in smart cities into three main themes: citizen engagement, open data and climate resilience. Through the empirical process it became clear that the overlapping and complex relationships between these themes were the key to further insight for answering my research questions. Furthermore, this process of shared learning illustrated in the framework correlates with the continuous evolving of the smart city and the complimentary nature of its components: improved open data solutions lead to improved ways of citizen participation and engagement and climate resilience solutions and vice versa.

This framework was chosen for this study, as it is perfectly suitable for studying climate resilience outcomes in the context of the smart city, which indeed consists of agents, systems and institutions. Citizens and their engagement, as well as the smart cities governing entities, policy makers, organizations, academia, and NGO all fit into the climate resilience components of systems, institutions, and agents. However, for the purposes of this study, where we are looking at how these components engage and communicate with one another for improved climate resilience outcomes, the key is open data, which is the facilitator of communication and engagement in the framework, represented by the arrows between systems, agents, and institutions. In truth, we are using the same framework, but adding the key bridging element of open data, which facilitates participation, engagement, communication, and information flows between the frameworks existing components.

## 2.10 Summary of reviewed articles

In this literature review I have discussed articles ranging from smart city governance, open data, viewing the city as a platform where citizens are seen as an integral part of the city, social inclusion and knowledge sharing in smart cities, to identifying climate vulnerability and building climate resilience in smart cities to form a theoretical framework on which to base the further research and reflect the findings of this thesis.

According to the literature, for cities to adapt to climate change, climate resilience should be placed at the centre of a smart cities climate strategy, which should be given priority in smart city development planning. This coupled with open citizen access to data, fluid information flows between citizens and governments, and institutions that enable all citizens access to resources and self-organisation could potentially plant the seeds for fruitful and iterative processes of both vulnerability assessment and resilience building. Adoption of these practices by the FinEst Twins model could boost coordination efforts for climate adaptation between nations and affectively fortify climate impact mitigation on a grander scale. As said by Pereira (2017), the role of the government in the smart city is viewed as that of an enabler of new knowledge from multiple data sources, an informer and information provider to citizens by increasing transparency, participation, citizen empowerment.

Additionally, the literature covered guides the reader in rudimentary understanding climate adaptation, vulnerability, and climate resilience and the three climate resilience actors: systems, agents and infrastructures, as provided by Moench & Tyler (2012). Additionally, some articles covered the differences in smart city governance philosophies, as well as social sustainability in smart cities. As the reader will find out in later chapters, all of the above are relevant themes to be considered when studying smart cities.

### **3 Methodology and methods**

To properly investigate the relations between citizens, open data, and climate resilience in the smart city setting, I conducted exploratory semi-structured interviews with professionals involved with the smart city agenda. In the following chapter, I will review and justify the methods and the manner of approach used in this thesis. First, I will discuss the research design along with the methodological choices. Second, I will go over the context of the research. Third, I will briefly explain the data collection and analysis process. Fourth, I will conclude this chapter by discussing the ethical considerations of the research.

### 3.1 Research design

This study is conducted by following a qualitative research path. The qualitative research model is justified for this study, as the smart city is a relatively novel concept, with little consensus in the academic field over the concrete definition of the smart city (Fernández & Peek, 2020). Most qualitative research designs accommodate deviations and surprises during the research process in data collection and analysis (Eriksson & Kovalainen, 2008). As this research topic is relatively novel, the exploratory nature of the qualitative research tradition suits it well. The research philosophy adopted by the researcher for this study was the interpretive and constructionist ontological approaches, since one of the research questions focuses on the human sense making, understanding, and construction of reality (Eriksson & Kovalainen, 2008; Berger & Luckmann, 1967).

This thesis uses semi-structured narrative interviews as a method, and additionally borrows slightly from the ethnographic sense-making tradition in the study of understanding the smart city as a concept that lives in peoples' minds. The interview questions were open-ended and encouraged the participants to talk openly and from their own point of view, while the interviewer acted as an activator and followed the norms of everyday conversation, such as active listening, as per the tradition of narrative research (Eriksson & Kovalainen, 2008).

I started out by picking my research questions. I noticed that there was little consensus in the literature with what the term "smart city" means, so I decided to base one of my research questions around the sensemaking of the "smart city" term among professionals involved with the smart city agenda in some way (Fernández & Peek, 2020). My second research question focuses on the feedbacks of citizen engagement, open data, and climate resilience in the smart city context. Moench & Tyler (2012) speak of the framework of climate resilience consisting of systems, agents and institutions. The smart city fosters increasing interconnectivity, with many citizens passively or actively interacting with the city vis a vis smart city services or smartphone apps, so I wanted to focus on the agency of citizens in creating more climate resilient cities, and how the application of open data and open data systems could foster better and more effective citizen engagement, and in particular how these aspects need to come together to achieve the rapid sustainable transformations needed for a society capable of climate change adaptation.

### **3.2 Research context**

The research context of this study is the city of Helsinki in the years 2020-2021, although the findings of this research are not bound to a specific place, as they can be applied to most any smart city in the world in a general sense. However, many of the examples given by interview subjects were based in Helsinki and Finland, with some international examples mixed in. To reiterate, the context of the study is Helsinki, but the findings could be applicable to other smart city locations as well, but for the purpose of the study, I will be focusing on Helsinki. The reason behind this choice is the fact that the FinEst Twins initiative is based in Tallin, and focuses on how shared learning between Helsinki and Tallin in order for Tallin to "catch up", for lack of a better term, to Helsinki in the smart city field. Additionally, the framework by Moench & Tyler (2012) is also a suitable framework here, as the shared learning stated in the framework can be adapted to create shared learning between cities. Furthermore, open data solutions and participatory planning are increasingly being explored in Helsinki, and the FinEst Twins urban OS acts as a virtual bridge of knowledge between Helsinki and Tallin, and for these reasons the framing of climate resilience, open data, and citizen engagement are relevant themes to the FinEst Twins initiative and therefore this study.



### **3.3 Data collection**

The primary empirical data was collected via seven semi-structured narrative interviews. The nature of the research and the research questions are explorative and iterative, so they have undergone evolution and change as the research has been conducted. Before designing the interview questions, I designed my research group and context. I gathered professionals working within the smart city agenda, or whose work can be closely related to smart cities and divided them into four categories based on their professional backgrounds. These four backgrounds were "Private sector", "Public sector", "Academia" and "NGO". I was able to schedule and complete interviews with a total of seven subjects: two from each background, except "NGO", which only had one representative. The interviews were kept anonymous, so as to encourage more individualistic and personal views, as well as honest answers reflecting true beliefs and thought-patterns. Interview participants consisted of five males and two females, as well as two interview participants of non-Finnish background. I have provided a table with more background on the interviewees below.

## Methodology and methods

Table 2: List of interviewees and their backgrounds

Interview	Group	Interviewee	Title	Background in smart cities
1	Public sector	Public sector professional 1	Project Manager	Professional experience in regional and urban development, wellbeing, edutech and green infrastructure initiatives.
2	Private sector	Private sector professional 1	Chief Sustainability Officer	25 years of background in IT and IT services, Oil & Gas and infrastructure industry. Currently operating in a multinational company that orchestrates smart safe and sustainable cities with active citizen participation.
3	NGO	NGO professional 1	Development Director	Working in an environmental NGO, that addresses environmental issues in community in diverse, inclusive, and participatory ways from the grassroots.
4	Public sector	Public sector professional 2	Research Assistant	Research assistant specializing in urban development tools for achieving carbon neutrality in cities.
5	Private sector	Private sector professional 2	Chief Executive Officer	Experienced in consulting and new business development linked to sustainability and climate change. Member of the board of advisors in a large non-profit climate business network.
6	Academia	Academia professional 1	Professor/Researcher	Specialization in sustainability transformations, inclusive approaches to the management of protected areas and urban green areas and sustainable spatial planning for biodiversity and social inclusion.
7	Academia	Academia professional 2	Researcher	Master's thesis researcher who recently completed a Master's thesis on open data usage in the smart city environment

The reason for the four aforementioned categories is quite simple: smart cities consist of entities in all four categories and each individual falls into one of the four. This way I could draw possible similarities and contradictions between different backgrounds, if any were to emerge, and also boost the potential for a more diverse array of views and highlights in what the interviewees consider important in the smart cities.

Next I designed the interview questions. The interview questions were designed to conjure up mental images of what the smart city means to the interviewees, as well as to highlight what the interviewees deem most important in smart cities. Furthermore, the interview gauged the level of understanding the interviewees had of climate resilience and

## Methodology and methods

open data, and how citizens could be engaged to build more climate resilient cities, and where open data and smart city technologies could fit in in this framework.

The interviews were conducted on Microsoft Teams, with both audio and video enabled, and recorded. These recordings were then transcribed into text documents in Microsoft Word. Once all of the interviews had been transcribed, each interview was imported as its own document into ATLAS.ti.9 for qualitative data analysis and coding purposes. I grouped the documents into the following document groups: Public sector, Private sector, Academia, NGO, so that the data could be regarded from any background specifically. I started by reading through each document on ATLAS.ti.9 and highlighting and marking portions of interest as "quotations". These quotations were marked on the basis of many different factors: They were a direct answer to an interview question, something the interviewee had explicitly deemed important, something they were repeating, something that was directly or indirectly related to one or more of the themes in this thesis, or something that I otherwise deemed important or interesting. For each quotation, I would write a comment for that quotations providing context for the quotation, detailing what was said, or rephrasing the point of the quotation to be more easily understood. After going through each of the text documents and marking quotations for each relevant portion, I started going through each document again and creating and assigning relevant codes for the quotations. At first, the codes were very closely related to what the interviewee had said or what was written in the comment sections of the quotations. The goal was to remain close to the research material, no matter the number of codes generated as a cause of this. While going through the text documents, naturally many codes were generated that were similar, if not exact copies of one another, or codes that had to do with a specific topic, but from the viewpoint of different themes. After going through and applying codes to all of the relevant quotations it was time to start cleaning up my codebase.

