POLITECNICO DI TORINO

Architectural design in sustainable projects

Master's degree Thesis

Affordable living in the Smart City of Helsinki

The experiment of innovative solutions in Kalasatama Urban living lab

Academic year 2021-2022

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Acknowledgment

My sincere thanks go to Professor Mario Artuso for his patience, guidance, and support. I have benefited greatly from his wealth of knowledge.

Thank you to my very best friend, Hesam Alemi far, for always being there for me and his support and assistance in every step of this thesis.

Most importantly, I am grateful for my parent's unconditional and loving support during all these years which reaching this step wouldn't be possible without them.

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Abstract

The aim of this thesis is to gain a better understanding of how we can use the smart implementation in our cities in a way that rather than just digitalizing and reduction of carbon emission they also help us to cut back on living expenses and make future cities more livable for all people and give every citizen equal living quality. The main focus of this thesis is to find out about the most effective tools and methods to experiment with different innovative solutions and ways we can have better cities in the future and how we can try different solutions faster and waste less time on urban renovation, and how can we enhance citizens involvement in decision makings .these were main questions this thesis try to find an answer for them which to answer them in this paper we focused on Helsinki smart region and specifically Kalasatama region as a case study. Here you will find about the current situation of kalasatama and the methods they are using for implementing innovative methods in order to reach their periodic strategy which they publish every four years by Helsinki city municipality and the role of furom virium Helsinki firm. The data is gathered from academic articles published in scientific journals, academic reports, government reports and non-scientific articles and strategies published on online sources.

Keywords: Smart city, Open data, Agile piloting, Affordable living, Helsinki, Kalasatama, urban living lab

1-Introduction

The introduction describes the subject of the present paper and leads to the topic. Furthermore, problems, as well as objectives, are explained, and the methodology is described.

1-1- Background

Definitions and characteristics of smart cities vary, and promotional materials make disparate claims about the value and purpose of these new constructions. Common to most of them, however, is a reliance on ICTs as the foundation and definitive quality of smart cities. Frequently, smart cities are regarded as urban environments where ICTs are aggressively implemented to collect data to support, monitor, and improve urban infrastructures such as transportation, waste management, energy consumption, and emergency response (Halegoua, 2020).

The key narrative framework used to describe the need for smart cities is that cities need to be updated to house the world's future population. Plans and presentations about smart cities repeat the statistic that approximately 70% of the world's population will be living in cities by 2050 (Halegoua, 2020).

The Smart City Index ranks cities based on economic and technological data, as well as residents' perceptions of how smart their city is in its operations. In April-May 2020, hundreds of city-dwellers in the participating cities responded to a survey to assess their hometown in five key areas: health and safety, transportation, activities, opportunities, and governance. Helsinki has been ranked one of the top three smart cities in the world in the Smart City Index 2020, published on 17 September (hel.fi).

Smart Kalasatama, a brownfield district in Helsinki is a vivid Smart City experimental innovation platform to co-create smart&clean urban infrastructure and services. Smart Kalasatama is developed flexibly and through piloting, in close co-operation with 200 + stakeholders including residents, companies, city officials and researchers (fiksukalasatama.fi).

In 2020, European Federation for Living (EFL) hosted a competition in order to push the limits of creativity and to bring innovative ideas for sustainable urban communities. Along with partners LiM - Living in Metropolises, and Village Co-Living we invite student teams around Europe to design a concept for a real site in Helsinki, within a newly developing smart-city district.

Nowadays, "smart city" is the dominant paradigm in urban development. As it is said before, Helsinki is a leading smart city and Kalasatama is the testbed for Helsinki to accelerate the experiment of new ideas. The competition was the main motivation of this research. Kalasatama will experience the population growth in future, and it is a chance to develop affordable housing in Helsinki by using smart city advantages and based on ICT technologies.

1-2- Research question

The main question which is tried to find an answer for in this dissertation is finding the relation between smart city and the opportunities it can provide for people to have an easier and more affordable more sustainable life. and how making a city smart can reduce the cost of living in general such is energy, transport, and housing expenses. The research aim is to find policies that can allow new proposals and innovative solutions to get into action and how a smart city can provide a base for organizations and start-ups to test their ideas in order to reach to smart city goals faster and more efficiently.

1-3- Methodology

This thesis is descriptive-analytical research which is based on library studies. In other words, methodology of this dissertation has been carried out by scientifical research by studying articles, books and reading conference reports. A systematic approach has been chosen in order to provide an answer to this dissertation's question, dividing the into three main part , in which I will first explain about the general concept of smart city and its different means of accelerating innovative ideas and the relation between smart city, government and citizens and then the second part will be begin by explaining about Helsinki ,Capital of Finland and about reasons which makes it one of the leading smart cities in recent years and about the process and policy the Helsinki city decision maker have in order to implement and take in to experiment new ideas and how they are enhancing the citizens engagement in the process of making their cities reaching its strategic goals each four year and in the third part I chose Kalasatama , which is an urban living lab, former

industrial zone of Helsinki , and the technologies and policies implemented in this urban zone that makes it to provide Helsinki and Finland in general to implement and experiments innovative solutions such as smart waste management, robot delivery system and smart transportation into practice and the process of selecting and investing in each of this projects with involvement of the stakeholders in the experiment in detail and then at the end in the conclusion I explained how smart cities can save money for both government and city organizations and its inhabitants considering the general information in chapter 4 and 5 about affordable living and the case studies in affordable living innovative solutions.

2-Smart City

2-1- Smart City Definition and literature review

Although the notion of smart cities has gotten a lot of press in the last few years, it is still mostly unexplored (Angelidou 2014, S9; Touminen, 2018). Furthermore, because numerous phrases are frequently used interchangeably, there is a lot of misunderstanding about smart cities and what they are (Albino et al. 2015, 3; Touminen, 2018).

The United Nations (UN) General Assembly approved 17 essential sustainable development goals to be achieved by 2030 in 2015. These include everything from poverty alleviation to universal education, gender equality, and climate action. Goal 11 aims to achieve sustainable cities and communities since the world's urban population is expected to grow by 1.5 billion people by 2030 (to a total of 5 billion), putting pressure on resources, infrastructure, jobs, and healthcare (United Nations 2018). The United Nations (UN) has determined that we must employ innovative techniques to deal with these developments. On the one hand, there is a need to decrease environmental harm, pollution, and unfairness; on the other hand, there is a need to increase safe and cheap housing, improve infrastructure, and provide people with safe cities to live in (United Nations 2018). As a result, a variety of techniques to ensure sustainable cities have been offered, including the 'Smart City' notion (Mark & Anya, 2019).

The term "smart city" was coined in 2008, and it "is defined by real-time, interactive, and intelligent systems" (Li, Cao, and Yao 2015, p. 2). A smart city is one whose economy and governance are fueled by innovation, creativity, and entrepreneurship, all of which are carried out by clever people (Kitchin 2014, p. 2). There have been many various definitions of the smart city, but it is often based on a desire to improve the lives of city people via technology innovation. Smart information systems (AI and Big Data) and other emerging technologies have the potential to help us build more sustainable cities (Kitchin 2013; Kitchin 2014). However, it is critical that technology and data are introduced in an appropriate manner (Mark & Anya, 2019).

One of the common threads running across smart city definitions is a major emphasis on the adaptation and integration of technology inside cities, which has revolutionized how they operate in practice. While not all definitions of a smart city correspond to the popular acceptance and assimilation of technological development, technology plays a significant part in the majority of smart city definitions (Mark & Anya, 2019):

"The term Smart City is a broad term that refers to the smart management of the cities socio-economic and environmental capital through the use of Information and Communication Technologies. These technological solutions are said to be smart as they provide ways to enable social, cultural, and urban development, improving social and political capacities and/or efficiency (Vázquez-Salceda et al. 2014, p. IS-7; Mark & Anya, 2019)

In addition to conceptual diversity, the practical execution of smart city initiatives and strategies shows great variability in terms of the many disciplines involved. Cities, as governing entities, are implementing their own smart projects in a variety of methods, adding to the smart city phenomenon's diversity and relative obscurity. (Dameri, 2016,3; Touminen, 2018)

As can be seen from the many labels and descriptions, there is a propensity to categorize cities based on characteristics that indicate a preference for certain attributes. In other words, a city is seen as more than just a geographical location or a level of government. A city can be described by its attitude to its relationship with something as ethereal as creativity, intellect, or knowledge, or something more concrete like digital infrastructure, according to the labels (Touminen, 2018).

The majority of smart city scholars, politicians, and citizens highlight the critical role that technology will play in urban areas, notably the widespread adoption and usage of the Internet of Things (IoT), Artificial Intelligence (AI), Big Data, and ICT infrastructure (Nigon et al. 2016; Mark & Anya, 2019).

2-2- Characteristics of a Smart City

There has been considerable discussion over what characteristics are representative of a smart city, just as there has been some uncertainty about smart city definitions. (Albino et al. 2015, 13) found four most used characteristics in their research into the literature focusing on main dimensions and elements characterizing smart cities (Touminen, 2018).

First: "city's networked infrastructure enabling political efficiency as well as social and cultural development.
Second: an emphasis on business-led urban development and creative activities promoting urban growth.
Third: social inclusion of various citizens and social capital in urban development.
Fourth: the perception of the natural environment as a strategic component for the future. "(Albino et al. 2015, 13; Touminen, 2018)

Similarly, Caragliu et al. (2011, 68) summarize that, cities are characterized as smart when they use networked infrastructure as the main development model and connectivity as the source of growth, and emphasize business-oriented urban development, based on their overview of the smart city concept as well as the planning and economics approaches related to it (Touminen,2018).Smart city growth is said to be dependent on ICT infrastructure, data, and information management.

According to Schaffers et al. (2011, 435), smart cities must first develop a rich ecosystem of broadband networks that enable digital applications in order to become smart. This comprises the creation of appropriate ICT infrastructure as well as the addition of embedded systems, smart devices, actuators, and sensors that provide real-time data and information processing to cities' physical spaces and infrastructures (Touminen,2018).

Another distinguishing feature of many self-declared smart cities is their focus on business-led urban development (Hollands 2008, 308). According to Schaffers et al. (2011, 436), municipal officials who want to make their city smart must first develop an atmosphere conducive to long-term smart city operations (Touminen,2018).

However, because governmental investment is typically restricted and hence ineffectual, private capital investment and business-led urban development are frequently viewed as critical aspects in smart city development and urban growth (Kraus et al. 2015, 602; Touminen,2018). According to Kitchin (2014, 10), the strong presence of large corporations in the implementation of smart city agendas may result in corporatization of city governance and technological lock-in, as some companies increasingly view cities, their governance, and infrastructure as homogeneous, long-term markets for their cookie-cutter products and solutions (Touminen,2018). Smart cities are frequently expected to include residents in public services and have open governance structures that allow citizen participation, in addition to offering favorable circumstances for enterprises (Touminen,2018). By bringing smart city initiatives to citizens and keeping both the decision-making and implementation processes transparent through ICT mediated e-governance, smart citizen-centric, and citizen-driven governance is expected to engage various stakeholders in decision-making and public service processes (Albino et al. 2015, 12). Furthermore, smart cities should launch large-scale participatory innovation processes for the construction of apps that operate and improve every area of activity, infrastructure, and urban cluster, according to Schaffers et al. (2011, 435). According to this perspective, every urban activity and utility may be viewed as an innovation ecosystem in which enterprises and individuals collaborate on product creation, supply, and consumption. However, according to Kraus et al. (2015, 607), most businesses do not see citizen participation as a critical component of smart city development. Citizens were primarily viewed as customers, and their influence on the development of new smart solutions was undervalued (Touminen,2018).

Finally, as the population living in cities is more than half of the whole world's population; there is a greater feeling of urgency to put local and global policies in place to address climate change and ecological degradation, which is mostly due to human interventions (Srivastava et al. 2012, 146.).As a result, social and environmental sustainability is frequently cited as one of the primary goals of smart cities, which are anticipated to address resource limitations and focus on developing long-term solutions to urban problems (Kraus et al. 2015, 604; Touminen,2018).

It is, indeed, impossible to evaluate the stability and relative weight of the various traits based on existing research. It's also uncertain if a city can be or become smart by focusing solely on some qualities and attributes while neglecting others. Similarly, it's uncertain if a city's smartness is the result of a stage-based or continuous growth process. Strategic planning for smart city development has remained a somewhat

abstract topic with unexplored and multidisciplinary domains, maybe due to this sort of obscurity (Angelidou 2014, S3; Touminen,2018).

Figure 1 Commonly used characteristics to describe smart cities (Touminen,2018).by Author

2-3- Smart city's Conceptual Framework

Chaurobi et al. (2012) provide an integrated conceptual framework (Figure 2) with a comprehensive collection of characteristics that are crucial to understanding the notion of smart cities, which is the product of an intensive assessment of literature from several academic fields.According to Esquivel Duran (2020); This framework is made up of eight main elements "that may be used to describe how to conceive a smart city and create activities."

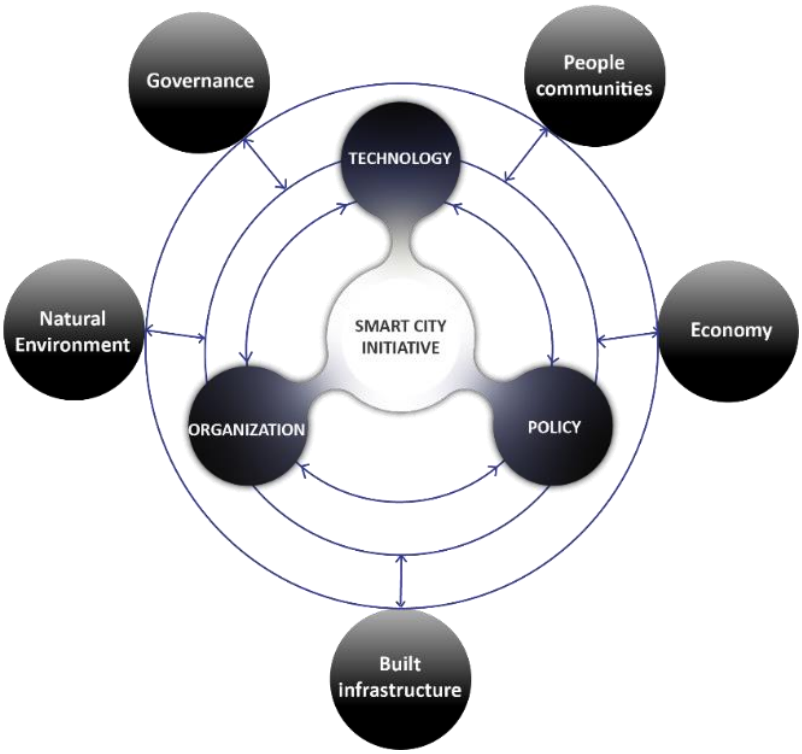


Figure 2 . Smart City Framework: 8 core components by Chaurobi et al. (2012); Esquivel Duran (2020); Author

1. "Management and organization,
2. technology,
3. governance,
4. policy,
5. people and communities,
6. the economy,
7. built infrastructure, and
8. the natural environment makes up the eight basic components "(Esquivel Duran, 2020).

Management and organization: A robust structure, alignment of organizational objectives and projects, identification of essential players, end-user participation, and inventive finance are all needed for a smart city project to thrive (Esquivel Duran, 2020).

Technology: A smart city uses smart technology to manage infrastructure and services in real-time, allowing cities to make better-informed decisions and improve municipal administration and functioning (Esquivel Duran, 2020).

Governance: is defined as a smart cooperation among many stakeholders, the presence of leadership, citizen involvement, and private/public partnerships that work together to support local governing operations while ensuring openness and accountability (Esquivel Duran, 2020).