### 3.4 Data analysis

I had some 500 different codes after going through all of the text documents and during the coding process I had begun to sort these different codes into code groups, reflecting themes such as: climate resilience, open data, citizen engagement, based on the context and explicit content of the quotations and therefore the codes. However, as I mentioned before, there were many similar and duplicate codes, and many codes were only used on one or two quotations due to this. I began merging similar and duplicate codes together, as well as further allocating the codes into code groups. The process was very organic and iterative, and the sorting would alternate between merging and code allocation to code groups based on intuition. Several codes belong to more than one group, with usually one group being the primary group. This way, I could gather the most relevant codes into groups most suitable for tackling my research questions.

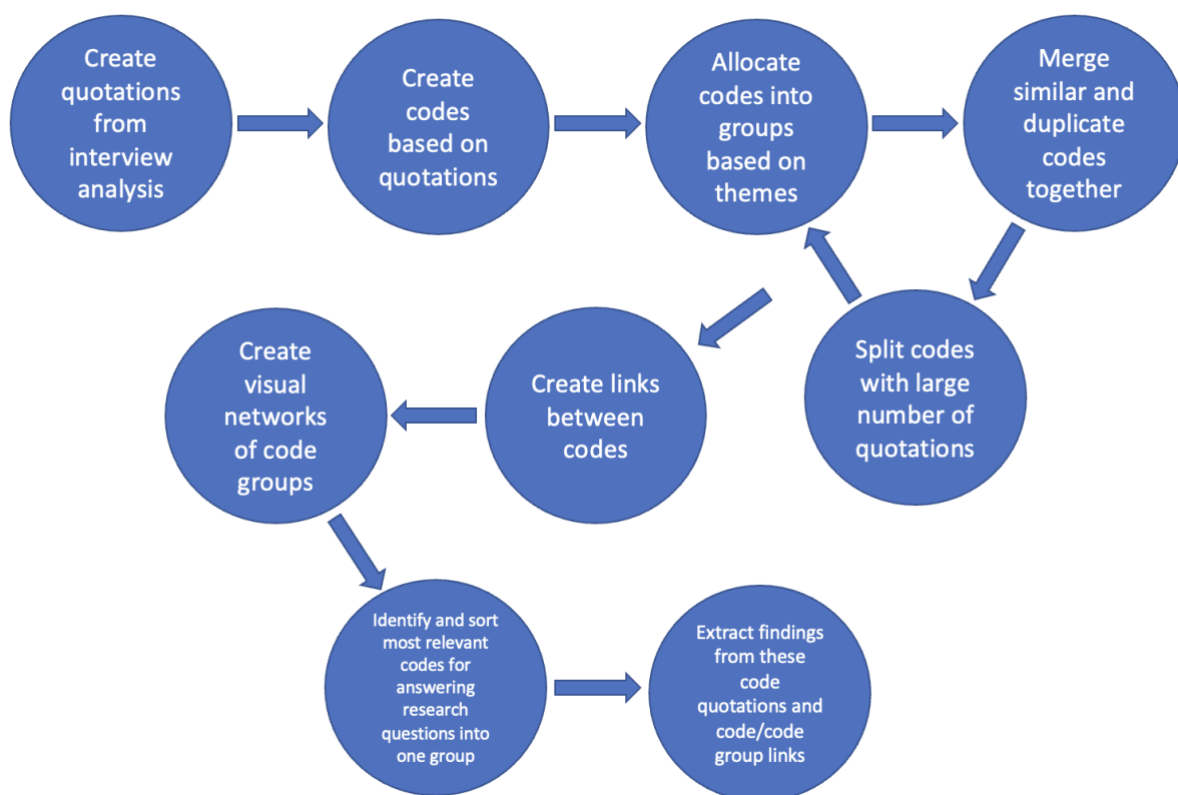


Figure 4: Data analysis process visualisation

## Methodology and methods

Table 3: Examples of code groups, codes and quotations used in the data analysis process

Code group	Example codes	Example quotations
Open data	data accessible to all	<i>Everyone can access it, everyone knows where to find it, it's easy to use and would still be completely anonymised.</i>
Open data	citizen science	<i>I'm looking forward to seeing more citizen science initiatives, where citizens who produce data can use that same data to recommend improved avenues of action and build on top of existing applications and services.</i>
Open data	data collection	<i>Data collection and visualising that data in new ways could be something that citizens could be involved with in maintaining and monitoring green infrastructure.</i>
Climate resilience	green building	<i>Wood construction could largely reduce construction emissions, but it's merely the first step.</i>
Climate resilience	climate resilience embedded in planning	<i>I would say that it should be there from the beginning, because it is such a holistic concept. Therefore, it should be already integrated in the planning phase.</i>
Climate resilience	adaptable urban development	<i>In Kalasatama for instance, sea-level rise has been taken into account and first floors are at least four meters elevation, which means taking into account long term scenarios in development.</i>
Citizen engagement	crowdsourcing	<i>For example various teams developing some kind of smart city service or application, which they would then present to the city</i>
Citizen engagement	citizen ownership	<i>If the city is indeed built for its citizens, then they should be engaged and encouraged to participate.</i>
Citizen engagement	needs to happen at an early stage	<i>Citizen engagement needs to happen at a very early stage and on every level.</i>
Smart city sense making	data driven	<i>A city that is data driven and uses new technologies and processes for developing and building that city, but also for living and thriving there.</i>
Smart city sense making	optimization	<i>The key word in the smart city agenda is optimization.</i>
Smart city sense making	e-governance	<i>A lot of the smart city debates are grounded in efficiency logics around how to improve material flows or how to make labour more efficient and how to also make governance more efficient.</i>
Most important aspects of a smart city	transparency	<i>Transparency and working towards climate targets, efficiency and making life easier.</i>
Most important aspects of a smart city	carbon neutrality	<i>Efficiency is also in terms of efficient use of energy, and that can of course have a carbon mitigation component to it, to help us address the carbon neutrality goals of Finland.</i>
Most important aspects of a smart city	trials and experiments	<i>Trials and experiments, and specifically, upgrading those trials and experiments to fully fledged services that are available to all of the city's inhabitants.</i>

## Methodology and methods

For example, for my first research question on smart city sense making, I allocated codes to quotations derived from the sense making interview questions and organized them into code groups “most important smart city aspects” and “smart city sense making”. The primary code group focusing on traits that interviewees had noted as especially important for successful smart cities and the latter code group was dedicated to mental images and traits that came to interviewees minds when picturing a smart city, in other words, traits commonly associated with smart cities.

After allocating all of the codes into groups, and merging them together until there were no more redundant codes, and minimizing codes with only one or two uses, I began creating links between codes. These links represent association, causality, and belonging. For example, the code “green infrastructure” is associated with both codes “climate resilience” and “sensors”, which are further associated and linked with their own respective codes. This way I was able to create visualizations of linkages in the realms of the smart city, climate resilience, citizen engagement, and open data. It is my belief based on the literature, as well as my own findings that these four themes are inseparable from each other, and cannot be analysed in a vacuum in the context of smart cities and climate resilience.

Once the linkages of the codes had been established, I created network visualizations in ATLAS.ti<sup>9</sup> of each code group and document group. These network visualization showcase linkages between different codes, as well as linkages between different code groups. I have included these network visualizations as appendices in this thesis. The code group “Tools for rapid sustainable change” represent the findings for the second research question in a broad sense, and what factors are needed to make the successful transition into smart cities made for citizens by citizens, utilizing open data ethically, to create more climate resilient and sustainable cities. This code group was generated by picking the most relevant codes from code groups “citizen engagement”, “climate resilience” and “open data”, which were linked together by causality and association. By then examining the systemic and network relationships between these codes and their quotations I was able to formulate the findings for my second research question, for which the objective was to analyse the various ways in which these three themes intertwine, compliment, and sometimes hinder one another.



Figure 5: Network visualisation of code group "Tools needed for rapid sustainable change"

### **3.5 Ethical considerations and trustworthiness of the study**

In this sub-chapter of the thesis, I will be discussing the different ethical concerns and considerations, as well as how I will attempt to address these concerns. The first consideration I would like to bring up is my own reflexivity as a researcher. As a researcher, I was aware of my part in the knowledge production process and the terminology used in interviews plays a large role in that (Eriksson & Kovalainen, 2008). I was interested to see how interview subjects understood climate resilience and how they would intertwine the concepts of citizen engagement, climate resilience and open data into concrete examples and suggestions, and how they could retroactively apply those concepts to their own professional experiences and anecdotal knowledge. In hindsight, I had trouble finding a suitable Finnish translation for the term "climate resilience", as some of the interviews were conducted in Finnish, and then translated into English after the transcription process, and the wording I chose for the first couple interviews would be more accurately translated as "climate adaptation". As per the interpretive and constructionist philosophical position, reality is constructed through language and shared meanings (Eriksson & Kovalainen, 2008). From this viewpoint, the choice of term used may have led the discussions in the interviews into different directions than they would have with a more accurate translation. However, as climate adaptation is an umbrella term for climate resilience, it does not significantly impact the trustworthiness of the study, but still it is a worthy consideration to note.

Additionally, as I am an Information Services Management student with a heavy focus on, and interest in, sustainability, I am aware of my own bias and potential of aligning facts with my own sustainability narrative and directing conversation towards that avenue. However, I tried to minimize that type of behaviour by simply listening and letting the interview subject tell the story. Furthermore, I am presenting both supporting and challenging evidence for my findings.

Finally, this thesis was commissioned by Aalto University, which is a prominent partner in the FinEst Twins initiative. I am regarding a university commissioner as a commitment to the scientific quality of this study and therefore hold firm that ethical issues surrounding censorship are minimal.



## 4 Findings

At this point it would be prudent to revisit the two research questions posed at the beginning of this thesis.

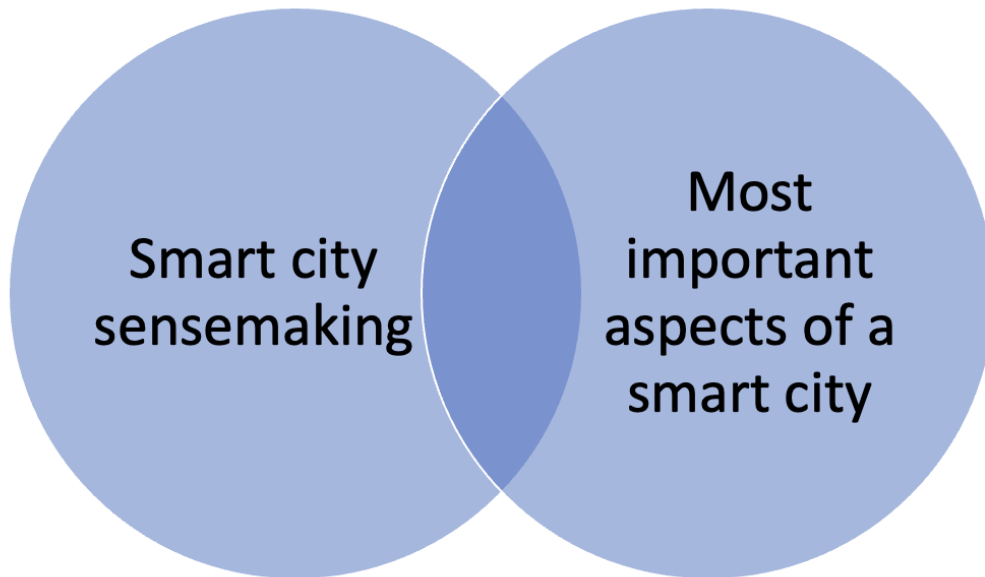
1. *How do professionals working with smart cities define the term "smart city"? What is the sense making behind the phenomenon?*
2. *How do we engage citizens in building climate resilience in smart cities using open data?*

In academic literature (Hollands, 2008; Fernández & Peek, 2020) in place of a concrete definition for the smart city, there is a vague idea, and crystallizing this vague idea into a more standardized definition for future use was one of the goals of this thesis and that process begins with understanding how professionals working closely either in fields related to smart cities or specifically in the smart city field view the term, and what kind of ideas and mental images are conjured up by the term. In short, what the smart city looks like to professionals. This portion of the findings section will focus on the first research question: *1) How do professionals associated with smart cities define the term "smart city"? What is the sensemaking behind the phenomenon?* In the segments following, I will discuss the themes of citizen engagement, open data, and climate resilience, as per the second research question. After going through all of the central themes and code groups, I will take another look at the research questions and attempt to provide adequate answers them.

In analysing the data gathered for this research I distinguished between aspects that interview participants mentioned came to mind when thinking of the term "smart city", and aspects that they stated were most important for a smart city to exhibit so as to be a successful smart city. The dissonance between these two data sets could reflect the gap between what is perceived to be a part of the smart city agenda, and what interview subjects believe should be part of the smart city agenda, to create improved cities for the wellbeing individual citizen, the group and the environment. However, the line between these two sets is blurred and not explicit, and this dissonance is how the author of this thesis interprets these results. The overlap between these two data sets represents topics and aspects that interviewees deem most important, and which are perceived to be represented in the discussion surrounding the

## Findings

smart city, and in the smart city agenda. I will first discuss the themes apparent in each data set individually, and then discuss the themes apparent in the overlap.



*Figure 6: Visual representation of overlap between "Smart city sense making" and "Most important aspects of a smart city" datasets*

## 4.1 Smart city sense making

In regards to the themes belonging to the "smart city sensemaking" data set, but not in the overlap with the data set of aspects deemed most important by interviewees, the most common themes mentioned by interview participants were: interconnectivity, new technologies, smart technologies, accessibility, data driven, and technology driven. This coincides with what is already the most common lane of discussion in the smart city agenda, as noted by the literature review portion of this thesis (Townsend & Lorimer, 2015; Söderström et al., 2014). The "smart city" term conjures mental images of a technology-driven city, accessible to everyone, utilizing big data.

Interview subjects mentioned that smart cities to them were **interconnected cities that use data, sensors, and internet connections to make life easier and safer for inhabitants, and improving environmental sustainability as well as the efficient functioning of the city**. Others mentioned that the smart city is **driven by data and uses new technologies in urban planning** and construction solutions. **Citizen wellbeing** and the **presence of nature** were also factors that came to interview subjects' minds when thinking of the smart city. Clean air, and easy access to both public and private services are examples of ensuring citizen wellbeing. In particular, Helsinki residents seem to value proximity to nature, and one interviewee mentioned that it is often a topic that citizens speak out on, in the wake of new construction ventures. Examples of this are movements such as "Lisää kaupunkia Helsinkiin" (in English: More city in Helsinki), which promotes denser construction so as to not encroach upon natural areas. Interviewees also described the smart city as being accessible. While accessibility can have many different interpretations, the most commonly voiced examples included general access to both private, and public services as mentioned above, as well as making the city accessible to everyone, including, for example, disabled persons. Other themes that were mentioned include: optimization, e-governance, and research-based urban development.

## Findings

### 4.2 Most important smart city aspects according to interviewees

In regards to aspects that interviewees specifically deemed as most important for successful smart cities, that do not overlap with the previous data set, the most frequently mentioned aspects included:

- **Understanding the needs of the individual and the group and reflecting it in the technological design**
- **Well designed, resilient and green infrastructures**
- **Clear communication channels**
- **Climate targets**
- **Trustworthy institutions and institutional support**
- **Purpose-driven technology**
- **Carbon neutrality**

It is immediately apparent in not just the data set, but also in the interview transcripts, that climate adaptation and climate targets are given greater importance than what is necessarily present in the smart city agenda. Additionally, many interviewees voiced the need for **clear communication channels** for citizens to be able to communicate with the city with ease, and to be able to raise awareness on issues and improvements needed in the local area.

Through clear communication between the city and its citizens, the governing entities of the city could gain a better **understanding of the needs of citizens**. By understandings I mean how do we actually understand everyday human behaviour, everyday ecological behaviour, other forms of behaviour, which have validity. Understanding this behaviour, and mapping the values and placemaking of citizens would allow the city to identify what is needed and where. This understanding of the people's needs should be present in everything, for example, if we are talking about autonomous vehicles, how do we ensure that those vehicles are created in a way that meets peoples' needs and also groups' and society's needs. This touches on the citizen engagement portion of this research, which I will discuss more later on.

In regards to **well designed, resilient and green infrastructures**, interviewees emphasized sustainable process flows, such as material flows, waste flows, energy and data

## Findings

flows, all designed to promote ecological and social sustainability and laid at the foundation of the smart city.

Another noteworthy mention by many interviewees was the need for **trustworthy institutions**. According to the climate resilience framework by Moench & Tyler (2012), laid out in the literature review the three main actors in building climate resilience are systems, agents and institutions. We can have the best climate resilience plans individually, but if they are not supported by institutions to be effective. In particular, one interviewee mentioned the importance of so called **value-articulating institutions**. These are the institutions that set the rules around how we should act in society, whether it be the financial sector, the educational sector, or the sports and recreation sector. According to the interviewee, they all have a very important role around setting the rules and norms around sustainability. After analysing each of these data sets individually, I will now analyse the overlap of the data sets: the themes and aspects that were present in both smart city sensemaking and aspects seen as most important by interviewees.

### 4.3 Overlap between sense making and most important aspects

After going over the aspects that interviewees mentally associated with smart cities as well as the aspects that interviewees deemed most important for successful smart cities, we can now discuss the overlap between these two data sets to determine what aspects are shared between the two. As previously mentioned, we can loosely base the dissonance between these two data sets as what the term "smart city" mean to professionals versus what professionals believe smart cities should strive for, however, just because a certain code is included in both data sets does not mean that these aspects are necessarily adequately represented in the smart city agenda. It simply means that interviewees both associate those aspects with the smart city agenda and believe they are among the most important aspects a smart city should exhibit. For example, in some instances, interviewees placed particular emphasis on the fact that a certain aspect is strongly associated with their ideal view of the smart city, but in reality, should be improved upon to reach this ideal level, while other aspects were mentioned to be direct views on aspects that have been emphasized in the smart city agenda. Furthermore, having an aspect included in the general rhetoric of the smart city agenda does not mean that it is necessarily realized in actuality, at least at the same level of emphasis as in the rhetoric. However, that is not the subject of this study. The aim of this study is simply to conclude what smart cities mean to smart city professionals. The other main aim of this study shall be discussed later on.

The codes with the most appearances were present in both data sets, and these included:

- **Privacy and security**
- **Efficiency**
- **Transparency**
- **Sustainability**
- **Trials and experiments**
- **Nature-based solutions**
- **Making life easier**

According to one interviewee, who has conducted research into open data, smart city applications, and how citizens view these applications, the conclusion of their study showed

## Findings

that citizens place a much greater emphasis on their data being safe, secure, and anonymized, than on the functionality of the smart city applications themselves. If the applications make citizens' lives easier, but exhibit data security breach risks, or risks of mishandling and misusing of the data, then the end result would not have been the increased ease of citizens' lives, but rather an increase in uneasiness of citizens' lives. Therefore, when using citizens' data for the improvement and optimization of the functions of the city, citizens' data privacy should be placed in the position of utmost importance.

Table 4: Interview quotes reflecting the sensemaking of the smart city concept

<i>In my view the smart city agenda is all about how to bring new forms of technical innovations into cities to improve the efficient functioning and operation of the city.</i>
<i>The smart city has well designed infrastructures, which enables efficient material, waste, energy, and data flows.</i>
<i>Transparency and working towards climate targets, efficiency and making life easier.</i>
<i>Using various types of technology to make the city smarter, and life in the city easier.</i>
<i>As close as possible to nature, that is what smart cities should look like.</i>
<i>Mental images of clean air, close proximity to nature, good urban ecosystem to live, work, practice hobbies, and easy access to both private and public services for everyone.</i>
<i>I would say that we really need to think about how does the sustainability and nature-based solution agenda come together with the smart city agenda, so that we can have real sustainable solutions and not just smart solutions.</i>
<i>Two-sided transparency, where the city gathers anonymized information on how citizens behave and operate, and citizens also gain access to insight on the functionings of the city and government processes.</i>
<i>It is very important to citizens, that the digital, and smart city services are such that they can be trusted to keep their data safe and for it to be utilized ethically.</i>
<i>The key word in the smart city agenda is optimization.</i>

In all of the interviews conducted, **efficiency** was a consistent theme. In the words of one interviewee:

*"The smart city agenda is all about how to bring new forms of technical innovations into cities to improve the efficient functioning and operation of the city."*

Furthermore, according to many interviewees, many of the smart city debates are grounded in efficiency logics around how to improve material flows or how to make labour more efficient and how to also make governance arrangements and institutional administrative arrangements more efficient. Another interviewee highlighted the link between efficiency and sustainability, in particular, how efficiency can be used in data

## Findings

collection to optimize the energy consumption of buildings. This leads us to our next topic of discussion: sustainability and the **pairing of efficiency and sustainability**.