Policy context: To implement the required policy changes, the transition to a smart city necessitates institutional preparedness to eliminate barriers. It also necessitates cooperation between political and institutional components, such as the city council, city mayor, and policy agendas (Esquivel Duran, 2020).

Economy: Economic growth is a vital indicator of a smart city; it may be seen in business and job creation, workforce development, and productivity gains (Esquivel Duran, 2020).

Built infrastructure: A smart city must have a solid, high-performance ICT infrastructure, including wireless infrastructure and service-oriented information systems, in order to flourish. It should also consider security and privacy (Esquivel Duran, 2020).
Natural environment: enhancing the city's sustainability and better managing its natural resources is one of the main drives of a smart city project. It also aspires to mitigate climate change and create a brighter future for its citizens (Esquivel Duran, 2020).
People and communities: Because smart city initiatives will have an influence on people's quality of life, they should attempt to promote more informed, educated, and participating citizens. It is also necessary to enable people to engage in decision-making and become active participants in municipal management (Esquivel Duran, 2020).

This framework describes the most critical criteria that are currently deemed necessary for smart cities to prosper, as well as a guide to determining where smart cities need to improve or spend more resources (Esquivel Duran, 2020).

Another issue that smart cities confront is the rapid development and implementation of technology as part of their plan, which is outpacing the state's ability to create public rules to control them (Esquivel Duran, 2020).

Furthermore, the massive amounts of data that smart cities collect need ever-increasing resources to store, analyze, and safeguard it, putting the smart city's infrastructure and resources to the test (van Zoonen, 2016; Esquivel Duran, 2020).

The sensitive nature of the data collected in a smart city for various purposes such as city maintenance, mobility, air and water quality, energy usage, visitor movements, and neighborhood sentiment requires stronger oversight mechanisms to ensure ethical data use and protect citizens' personal information (van Zoonen, 2016; Esquivel Duran, 2020).

2-4- The role of citizens in a smart city

Several other authors emphasize the importance of making people central to smart cities and engaging them in planning—whether as co-creators or evaluators—and mention that this matter "traditionally has been neglected at the expense of understanding more technological and policy aspects of smart cities." Chourabi et al (2016) identify citizens as a core component of smart cities and mention that this matter "traditionally has been neglected at the expense of understanding more technological and policy aspects of smart cities." (Esquivel Duran, 2020).

Furthermore, Batty et al. (2012) argue that smart cities should be made up of a smart community,' which is defined as a group of people who actively engage in the city's planning and design. Citizens are currently involved to some extent by being informed of decisions and measures implemented in their neighborhood area, but they do not play an active role in the creation of a smart city, which, according to Batty et al., could be informed using data and scenarios, all of which could be facilitated by smart technologies (Esquivel Duran, 2020).

There are two reasons for the urgency and importance of enabling civic participation: first, because it takes place in the public domain (the smart city infrastructure), citizens must be informed about whatever project they are participating in - whether passively or actively - and how it benefits them. The second reason, which is as essential, is that because we are all part of this infrastructure, each citizen produces a great quantity of data over which they should have more control and be able to explain who is using it and how it is being used (Batty et al., 2012; Esquivel Duran, 2020)

In conclusion, the citizen's perspective is critical in the development of a fair, transparent, and responsible smart city; as Papa et al (2013) point out, a smart city is "about being able to function as an integral part of a larger system that also considers participation, human capital, education, and learning in urban development"—"it is about being able to function as an integral part of a larger system that also regards participation, human capital, education, and learning in urban development." (Esquivel Duran, 2020).

2-5- Factors Affecting Smart City Development

Despite the rising interest in smart cities and over three decades of literature on the subject, research has yet to fully explain what has to be done for urban settings to be effective when creating and executing smart city development plans. Mora et al. (2018a, 2018b) found that there are five primary development trajectories for smart cities, which overlap and create confusion about how to cope with smart city development in real-world situations. These paths reveal divergent strategic principles, making it difficult to determine whether smart city development should be approached through a (Mora et al., 2019).:

1. " Technology-led or holistic strategy.
2. Double or quadruple-helix model of collaboration.
3. Top-down or bottom-up approach; or
4. Mono-dimensional or integrated intervention logic." (Mora et al., 2019).

In May 2016, the European Union's Urban Affairs Ministers agreed to create an Urban Agenda for European Member States that promotes a new model of urban development and contributes to the implementation of both the United Nations' 2030 Agenda for Sustainable Development and the Habitat III Secretariat's New Urban Agenda. These three international policy statements all emphasize the critical importance of sustainable urban development in boosting global economic success, social and territorial cohesion, and welfare. They also see smart city development as an important element of the urban development process, with smart technologies that can help cities become safer, more inclusive, resilient, and long-lasting (European Commission,2016b; United Nations, 2015, 2017; Mora et al., 2019).

Smart city development has the ability to enable revolutionary changes in society by assisting cities in addressing the increasingly complex difficulties they are now experiencing, according to the UN's strategy paper on urban services and technology. However, this policy paper recognizes that there is a knowledge vacuum in terms of how cities may support such growth and, as a result, urges for a stronger theoretical and practical understanding that present smart city research lacks (United Nations, 2016; Mora et al., 2019).

The ambiguity created by Mora et al. (2017, 2018a, 2018b) and Komninos and Mora (2018) in their studies creates a fundamental challenge that must be addressed before it is possible to clearly articulate what needs to be done in order, for urban environments to be successful in enabling smart city development (Mora et al., 2019). The deductive multi-case study analysis discuss about strategic principles for smart cities of Helsinki, Amsterdam, Barcelona, and Vienna helps to meet this challenge in European countries. The question of how best to address the dichotomous nature of smart city research and enable ICT-related development and innovation in urban environments is a major challenge which This paper reports on how those four European cities have tackled this challenge by examining the design and implementation of their smart city development strategies (Mora et al., 2019).The Aim of this study is to build a set of strategic guidelines that will guide European cities in developing and implementing such strategies (Mora et al., 2019).the results of this analysis are summarized in fig 6 in this article as shown below in order to demonstrates how Amsterdam, Barcelona, Helsinki, and Vienna made decisions that allowed them to successfully handle the dichotomous nature of smart city research and enable ICT-related development and innovation in urban contexts (Mora et al., 2019).

Dichotomies	Strategic principles	Best practices' choice
Dichotomy 1 Technology-led or holistic strategy	**Hypothesis 1.1** Technology-led strategy **Hypothesis 1.2** Holistic strategy	Assembled a smart city development strategy based on a holistic vision of smart cities
Dichotomy 2 Double or quadruple-helix model of collaboration	**Hypothesis 2.1** Double-helix model of collaboration **Hypothesis 2.2** Quadruple-helix model of collaboration	Exploited the triple-helix model of collaboration and made efforts to move towards a quadruple-helix collaborative ecosystem
Dichotomy 3 Top-down or Bottom-up approach	**Hypothesis 3.1** Top-Down approach **Hypothesis 3.2** Bottom-up approach	Combined top-down and bottom-up approaches
Dichotomy 4 Mono-dimensional or integrated intervention logic	**Hypothesis 4.1** Mono-dimensional intervention logic **Hypothesis 4.2** Integrated intervention logic	Adopted an integrated intervention logic

Table 1. Dichotomies and divergent strategic principles: the best practices' choices. (Mora et al., 2019; author)

"Strategic principle 1: look beyond technology
Strategic principle 2: move towards a quadruple-helix collaborative model
Strategic principle 3: combine top-down (government-led) and bottom-up (community-driven)
Strategic principle 4: build a strategic framework
Strategic principle 5: boost the digital transformation by establishing a smart city accelerator
Strategic principle 6: adopt an integrated intervention logic" (Mora et al., 2019).

These strategic principles are proposed based on multiple case study analyses done by Mora, Deakin, and Reid; based on this article, these strategies should take into consideration for European cities toward successfully developing, designing, and smart city development (Mora et al., 2019).

2-6- The role of Bigdata in Smart Cities

In today's world, all digital devices connected to the Internet generate a large amount of data. And with computational power, all of this was converted into knowledge. With this insight, we can enhance efficiency, productivity, and quality while also lowering expenses and reducing waste (BĂTĂGAN, 2012).

Figure 3. The importance of data in the future societies

Because today's development depends on the production of information and innovation, it's more necessary than ever to effectively use our society's vast amounts of data (Figure 1) (BĂTĂGAN, 2012).

Open Data is a notion that emphasizes the idea that some data can be used and republished by anyone without constraints imposed by copyright or other control mechanisms. Open data opens us new avenues for analyzing and visualizing data from many sources. Open data has the potential to improve the world, and

this is a fact because the information is a critical component of innovation. The public sector generates the vast majority of the data in our world. In the Visby Declaration (presidency of the European Council, 2009), the European Council said that European Union (EU) member states should make data freely accessible to everybody and encourage the re-use of public sector information using open data (BĂTĂGAN, 2012).

In the European eGovernment Action Plan 2011-2015, the European Commission and EU member states committed to "maximizing the value of re-use of public sector information (PSI) by making raw data and documents available for re-use in a wide variety of formats (including machine-readable formats) and languages, and by establishing PSI portals." This emphasizes the need to utilize open data in many aspects of our cities (BĂTĂGAN, 2012).

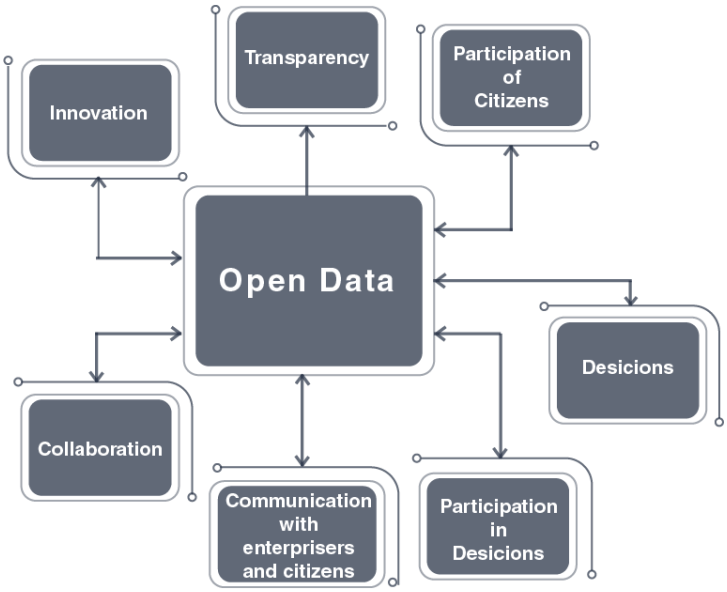


Figure 4. Open Data Benefits, by author

"Cities create a lot of important data," says Tuomo Haukkovaara, General Manager of IBM Finland, "and the city as a whole must work actively to make that data available." Open data has the potential to make the world a better place, and this is a genuine possibility in our culture because information is a critical force in a knowledge society. Information is an extremely valuable resource. It is a "public good" in the sense that the consumption of knowledge by one person does not limit the availability of information for others. Governments are in a great position to invest in innovation by supporting accessible government data since they are a large producer of information. Open Data is generally viewed as a critical component of open government, a larger concept that examines how governments and individuals interact to give public services to society (BĂTĂGAN, 2012). The efficient utilization of large amounts of data through smart solutions is the primary objective for future cities. Today's world is increasingly linked, and sophisticated, and Data is at the center of it all, as everyone attempts to make the most of it. In today's world, data availability and processing are essential for progress. We may say that today's evolution is founded on the production of information and innovation; thus, it's more vital than ever to make effective use of our society's vast amounts of data (BĂTĂGAN, 2012).

The growth of big data and the development of Internet of Things (IoT) technology have aided the viability of smart city efforts. The IoT allows the integration of sensors, radio-frequency identification, and Bluetooth in the real-world environment by utilizing highly networked services. Big data offers the opportunity for cities to get essential insights from a significant quantity of data collected from multiple sources (Hashemet al., 2016). The intersection of IoT and Big Data is a new study topic that has presented new and exciting problems in pursuing future smart city goals. These new difficulties are primarily focused on business and technical issues that enable cities to realize the vision, principles, and needs of smart city

applications by achieving the critical features of smart environments. The state-of-the-art communication technologies and smart-based applications utilized in the framework of smart cities are described in this study. Big data analytics visions for smart cities are presented, emphasizing how big data may radically impact urban populations at many levels (Hashemet al., 2016). Furthermore, a future big data business model for smart cities and the commercial and technological research difficulties are offered. This research may be used as a benchmark for researchers and businesses for future smart city improvement and development in the context of big data (Hashemet al., 2016).

Big data for smart cities has the potential to alter every aspect of a country's economy (Batty, 2013). By fulfilling the primary smart environment features, cities can realize smart city applications' learning principles and needs. Sustainability, resilience, governance, enhanced quality of life, and intelligent management of natural resources and municipal amenities are among these features (Al Nuaimi, Al Neyadi, Mohamed, & Al-Jaroodi, 2015). Emerging technologies, such as wireless sensor networks (WSN), are used in smart cities to cut costs and resource use (Hashemet al., 2016).

Big data analytics in the smart environment, on the other hand, is still in its infancy. Big data analytics is one of the developing technologies with much potential for improving smart city services (Al Nuaimi et al., 2015). Different data sources, such as smartphones, computers, sensors, cameras, global positioning systems, social networking sites, commercial transactions, and games, are generating vast amounts of data. Because the amount of data created in today's digital world is constantly increasing, traditional data mining and analytics systems have had to deal with new issues. (Yaqoob, Chang, Gani, Mokhtar, & Abaker, et al., 2016). Big data analytics can extract valuable information from the seas of data created by sensor devices. Practical analysis and usage of Big Data is a vital determinant for success in many commercial and service fields, including the smart city application. The availability of substantial computational and storage facilities to handle data streams created inside a smart city setting is one of the many benefits and problems of using big data in a smart city. Reliance on cloud computing services and IoT technology is one way to tap into this value (Hashemet al., 2016).

The Internet of Things (IoT) enables a structure for sensors and actuator devices to connect with one another in a smart city context, allowing for more convenient information exchange across platforms (Gubbi et al., 2013; Hashemet al., 2016).

The smart city focuses on incorporating next-generation information technology into all aspects of life, including hospitals, power grids, railways, bridges, tunnels, roads, buildings, water systems, dams, oil and gas pipelines, and other objects around the world, resulting in the Internet of Things (IoT) (Su, Li, Fu, Ieee, 2011; Hashemet al., 2016).

The interconnectedness of sensing and actuating devices is emphasized in the smart city, allowing information to be shared across platforms with the use of a single framework. Such sharing is enabled by cloud computing, which serves as a unified foundation for omnipresent sensing, data analytics, and information representation. The post-PC age is here, and smartphones and other mobile gadgets transform our environment by making it more interactive and informational (Gubbi et al., 2013; Hashemet al., 2016).

In smart cities, extensive data systems are adequately stored, processed, and mined to create information to enhance various smart city services. Big data may indeed assist decision-makers in planning for any prospective development of smart city services, resources, or locations. Big data's numerous properties highlight its vast potential for gains and improvements. The possibilities are limitless, but the availability of modern technology and equipment limits them. With the correct tools and methodologies for efficient and effective data analysis, big data can fulfill its aims and develop smart city services (Hashemet al., 2016).

Such efficiency will foster collaboration and communication among institutions and the development of new services and apps that will improve the smart city. Big data applications may benefit a wide range of industries in a smart city, resulting in improved consumer experiences and services and enhanced corporate performance (e.g., higher profits or increased market shares). Preventive care services, diagnostic and treatment tools, healthcare record management, and patient care are all aspects that might be improved.

Big data helps transportation networks optimize routes and timetables, handle changing demand, and become much more environmentally friendly (Hashemet al., 2016).