Sustainability is often left out of the smart city agenda, despite the need for smarter, more efficient cities coming from the imminent prospect of climate change. This is evident in the literature, and further confirmed by my own research in the form of interviews. The smart city agenda places a great emphasis on efficiency, however, efficiency and sustainability are intertwined concepts. For example, efficiency can be discussed in terms of efficient uses of energy, and that of course can have a carbon mitigation component to it. However, according to interviewees, smart cities should take it a step further. According to interview results, the principles of sustainability should be incorporated into the core values of the smart city. This leads to the question of how do we actually develop our cities in ways that are not only managing energy, or efficiently using energy, but also helping to support nature and the basic life support systems that we all depend upon, which is a crucial component of climate resilience. Additionally, other aspects of sustainability need to be firmly baked into the smart city agenda, meaning that the urban ecosystem needs to be economically prosperous and the city should be able to produce jobs in a way that all citizens have access to employment and a decent quality of living, and that it can be maintained.

Sustainability may often be circumvented as well in the smart city agenda. For example, in one of the interviews I conducted, when discussing the topic of carbon neutrality, the interviewee mentioned that many countries may outsource their carbon accounts. For example, if a nation is using fossil fuels for energy production, but that energy production happens outside of the borders of that given nation, it will not show up in the given nation's carbon accounting. Meaning on paper, that nation is closer to the goal of carbon neutrality, but those carbon accounts still exist and cause the same amount of environmental harm. According to that same interviewee, this type of discussion is often left outside of the smart city debate. To combat this, for one, smart cities should have more ambitious carbon neutrality targets, and the city should be more transparent in its functions, which includes energy procurement.

During the course of this study, I have realized that the smart city debate sits at the intersection of many complex questions and issues. On one hand, we have the open data discussion, the sheer volume of data in existence and constantly being produced, privacy and ethical questions, questions of surveillance capitalism, and questions of ownership. On the other hand, we have the climate change, climate resilience and sustainability discussion: the need to mitigate carbon emissions; clean energy; building and designing cities,



## Findings

infrastructures and institutions that can withstand, navigate and allow populations to thrive in, in the wake of already existing, and future climate change impacts. Tied to the sustainability discussion are questions and issues of equality, governance, justice, citizen ownership and collaboration, co-creation and inclusivity, along with questions of funding, growth and economic prosperity. Overshadowing all of these subjects is the general smart city debate of efficiency, innovation and technological advancement, and massive private corporations exceeding national borders. In short, there are many compatibilities, incompatibilities, tensions, and potential conflicts between these collectives, often making these issues wicked problems. However, there is opportunity there as well. There are no easy solutions to be offered.

The smart city agenda sits in the middle of a vast mess, and as one interviewee stated, acknowledging that mess is the first step towards sustainable transition. In the following portion of the Findings chapter of this thesis, I will be discussing and analysing the second research question:

*2) How do we engage citizens in building climate resilience in smart cities using open data?*

## 4.4 Citizen engagement, climate resilience and open data

In order to adequately tackle my second research question, the three main themes of the question should be addressed, all of which are veritable fields of their own: **citizen engagement**, **climate resilience**, and **open data**. I included each of these themes in my research and in my interview questions, and attempted to find links between these themes, that could weave a coherent narrative for the approach of formulating an answer for my second research question. I will first start with the theme of citizen engagement.

### 4.4.1 Citizen engagement

To analyse the intricate tools and practices to improve citizen engagement according to the interviewees, I devised a code group linking codes having to do with citizen engagement under one category. This category had overlaps with some other code groups, including the "most important aspects of a smart city" code group, which was analysed in the previous segment. All of the interviewees listed citizen engagement as either "very important" or "important" for better decision making, and planning in smart cities. The most frequently used codes for this category were:

- **Crowdsourcing**
- **Understanding the needs of the individual and the group and reflecting it in the technological design**
- **Channels for feedback and suggestions from citizens**
- **Better communication from the city**
- **Awareness**
- **Climate targets: ambitious in setting targets**
- **Privacy and security**

Almost all of the interviewees mentioned some form of crowdsourcing as an integral tool to integrate citizen participation in decision making and planning in smart cities, be it hackathons, workshops, collaborative platforms, or participatory planning, mapping or budgeting.

## Findings

These forms of participation enable two things:

- 1) The outsourcing of meaningful innovation to citizens
- 2) Meaningful engagement and listening, making citizens feel heard on issues that need improvement and change.

However, usually hackathons and crowdsourcing events look for new cutting edge innovation. According to the information gathered in my interviews new technologies are not necessarily needed to make important improvements to the city in regards of sustainability, climate resilience and quality of life. Many issues are local, and on a smaller scale, which require incremental improvements, and are therefore not necessarily suitable for hackathons. For this reason many interviewees listed having **clear communication channels** for citizens to be able to interact with the city, and on the other hand for the city to **engage in more meaningful communication** with its citizens. While, according to Wamsler et al. (2020), the current structural conditions for citizen engagement could hinder sustainability outcomes, which partially contradicts the findings of this thesis. The findings indicate open data tools could actually be the key to improve the current lacking structural conditions for citizen engagement and boost climate resilience outcomes, thus providing a solution to the criticism of citizen engagement. The need for clear communication channels between the city and its citizens comes from the need for the city to **understand its citizens and reflecting it in the technological design**. As some interviewees pointed out: who is the city built for if not for its citizens, and if the city does not understand its citizens and what they want, then there is a major problem. A recurring issue that many interviewees pointed out was that citizens are unaware of clear channels to communicate with the city and raise awareness on local issues that they would like to see improved. These channels could be and have been previously seen in the form of apps. For example the Helsinki app. However, these apps are usually either taken down, poorly maintained, or go unnoticed by the general public, fracturing the line of communication between citizens and the city. Having **one clear communication channel, marketed by the city, with subcategories for issues and suggestions, where citizens could voice their opinions** would be a huge improvement for citizen participation in smart cities, allowing for citizens and the city to **co-create their vision** of what the smart city should be. Incidentally, this aspect heavily links citizen engagement to the realm of open data. Additionally, the important theme of citizen ownership also comes into play here.

## Findings

Table 5: Interview quotes reflecting the complex elements of citizen engagement

<i>I don't care what the demonstration is, but we have to be able to demonstrate the benefits of that to the community. It needs to be science informed, but we also have to have the governance and political processes to bring different thought collectives into the picture so that, when we navigate these conflicts that are emerging, and not necessarily always solve them, but to have them more transparently discussed, and being part of the agenda.</i>
<i>Citizen engagement needs to happen at a very early stage and on every level.</i>
<i>We need new forms of engagement, new platforms to encourage the citizen to be discerning, meaning to be able to understand the different thought collectives out there, to be able to understand the different interests and influences that are at play, and for them to be able to make more objective and systematic decisions on how we should go forward based upon these different interests and influences.</i>
<i>We have a lot of technologies and tools to engage in communities, and the science of tool development has now really advanced, but the use of these tools and the data and decision-making is lagging way behind, and there is a whole range of reasons for that institutionally, politically, etc.</i>
<i>How do we ensure that the needs and aspirations of the individual and the group are reflected in the technological design of the smart city?</i>
<i>Participation should not always need to be active. It could start from passive participation, and build on top of that with active co-creation and public discussion.</i>

According to the data generated by the interviews, **citizen ownership** is a key component to successful citizen engagement. A great example of this was given by one interviewee, who mentioned a municipal biowaste compost hub close to their rural cabin. This compost hub is powered by solar energy, and in springtime, the composted dirt is placed in boxed areas around the local vicinity, and local residents can then decide what will be planted in them. The key to the success of this type of initiative, the interviewee continues, is creating solid links of communication with local residents. The choice of what plants will be planted gives the local residents a sense of ownership, which creates a positive cycle of citizen engagement.

Touching on the topic of different forms of engagement using open data, an important note to take into account, which emerged during a few interviews was the potential of open data to not only facilitate active citizen participation but passive as well. Different people want to engage in different ways, some want to actively participate, while others tend to not be as interested in participation. Passive participation can be done in the form of divulging data to the city on how the citizen moves, and interacts with the city. I will return to the subject of open data, and it's role in citizen engagement later on.

Returning back to the topic of active citizen participation in smart city development, engaging citizens in the early stages of planning and embedding these tools of participatory engagement into municipal planning structures is another key insight into improving collaboration between citizens and the city, which surfaced during the interviews. According

## Findings

to interviewees, citizen engagement often happens much too late in the process of planning and development to have any meaningful impact apart from minor details and cosmetic nuances. This can be usually seen as a kind of cop-out, as the citizens have been engaged, but not on any significant level. Furthermore, with the engagement and participation of citizens, especially using open data, comes the concern of vast amounts of personal information potentially falling into the wrong hands, or misused, such as being used to influence consumption habits instead of for public good. To mitigate this risk and to effectively get citizens on board with participation, privacy and security concerns must be addressed. This is a major component in citizen participation and open data, and this thesis will not be addressing how to do this, as improving data privacy is not the main subject of this thesis. The objective is simply to pinpoint key components that are needed in order to successfully engage citizens in meaningful ways via open data solutions to build climate resilience in smart cities. Privacy and security were among the most frequent and numerous codes identified in the interviews, and they are strongly linked to citizen trust, which is in turn a key component to successful citizen engagement. In the next segment we will discuss open data, after which we will address the topic of climate resilience.

## Findings

### 4.4.2 Open data

Open data is the second theme associated with the second research question of this thesis, and one of the main focuses in the research interviews. The analysis of text transcribed from interviews once again produced a number of codes.

The most used codes were codes present in all of the previous data sets I have mentioned in this thesis: namely:

- **Privacy and security**
- **Understanding the needs of the individual and the group and reflecting it in the technological design**

To effectively collect and use open data, **privacy and security** must be addressed, which will in turn correspond to increased **citizen trust**, whereby the process becomes a positive cycle, feeding itself. When there is trust in the institutions and actors using the data, and the results are visible, it encourages citizens to share more. However, open data is a two-sided process, which leads us to another important code born out of this data set: **citizen access to information**. Just as open data provides the city with increased amounts of information on citizens' daily lives, how they move, and their consumption habits, open data is a tool for citizens to gain more visibility into the processes of the city, its institutions, and the companies operating within it. **Increased transparency** in government processes is key to laying down the groundwork for increased trust in the government, fact checking, and being able to influence the government in ways that benefit the individual and the collective. One of the key insights attained from these interviews was the need for open data to be for **public interest, instead of corporate interest**.

Open data is most often linked to services and apps. Interviewees named examples such as the HSL app that provides numerous different routes to a given destination. Furthermore, open data provides an avenue for **citizen science** to be undertaken, and used in numerous beneficial ways, having citizens produce and use their own data to create services, or improve existing services and apps. A good example of this in the climate resilience realm are the air quality screens apparent in the Helsinki metro system. It is important to note that open data itself does not constitute positive change. The answer lies in how this data is implemented, and what kind of solutions, innovations and services are born from it. This is echoed by the literature (Grimmelikhuijsen et al., 2017), which states

## Findings

that the main problem with open data is how it is used and the lack of use. Ideally, open data would be used to influence positive changes in behaviour, by providing citizens with relevant information. For example, one interviewee mentioned using open data to gauge individuals carbon footprint relative to their consumption, which could influence more sustainable consumer behaviour. Another interviewee stated that the most important aspect of these new solutions, be they open data solutions or climate resilience solutions, or both, would be the ability to effectively **demonstrate the benefits to the public** in ways that are relevant to their everyday lives.

Table 6: Interview quotes regarding open data solutions for smart cities

<i>We need a de facto communication channel between the smart city and its citizens.</i>
<i>I believe that the smart city should have an official channel, with discussions threads on different city sectors. Right now we have facebook groups, but they are unofficial and there are different degrees of activity between them.</i>
<i>I'm looking forward to seeing more citizen science initiatives, where citizens who produce data can use that same data to recommend improved avenues of action and build on top of existing applications and services.</i>
<i>Open data should increase transparency of governance and enable fact checking in the public sector.</i>
<i>I believe that smart cities are the product of co-creation. It becomes a collective effort when data is open and accessible and it can be used to create services and apps for public good.</i>
<i>Helsinki has a lot of open data, meaning data that Helsinki produces, which can be used by both citizens and also private companies, to create applications, for example mapping, and placemaking applications, built upon the data that Helsinki collects.</i>
<i>Open data is quite fragmented and not necessarily real time, so there are some barriers to effective use.</i>
<i>We need to come up with better ways to engage with citizens in the context of relevant issues in their own urban environment. Open data could provide improved ways to accomplish this.</i>
<i>Open data can be used to create improved visualizations of climate change in ways that are more relevant to the average citizen, enabling and nudging the right kind of change that is needed.</i>

A couple interviewees pointed out that one of the challenges surrounding open data is the sheer volume of data, and the tendency for it to be fragmented. This also relates to what was discussed previously in the citizen engagement section of the findings, where **clear communication channels** are hard to find, and identifying between viable and active ones create distortions in communication between citizens and the city. Currently, the closest thing we have to clear communication channels are informal discussion platforms such as Facebook groups, which are often split into sections representing different areas of the city, and even these are dwindling in popularity due to younger generations quietly abandoning Facebook in favour of other platforms. Additionally these Facebook groups have an absence of government representation, making the conversation purely between residents. Navigating through the avalanche of data to find relevant information is a cumbersome task,

## Findings

not to mention the myriad of different databases information is stored in. One interviewee stated that there should be **one clear database** to access all of this data. Ideally, everyone would know where to find it, everyone has access, and everyone knows how to use it, while keeping the data completely anonymized. This would require background processes to maintain and categorise the different types of data into clear subsections. However, this would greatly benefit both the public and the government in terms of **easier access to relevant data**. This in turn promotes innovation. Another important point addressed by an interviewee was that the apps and services that utilize open data need to be good enough to be adopted by the wider public audience. If the apps are not used by the general public, then they cannot serve their purpose. This is where the role of the city comes in. **The city plays a large role in marketing apps and services**, as people tend to trust apps and services backed by legitimate institutions. Many apps and services might be incredibly useful and needed, but people simply cannot find them, this is another issue that could be solved by increased marketing and support from the city. In other words, the city should encourage the development of these apps and services and actively promote them to the general public, so that citizens can be made aware of their existence.

In the next segment of the findings, I will be discussing the data obtained through interviews and analysis on climate resilience. After going through these results, I will combine the findings for the themes of citizen engagement, open data, and climate resilience to answer the second research question of this thesis.



## Findings

### 4.4.3 Climate resilience

Climate resilience is the final theme in the three themes associated with the second research question, and a core subject of this thesis. As with the previous segments, I will be first dissecting the most frequent codes related to climate resilience, which became apparent in the interviews.

The most frequent codes included:

- **Climate targets: ambitious in setting targets**
- **Activism**
- **Adaptable urban development**
- **Well designed, resilient, and green infrastructures**
- **Nature-based solutions**
- **Taking into account couplings and feedbacks**
- **Politics, interest, and influence**
- **Holistic thinking**
- **Sensors**

According to multiple interviewees, improving climate resilience in urban areas requires **holistic thinking, understanding long-term scenarios and causality, societal adaptability, green building, and adaptable urban development**. One interviewee had studied green building and in particular wood construction as a more sustainable alternative to building materials such as concrete. According to that interviewee, wood construction could greatly mitigate the emissions of the construction sector, and as a material it is very cost effective and agile. However, this is only the first step, and sustainable wood construction also requires the sustainable management of forests. Coupling green building and green infrastructures with a societal understanding of the carbon footprint and causality would make society as a whole more adaptable to changes in climate. Factors such as sea-level rise and increased rainfall should be taken into account when planning the construction of new buildings and urban areas. These factors are intertwined with **long-term scenarios**, for example 100 years. This is sensible, when thinking of the lifespan of buildings and infrastructure, for instance. Coupling these long-term scenarios with **adaptable urban**

## Findings

**development** helps in resilience against climate impacts. For example, in Kalasatama, newer buildings are already being constructed with sea-level rise in mind, with the first floors being constructed at an elevation which takes that into account.

In addition to green building, green infrastructures, long-term scenarios, causality and climate impacts implement **nature-based solutions** should be implemented into the smart city. Nature-based solutions takes natural processes and uses them in resolving societal issues. Nature-based solutions can be anything from green walls, to green roofs and stormwater swales. A good example of this is using stormwater management to irrigate green areas and unburden water management facilities, using new forms of wetlands or water squares for instance, which were featured in the literature review portion of this thesis as a climate resilience solution. A key focal point of nature-based solutions is creating space in the urban environment for natural processes, thereby bringing nature closer to the public. One interviewee described the smart city as a city and its inhabitants being closer to nature, this is a perfect example of that.

Table 7: Interview quotes regarding climate resilience in smart cities

<i>I think climate resilience in cities is about having solution-oriented approaches, which are evidence informed, where we can demonstrate to the public and different thought collectives, the benefits of shifting from the status quo to something else.</i>
<i>The art of sustainability and the art of climate resilience to me is about how we develop active urban experimentation or regional experimentation, that not only engages diverse actors, but also can bring in issues of power, interest and influence in ways that we are not seeing right now, so that we can have discerning discussions that really enable reflexivity and people from different perspectives to really think through the issues in ways that may not always be comfortable, but are needed to actually make these major transformations.</i>
<i>Climate resilience needs to be included in urban development at the very beginning and at every level.</i>
<i>Climate resilience to me is about how we bring together the ecological design and natur-based solutions in ways to address the complex feedbacks between these different systems, and that does not occur by purely looking at technology alone, or society alone. They have to come together into a multidisciplinary and arguably transdisciplinary understanding of the system.</i>
<i>Ambitious targets, longevity, and taking into account long-term scenarios are important. For example carbon neutrality goals are often given up on, due to the belief that they are not possible to achieve at this moment in time.</i>
<i>From the urban development perspective, planning and modeling are in integral roles concerning climate resilience. For example, planning stormwater swales and runoff infrastructure in ways that do not overburden water treatment systems is crucial.</i>

Many of these solutions surrounding adaptable urban development require **sensors**. Sensors help us understand the current state and changes in our environment, be those changes in air quality, rainfall, sea-level rise, etc. and help us adapt accordingly. In essence

## Findings

the sensors are our collective antennae. There are a number of climate resilience apps that operate using sensors. One interviewee mentioned an app that monitors a given household's energy usage and optimizes energy consumptions in heating and lighting according to the usage of space. Take for example an office building. If a meeting room is only used a couple of hours a day, then the app would switch off the heating after these scheduled meetings, and switch it back on half an hour before meetings, to give the space time to heat up. Not only could this save on energy costs, but it could minimize the energy consumption of large office buildings.

The solutions and methods mentioned above have to do with tangible initiatives such as adaptable urban development, green building, and nature-based solutions. However, there is also an intangible side to climate resilience, which is equally important. This intangible side has to do with societal adaptability, holistic thinking, individual and group behaviour, and understanding the different interests and influences at play in the smart city. This latter half of the climate resilience section will be focusing on the intangible side of climate resilience.

One interviewee emphasized the importance of a "sets" understanding, taking into account **couplings and feedbacks**. What this means is looking into couplings of ecology and technology, society and technology, society and ecology etc. And how they relate to one another. It is less important to look at these factors on their own than it is to look at the feedbacks between these factors and how they complement or hinder one another, to better understand climate resilience, and the functioning of our society. In the words of this interviewee:

*"Climate resilience to me is about how we bring together the ecological design and nature-based solutions together with the technological or smart city solutions in ways to address the complex feedbacks between these different systems, and that does not occur by purely looking at technology alone, or the ecology alone, or society alone. They have to come together into a multidisciplinary and arguably also a transdisciplinary understanding of the system".*

So for the sustainable smart city, the question becomes how do we bring a sets understanding, into bringing together the smart city and green city debates? Recognizing that there are many tensions between these, but also potential for a lot of compatibility as

## Findings

well. What are the synergies and trade-offs? How do we adequately plan and manage for them going forward?