Most big data applications for smart cities require smart networks to link all of its components, including citizens' equipment such as vehicles, smart home gadgets, and smartphones. This network should be capable of accurately transmitting data from various sources to locations where big Data is gathered, stored, and processed, as well as delivering replies back to the many organizations in the smart city that requires them (Al Ni). Network support for quality of service (QoS) is critical for real-time big data applications in smart cities. All current dispersed application events should be sent in real-time to where they may be processed in these apps. These events can be transmitted as raw events, filtered events, or aggregated events from their sources (Hashemet al., 2016).

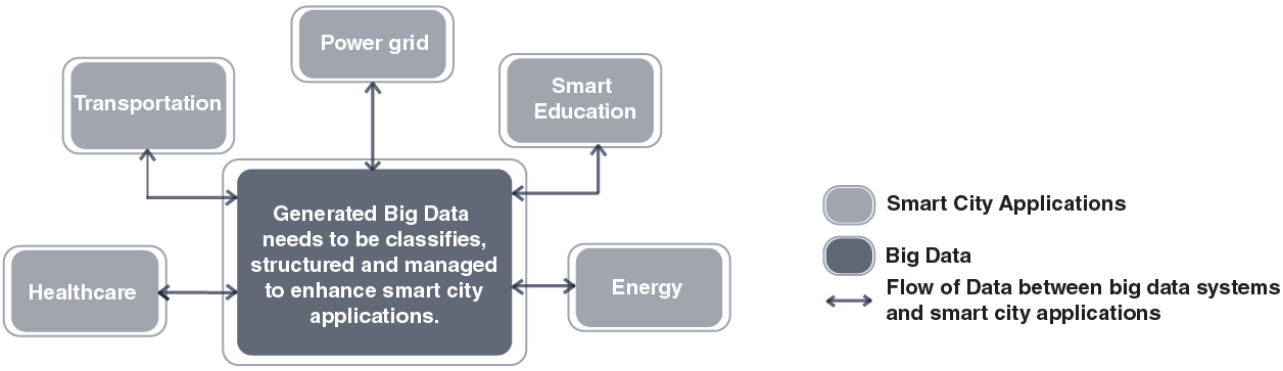


Figure 5. Smart City and Big Data relationship by author

The use of big data technology in the smart city allows for adequate data storage and processing, resulting in information that can be used to improve a variety of smart city services. Big data also aid decision-makers in planning for any future development of smart city services and resources. Big data requires the correct tools and methods for efficient and effective data analysis to fulfill its aims and enhance services in smart cities. These technologies and strategies may improve consumer experiences and commercial prospects by encouraging collaboration and communication across entities and providing services to numerous sectors in the smart city. Smart grid, smart healthcare, smart transportation, smart governance are examples of different smart city applications (Hashemet al., 2016).

Big data applications are used in smart cities, as seen in Figure 2. Smart city apps generate massive volumes of data, which big data systems then use to improve smart city applications (al Nuaimi et al., 2015). Big data systems will efficiently store, process, and mine information from smart city apps in order to generate data that will improve various smart city services. Big data will also aid decision-makers in planning for any future growth of smart city services, resources, or locations (al Nuaimi et al., 2015).

2-7- IoT Technology

The knowledge of the Internet of Things is made up of an ever-increasing number of items that are being linked to the Internet at an incredible rate (IoT). According to CISCO, the number of items linked to the Internet surpassed the number of people on the planet in 2008, and by 2020, it will reach the limit of 50 billion, enriching the digital world. There is another area where IoT plays an important role and enhances human life quality. Capillary devices are now being used in IoT for health applications (Rathore et al., 2016). Similarly, there are many other areas where IoT makes a significant difference in people's lives, such as healthcare, automation, transportation, and emergency responses to man-made and natural disasters, where making judgments is challenging. Embedded systems and billions of smart gadgets will be part of the internet of things. As a result, the Internet of Things (IoT) will grow in scale and breadth, presenting both new possibilities and difficulties. After achieving the intangible stage of service level, the majority of nations developed long-term national policies for IoT deployment (Rathore et al., 2016).

The Internet of Things (IoT) is seen as the Internet's next game-changer. As a result, the notion of smart homes emerges, in which various electronic equipment are integrated to provide high-quality two-way

interactive multimedia services. A significant volume of data (known as Big Data) is created in a system where a big number of devices communicate with one another. Better Big Data analytics might play a critical role in the progress of Information and Communications Technologies by enriching smart home technologies (ICTs). This sort of Big Data analysis gives us a piece of better knowledge and helpful information about the future, as well as planning and development, and thus gives us Big Data insight (Rathore et al., 2016).

By 2050, cities and surrounding regions will house 70% of the world's population (more than six billion people). With such a large population, billions of gadgets will communicate with one another, resulting in vast amounts of Big Data. Cities would grow increasingly smarter as a result of evaluating data based on consumer demands and preferences. As a result, the IoT has progressed from its early phases and is now entering the period of changing existing network infrastructure into a fully connected future with the Internet, thanks to a variety of supporting technologies and data analytics. The Wireless Sensor Network (WSN) and related technologies are seamlessly integrated into urban infrastructure, resulting in the creation of a digital skin. The huge amounts of data created by embedded and ubiquitous devices will be exchanged across a variety of platforms and apps to improve cities and predict planning and development (Rathore et al., 2016).

The main notion of the smart city is to collect the correct information at the right time and on the right device to make city-related decisions swiftly and assist inhabitants. We make real-time decisions based on real-time data in a smart city. We leverage earlier historical data gathered from the same smart city's IoT devices to prepare for the future in urban planning. For example, by examining prior years' power use, we may forecast demand for the coming year and take the required steps to meet it (Rathore et al., 2016).

2-7-1- The role of IoT in Smart City

The term "internet of things" dates back over a century, and it was used by Nikola Tesla in a 1926 interview when he discussed wireless communication. Professor K. Ashton invented the phrase during a presentation at Procter & Gamble in 1999, but it is only lately that IoT, or the interconnection of physical objects with integrated sensing and communication capabilities, has been utilized in the context of smart cities (Ashton, 2009). The use of network infrastructures to increase general efficiency and facilitate economic and political development in social, cultural, and urban areas is central to the idea of a "smart city" (Ianuale et al., 2015). A smart city is a complex ecosystem defined by extensive use of information and communication technology (ICT) with the goal of making cities more appealing, sustainable, and unique environments for innovation and entrepreneurship. Application developers, service providers, citizens, government and public service providers, the research community, platform developers, and others are among the primary stakeholders (Mehmood et al., 2017). IoT will have an impact on several elements of inhabitants' lives in smart cities, including health, security, and transportation. On the other hand, it may play a significant role at the national level in terms of policy choices (such as energy conservation, pollution reduction, and so on), remote monitoring, and essential infrastructure, among other things (Arasteh et al., 2016). However, despite its benefits, the Internet of Things is still expanding and experiencing several hurdles. As a result, the next section lists the major obstacles to the development of IoT-based smart cities (Janssen et al., 2019).

2-8- Digital Twin technology

As mentioned above in the last two decades, cities have become significantly smarter (Albino et al., 2013), utilizing pervasive information and communications technology (ICT) to monitor city operations (Neirotti et al., 2014; White et al., 2021).

The advancement of modern technologies is paving the way for smart cities, in which all physical things will have embedded computer and communication capabilities, allowing them to detect their surroundings and connect with one another to deliver services. IoT or machine-to-machine (M2M) communications are other terms for these intelligent linkages and interoperability (Farsi et al., 2019).

Data may then be gathered from several city operations, including traffic and transportation (Menouar et al., 2017; White et al., 2021), electricity generation (Oldenbroek et al., 2017), utilities providing (S'anchez et al., 2013; White et al., 2021), water supply (Parra et al., 2015), and garbage management (Menouar and al., 2017; White et al., 2021). (Medvedev et al., 2015; White et al., 2021). The data may subsequently be used by smart cities to improve mobility, the environment, living standards, and government (Abella et al., 2017; Angelidou, 2015; White et al., 2021).

Digital twins, the Internet of Things (IoT), block chains, and artificial intelligence (AI) may reshape our understanding of globalization in the future. Digital Twin will most certainly have an impact on most businesses throughout the world since it replicates the physical model for remote monitoring, viewing, and control in a digital version. It is a live model of a physical system that adjusts to operational changes based on real-time data from various IoT sensors and devices and anticipates the future of the physical equivalents using machine learning/artificial intelligence (Farsi et al., 2019).

Smart cities are intriguing testbeds for data mining and machine learning because of the data they create (Mohammadi & Al-Fuqaha, 2018; White & Clarke, 2020). Machine learning, the internet of things, and big data may be used to personalize the services supplied to people in a smart city (Chin et al., 2017; White, Palade, et al., 2019). These deep learning algorithms may be used in a variety of data streams, including videos, to categorize and conduct analytics (Wang & Sng, n.d.; White et al., 2021). In a smart city, more contemporary neural network techniques, such as the generative adversarial network (GAN), can be utilized to improve crowd routing (Zhao et al., 2019; White et al., 2021). Reinforcement learning algorithms may also be employed in the digital twin layer to learn the optimum action policies to increase performance in a variety of urban intelligence tasks, such as traffic and power system management (Hsu et al., 2014; Mannion et al., 2016; White et al., 2021). Because of the additional data accessible from smart cities, artificial intelligence, data analytics, and machine learning, a digital twin may be created that can update and alter as the physical counterparts' change (Kaur et al., 2020). A digital twin is a combination of the virtual and physical worlds that enables data analysis and system monitoring to prevent issues from occurring, reduce downtime, and even prepare for the future using simulations (Boschert & Rosen, 2016; White et al., 2021).

Digital twins at first have been used in the manufacturing industry, but they are beginning to find new applications in other fields of research and business. An ideal digital twin would be physically identical to its physical counterpart and would have a comprehensive, real-time dataset of all information about the object/system. As the object/system becomes more sophisticated, a digital twin may be similar in only the parts that matter and include only the real-time data required to enable any simulations. The level of detail placed into a digital twin and the amount of data available determine its accuracy and use. Before taking actual action in the real world, digital twins allow for the simulation of numerous choices to determine the strengths and flaws of each strategy. This is especially crucial in safety-critical circumstances, where only one choice is available and several competing alternatives must be considered (White et al., 2021).

Digital twins can be used in a variety of different fields. Digital twins can be used to simulate urban planning and policy choices using data supplied by smart cities. Virtual Singapore, a three-dimensional (3D) city model and data platform (Alam & El Saddik, 2017; White et al., 2021), is an example of a work-in-progress digital twin of a city (White et al., 2021).

A digital twin is a digital representation of a real thing that is either alive or dead (El Saddik, 2018). The rising popularity of digital twins is due to the availability of enabling tools for data, services, modeling, and connectivity to the real world (Qi et al., n.d.). Digital twins use IoT, machine learning, AI, and data analytics to build dynamic digital simulation models that update and alter in sync with their real counterparts (Luo et al., 2019; White et al., 2021). To represent the actual thing in near real-time, a digital twin is constantly learning and updating itself from many data sources. The system can learn from other digital twins with comparable domain expertise, as well as from human experts with appropriate domain knowledge. It can also benefit from previously used historical data and incorporate that into its digital model (White et al., 2021).

NASA was the first to establish digital twins as a model for future NASA and US Air Force vehicles (Glaessgen & Stargel, 1818; White et al., 2021). A digital twin would provide ultra-high fidelity simulation using data from the vehicle's onboard system, maintenance history, and all historical and fleet data to identify any potential safety or reliability issues. They've subsequently been used in a variety of industrial initiatives due to their ability to bridge the gap between virtual and real space at various phases of a product's life cycle (Tao et al., 2018; White et al., 2021). A digital twin enables product testing at all phases of the design process, ensuring that the design is viable, safe, efficient, and dependable (Rosen et al., 2015; White et al., 2021).

Controlling and experimenting with a complicated system is possible thanks to a digital twin (Grieves & Vickers, 2017). As a result, they're now employed in a variety of complicated systems outside of product design and manufacturing. Digital twins can be utilized to generate digital twin people for medical purposes (Bruynseels et al., 2018). Users may now collect more data on their physical activity, sleep quality, food, heart rate, weight, productivity, working environment, and social interaction thanks to the emergence of quantified self (White, Liang, et al., 2019). This information may then be used to develop a precise digital twin that can anticipate future health difficulties and test ways to avoid or mitigate the effects of such troubles (Bhavnani & Sitapati, 2019; White et al., 2021).

Data obtained from smart city services may be used to establish digital twin cities (Mohammadi & Taylor, 2017). The virtual representation makes it possible to model and visualize spatiotemporal data in a city. Much of the recent success in smart cities throughout the globe in integrating dependable ICT technologies into the city may be applied to the creation of a digital twin of the city (Mohammadi & Taylor, 2019; White et al., 2017). Digital twin programs are in their infancy, with a roadmap being developed at Cambridge University's Centre for Digital Built Britain (Enzer et al., n.d.). The roadmap depicts the important components and people who, when combined, would allow effective digital twins in the built environment (White et al., 2021).

According to an article done by White et al. (2021) in Cities journal “an online digital twin enhances citizen’s engagement on essential urban plannings and policy decisions by their ability to propose their feedbacks which is a valuable point in developing smart cities” (White et al., 2021).

The capacity of services and infrastructures in a smart city to be monitored using IoT devices and have sensors is extremely valuable for futureproofing (Fuller et al., 2020). It can be utilized to aid in the planning and development of current smart cities, as well as future smart city developments. In addition to the advantages of planning, there are also advantages in the field of energy conservation (Fuller et al., 2020).

This information is really useful in understanding how our utilities are distributed and used. The ability to use Digital Twin technology to advance the smart city is a significant step forward. It can help with growth by allowing Digital Twins to construct a living testbed within a virtual twin to do two things: one, test scenarios, and two, learn from the environment by analyzing changes in the data collected (Fuller et al., 2020). Data analytics and monitoring can be done using the information gathered. The use of Digital Twins is becoming more realistic as smart city development improves connection and the amount of data that may be used (Fuller et al., 2020).

2-9- Smart city’s critical issues in the scientific debate

A well-planned smart city will take the core concept of automation and level it up to facilitate all the best aspects of a smart city: connectivity, convenience, sustainability, and more (Hamilton, 2021).

the establishment of smart city can make the city easier to be perceived and the urban resources easier to be fully integrated. On this basis, the refined and intelligent management of the city can be realized, so as to reduce environmental pollution, solve traffic congestion and eliminate security risks. Though these, the goal of “better city, better life” can be achieved (Yuan, 2018).

Technology is the main driving force of urban development. Smart cities are based on the development of ICT represented by the Internet of Things, big data, 5G, artificial intelligence, and cloud computing. By exploring the efficacy of data collection, we can analysis and achieve more efficient city management and services, which could promote industrial transformation (Huang, et al. 2021).

smart cities are advantageous in their efficient distribution of resources, which leads to improved planning. This can be seen particularly in the transportation sector. Cameras at bus stops can gauge passenger density while sensors on approaching buses can determine how many people board the bus at a given time (Hamilton, 2021).

Gao and Yuan examine the impacts and potential mechanisms of SCI on air pollution governance from the objective satellite monitoring data within a quasi-natural experiment framework. they find that smart cities initiative (SCI) directly reduces the air pollutants concentration such as PM2.5, SO2, NO2, and smog in urban China and improves the air quality very well, which also has significant and positive spillovers on air pollution governance in adjacent cities (Gao and Yuan, 2022).

Obstacles of smart cities:

we should not forget that every coin has two sides. The Internet era brings us convenience, but also provides more opportunities for those with ulterior motives to steal our information. The government should establish an efficient information network security system to counter information theft by other countries, ensure the national information security and the safe operation of smart cities (Yuan, 2018).

Criticism of the smart city movement. Many citizens are concerned about the issue of confidentiality, as there is a high level of data collection and analytics, as well as the intensification of the implementation and application of IT technologies, which has widespread observation showing disruption in psychological, moral, and physical comfort. The discussion on smart cities centers around the usage and implementation of technology rather than on the inhabitants of the cities and how they can be involved in the process (Zoriana & Oleksii, 2018).

One of the most controversial aspects is the possible influence of electromagnetic fields (EMF) on the people's health. Electromagnetic radiation adversely affects the most sensitive systems of the body: the nervous, immune, endocrine, and reproductive. People are physically unable to feel the effects of electromagnetic waves, but they cause a decrease in immunity, adaptive reserves, disability and increase risks of diseases (Zoriana & Oleksii, 2018).

Because the development of these cities requires large budgets, they often end up favoring the rich and contributing to already existing social and economical divides, especially in developing countries. The greatest risk of digitizing our infrastructure is the threat of cybercrime that could wreak havoc on millions of lives. Smart cities are convenient targets for organized cybercriminal groups and can lead to massive losses of valuable information. Cybercrime activities are continuously evolving, resulting in the possibility of a breach at any point (Hamilton, 2021).

it is entirely desirable that specialized technological solutions are developed aimed at solving the problems of individual subjects: however flexible the technology must be calibrated on functional and social parameters. However, if these solutions are not integrated into a hybrid and complex system, there is a real risk of simply accompanying, in an intelligent way, trends already underway to the fragmentation of the city (smart city dark side).

2-10- Conclusion

The purpose of this chapter has been to identify the definition of a smart city and the relationship of smart cities with open data and its characteristics as technology is one of the most important factors in city development in our era. IOT (internet of things) plays an important role and enhances human life quality and in this rapidly growing world of technology and digital items, the number of items that are connected to the internet is more than the number of people. IoT allows getting big data. As governments make these data available for everyone to access enhances the chance for having more innovative solutions in every field specifically for urban designers and urban planners. As urban implementations and developments are time-consuming processes by means of big data, we can create a digital twin of our cities to have a live model of the city to test every innovative solution in different fields such as transportation or waste management.

In other words, Digital twins, the Internet of Things (IoT), blockchains, and artificial intelligence (AI) may reshape our understanding of globalization in the future. Digital Twin will most certainly have an impact on most businesses throughout the world since it replicates the physical model for remote monitoring, viewing, and control in a digital version. It is a live model of a physical system that adjusts to operational changes based on real-time data from various IoT sensors and devices and anticipates the future of the physical equivalents using machine learning/artificial intelligence (Farsi et al., 2019).

But to enhance the engagement of citizens in decision makings and studying the citizen's interaction with different solutions we need an urban living lab in order to get our solutions a live experiment in a small scale. in the next chapter of this thesis, the concept of the urban living lab and its impacts are explained in detail.

So, to conclude this chapter, the starting point of a smart city is the needs of its stakeholders and technology is an enabler to meet those needs so a smart city can have different definitions based on how its

stakeholders choose to define them. and as we make a city smarter we actually gain many advantages in different categories such as production, control, utility, services, transit, and public safety like reducing the cost of delivery of products, water management, smart waste management, and recycling, and reaching to the circular economy, 24-hour access to different services online, smart roads and intelligent rail and transit solutions, remote security monitoring and emergency response which each of these can help us to cut back costs of living.

3- Urban Living Lab

3-1- Urban living lab Definition

Cities are facing so many challenges in order to provide economic prosperity and social cohesion while reaching their sustainable environment goal. As mentioned in the previous chapter there is a growing trend to enhance citizens' involvement in city developments to make urban areas based on their needs. In order to reach this goal, it is essential to climate-related related factors besides the social impact of the new solutions. Cities require various and diverse approaches to address broad societal concerns and urban complexity (Chronéer et al., 2019; Ersoy & van Bueren, 2020). To handle such complicated issues, we must enlist the help of not only citizens, but also businesses, research communities, educational institutions, and government agencies. The Urban Living Lab could be the solution to such problems (Diego Hernando Florez Ayala & Prof. Dr. Anete Alberton, 2021).

Although the living lab (LL) movement began in the late 1960s and the establishment of the European Network of Living Labs in 2006 (Hossain et al., 2019), the development of ULLs began after the 2008 Global Economic Crisis. According to a report presented by Blezer and Abujidi at the Digital Living Lab Days conference in September 2021, cities have struggled to find solutions to three categories of concerns since then (Stefano Blezer & Nurhan Abujidi, 2021):

1. "There is no singular pathway towards urban sustainability (De Jong, Joss, Schraven, Zhan & Weijnen, 2015),
2. Interest increased in the potential of experimentation in place-based contexts that may overcome rigidity in existing socio-technical systems based on private contexts (Almirall & Wareham, 2011; Chesbrough, 2006),
3. Various stakeholders, like research and technology institutions started to see the urban environment as a place to support local communities and grassroots initiatives to align with National innovation (Luque-Ayala & Marvin, 2015; Marvin et al., 2018; Paroutis, Bennet & Heracleous 2014)." (Stefano Blezer & Nurhan Abujidi, 2021)

As Blezer and Abujidi discussed in their article," ULLs and parts of cities are positioned as a form of experimentations in a broader shift in the nature of urban governance (Bulkeley et al., 2016; Evans, Karvonen & Raven, 2017; McGuirk, Bulkeley & Dowling, 2014; Steen & van Bueren, 2017), and as such seem to be able to enhance learning about placed based contexts to achieve changes in socio-technical and socio-ecological systems by continuously enrolling new sites or actors (Astbury & Bulkeley, 2018; Baccarne, Schuurman, Mechant & De Marez, 2014; Bulkeley et al., 2016; Liedtke, Welfens, Rohn & Nordmann, 2012; Marvin et al., 2018; Scholl & Kemp, 2016; Steenbergen & Frantzeskaki, 2018; Voytenko et al., 2016)". (Stefano Blezer & Nurhan Abujidi, 2021)

Living labs, as defined by CoreLabs (2007), are systems that focus on daily people and their consumption expectations and requirements, with interactive engagement in the development of collaborative design, and hence in the innovation process itself (Veronika Torma, 2020). ULLs are commonly used interchangeably with phrases like testing grounds, testbeds, and city labs to refer to a variety of regional experiment settings with a participatory component (CoreLabs, 2007; Veronika Torma, 2020). Despite the fact that there are numerous articles on living laboratories as a concept, this concept has yet to be adequately defined (Veronika Torma, 2020). Living labs have been considered in the literature as a strategy (Leminen, 2015), a methodology setting (Hillgren, 2013), an environmental system (CoreLabs, 2007), and a governance model (Bulkeley, et al., 2015). According to Leminen (2015), the phrase "living lab" has been applied to a variety of innovation activities involving a variety of approaches and research perspectives. The physical region or virtual reality viewpoints are highlighted by Leminen and Westerlund (2014), who emphasize the nature of interaction spaces in which stakeholders create a collaboration between Public-Private-People-Partnership (Veronika Torma, 2020).

In another word, Urban living labs are expanding all over Europe and worldwide as a means of evaluating the building, transportation, and energy system advancements. They can also become an approach for experimental collaborations among scientists, stakeholders' companies, and government (Mccormick, K., & Hartmann, C, 2017)

To summarize, assessing ULLs' potential as a method of controlling transitions for sustainability requires a knowledge of the processes of translation, learning, and scaling via which they could have an impact beyond their local area (Smith & Raven, 2012). As a result, according to Smith & Raven (2012), it is necessary to investigate present ULLs in order to better understand how current settings can reconfigure regimes (Veronika Torma, 2020). Furthermore, what distinguishes ULLs from other advancements is the specific focus on cities, as well as the fact that experiments are conducted with prospective future answers and approaches while addressing current societal issues as challenges (Veronika Torma, 2020). They involve a wide range of stakeholders seeking intervention with the goal of implementing and developing new modes and approaches to address contemporary sustainability-related threats and challenges, innovating with new techniques, and critically exploring how such new societal-technical interventions can fit in a specific context and even mobilize beyond that context (Bulkeley, et al., 2015; Veronika Torma, 2020).

3-2- The characteristics of urban living labs

Based on this literature review of all definitions and studying different innovative projects and also based on research done by Delft university on 90 different projects in Amsterdam the following characteristics of urban living labs have been identified (Steen, K., & van Bueren, E. 2017):

<table>
<tr><th colspan="4">URBAN LIVING LAB
CHARACTERISTICS</th></tr>
<tr><th>GOAL</th><th>ACTIVITIES</th><th>PARTICIPANTS</th><th>CONTEXT</th></tr>
<tr><td>- Innovation
Developing new products to find new solutions to existing or new problems.</td><td>- Development of innovation
Living labs aim to develop an innovation or a product, and not only, for example, to test or implement a pre-developed solution.</td><td rowspan="2">- users, private actors, public actors, and knowledge institutes
Actors from these four groups are active contributors to the innovation and development process taking place within a living lab.</td><td rowspan="3">- Real-life use context
The living lab activities are enacted in a real-life use context.</td></tr>
<tr><td>- Knowledge development for replication
Producing and exchanging knowledge of the developed products and processes to achieve these products.</td><td>- Co-creation
The participating actors together give shape to the innovation process.</td></tr>
<tr><td>- Increasing urban sustainability
Sustainable development emphasizes the needs for supported, local solutions.</td><td>- Interaction between activities
The feedback gathered from use and evaluation further developed the product.</td><td>- Decision power
All participants including the users have decision power in the various stages of the innovation process.</td></tr>
</table>

Table 2. Urban living lab characteristics (Steen, K., & van Bueren, E. 2017), by author

3-3- Introduction to Agile Piloting

The easiest method to accelerate smart city development is to involve businesses and people in an agile piloting program that brings everyone together and establishes a shared understanding of the goals. The agile piloting program was developed to speed up smart city development by establishing a paradigm that could produce actual examples of new smart services in under six months. Experimentation makes smart city development visible and tangible, and it allows people and stakeholders to participate. Piloting provides a neutral area for all people engaged, with their diverse interests and working cultures, to collaborate on common progress. The agile piloting program provides a framework for innovators (startups, SMEs, and communities) to test innovative smart solutions in a real-world setting with real people. The objective is to maximize learning by including everyone, including government agencies and established businesses in the industry (Mustonen et al., 2018).

Forum Virium The methodology and procedure for the agile piloting program, which was utilized to speed up smart city development, were established by Helsinki's Smart Kalasatama initiative. The Smart Kalasatama team conducted 21 experiments involving over 30 enterprises and 1,000 citizens in 2016–17. The format swiftly spread throughout Helsinki and the rest of Finland. The format is being developed on a

constant basis: currently, programs linked to education and healthcare are being held at Kalasatama, and the co-operation and partnership model with larger enterprises is being investigated further (Mustonen et al., 2018).

3-4- What is Agile Piloting

3-4-1- Speed up Urban Development

Agile pilots are a powerful tool for accelerating urban development. They can, at their best, create the groundwork for larger development efforts. Experimenting is a method of learning that is rapid and iterative. Making pilots part of a city's strategic goals can help it get the most out of them. For businesses, they provide a once-in-a-lifetime opportunity to test a product or service in a real-world setting and receive consumer feedback (Mustonen et al., 2018).

Agile pilots are called agile because they can be completed quickly (in less than a month to half a year) and can be used to quickly bring an unfinished product or service to the right test environment and real users, rather than testing a service that has been developed without user input - back until it is nearly complete (Mustonen et al., 2018).

- **FOCUSING ON USERS**

A pilot, unlike late-stage testing of a service, should be expected to fail, at least in some respects. That's because the principles are still so new that the goal is to figure out exactly what works, what doesn't, and why. Experimentation will also show whether the concept is appealing to users and will aid in determining the future path. The proposal is ready for bigger scale pilots after multiple rounds of real-life trials and co-creation with users and other stakeholders. Agile piloting is defined by a user-centered approach and inclusive co-creation. What are the objectives of the pilots, and what do you hope to gain from them? What role do the pilots play in the city's strategy, the innovation platform's aims, and other smart city goals? (Mustonen et al., 2018).

- **LEARN AS MUCH AS POSSIBLE**

When agile pilots are grouped together to form a piloting program, the most effective use of resources may be achieved. Facilitation and other activities that assist piloting can be connected and planned together to support several pilots at the same time. Pilots working on the same subject can learn from one another during a piloting program, resulting in a variety of synergistic advantages. Stakeholders and users are asked to participate in the early stages of co-designing and co-creating a new solution. Co-creation may be used in the development of new business models, as well as the conceptualization of services. The goal of agile pilots is to get as much knowledge as possible in a short amount of time. During a pilot, the faster the service is built, the more rapid experimental sprints are done (Mustonen et al., 2018).

3-4-2- Key elements

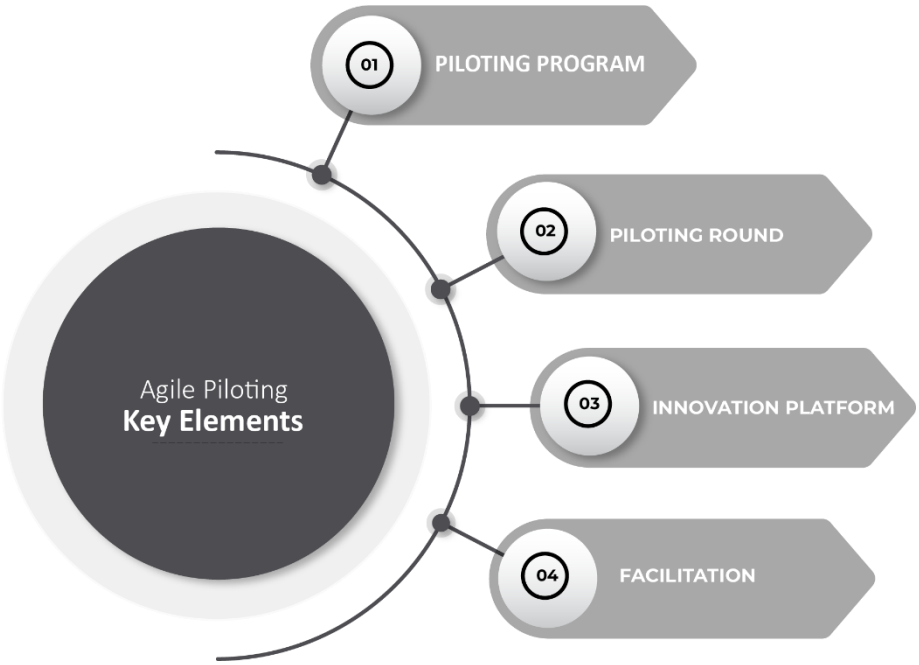


Figure 6. Agile piloting program key elements. By author

3-4-2-1- Piloting program:

A method for doing many pilots with the same format. As a piloting round, it contains numerous pilots that run concurrently. Each round of a program is assigned a subject, such as energy conservation, and numerous simultaneous but distinct pilots are employed to identify innovative solutions for that theme (Mustonen et al., 2018).

3-4-2-2- Piloting round:

Within a piloting program, the theme round of pilots.

3-3-2-3-Innovation platform:

An innovation platform (also known as a "living lab" or "experimentation platform") is a physical, digital, or social setting where piloting takes place. The platform's operator manages the piloting rounds and provides support to individuals selected to conduct the research. It streamlines the piloting process and brings stakeholders together to form a value-generating network. During the pilot, physical sites or municipal infrastructure are generally linked to the experiment, such as a neighborhood, carparks, information screens, cultural center, or school (Mustonen et al., 2018).

3-4-2-4- Facilitation:

Agile pilots necessitate a lot of facilitation to succeed, so make sure you budget adequate resources for it while you are developing the program.