According to another interviewee, it is of paramount importance for the average citizen to be aware of the **politics, interests, and influences** that are at play concerning these decisions. This awareness allows for citizens to be more discerning in their behaviour, and fosters the right kind of change. How do we actually bring together the institutional dynamic with the local individual dynamic in new ways, while dealing with institutional politics and resistance to change? This leads us into our next point, which revolves around individual behaviour.

Individual behaviour plays a large role in climate resilience and societal adaptability. Consumption habits and how people move in the city make up a large portion of that given populations carbon footprint. To understand causality and carbon footprint, climate impacts need to be quantified, and the information needs to be presented to the public in a relevant manner. However, an even more important aspect of individual behaviour is that of activism. **Activism** is heavily associated with understanding politics, interests, and influence, and gives citizens a way to add their own voice to the discussion, and influence agendas and decision-making. Furthermore, **thought collectives** play a huge role in these discussions.

**Thought collectives** are groups of individuals united by certain ideas. For example, citizens vying for less car traffic and more cycling constitute a thought collective. According to an interviewee, citizens usually hover in between thought collectives, having many different ideals. Involving these thought collectives in public discussion, studying compatibilities and emerging conflicts, while not necessarily solving those conflicts, but celebrating divergencies would be an important way for societies to navigate these issues such as climate change and climate resilience. Conflicts breed solutions, and harbouring discussion between different thought collectives is a good way to do that. For that to happen we need new forms of engagement, new platforms to encourage the citizen to be discerning, meaning to be able to understand the different thought collectives out there, to be able to understand the different interests and influences that are at play, and for them to be able to make more objective and systematic decisions on how we should go forward based upon these different interests and influences. So that means moving from purely engaging the public to engaging through group-based discussions with different interests and influences around the table.

## Findings

In conclusion to the climate resilience segment of this thesis, climate resilience in cities is about having solutions oriented approaches, which are evidence informed, where we can demonstrate to the public and different thought collectives, the benefits of shifting from a status quo to something else. What the demonstration is irrelevant, but we have to be able to **demonstrate the benefits** of that to the community. The literature on climate resilience (Moraci et al., 2018; Chan, 2015) agrees with this notion. The demonstrations need to be science informed, but we also have to have the governance and political processes to bring different thought collectives into the picture so that, when we navigate these conflicts that are emerging, we do not necessarily always solve them, but have them more transparently discussed, and include them in the agenda. To combine the tangible and intangible solutions of climate resilience, active urban experimentations or regional experimentations should be developed, that not only engages diverse actors, but also can bring in issues of power, influence and interest in ways that are currently missing, so that we can have discerning discussions, that enable reflexivity and people from different perspectives to really think through the issues in ways that may not always be comfortable, but are needed to actually make these major transformations. That means somehow linking the technologies around the science and the methods of participation to the processes of engagement. In effect, combining citizen engagement with open data, to build climate resilience.

## 5 Discussion

In this chapter of the thesis, I will interpret and discuss the research findings in light of previous research, and answer the two research questions with the help of conceptualizations from the literature review and the theoretical framework. This chapter is structured in a way that gives each research question their own sub-chapters.

### 5.1 How do professionals working with smart cities define the term "smart city"? What is the sensemaking behind the phenomenon?

As I stated in the beginning of this thesis, there is little consensus in academia on the definition and meaning of the term "smart city", and this thesis has hopefully helped both solidify that claim as well as shed light onto the complex phenomenon that is the smart city agenda.

The findings for my first research question were divided into two separate datasets, with overlap between them. One dataset that describes how the smart city concept and agenda is understood in the minds of professionals, and another in which fundamentally important aspects are described, and which are seen to either be part of the smart city agenda currently, or are a glaring oversight, which should be rectified and included in what it means to be a smart city and what smart cities should strive for.

The major issue of dissonance seems to be that many interviewees mentioned, carbon neutrality climate targets, and other aspects related to the social and environmental sustainability agenda, that they felt is often left out of the smart city agenda, but which should very firmly and notably hold a place there. The literature also agrees with this, as many studies critiqued the smart city agenda for focusing on "smart" aspects while conveniently omitting mentions of sustainable change (Hunt & Watkiss, 2014; Fernández & Peek, 2020; Moench & Tyler, 2012). Many interview discussions also echoed this view and gave gentle reminders of technological advancement without purpose, is not advancement:

*"The smart city and its technologies and solutions need to serve a meaningful purpose, otherwise they are just technology for the sake of technological development, which is neither smart, nor sustainable."*

## Discussion

As I mentioned earlier in the Findings chapter, the smart city debate sits at the intersection of many complex questions and issues. We have the open data discussion, the avalanche of already existing and newly emerging data, privacy and ethical questions, questions of surveillance capitalism, and questions of ownership. Additionally, we have the climate change, climate resilience and sustainability discussion: climate targets; clean energy; building and designing cities, infrastructures and institutions that can withstand, navigate and allow populations to thrive in, in the wake of already existing, and future climate change impacts. Intertwined with the sustainability discussion are questions and issues of equality, governance, justice, citizen ownership and collaboration, co-creation and inclusivity, along with questions of funding, growth and economic prosperity. In the midst of the debates and agendas mentioned above, resides the general smart city debate of efficiency, innovation and technological advancement, and massive private corporations exceeding national borders driving economic growth. All of these factors need to be taken into account when studying the smart city, as the smart city is intertwined with each of them and veritably cannot and does not exist without them.

To answer this research question, I must emphasize that definition of the smart city, offered by this answer, will represent the smart city in its most ideal form, i.e. the definition we should have in our minds when we embark on making a city "smart". The smart city according to the research gathered in this thesis, as defined by professionals working in fields closely entwined or directly embedded in the smart city agenda, is a data- and technology-driven amalgamation of systems, institutions and agents engaged in co-creating an interconnected urban living environment, designed for its inhabitants. The smart city has the triple-bottom-line values rooted deeply into its core, which fundamentally shape the functions of the city. The smart city is engaged, and consists of, a constant discussion between its inhabitants, service providers, and governing institutions and actors, and private companies, in an iterative feedback loop, which constantly seeks to improve the economic and social wellbeing of its inhabitants, and the environmental wellbeing of the natural life support processes on which we all depend on. The smart city is close to nature, incorporating natural elements and processes into the urban environment, to improve resilience, but also to mimic the natural world and bring it closer to its inhabitants. The smart city is driven by data, provided by its' inhabitants in ways that protect their privacy and anonymity, and in a way in which citizens know what their data will be used for, and can choose exactly what they want and do not want to share. In turn, the smart city operates transparently and citizens

## Discussion

have access to the same information and data that the city does, and can fact check the processes and functions of the public sector.

This is the smart city concept and ideal, coalesced from interview results and reflected on through the lens of pre-existing literature.

## 5.2 How do we engage citizens in building climate resilience in smart cities using open data?

For the second research question of this thesis, I have studied the themes of climate resilience, citizen engagement, and open data, and reflected on them in the light of the theoretical framework created by Moench & Tyler (2012), from the perspective that these themes can be divided into the three components used in the framework: systems, institutions, and agents, and therefore enhance the framework by improving the understanding of vulnerability and building resilience. From the perspective of the framework, open data and the regulations that govern it act as the institutions, citizens engaged by, and participating via open data solutions are the agents, and smart city services, solutions and applications, as well as initiatives such as nature-based solutions and natural processes act as the systems. On to the question itself: *How do we engage citizens in building climate resilience in smart cities using open data?*

According to findings obtained from interviews, there are a number of ways to improve citizen engagement and therefore improve climate resilience using open data in smart cities.

**First**, virtually all interviewees unanimously advocated for official communication channels between the city and its citizens. Currently there is no official communication channels between citizens and the city of Helsinki for instance. There are unofficial Facebook groups, but they have varying degrees of activity and it is not guaranteed that citizens will be heard by relevant officials through these groups. One of the most frequent criterion mentioned by interview subjects, and emphasized as particularly important was that the smart city and its governing entities must understand the needs of the individual and the group. If communication between the citizens and the city is severed, or fragmented, then how will the city know what is needed? This is essential for building resilience and



## Discussion

understanding vulnerability, as citizens are well equipped to identify targets for improvement in their local respective areas, as well as possible vulnerabilities.

**Second**, due to the enormous volume of existing and emerging data, categorized open database platforms should be implemented to store and sub-categorize data depending on its nature, so that it could be easily accessible by citizens, corporations, and public entities alike for developing and improving different climate resilience and smart city applications and services. This would require significant investment and robust processes for data management and database maintenance, as well as funding, but I will not be delving deeper into those aspects in this thesis as they are not part of the scope and focus area. Creating climate resilience solutions with the use of open data, requires a vast and easy to use, and access, repository of data.

**Third**, the smart city must be able to guarantee the privacy, anonymity, and security of the data of its citizens, and give them a choice in what data they want and do not want to share. This needs to be guaranteed in order to obtain citizen trust, which is the key to successful engagement and participation initiatives. If there is no trust, there is no co-operation.

**Fourth**, active urban and regional experimentations need to be developed that not only engage diverse actors, but bring in issues of power, interest and influence to enable discerning and reflexive discussions in people from different perspectives. Crucially, no matter what the solution or experimentation may be, it needs to be evidence informed, and we need to be able to demonstrate the benefits of that solution, of shifting from the status quo to something else, to the public. As Moraci et al. (2018) put it, improving awareness within the population is important to ensure maximum participation, which can be done by communicating the benefits of contributing to climate adaptation.