Facilitation's duty is to bring people together, solve issues fast, demand choices, find the necessary contacts, streamline bureaucracy, recognize experimental synergies and the big picture, and communicate fascinating subjects about the pilot with the rest of the world. Facilitation, in the context of agile pi-lots, refers to supporting the whole process rather than just conducting workshops (Mustonen et al., 2018).

3-5- Conclusions:

ULLs are inventive policy processes built on the concept of multi-stakeholder collaboration, in which co-producers explore, examine, experiment, test, and assess new ideas and alternative solutions in a real-world setting (Ascione et al., 2021).

Inspired by MIT's classic definition of a 'living lab,' ULLs transpose its structure toward an urban scale with a multi-stakeholder and interactive aspect. One of the key goals of ULL is to co-create inventions and test them in a real-world setting. (Ascione et al., 2021).

ULLs are defined by a major presence of municipalities and public actors who operate as primary leaders and organizers, addressing social concerns unique to that area. ULL efforts, on a city scale, are engines for urban regeneration and requalification, particularly in polluted areas where the social infrastructure may be threatened by the industrial crisis. ULLs can promote social and sustainable transformations in such vulnerable places, which can also be developed in accordance with Circular Economy principles. As a result, multi-stakeholder partnerships should be formed to involve stakeholders in the design, development, implementation, testing, and evaluation of innovation. (Ascione et al., 2021).

ULLs are the appropriate physical locations where citizens and end-users actively seek answers, close resource, and energy cycles, and establish productive collaborations between public and private actors (Ascione et al., 2021).

ULL is a human-centered, in-the-wild design approach for developing services and/or technologies to resolve societal concerns in cities and regions. Despite the fact that it would have received widespread attention in recent years, few research have yet to provide relevant information on its efficient construction and operation phases (Akasaka & Nakatani, 2021).

To sum up all of these definitions, we refer to the urban living lab as (Mustonen et al., 2018):

•" The neighborhood and key sites for developing new services
• Networks formed by people and other stakeholders
• Open innovation platforms and environments" (Mustonen et al., 2018).

After defining and explaining the urban living lab, we discuss agile piloting, which is the most effective strategy to accelerate smart city development by incorporating businesses and people in an agile piloting program that connects all parties and establishes a shared understanding of its goals. The rapid piloting program was created to speed up smart city development by developing a mechanism for producing actual examples of new smart services in under six months. Experimenting makes smart city development visible and tangible, allowing citizens and stakeholders to participate. Piloting provides a neutral area for all people involved, with their diverse interests and working cultures, to collaborate on shared progress agile piloting program provides a framework for innovators (startups, SMEs, and communities) to test new smart solutions in a real-world setting with real people. Different stakeholders with various roles will be involved in each agile piloting program depending on its goal, and each of them will have different needs, which we will study in-depth in the following chapters through a ULL and the agile piloting programs running there.

4- Affordable Living and open data

4-1- Affordable living, Affordable Housing

4-1-1- Affordable Housing Definition

The word "affordable housing" is occasionally used in a broad sense without knowing what it refers to. It refers to housing that is made available at a cost that a modest household with an average annual income can afford; statistically, it refers to the median price that a median household can pay; and symbolically, it refers to the proper housing options for the correct income groups (Ramakrishna Nallathiga, 2010). The following are three measures that represent the availability of affordable housing:

1. “Price-to-Income Ratios: In the United States and Canada, a widely accepted criterion for determining housing affordability is if housing unit expenses surpass 30% of a household's gross income. This guideline considers housing expenditures that typically include taxes and insurance for owners, as well as utility costs. When a home's monthly carrying expenses exceed 30–35 percent of a household's monthly income, the housing unit is termed unaffordable. Of course, this is true in the case of a country that places a high value on human resources despite the ready availability of technology and materials. In the case of owner housing, affordable housing is primarily quantified in terms of broad aggregates of home price to yearly income ratios, and in the case of rental housing, house rent to monthly income ratios. For example, in the EU, the former was in the range of 2.0-2.4 percent, while the latter was in the range of 10-25 percent” (Ramakrishna Nallathiga, 2010).
2. “Poverty line Measures: Another indicator of affordable housing is the number of poor individuals, or those living "below the poverty line (BPL)," who, in their struggle for basic survival, may be unable to afford appropriate accommodation” (Ramakrishna Nallathiga, 2010).
3. “Housing Property and Its Values: Because both the cost of land and the cost of a housing unit is included in the property value, it is frequently used as a barometer for the availability of affordable housing. Here, the concept of a basic standard of living space, which varies from country to country, state to state, and even city to city, becomes critical. However, because property values vary by region, it can only provide an indication of relative affordability. Instead, when paired with the minimum required living space, the average property value can be used as another indicator of affordable housing supply. If property values are very sensitive to factors such as location, access, amenities, and public goods, values in areas that are quite modest in all of the above categories may become the norm” (Ramakrishna Nallathiga, 2010).

4-2- Living Costs

4-2-1- the Cost-of-Living definition

In a specific location and historical period, the cost of living is the amount of money required to pay basic expenses such as housing, food, taxes, and healthcare. The cost of living is frequently used to compare the expense of living in different cities. Wages determine the cost of living. If living costs are higher in a metropolis, such as New York, salaries must be higher to allow people to afford to live there (Cost of Living, 2021).

4-2-2- Cost of Living and Lifestyle

Because a wage can provide a greater standard of living in a place where daily expenses such as rent, food, and entertainment are less, the cost of living can be a key influence in personal wealth building. In an expensive city like New York, however, a high salary may feel insufficient. According to a 2018 survey conducted by Mercer, a worldwide human resources business, the cities with the highest cost of living are Hong Kong, Luanda, Angola's capital, Tokyo, Zurich, and Singapore, in that order. The most expensive city in the United States is New York City, followed by San Francisco and Los Angeles, Chicago, Washington, and Boston (*Cost of Living*, 2021).

4-2-3- **The Index of living cost**

The cost-of-living index compares the cost of living in a major city to the cost of living in a comparable metropolitan area. The index combines the costs of numerous living expenses to provide an overall metric that new workers can use as a benchmark. The index gives an insightful overview of rental, transportation, and grocery expenditures as college graduates assess employment options and presently employed job seekers consider relocation (*Cost of Living*, 2021).

Living expenses may be calculated differently by different index values. For example, according to the Council for Community and Economic Research, San Diego was the most expensive city in 2018, not New York City. The Council's cost of living index looked at prices for housing, groceries, energy, transportation, healthcare, and even getting a haircut or going to the movies in 269 cities. Housing costs in San Diego are 138 percent higher than the national average, while transportation costs are more than 20% higher (*Cost of Living*, 2021).

4-3- Living Cost distribution

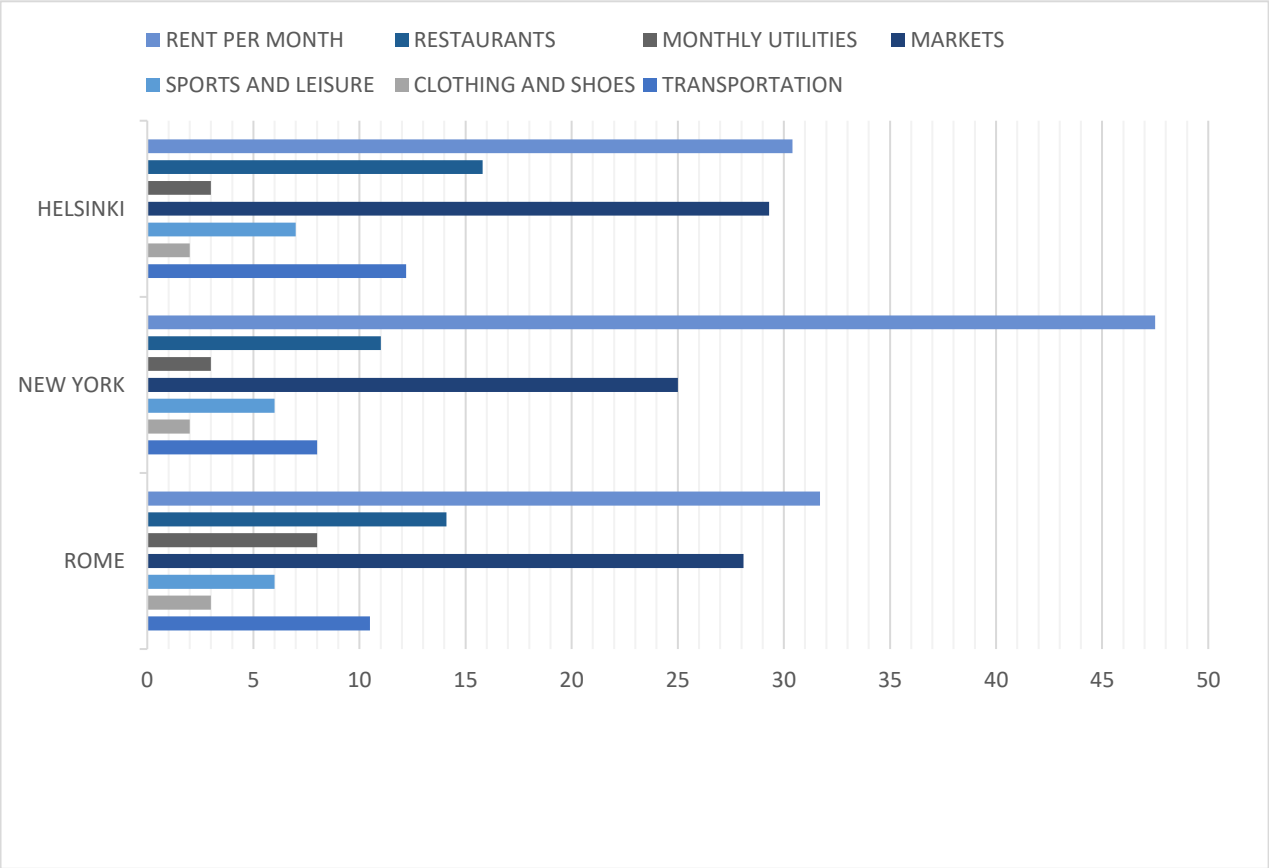


Table 3. Cost distribution comparison, Helsinki, Rome, New York

Indices Differences
Consumer Prices in New York, NY are 45.89% higher than in Rome (without rent)
Consumer Prices Including Rent in New York, NY are 89.66% higher than in Rome
Rent Prices in New York, NY are 183.93% higher than in Rome
Restaurant Prices in New York, NY are 46.67% higher than in Rome
Groceries Prices in New York, NY are 66.96% higher than in Rome
Local Purchasing Power in New York, NY is 100.72% higher than in Rome

As it is seen in the charts above major part of cost distribution is the cost of rent in all of these big cities. Then the second one is the market which is a major part of that includes the money people expend on food each month and then transportation which includes the cost of fuel and public transportation.

In this thesis as we mentioned in the introduction our main aim is to find innovative solutions which smart city feasibilities allow us to experiment them and make them into action in order to reduce the living

cost other than just suggesting for building social housing, we find solutions to reduce the living costs for everyone which can be the energy consumption reduction and circularity of local materials and also waste management and smart transportation and local food cultivations.
consumer Prices in Helsinki are 8.49% higher than in Rome (without rent)
Consumer Prices Including Rent in Helsinki are 6.42% higher than in Rome
Rent Prices in Helsinki are 1.96% higher than in Rome
Restaurant Prices in Helsinki are 19.43% higher than in Rome
Groceries Prices in Helsinki are 10.71% higher than in Rome
Local Purchasing Power in Helsinki is 63.74% higher than in Rome

4-4- Open data and affordable living

The next stage in transforming affordable housing projects into long-term, effective systems is to use big data. Housing choices may be made using the most detailed, evidence-based way available by using big data and giving the appropriate tools to housing authorities and politicians. While companies like Google and Facebook have been utilizing big data for decades to analyze their techniques and improve their outcomes, policymakers, legislators, and lawyers are just now beginning to build tools that allow them to use big data in a safe and productive manner. Public interest is a traditionally underfunded and under-regarded sphere but using big data and big data tools to help reach public interest goals can directly cut down on costs and allow people to glean more pertinent information in the little time they have to focus on each problem *(Kara Simon,2017).*

4-5- Big data and policy of affordable housing

This section gives a quick overview of big data's policy-making possibilities. It then moves on to the beginning of the adoption of outcome-driven policies in the field of affordable housing. In fact, big data and outcome-driven policymaking are not synonymous – the former has several uses, while the latter does not necessitate the use of innovative data tools–, but their junction opens up exciting possibilities (Jones, Meg,2014; Davidson, N. M.,2017).

4-5-1- Big Data and Policy

To emphasize the obvious, officials have traditionally made judgments based on facts. Indeed, classification, record-keeping, sorting, and other bureaucratic informational management technologies have been part of the administrative state for so long that we rarely notice their pervasiveness (Davidson, N. M.,2017).

The modern policy has always been data-driven in this respect, and a wide range of policymakers have embraced the concept of evidence-based solutions (Berlin & Rekha, 2015; Davidson, N. M.,2017). The availability of substantially more data and significantly more powerful processing capabilities is what is changing today. Big data is one of those overused buzzwords that is difficult to define accurately, and it isn't essential here. However, in general, the phrase refers to a group of connected occurrences.

First and foremost, big data refers to the ability to acquire and organize huge datasets and related information—this is what makes the phenomena "big" as opposed to "simply data." (Davidson, N. M.,2017).

Secondly, big data frequently necessitates the aggregation of data from disparate sources. Hundreds of millions of tweets can disclose some information, but when those tweets are connected with other social media inputs, additional insights emerge. The correlation of social media posts with seemingly unrelated data, such as where individuals reside and their purchasing habits, may reveal even deeper trends (Davidson, N. M.,2017).

Third, big data refers to a collection of analytic tools that may be used to harvest and activate data. These new capabilities are aided not just by people's rising digital footprints as they navigate the internet world, but also by the proliferation of new sensing devices. Not only can these analytics be used to analyze historical trends, but they can also be utilized to forecast how to act in the future. The most essential drawbacks to this somewhat idealized interpretation of big data's potential are mentioned

below, but the last function—impact evaluation and prediction—is the most crucial for policymakers. Big data applications are becoming more and more frequent (Davidson, N. M.,2017).

For example, in 2009, Google began tracking flu outbreaks in real time by combining frequent search phrases with data from the Centers for Disease Control and Prevention. Spell-checking was also revolutionized by Google from an educated guess by engineers at the most common errors and their fixes to a far more accurate technique based on a vast database of real errors and how users rectified them. In the commercial sector, similar examples of data aggregation and new analytic skills abound, and they're becoming increasingly important for management planning and decision-making (Davidson, N. M.,2017).

These new tools are also gaining traction among policymakers.

Perhaps most controversially, defense and national security organizations like the CIA, NSA, and Department of Defense have embraced big data, raising serious worries about civil rights and privacy. Big data is becoming more significant in a variety of industries, including public safety, traffic management, public health, fraud detection, and many more. To understand the possibilities for affordable housing, we must look at another developing trend in that policy arena: the move from outputs to outcomes (Davidson, N. M.,2017).

4-5-2- From Outputs to Outcomes in Affordable Housing

Affordable housing officials have traditionally concentrated on outputs, but they are now beginning to focus on outcomes. This move has the ability to broaden the possibilities for improving the development and delivery of affordable homes (Davidson, N. M.,2017).

To the degree that policymakers have tracked the impact of inputs like subsidies or less direct housing interventions, they have typically concentrated on the immediate outcomes of a certain program or policy. For example, HUD (Housing and Urban Development in US) has long tracked and reported on fundamental housing indicators such as the number of units built or funded, the number of construction and management jobs produced, and certain indicators of the quality of the resultant housing, such as overcrowding levels (Davidson, N. M.,2017).

Despite recent efforts by HUD to widen its planning and assessment horizons, the Department continues to place a strong emphasis on metrics that directly evaluate current results. For example, the Department of Housing and Urban Development stated a detailed set of housing targets in its five-year Strategic Plan for the years 2014 to 2018. The following are some notable examples:

- “The number of households with "Worst Case Housing Needs," defined by HUD as having an income of less than half of the Area Median Income (AMI), not receiving public assistance, and paying more than half of their income on rent, living in extremely inadequate circumstances, or both.
- The percentage of tenants with significant rent burdens that are very low-income.
- The proportion of rental units constructed in the last four years that are affordable to extremely low-income tenants; and
- The creation of rental properties.” (Davidson, N. M.,2017).

These are critical fundamental indicators, and it's laudable that the Department has established clear, verifiable targets around its basic aim.

Nonetheless, these output measurements reveal little about the lives of the individuals who live in the housing, as well as the broader community implications of housing investments and other policy initiatives (Davidson, N. M.,2017).

Other indicators in the HUD Strategic Plan make an attempt to achieve this. determine how much of difference federal investments make for beneficiaries in addition to the immediate output indications for instance, in the section titled the "HUD now measures the "percentage of the population who lives in economic prosperity. "FSS [Family Self Sufficiency] program members who Wages have been raised "That gets at the link between the two. Housing and its effects for occupants, as well as a policy that facilitates housing employment results after the intervention (Davidson, N. M.,2017).

In other sections, however, the Department criticizes the absence of performance measurements in areas like health outcomes. However, as previously said, academics and policymakers are increasingly connecting housing to longer-term life outcomes. Raj Chetty, Nathanial Hendren, and Lawrence Katz, for example, recently released the findings of a study of HUD's experimental voucher program "Moving to Opportunity." HUD provided subsidies to randomly chosen families to relocate from high-poverty to low-poverty neighborhoods as part of the experiment, allowing researchers to examine roughly comparable families who did not have the same opportunity (Davidson, N. M.,2017).

A transition from outputs to outcomes presents a number of problems, the most important of which is how policymakers can properly operationalize this shift. Doing so, among other things, necessitates obtaining and comprehending large volumes of data, which is partly why agencies have tended to focus on more simpler indicators like the number of units created in a year. However, with the emergence of big data, new methods to resource targeting and combining related, but often functionally separated, policy domains may be operationalized (Davidson, N. M.,2017).

4-6- Big Data in affordable housing law and policy

With that context in mind, we can look at the specifics of where the move toward data-driven decision making is beginning to show up in affordable housing, as well as instances of areas where more advanced aggregation and analytical capabilities appear to hold special potential. This section focuses on siting decisions and locational choice, resident interactions and services, portfolio management and property supervision, and portfolio management and property oversight, particularly throughout the subsidized and unsubsidized affordable housing stock. These examples are given at a high degree of generality by necessity, but they should offer an idea of some key areas of affordable housing policy and practice where new data techniques have special promise. The section finishes with some thoughts on what these instances say about the role of big data in improving affordable housing policy and law, as well as boosting data availability (Davidson, N. M.,2017).

4-6-1- Examples of Big Data's Potential in Affordable Housing

a. Siting Decisions, Mobility, and Neighborhood Effects

The effect of local and regional context is the first step beyond simple outcomes measurements in affordable housing, which means that locational choice is particularly accessible to developing analytics (Davidson, N. M.,2017).

HUD's new AFFH policy framework is a small but promising attempt to use data to address the locational repercussions of housing siting decisions, among other purposes. The regulation stems from the federal Fair Housing Act's requirement that beneficiaries of federal housing funds positively advance the Act's goals. HUD has established a national planning framework under which the Department will provide data to state and local governments as well as public housing agencies ("PHAs") across the country—almost all local governments receive HUD funding, and there are thousands of PHAs—on integration and segregation, housing needs, and indicators of economic opportunity. The regulation then asks these program participants to conduct their own fair housing analysis based on the data and their own unique insights, in order to determine (Davidson, N. M.,2017):

- "Patterns and trends of integration and segregation within the jurisdiction and region based on race, color, religion, sex, family position, national origin, and handicap;"
- "Poor areas within the jurisdiction and region that are racially or ethnically concentrated;"
- "Substantial inequities in access to opportunity within the jurisdiction and region for any protected class;" and
- "Any protected class within the jurisdiction and region has disproportionate housing demands." (AFFH Final Rule,2015)

This data-driven initiative is a huge step forward, and it has the ability to shed light on a wide variety of decisions made by local governments and PHAs that now lack context (Davidson, N. M.,2017). Understanding

longitudinal patterns in the demographics of housing needs, for example, might aid in site decisions and the development of positive marketing campaigns. It can also assist policymakers in comprehending issues like concentration and agglomeration impacts (Davidson, N. M.,2017).

The data will be used differently by each jurisdiction, but the underlying theory is that grantees will not only address obvious barriers to fair housing choice but will also use the planning tool data to guide housing siting, target enforcement resources, and make other policy decisions based on the patterns revealed by the data.

One problem in this evolving framework is that the data tools that the agency and its grantees rely on are quite broad in scope since they must be provided for every jurisdiction in the country by necessity (Davidson, N. M.,2017).

Neighborhood demographics, poverty concentration by race and ethnicity, school quality, employment proximity, transportation expenses, and environmental health offer a lot about broad trends and context for housing policy decisions, but they also take a lot of interpretation to affect decisions (Davidson, N. M.,2017).

In terms of the repercussions of locational decisions, big data can provide a deeper knowledge of the relationship between inputs and results (Davidson, N. M.,2017).

New methods can help by providing considerably more detail in terms of individual communities, as well as addressing one of the most difficult aspects of evaluating impact: the long-term repercussions of policy initiatives. The AFFH framework can provide a precise snapshot of where the Fair Housing Act's protected categories intersect with opportunity and housing investments at any given time, but it will take more data and more sophisticated analytical tools to figure out how that context changes as policy choices are made (Davidson, N. M.,2017).

If aggregated across locales, these methods might eventually target not only community-level results but also city-wide and metro-level alterations. They may also assist policymakers in focusing on larger outcomes such as neighborhood transformation, such as gentrification, and displacement as a result of different public initiatives. This will not make deciding whether to build a housing development at site A or site B any simpler (given the severe market and political constraints on all affordable housing), nor will it end the argument about a place versus mobility. Nonetheless, it has the potential to make the repercussions of individual subsidy decisions as well as the wider subsidy system more clear (Davidson, N. M.,2017).

b. Management of a Housing Portfolio

Market circumstances, as well as the inspection and management of housing assets, constitute a second major area of affordable housing policy where new data techniques hold special promise. In many cases, the emphasis is on utilizing technology to aggregate data to enhance affordable housing practice and pragmatic policy implementation, rather than on using data to refine our understanding of where to deploy resources in terms of results (Davidson, N. M.,2017).

i. Market Conditions and Subsidy Targeting:

Understanding how rent subsidy levels fit with market conditions can be aided by big data techniques. Better targeting of subsidies, as Matthew Desmond recently suggested, might free up significant housing resources (Davidson, N. M.,2017).

As Desmond points out, the bigger the region for which rent subsidies are fixed, the more over- and under-inclusive they are likely to be, paying landlords in certain districts above market while restricting movement to higher-income areas (Davidson, N. M.,2017).

In metropolitan regions where voucher holders are concentrated in high-poverty communities, HUD has begun to transition from metropolitan-level Housing Choice Voucher "fair market rentals" to far more focused zip code level measurements (Davidson, N. M.,2017).

However, this is a pilot program that only focuses on a selection of markets in a particular campaign. Policymakers may acquire a considerably more fine-grained window into market conditions and hence appropriate subsidy levels across a range of programs by collecting information regarding much more closely targeted market rents, as well as a plethora of associated transactional data (Davidson, N. M.,2017).

ii. Enforcement and Housing Quality

New capabilities to collect and analyze huge data streams show promise for assisting policymakers in ensuring housing quality and targeting actions to address housing quality challenges more efficiently and effectively. Local governments now gather a lot of property-level data via code enforcement, nuisance complaints, fire and police dispatches, and other sources, whereas states and the federal government collect data on housing quality through subsidy programs. However, this data is rarely brought together, let alone used to enhance supervision (Davidson, N. M.,2017).

This type of aggregation might be very useful when it comes to the relationship between housing quality and health outcomes. The data relating to indoor lead paint and developmental issues in children, for example, is compelling. Although some state and municipal agencies keep track of lead-paint inspections and infractions, there is no comprehensive database on lead in homes (Davidson, N. M.,2017).

A big-data strategy might bring together many sources of data—home inspections, transactional data, lead-law citations, and complaints—to create a far more comprehensive view of not just the risk landscape, but also the effectiveness of risk reduction. Indoor air quality, vectors of chronic illness associated to wet, cold, and mold, and even injuries are just a few instances of how data may enhance policy surrounding the nexus of housing and health outcomes. Big data might also be used to track which landlords are performing well and which are not, in order to better target enforcement resources and, eventually, to influence decisions about which housing developers or managers should receive support. HUD presently oversees a procedure called as the "2530 process" that identifies providers that pose financial or operational concerns. HUD has overhauled this procedure, which formerly required paper submissions and individual evaluation. However, both HUD and other housing providers frequently struggle to assess the risk of potential grantees (let alone use prior performance to influence subsidy decisions in times of scarcity) (Davidson, N. M.,2017).

Bringing information about providers, their management structures, and their past experience not only with specific subsidy programs but also with other housing ventures could not only speed up this type of past-participation review, but it could also help policymakers better understand the operational and managerial factors that differentiate lower-risk partners from higher-risk partners (Davidson, N. M.,2017).

iii. Unifying the Subsidized and Unsubsidized Housing Portfolio

In this sense, new data technologies may hold special potential for bridging the gap between subsidized and unsubsidized affordable housing portfolios. For logical reasons, affordable housing policy focuses on the publicly subsidized component of the housing stock available to low-income individuals. However, according to Harvard's Joint Center for Housing Studies, nearly three-quarters of the affordable housing supply is unsubsidized (Davidson, N. M.,2017).

The component of the portfolio that is not part of any direct subsidy program is frequently overlooked by policymakers, is seldom overseen in any meaningful way (unless when it overlaps with nuisance claims and individual code enforcement) and is rarely incorporated into comprehensive schemes. It would be possible to start unifying this "shadow" inventory with the much more transparent subsidized portfolio in a variety of ways, from gathering cost data related to development and operations to including outcomes related to the unsubsidized portfolio in locational analyses, to offering tools to assist with property management and tenant relations, with improved data collection and analytics. Those in the shadow portfolio might also benefit from new aggregation mechanisms that connect them to services that are typically more easily available to residents in the subsidized portfolio (Davidson, N. M.,2017).

4-7- Big data’s dark side: caveats and responses

To this point, it would be reasonable to interpret this article as an unadulterated eulogy for big data's potential worth in affordable housing, but there are several reasons to proceed with caution in any investigation of the phenomenon's potential. Several cautions arise from the literature on big data that are worth noting, both structurally and in terms of the people who are the unavoidable subjects—to use that phrase with caution—of any big-data endeavor. To begin with, numerous critics have pointed out that big

data, like traditional data (and arguably much more so), has the potential to suffer from basic informational quality issues (Davidson, N. M.,2017).

Furthermore, the quality of any study is always constrained by the quality of the sources and maintaining data governance may be an expensive endeavor. Measurability can be a deceptive proxy for policy outcomes that are more difficult to quantify but no less (or even more) critical. These alternatives may be concrete but difficult to quantify (just as units produced are easier to measure than long-term subjective well-being), but there is a risk that non-quantifiable values—fairness and dignity—will be lost (Davidson, N. M.,2017).

There are no definite answers to these structural issues, and the optimum reaction is practical rather than legal. To the degree that policymakers rely on data, particularly the potentially cumbersome reams of data in a big data strategy, they must focus on continual improvement and a feedback loop that might come from actually using the data in reality. As difficult as it is to resist the temptation of the concrete, data quality and data management difficulties also augur strongly for a level of skepticism in not allowing the data to be unduly determinative in decision making (Davidson, N. M.,2017).

Moving on to the individuals whose lives and experiences provide the data on which big data lives—and whose lives will be impacted by decisions made based on that data—the advent of new analytic tools raises serious worries not only about privacy, but also about the loss of identity control. A worry about datafication undermining the dignity and individual humanity of the persons being measured is closely tied to this. Individual voices can be drowned out by numbers, and apparently indestructible statistics can hide very genuine human experiences. This has an impact on policy, but it also has an impact on individuals since it reduces who they are to a series of statistics and measurable consequences (graduation rates, health assessments, and the like). And all of this has the potential to worsen existing power relations, perhaps reducing the agency of those serviced by affordable housing programs (Davidson, N. M.,2017).

These are significant challenges, and policymakers must be aware of the viewpoints of people serviced as well as power relations, but they are manageable in the context of affordable housing. Much of the data that would be collected as part of any endeavor to improve our knowledge of outcomes may be anonymized and processed in aggregate. And how data is gathered, kept, and analyzed must prioritize privacy for both residents and providers (Davidson, N. M.,2017).

However, the significance of protecting individual voices and privacy should not be an impediment to achieving practical value from new data technologies. Consumers choose to share information with technology businesses on a regular basis in order to enrich the collective information base available to all users. When someone uses Google Maps on a mobile device, they are getting and providing information about their position, traffic conditions, and other factors, and it is appropriate to sacrifice privacy for the usefulness of that data exchange. A similar trend may be found in the domains of affordable housing and associated policies (Davidson, N. M.,2017).

More fundamentally, "as compared to what?" is a good question to ask. For individuals who are concerned about individual voices and people' dignity, it is unclear if our existing affordable housing system is serving the most disadvantaged in the best way possible. Indeed, it is reasonable to claim that under the existing housing policy system, we do not pay enough attention to residents and customers. Better tools may help promote fundamental principles, and they aren't mutually exclusive objectives. In practice, we may focus on humanity and dignity and utilize statistics to help us do so (Davidson, N. M.,2017).

For all the issues with quantifiability, data has the potential to focus housing policy decisions on outcomes that place persons (rather than structures or providers) more clearly at the center of policy emphasis. Limited public resources may be used considerably more efficiently in many crucial areas of public policy, such as providing affordable housing for the neediest. Data as a decision-making tool and the individual dignity of persons serviced by government programs may and do clash, but they can also work together (Davidson, N. M.,2017).

Of all, data alone cannot resolve fundamental policy disagreements that involve not just comparative results but also relative and even incompatible agendas, as well as different political economies. As a result, no amount of effect analysis will be able to address the age-old dispute in housing policy between mobility vs community investment. In a scarcity context, this argument will always reflect marginal trade-offs as well

as interaction effects with other policy initiatives and market forces. Understanding the trajectory of the investments we make in the name of affordable housing, on the other hand, can help us target those expenditures. That might not be ambitious enough, but it's still a step forward (Davidson, N. M.,2017).

4-8- Conclusion

The goal of this chapter was to highlight the potential benefits—as well as the considerable challenges—of employing new data aggregation and analytic techniques to enhance affordable housing policy and to clear out the meaning of affordable living and living costs. There is the undeniable promise at the very least to make better decisions, whether informing siting decisions, understanding the regional housing market consequences of local zoning policy, transforming management and resident services, or other areas of affordable housing, and recognizing the practical barriers to implementation (Davidson, N. M.,2017).

In this area, we are starting to see a cycle where law encourages the collection of data that can be pooled across various domains to offer a fuller picture of the effects of public investments and other policy choices. Other legal demands, particularly regarding enforcement, can be driven by this data. As previously stated, we must proceed with caution in adopting these new tools because they will always be limited in their ability to accurately capture ground-level reality, and they must be used with a keen appreciation for the people whose lives are being measured and whose voices are all too often ignored. The alternative, though, is much less appealing: continuing to muddle through (Davidson, N. M.,2017).