**Fifth**, workshops and crowdsourcing should be a primary source of citizen engagement, and in such a way where the "ownership" of the solutions are passed on to the citizens, and sustainable and climate resilience solutions are financially incentivized. In many of the research interviews, workshops and crowdsourcing were hailed as a meaningful way to engage citizens in building urban climate resilience. Multiple people from diverse perspectives working on different projects typically come up with better and more solutions than a few experts working in-house. According to the research presented in this thesis, it is critical when crowdsourcing for solutions, to engage citizens at a very early stage to both attain a meaningful level of input, as well as for citizens to gain a sense of purpose and therefore encourage participation to begin with. Crowdsourcing at late stages, when only

## Discussion

minor details and cosmetic changes can be tweaked, was found to be largely without purpose or gain, by this thesis. Crowdsourcing and workshop examples presented by interview subjects ranged from participatory mapping to participatory budgeting, both of which already exist, but should be expanded upon and used more frequently. The Naturvation project, i.e. the Urban Nature Atlas is a great example of a climate resilience participatory mapping initiative. Funded by the European Commission, it provides a summary of different nature-based solutions, with reference examples on an interactive digital map, so the user can see where these solutions are taking place, what are the benefits, the costs, and how different groups can engage with them in the future. For further discussion on existing climate resilience initiatives and their future potential, please refer to the sub-chapters "Practical implications" and "Suggestions for further research" in the Conclusions -chapter.

## 6 Conclusions

The goal of this study was to answer the overarching questions: *How do professionals working with smart cities define the term "smart city"?* and *How do we engage citizens in building climate resilience in smart cities using open data?* In regards to the former, smart cities are defined as cities that are data-, and technology driven to improve, optimize and make more efficient the functions of the city, and improve quality of life for citizens. However, smart cities are also born out of the need to adapt to, and overcome the challenge of climate change, as put forth by Fernández & Peek (2020) at the beginning of this thesis: *"The need to create adaptive societies is more crucial than ever."* This study suggests that greater emphasis should be placed on climate resilience in the smart city debate, and that smart cities should be built around the core pillars of sustainability.

In regards to the latter research question, this study finds that: clear and official communication channels between the city and its citizens; data categorization, accessibility and storage; data security and privacy; evidence informed demonstrations of solutions to the public, coupled with active urban experimentation engaging diverse actors; and participatory initiatives such as crowdsourcing and workshops are all efficient and meaningful ways to engage citizens in building climate resilience using open data.

### 6.1 Main findings and theoretical contribution

The main findings of this study are:

- 1) Smart city professionals acknowledge the importance and indeed the central role of sustainability and climate resilience in the actualization of smart cities, despite, and indeed because of the themes being often sidelined in the broader smart city agenda.
- 2) Effective urban climate resilience building using citizen engagement, requires changes and improvements to structures and processes supporting both citizen engagement and climate considerations, which in turn can be achieved using open data solutions such as clear digital communication channels between citizens and the smart city; categorized and well maintained open access databases; proper data

## Conclusions

privacy and security measures; regional experimentations engaging diverse actors and enabling reflexive and transparent discussion; and workshops and crowdsourcing, where citizens are engaged at an early stage.

According to Wamsler et al. (2020), the current conditions, structures and processes for mainstreaming climate resilience and nature-based solutions into urban sectoral planning remain lacking, and that citizen engagement under these conditions often hinders sustainability outcomes. The theoretical contribution this study provides is a glimpse into possible avenues that could be undertaken to improve these current conditions into ones that can effectively and meaningfully tap into the potential of citizen engagement through open data in urban climate resilience initiatives and nature-based solutions. This thesis builds on previous literature on climate resilience, open data, and citizen engagement, and fills the gap that exists on the topic of improving conditions for more effective climate resilience outcomes by using open data solutions for citizen engagement.

## 6.2 Practical implications

The practical implications of this study suggest that the current conditions and structures for tapping into the potential of citizen engagement and participation in climate resilience building could be improved by focusing on strengthening the connection between citizens and the city with official communication channels, as well as investing in data management and storage. Of course, these changes alone require significant financial investment and structural change in policies and governance, as well as rethinking the processes of urban planning, which are no small tasks. However, many of these changes are already underway, and solutions combining climate resilience, citizen engagement and open data already exist, but are largely in their early days as of yet. The potential is there, but it is currently untapped (Wamsler et al., 2020).

In regards to the FinEst Twins initiative, the structural changes for building climate resilience by enhancing citizen engagement with open data are transferable to Tallin via the urban OS. Tallin and Helsinki are geographically close to each other, meaning that many of the climate resilience solutions in adaptable urban development can also be replicated in Tallin. Furthermore, the communication channels between the city and its citizens can be broadened further to include the communication channels between Helsinki and Tallin using

## Conclusions

the urban OS. Participatory mapping initiatives can be experimentally piloted in Helsinki and the successful experiments can then be implemented in the city of Tallin, and vice versa. This would be ground-breaking in terms of knowledge sharing in a transnational climate resilience context. Additionally, this would help researchers and government officials in understanding if and why certain solutions work only in a certain city or region and why, enabling further improvement. Navigating a problem as complex and multifaceted as climate change requires international cooperation, and the FinEst Twins Centre of Excellence certainly offers a great preliminary opportunity for learning in the field of international cooperation in climate resilience building.

### **6.3 Limitations of the study**

The greatest limitations of this study lie in the methodological avenues chosen, as well as the general time constraints and measure of depth possible in a Master's thesis also limited the scope of the study. Furthermore, the sampling size of the semi-structured narrative interviews could also be seen as a limitation, but it also provides avenues for further research. Although the interview subjects were a diverse array of professionals from different sectors and of differing backgrounds, the number of interview subjects can also be seen as a limitation to the study.

### **6.4 Suggestions for further research**

For further research, this thesis would suggest the studying the effects of transnational participatory mapping from the climate adaptation and resilience perspectives, as well as empirical studies of the effects of official digital communication channels between governing institutions and citizens on climate resilience building. Furthermore, studying the difference between current adaptive urban planning and experimental co-creation in adaptive urban planning under favourable policy change could shed light on the true potential of climate resilience building through citizen engagement.

## 7 References

- Anttiroiko, A. (2016) City-as-a-Platform: The rise of participatory innovation platforms in Finnish cities, *Sustainability* 8, 922
- Baird, V. (1999) Green cities. *New Internationalist*, 313
- Bakici T, Almirall E, Wareham J. (2013) A smart city initiative, the case of Barcelona. *Journal of the Knowledge Economy*.
- BBC NEWS. (2004) Global warming “biggest threat”. *Science/Nature*.
- Berkes F. (2007) Understanding uncertainty and reducing vulnerability: Lessons from resilience thinking. *Natural Hazards*, 41, 283-295.
- Biesbroek G.; Klostermann J.; Termeer C.; Kabat P.; Biesbroek, R. (2013) On the nature of barriers to climate change adaptation. *Reg. Environ. Chang.* 13, 1119–1129.
- Bolívar M.; Meijer A. (2016) Governing the smart city: a review of the literature on smart urban governance. *International Review of Administrative Sciences* Vol. 82(2) 392-408.
- Casini, M. (2017) Green Technology for Smart Cities. *IOP Conf. Ser. Earth Environ. Sci.* 83, 12014.
- Chakraborty A.; Wilson B.; Sarraf S.; Jana A. (2015) Open data for informal settlements: Towards a user’s guide for urban managers and planners. *Journal of Urban Management*. Elsevier; 4(2): 74-91
- Chan, A. (2015) Connecting cities and their environments: Harnessing the water-energy-food nexus for sustainable urban development, *Change and Adaption in Socio-Ecological Systems*, 2: 103-105
- Chappin E.; van der Lei T. (2014) Adaptation of interconnected infrastructures to climate change: A socio-technical systems perspective. *Util. Policy* 31, 10–17.
- Chuev I.; Pachenko T.; Novikov V.; Konnova O.; Iraeva N.; Karabulatova I. (2016) Innovation and integrated structures of the innovations in modern Russia. *International Review of Management and Marketing*. 6(S1), 239-244
- Colding J.; Barthel S. (2017) An urban ecology critique on the “Smart City” model. *J. Clean. Prod.* 164, 95–101.
- Colding J.; Barthel S.; Sörqvist P. (2019) Wicked Problems of Smart Cities. *Smart Cities*, 2, 512–521.

## References

- Eriksson P. & Kovalainen A. (2008) *Qualitative Methods in Business Research: Research Design and Process*
- Fernández, C. G.; Peek, D. (2020) Smart and Sustainable? Positioning adaptation to climate change in the European smart city, *Smart Cities* 3, 511-526
- Graham S. (2002) Bridging urban digital divides: urban polarisation and information and communication technologies. *Urban Studies* 39(1), 33-56
- Griffinger, R. (2007) Smart cities: Ranking of European medium-sized cities, Centre of regional Science, Vienna
- Grimmelikhuijsen S, Meijer A. Safarov I. (2017) Utilization of open government data: A systematic literature review of types, conditions, effects and users. *Information Polity* 22, 1-24
- Gunderson L. & Holling C. (2002) *Panarchy: Understanding transformations in human and natural systems*. Washington, DC: Island Press
- Gurstein M. (2011) Open data: Empowering the empowered or effective data use for everyone? *First Monday*, 16(2)
- Harvey D. (1989) From managerialism to entrepreneurialism: the transformation in urban governance in late capitalism. *Geografiska Annale*, 71B(1), 3-17
- Hodgson G. (2006) What are institutions? *Journal of Economic Issues*, 40(1), 1-25.
- Hollands R. (2008) “Will the real smart city please stand up?”, *City* 12:3, 303 — 320
- Hossain MA, Dwivedi YK, Rana NP. (2016) State-of-the-art in open data research: Insights from existing literature and a research agenda. *Journal of Organizational Computing and Electronic Commerce*. 26(1-2): 14-40
- Höjer, M.; Wang, J. (2014) Smart Sustainable Cities: Definition and Challenges. In *ICT Innovations for Sustainability*, (Advances in Intelligent Systems and Computing 310), 2015 ed.; Hilty, L.M., Aebischer, B., Eds.; Springer International Publishing: Cham, Switzerland.
- Joss S.; Sengers F.; Schraven D.; Caprotti F.; Dayot Y. (2019) The Smart City as Global Discourse: Storylines and Critical Junctures across 27 Cities. *J. Urban Technol.* 26, 3–34.
- Lassinantti J, Bergvall-Kåreborn B, Ståhlbröst A. (2014) Shaping local open data initiatives: politics and implications. *Journal of Theoretical and Applied Electronic Commerce Research*, 9(2), 17-33