5- Innovative solutions toward affordable living

As explained in previous chapter when we talk about affordable living it does not only refer to affordable housing and it includes all the costs of living such as grocery, transportation. In this chapter I am going to introduce some intelligent innovative projects of affordable living and the relation between smart cities and affordable living.

5-1- Katerra Construction Firm

The American company Katerra specialized in off-site building and was driven by technology. It was established in 2015 by Fritz Wolff, executive chairman of The Wolff Co., and Michael Marks, a former CEO of Flextronics, and interim CEO of Tesla. Katerra was recognized as one of the "Top Startup Companies" to work for in 2017 by LinkedIn. The industry-changing construction powerhouse Katerra has declared its closure. The construction firm, which was founded in 2015, would reportedly "let go of thousands of staff and is expected to walk away from dozens of building projects it had vowed to undertake (Clouse, 2021).

“The firm started informing personnel about the stoppage on Tuesday, according to "The Information. An employee who was present at the meeting claims that an executive informed staff via video chat that the business lacked the funds to pay severance benefits or unused paid time off. The CEO of the corporation claims that Covid-19's effects, along with rising labor and material costs, are to blame for the organization's most recent financial struggles. Katerra claimed that they will disrupt the building industry by bringing Silicon Valley ideas (and money) to it. Katerra is "revolutionizing the world of design and construction by bringing new ideas and technology to the table," In order to reduce time and money spent during the planning, design, and construction of buildings, systems thinking is being used.” the company claims (Clouse, 2021).

With $2 billion in funding from Softbank, Katerra went on a buying frenzy, acquiring manufacturing companies, engineering firms, construction companies, and architectural firms. It invested $200 million on a cross-laminated wood factory in Oregon. Before he left Katerra in 2017, Fritz Wolff, one of the company's co-founders, explained how the company would transform the sector (Clouse, 2021).

The Spokesman-Review reports: “Traditional building construction is mired in processes similar to having a custom-made, or “bespoke,” shirt sewn by a tailor or ordering a one-of-a-kind automobile, Wolff said. For Katerra’s customers, choosing a building is similar to ordering a new car with custom features, Wolff said. “We’re taking a controlled manufacturing approach to construction versus a bespoke approach, where every building throughout the world is (one of a kind) with no repetition.” (Clouse, 2021).

This raised a lot of red flags because it came from one of the few employees who truly knew something about construction. I noticed what the following at the time (Clouse, 2021):

"When it comes down to it, a building is much closer to a bespoke suit than it is to a car. If buying a building was like “ordering a new car with custom features,” they would all be roughly the same size, every city would have the same zoning bylaws and parking requirements, you could park them anywhere in a moment, and you wouldn’t have NIMBYs." (Clouse, 2021; Construction Giant Katerra Is Shutting Down, 2021)

As noted by Lanefab co-owner Bryn Davidson, scaling prefab is difficult because each site and city is unique. Not just him but others had reservations. John McManus, a writer for several construction-related blogs, including The Builders Daily, speculates that Katerra staff may have been made aware of the situation four years ago by "more than a few house building, construction, real estate investment, product manufacturing, and distribution brilliant lights." According to him, Katerra chose not to establish ties because it thought it could handle matters on its own. We'll do it better, more intelligently, and with more resources than anyone else, therefore Katerra erred by deciding to go it alone, according to McManus. He predicts that many people would remark, "I told you so." He is right (Construction Giant Katerra Is Shutting Down, 2021).

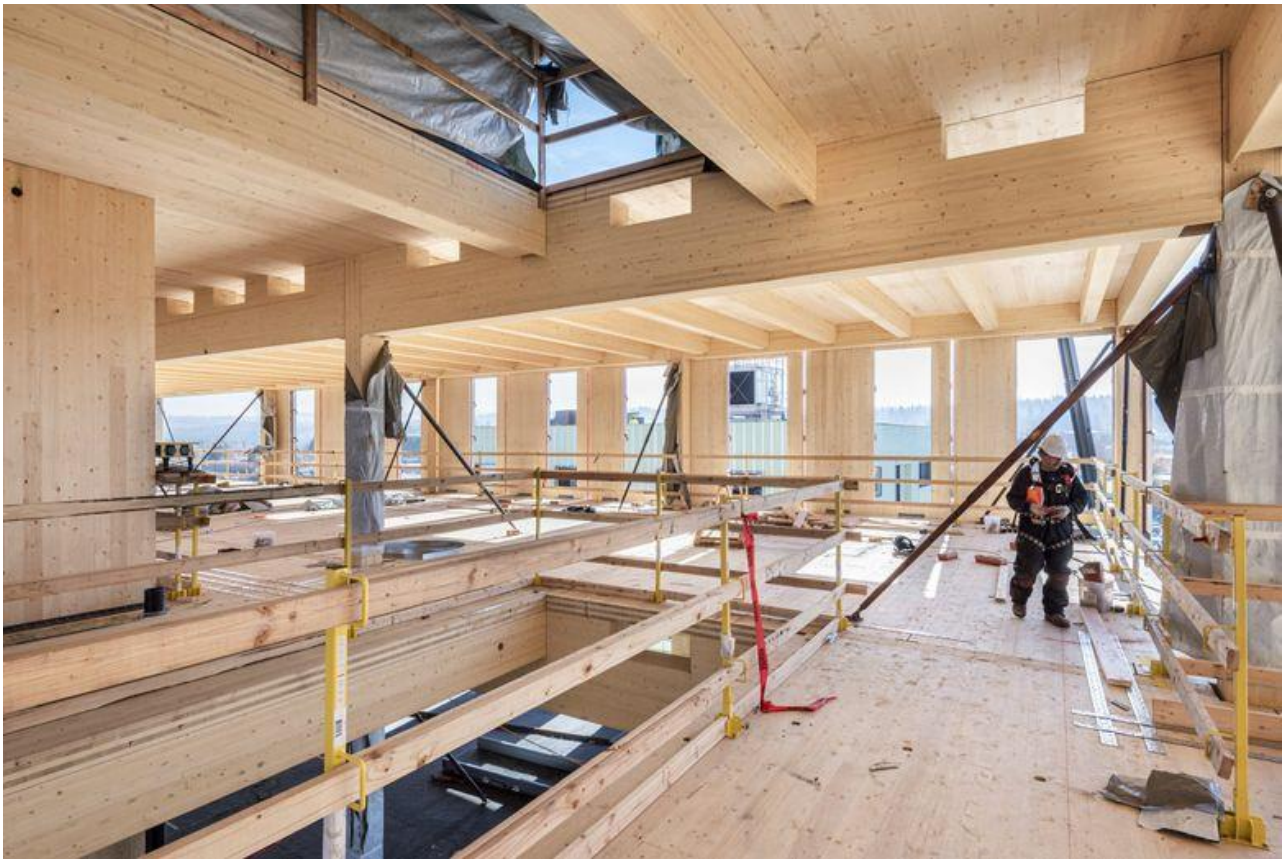


Figure 7. Katerra construction site (Seattle Times business, 2021)

The ceo was from the electronic industry and he wanted to bring end-to-end end manufacturing process of that industry into these prefab buildings, and they were doing all the parts of construction phases of a building same as manufacturing a digital device which is not how architecting works.

and foremost, we need to exercise caution around outsiders, especially those from the IT sector, who have lofty goals of "fixing" the architecture, engineering, and construction, or AEC, business. While having an outside perspective is useful, it is sometimes foolish. Katerra's creator, Michael Marks, has a background in electronics. He aimed to apply the end-to-end approach used in the electronics industry to the building sector (The Rise and Fall of Katerra | WeWork 2.0, 2021).

Katerra invested millions of dollars in global mergers and acquisitions in order to grow into a complete service company. Not in the IT sector is construction. By having complete control over everything, including the production of windows and light bulbs, Katerra believed it could save time and money. They claimed that any construction could be constructed using factory-produced components in its own facilities before being transported to job locations. Katerra developed hotels, apartments, single-family houses, workplaces, and other types of structures rather than specializing in just one (The Rise and Fall of Katerra | WeWork 2.0, 2021).

To conclude Katerra was trying to eliminate the other chains in between the building material producers to manufacturers and engineers and do all by their own to cut back on costs and provide their services with less cost but they were not paying attention to people’s needs and differences and were thinking of a building as any other mass produced materials we use every day so they were not able to continue their growth because people lost their interest toward them and it makes the stock of Katerra to fall and them loosing lots of money and at the end we got bankruptcy.

5-2- Rooftops in Bristol

An Agile Approach to Dealing with Homelessness

Agile Homes builds low-carbon straw prefab homes and is now dropping them on rooftops.

Agile and Emmaus Bristol are collaborating to create a neighborhood of move-on houses for formerly homeless persons. On the top of Backfields House, they are constructing up to 15 new TAMs, or cheap, low-carbon eco-homes (Wilde, 2022).

The TAMs are eco-houses, thus in addition to having a small carbon impact, they will also be inexpensive to run, using up to 90% less energy than a typical home. On the roof, there will be shared community-planted spaces. Support and company will be available because of the Emmaus team's near vicinity. As they investigate which mix of studios and half-beds might work best for the neighborhood, create comprehensive plans, and apply for planning approval, Homes England's Community Housing Fund has assisted with feasibility expenses (Wilde, 2022).

TAM is:

- “A versatile, eco-friendly residence.
- A dwelling structure designed to maximize limited sites.
- A healthy dwelling that can adapt to your requirements and can be moved to other locations and joined with more units.
- A green construction method.
- TAM is produced with the least amount of environmental impact possible utilizing renewable, carbon-capturing resources like straw and wood.
- TAM is warm in the winter and cold in the summer. Both its functioning and design are clever”(Wilde, 2022).

Figure 8. Bristol rooftop modular housing elevation. (Wilde,2022)

These days, homelessness is a widespread problem, and many in the housing industry look for creative solutions to address it. Craig White and his coworkers at Agile Property & Homes in the UK create prefabricated homes from wood and hay. They are even dumping them in Bristol, as recently shown by Treehugger (An Agile Approach to Dealing With Homelessness, 2021).

According to Treehugger, White, an architect by trade, invented ModCell, known for its prefabricated wood panels that are insulated with 16 inches of straw. As already said, "The Modcell system combines the substantial insulating capacity of straw with the strength and stability of a timber construction. Straw is cheap, completely renewable, and a waste product."

Agile Property and Homes, a development company White created, blends ModCell technology with White's background in design. According to him, the company's "model of prefabrication is not to do it from

centralized factories, but to unlock the potential of assembly using an international standard for manufacturing in temporary facilities, like someone's warehouse, to figuratively have flying factories" or technically, "distributed manufacturing." (An Agile Approach to Dealing with Homelessness, 2021).

According to White, a normal developer must take into account three aspects when building structures, including remarkably affordable housing. He continues, "You have to buy your land, make your buildings, your homes or your apartments, and sell them." "Agile is based on the premise that development may be done without having to pay for land. The reply is that you most certainly can. We never purchase real estate; instead, we locate unclaimed free land that is readily available." (An Agile Approach to Dealing with Homelessness, 2021)

Agile constructs its units in accordance with the dimensions and requirements of the Caravan Sites Act, a British regulation that regulates what are known as mobile or HUD homes in the United States. "The key that saves you about 35 percent on your development expenditures is that because our apartments are transportable, we can lease property rather than buy it completely," White continues. As a former real estate developer who attempted projects like this over 20 years ago in a market that wasn't yet ready for the concept, I can speak to its genius. Even though buying land is expensive, a lot of it remains undeveloped while waiting for permits or zoning changes. (An Agile Approach to Dealing with Homelessness, 2021).

Figure 9. Bristol rooftops 3d model

A Bristol-based nonprofit is building 15 brand-new, reasonably priced eco homes on the roof of its city center headquarters. In mid-February, a decision on the planning application presented by the homeless nonprofit Emmaus Bristol is expected. During the conversation, the St. Pauls neighborhood endorsed the charity's request. By using the unclaimed land—the air space—on the roof of the group's headquarters and store at Backfields House, Emmaus Bristol hopes to create a new rooftop community. There will be a community amenity space, a place to grow food, 11 one-bedroom two-story homes, 3 two-bedroom single-story homes, and 1 one-bedroom single-story home. (Bristol Charity Building up to Create Eco-Home Community on City Centre Roof | Agile Property, 2021).

The initiative's main objective, according to Chief Executive Jessica Hodge, is to provide affordable housing for those who are ready to leave the nonprofit's supported housing: "We provide more than just a place to sleep at night. A new member of our Emmaus Bristol community works full-time in our shops to develop new skills and improve their resume while also receiving daily support, mentoring, and training to

help them rebuild their lives. People can remain with us for however long they need, whether that is a few months or years, and there is no time limit on the support we offer. (Bristol Charity Building up to Create Eco-Home Community on City Centre Roof | Agile Property, 2021).

Some of the individuals we assist eventually and rightly want their own home and independence, but they subsequently struggle to find cheap rental homes to move into or must overcome considerable obstacles to private rented housing, such as cost, competition, credit ratings, and references. When people are ready to live independently, our rooftop development will provide them that option while still keeping them connected to Emmaus Bristol and the support we can offer if they need it.

Jessica continues, "The group believes that community-led housing within the city of Bristol is crucial in aiding people in overcoming their homelessness as well as feelings of loneliness and isolation."

A strong feeling of community and getting to know your neighbors are crucial elements of a safe and sustainable neighborhood. While the move-on accommodations we offer include independent living quarters, it is essential that they experience a sense of community. (Bristol Charity Building up to Create Eco-Home Community on City Center Roof | Agile Property, 2021) People have left Emmaus Bristol for more affordable places only to suffer terribly there, without a job or any close community.

In order to lower the cost of building construction in Katerra and in Bristol to lower the cost of land which is the major portion of any project, Katerra and Bristol rooftop prefabricated houses were instances of agile projects.

5-3- Co-housing

5-3-1- Co-housing definition

Co-resurgence housing's coincides with the present upsurge of "DIY," "Re-urbanizing," and "New Commons" tendencies in Western European nations. The aims of the initiatives are remarkably similar globally, and there is a significant information flow between projects and across borders, according to publications and websites of co-housing networks. Urban policy makers and residents frequently have high expectations for the resiliency and influence of self-organized housing communities. The underlying causes behind the trend, however, vary depending on the nation: they can range from changing demographics to land scarcity, the promotion of private property, and inadequate housing distribution (Tummers, 2015; Wang et al., 2020).

For millennia, the idea of communal life has been present (Newsham, 2018; Wang et al., 2020). Hunter-gatherers who lived in vast camps and relied on one another for food, infant and elder care, and other necessities for the majority of human history (Strauss, 2016). The intentional sharing lifestyle has roots in agricultural times when elderly farmers resided in what are now known as Accessory Dwelling Units (ADUs) or "granny flats" in the US (Anacker & Niedt, 2019; Wang et al., 2020). Additionally, people in medieval Europe lived with a group of acquaintances and extended family throughout that time (Gillis, 1997; Wang et al., 2020).

At the moment, communal living with friends and neighbors might be seen as a comeback to how people have constructed their homes for thousands of years (Strauss, 2016; Wang et al., 2020). DePaulo & DePaulo (2015, p. 66) (Wang et al., 2020) describe this as well: "Today, all across the nation, Americans are enjoying the new happily ever after. The "new" aspect is that they are living together with people who are not only spouses or romantic partners. In the UK, diverse types of communal living have emerged (Wang et al., 2020). These include communes, where a group of families jointly own property and share their income and other resources but have relatively little privacy, and housing co-ops, in which the cooperative owns dwellings but does not necessarily co-live in a community (Ahn et al., 2018; Livingston, n.d.; Wang et al., 2020). The arrangement in which many people live together in a community with separate, private dwellings for each person or family and larger communal areas that are shared by all is known as cohousing, which is the subject of this study (UK Cohousing Network, n.d.; Hopwood & Mann, 2018; Livingston, n.d.). In the 2000s, cohousing expanded quickly in both the United States and Europe (Hagbert et al., 2019; Wang et al., 2020). More than 300 cohousing communities were listed on The CoHousing Association of the America's website as of the beginning of 2020, including those that were already founded, still being built, or just getting started.