## References

- Layne K. & Lee J. (2001) Developing fully functional E-government: A four stage model, *Government Information Quarterly*, 18, 122-136
- Linders, D. (2013) Towards open development: Leveraging open data to improve the planning and coordination of international aid. *Government Information Quarterly*, 30(4), 426-434
- Makushkin S.; Kirillov A.; Novikov V.; Shaizhanov M.; Seidina M. (2016) Role of Inclusion “Smart City” Concept as a Factor in Improving the Socio-economic Performance of the Territory, *International Journal of Economics and Financial Issues*, 6(S1) 152-156.
- Meijer R, Conradie P, Choenni S. (2014) Reconciling contradictions of open data regarding transparency, privacy, security and trust. *Journal of Theoretical and Applied Electronic Commerce Research*. 9(3): 32-44.
- Moench M. & Tyler S. (2012) A framework for urban climate resilience, *Climate and Development*, 4:4, 311-326
- Moraci F.; Errigo M. F.; Fazia C.; Burgio G.; Foresta S. (2018) Making less vulnerable cities: Resilience as a new paradigm of smart planning, *Sustainability* 10, 755
- Moser C. & Satterthwaite D. (2010) Towards pro-poor adaptation to climate change in the urban centers of low- and middle-income countries. In R. Mearns & A. Norton (Eds.), *Social dimensions of climate change: Equity and vulnerability in a warming world*. Pp. 231-258. Washington, DC: World Bank.
- Paquet G. (2001) Smart communities. *LAC Carling Government’s Review*. 3(5), 28-30
- Pelling M. (2003) *The vulnerability of cities: Natural disasters and social resilience*. London: Earthscan.
- Power R, Robinson B, Rudd L, Reeson A. (2015) Scenario planning case studies using open government data, environmental software systems. 11<sup>th</sup> IFIP WG 511 International Symposium, ISESS; 448: 207-16
- Report of the World Commission on Environment and Development: Our Common Future: Towards Sustainable Development. (1987) A/42/427
- Satterthwaite D. Dodman D. & Bicknell J. (2009) Adapting cities to climate change: Understanding and addressing the development challenges. Pp. 359-383
- Soe, R. (2017). *FINEST Twins: platform for cross-border smart city solutions*. In *Proceedings of 18th Annual International Conference on Digital Government Research*, Staten Island, NY, USA, June 2017
- Sherbinin, A.; Schiller, A.; Pulsipher, A. (2007) The vulnerability of global cities to climate hazards, *International Institute for Environment and Development*, Vol 19(1): 39-64.



## References

- Söderström O.; Paasche T. & Klauser F. (2014) Smart cities as corporate storytelling, *City: analysis of urban trends, culture, theory, policy, action*, 18:3, 307-320,
- Townsend, A.; Lorimer, S. (2015) Digital Master Planning: An emerging strategic practice in global cities, Working paper #25, Marron Institute of Urban Management
- Twigg J. (2007) Characteristics of a disaster-resilient community: A guidance note.
- United Nations Environment Programme (UNEP). (2013) Cities and Buildings; UNEP-DTIE Sustainable Consumption and Production Branch: Paris, France.
- United Nations. (2008) People Matter Civic Engagement in Public Governance. World Public Sector Report 2008. New York
- Urry J. (2015) Climate Change and Society. In Michie J. & Cooper C. Why the Social Sciences Matter. Academy of Social Sciences. 3, 45-47
- Wamsler C.; Alkan-Olsson J.; Björn H.; Falck H.; Hanson H.; Oskarsson T.; Simonsson E.; Zelmerlow F. (2020) Beyond participation: when citizen engagement leads to undesirable outcomes for nature-based solutions and climate change adaptation. *Climatic Change* 158: 235-254



## Appendices

### Appendix A: Interview questions

1. Which of the following best describes your professional background? 1. Public sector, 2. Private sector, 3. Academia, 4. NGO sector
2. What does the term smart city mean to you? What aspects come to mind?
3. What do you think are the most important aspects of a successful smart city?
4. What does climate resilience look like to you? What comes to mind?
5. What do you think are the most important aspects of building climate resilience?
6. What do you think are the biggest challenges concerning citizen participation? How would you address these challenges?
7. Are you familiar with the term “open data”? What does that look like to you? -
8. How important do you think open data is in regards to smart city governance? Can you give me some examples of successful uses of open data?
9. What do you think would be the most effective ways of engaging citizens in decision making concerning smart cities?
10. How do you think climate resilience and sustainability can be improved in cities?
11. How do you see citizens’ role in building more climate resilient cities?

## Appendix B: Citizen engagement & climate resilience code co-occurrence

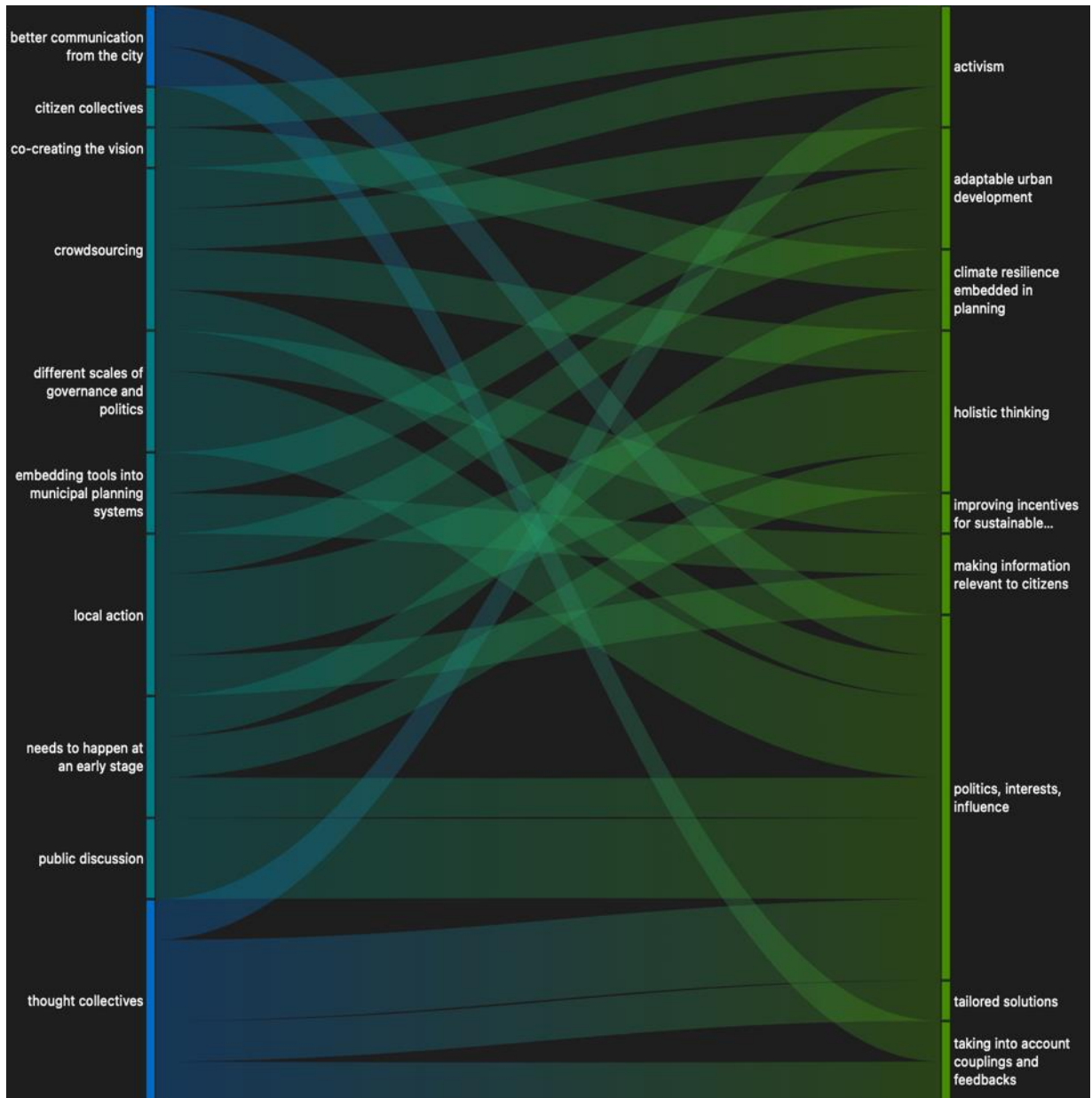


Figure A1: Citizen engagement and climate resilience code co-occurrence Sankey diagram

## Appendix C: Smart city sense making & most important smart city aspects code co-occurrence

Table A1: Smart city sense making and Most important smart city aspects code co-occurrence table

	data driven Gr=6	e-governance Gr=3	efficiency Gr=13	interconnectivity Gr=11	making life easier Gr=7	nature-based solutions Gr=8	new technologies Gr=6	privacy and security Gr=15	research based urban development Gr=2	smart technologies Gr=4	sustainability Gr=15	technology driven Gr=5	transparency Gr=3	trials and experiments Gr=5
carbon neutrality Gr=4	0	0	1	0	0	0	0	0	0	0	1	0	0	0
climate targets: ambitious in setting targets Gr=12	0	0	2	0	1	0	0	0	0	0	4	0	1	0
climate targets: mitigating carbon emissions Gr=8	0	0	1	0	0	0	0	0	0	0	3	0	0	0
climate targets: sustainable construction materials Gr=3	0	0	0	0	0	0	0	0	0	0	1	0	0	0
efficiency Gr=13	2	1	0	1	4	1	1	1	0	1	4	3	1	0
funding Gr=7	0	0	0	0	0	1	0	0	0	0	0	0	0	1
making life easier Gr=7	1	0	4	1	0	0	0	1	0	1	2	2	1	0
nature-based solutions Gr=8	0	0	1	0	0	0	1	0	0	0	1	0	0	0
placemaking Gr=3	0	0	0	0	1	0	0	0	0	0	0	0	0	0
privacy and security Gr=15	2	0	1	3	1	0	0	0	0	1	1	1	0	0
sustainability Gr=15	1	0	4	1	2	1	0	1	1	1	0	1	1	0
taking into account couplings and feedbacks Gr=11	0	0	0	0	0	1	1	0	0	0	0	0	0	0
transparency Gr=3	0	0	1	0	1	0	0	0	0	0	1	0	0	0