Cohousing has received attention in Europe as a kind of communal housing, especially in Denmark, the Netherlands, Germany, and Sweden (Hagbert et al., 2019; Tummers, 2015). 2 J. WANG & CO An alternative housing concept built on cooperation, sharing, and tolerance is offered by cohousing (Chiodelli & Baglione, 2014; Tummers, 2015). By employing a sharing system, it might address the issues with social housing that exist now by lowering social isolation and promoting elder and childcare, self-management of real estate, and independent daily life. The term "co-housing" as a whole refers to a wider range of initiatives by resident groups that collectively create living arrangements that are not readily available on the (local) housing market, such as the French Habitat Participatif, German Baugruppen, and Dutch Collectief Particulier Opdrachtgeverschap. Co-housing is a manifestation of modern citizenship, when residents actively take control of their housing and environmental situations. As long as the organizational entity covers the spatial entity, these environments may be found in urban, suburban, or rural locations; involve any number of families; and be freshly constructed or (re-used) existing real estate (Fedrowitz and Gailing 2003; Tummers, 2015). While housing and planning environments vary from one country to the next, co-housing residents' ideologies and objectives are fairly similar. A structure for teamwork during construction and management, goals to establish a "non-anonymous" neighborhood, non-speculative, inexpensive housing, energy-efficient buildings, and a smaller ecological imprint are typical characteristics. Authors have suggested that modern co-housing can be seen as a pragmatic response to demographic change and new lifestyles over the past ten years (Kläser 2006; Jarvis 2011; Tummers, 2015). Social networks and energy-efficiency are not only idealistic ideals; they are also necessary in order to lower housing costs, including energy bills, battle loneliness after leaving the workforce, and manage the busy schedules of young middle-class families. However, elements from the idealist beginnings are still present. The initiatives can be seen as a practical response to the goals of urban policy that are social cohesion, care for an aging population, local identities under globalization, healthy and child-friendly environments, locally based responsible economies, energy transition, and participation in urban development, according to the charters and declarations published by co-housing networks. Instead, than promoting homogeneity and exclusion, co-housing initiatives try to put a vocabulary of diversity, solidarity, and inclusion into practice. As a planned paradigm for future housing provision or a gentrification strategy, this debate is of interest to residents as well as researchers and politicians (Maury and Bernard,eds. 2009;Fromm 2012; Tummers, 2015; Wang et al., 2020). Alternative housing programs, according to Lejeune, are currently "remain midway between utopia, experiment innovation, and social transformation" (Lejeune 2009, 108;Tummers, 2015; Wang et al., 2020).

Types of cohabitation Co-housing is a "family" of kinds that comprises a variety of organizational and architectural forms, and who belongs to this family is frequently left unstated. Several categories have been used, based on various sets of criteria, to understand the direction that co-housing is going (Tummers, 2015; Wang et al., 2020):

- “Residents' demographics and target group.
- The separation from society (alternative to mainstream).
- The level of involvement and self-management
- Community development.
- Time and setting in history.
- The ecological philosophy and notion of sustainability.
- Features of architecture and city planning.” (Wang et al., 2020)

5-3-2- How co-housing communities shape?

In a cohousing community, dwellings are typically distributed or constructed on a household basis in the UK. There are standard amenities in every single or attached home, including a private kitchen (Durrett Architects, 2020; Fabric, n.d.; Wang et al., 2020). A cohousing community's basic design features dwellings clustered around a communal area created for everyday usage to encourage private life (McCamant & Durrett, 1994; Tummers, 2015; Wang et al., 2020). Even yet, cohousing can also exist in a single structural building, which in the UK is typically a sizable single-family home that has been altered to accommodate the

needs of several homes. Typically, group founders and project architects collaborate to design freshly constructed cohousing, specifically for multiple homes (Plouffe & Kalache, 2011; Tummers, 2015; Wang et al., 2020). However, some cohousing communities can be created from already-existing structures, even older ones (such as a farmhouse or mill building), in which case residents work with architects to rebuild or restore them or combine the current structure with a brand-new residence. Some of the cases chosen for this study involved the construction of private homes surrounding old buildings that were used as a communal residence, shared workshop, or storage space. Residents share amenities, facilities, visitor lodgings, and—possibly most importantly—a common house where neighbors can congregate for get-togethers, social gatherings, and meals (Nelson, 2018; Wang et al., 2020). As a result, the common house, which might include a communal kitchen and dining space, common laundry, guest rooms, and children's play area, is an important aspect of a cohousing community (Berggren, 2017; Wang et al., 2020). In terms of the community's zoning and residents' participation, cohousing defies societal conventions of privacy (Jarvis, 2011; Tummers, 2015; Wang et al., 2020). A cohousing community's objective is to develop a thriving social environment with improved community support and care (Sanguinetti, 2014). Participation in organized activities promotes neighborhood interaction and community sustainability (Skidmore et al., 2006). (Garciano, 2011; Ruiu, 2014; Wang et al., 2020). By establishing a sense of community and belonging among family members, neighbors, the local community, and the larger neighborhood, it enables residents to establish a sense of ownership (Brenton, 2008; Yuryev et al., 2010). For instance, one neighbor may be able to watch over youngsters and babysit on short notice, while another may be able to help seniors with difficult duties like yardwork and snow shoveling or keep an eye on them in case of accident or injury (Glass, 2009; Smith, 2002; Tummers, 2015; Wang et al., 2020).

5-3-3- Co-housing purposes:

5-3-3-1- Sustainable contributions:

Environmental (ecological), economic, and social "pillars" are the three dimensions or "pillars" that have been associated with sustainable development (Brundtland et al., 1987; Dresner, 2008). It is crucial to talk about these contributions in order to comprehend how they affected the growth of cohousing in the UK(Wang et al., 2020).

5-3-3-2- Ecological benefits:

Cohousing communities usually exceed traditional housing in terms of environmental sustainability since community spaces and resources are shared (Crabtree, 2006; Jarvis et al., 2016; Meltzer, 2005; Wang et al., 2020). Additionally, cohousing projects could connect natural settings (such plants and animals) with environmental demands by pooling resources, growing food, employing consensus decision-making, offering regular social activities, and adopting improved community design (Sanguinetti, 2014, 2015; Wang et al., 2018; Wang et al., 2020). Cohousing communities could also significantly lower their energy and consumption requirements while promoting sustainable practices by implementing cutting-edge environmental technologies and building standards (such as the Passive House Standard, solar PV, and biomass) on fundamental building components (Jarvis et al., 2016). However, these technologies are rarely deployed because of their comparatively high implementation costs.

5-3-3-3- Economic benefactions:

Cohousing has the potential to be financially sustainable and cost-effective eventually in a variety of ways, including by sharing cars and commutes, using shared facilities, or by using a sound financial system like mutual home ownership models, which could make cohousing more accessible to young people, particularly middle-class individuals (Chatterton, 2013, 2014). Additionally, some cohousing groups continue to offer low- and moderate-income people financial assistance so they can live in a cohousing community through a variety of affordable housing solutions, as well as external and internal subsidies (such as community loans, vouchers) (Garciano, 2011). Since the 2008 Global Financial Crisis, the UK housing market has faced significant obstacles that have had detrimental financial and social effects. For example, mortgage repossessions, expanding social housing waiting lists, extremely high unemployment in the construction

industries, and rising housing costs have caused a collapse in home ownership (Parvin et al., 2011; Perry et al., 2019; The UK Collaborative Centre for Housing Evidence [CaCHE], 2019). Younger families who cannot afford to buy homes still require about 1.2 million rental dwellings (BBC, 2019a). To solve this issue, the UK government wants to construct 250,000 homes by 2022, including rental properties (BBC, 2019b). However, the current approach prioritizes increasing supply rather than finding a solution to the housing crisis, and if left alone, could lead to an increase in the number of abandoned properties (The UK Collaborative Centre for Housing Evidence [CaCHE], 2019). The UK government has a number of additional programs to address this issue, including the Help to Buy policy, affordable housing, the construction of more social housing, leasehold reform, and infrastructure grants to local governments (Letwin, 2018; Perry et al., 2019). Additionally, by investigating its shared ownership model and community financial plan, cohousing can be a successful strategy for resolving the housing issue and addressing the financial worries of older people and lower-income younger families (Housing LIN, 2013, 2019; Jarvis et al., 2016; The Social Market Foundation, 2019; Wang et al., 2020)

5-3-4- Limitations of cohousing :

The research on the subject has mainly concentrated on its advantages. However, there are also possible downsides and information gaps. Some studies have classified cohousing's drawbacks into the following categories (Chiodelli & Baglione, 2014; Riedy et al., 2018; Wang et al., 2020).

5-3-5- Territory-based arrangement

The restrictions on territory-based agreements could be categorized as environmental design restrictions or limitations on community planning. Public opinion of cohousing and its effects on neighborhood amenities is one obstacle to it. Because developers frequently do not completely comprehend the cohousing design concept, parking challenges, including placement and size, are frequent for cohousing site planning. A cohousing community may also turn into a gated community due to the unique social structure of these communities, which would separate it from nearby areas. (Chiodelli & Baglione, 2014 ;Wang et al., 2020).

5-3-6- Internal community management

The imbalanced "private public life" is the main problem with internal community management. First, because of these groups' open culture and members' intense involvement in one another's life, some private news and rumors will eventually become public information, making it challenging to distinguish between private and public affairs (Schacher, 2005; Wang et al., 2020). Second, various people may interpret comfort and intimacy differently according to their varied life experiences and preferences. As a result, it is challenging to assess community management using a common criteria Last but not least, cohousing residents may find it challenging to make decisions because doing so "may cause less freedom to modify one's living unit" (Fromm, 2000, p. 105; Wang et al., 2020) or may cause delays in long-term projects while waiting for responses from all community members.

5-3-7- Financial obstacles

Since land in the UK is so expensive, a major obstacle for cohousing members is money (Brenton, 2013; Riedy et al., 2018; Wang et al., 2020). Depending on their size, location, group members' income levels, and level of customization, some cohousing communities are still out of reach for potential purchasers despite cohousing's pricing being competitive with that of standard market-rate housing. Although a lot of cohousers in the UK prefer newly constructed housing due to its superior insulation, effective performance systems, and increased flexibility in the application of cutting-edge technologies and design standards, their initial costs are higher than those of repurposed existing structures. Sharing among group members may raise their cost of living in some situations, even though the communal feature of cohousing communities is often designed to decrease financial burden. For instance, even though some cohousing residents may not use all of the communal amenities, they are still required to pay or share the costs because they are a part of the neighborhood (Garciano, 2011; Wang et al., 2020). Additionally, it might be difficult to sell real estate in a

cohousing community because "A household can opt to sell their unit, but they must abide by the wider community's readiness to accept the household that has agreed to purchase" (Hoch, 2019, p. 17; Wang et al., 2020).As a result, cohousing properties are less accessible to non-cohousers, and it is more challenging for current inhabitants to identify prospective buyers(Wang et al., 2020).

Tummers (2015) described several perspectives on co-housing, including categorizations of various types and geographical situations. Co-housings around the world can be compared to find commonalities in aims as well as variances in planning and legislative background. The following characteristics of co-housing schemes are common:

- “Self-management and resident participation
- Organizational unit overlaps spatial entity
- Mutualization and collaboration oriented
- Non-speculative, frequently seeking sustainable lifestyle
- Preference mixed usage and mixed income “(Tummers, 2015).

However, despite the fact that co-housing and self-managed housing are becoming more prevalent in the housing discourse, little is known about their quantitative performances. As of yet, rather than coming from the engineering and design disciplines, the supporting Urban Research & Practice 75 evidence for the urban features of co-housing and its impact on the neighborhood has been presented at the case study level. There shouldn't be any reason to question the lived testimony that locals have provided for directories, websites, publications, or even academic case studies. However, because these experiences specifically increase expectations to "create a better world" (or at the very least, a less wasteful built environment), there is a need to more thoroughly evaluate how this actually works (Tummers, 2015).

Tummers (2015) has stated that understanding planning cultures is crucial to understanding the co-housing boom in Europe. It is first necessary to develop the "DNA" of co-housing efforts in order to "frame, map, and measure" the co-housing trend. Who is a member of the family? Planning criteria can help with a more accurate definition that takes into account local and national situations since they can show where problems have comparable impacts but different solutions (Tummers, 2015).

The analysis of planning documents using "Mapping and Measuring" could then yield important data, such as: What is the typical number of homes, and what number is best for social cohesion, energy smart grids, or other factors? Do they reside in central, suburban, medium-sized, outlying, or rural urban areas? What is the m2/person in relation to typical living conditions? What is the ecological footprint compared to typical home types? Which areas, outside living quarters, are shared: workshops, businesses, classrooms, guest rooms, and play areas; and to what extent do they replace public facilities? Second, studies on co-housing frequently cite examples from many nations without mentioning the various housing and planning systems in which the efforts are implemented. However, these factors play a significant impact in how projects are shaped, such as the participation of architects, suitable locations, discussions with and assistance from local authorities, or tenure regulations. If such surroundings are not taken into consideration, the architectural and urban elements of co-housing as a new housing paradigm cannot be comprehended correctly (Tummers, 2015).

To achieve a sufficient understanding, analyses from every area of planning, urban design, and strategic development, as well as engineering and legal regulation, must be merged. The co-housing concept is also important for planning and research since it shows housing desires and how the "traditional" housing market is failing to respond. Co-housing may be viewed from the standpoint of planners as a testing ground for the demand-side housing criterion. This raises the crucial question of whether the connection between spatial and social dynamics calls for new surroundings or, rather, a shift in mindset and communication in intentional communities as a new practice of social cohesiveness. The relationships between spatial and social architecture, the dynamics of international knowledge transfer, and the function and character of planning itself are some of the fundamental concerns that need to be addressed. These questions span a wide range of disciplines, and planning papers can greatly aid in comprehending them (Tummers, 2015).

5-4- Gamified co-housing start-up :

Figure 10. Gamified co housing App (Gamified Cohousing App Preview, 2022)

A Finnish start-up company called Gamified Co Housing was formed by Pedro Aibe, an internationally recognized MSc Architect and MSc Civil Engineer who has completed over 50 structures across 20 nations. Founder of the World Music School, the Gamified Cohousing Oy, and the theatre+games collective "Cidadania." Aalto University PhD candidate in "Architectural Democracy," art instructor, graphic novelist, and deputy member of Lohja's urban planning board (Bio CV Pedro Aibeo, n.d.).

This start up just has been nominated by the Nordic start up award for the best newcomer and also it has been granted a funding from the Helsinki think company and several Finnish publications has written about it.

Buildings that had been abandoned were renovated and turned into gamified communities. For this, they created a brand-new, cutting-edge mobile application alongside Metropolia's software engineering students. The program is a real-world version of The Sims for facility management.

The decision to convert the app development project into an innovation course with 10 study credits was made by Gamified Cohousing and Metropolia University of Applied Sciences. Ten fourth-year students studying software engineering joined up for the project in total. The objective was to create a mobile co-housing application that was gamified for facility management.

"More should be reaped from partnerships between the public and commercial sectors. According to Pedro Aibéo, CEO of Gamified Cohousing, the goal of this partnership was to further improve the app and eventually identify students who appreciate the value of our work and could want to collaborate with us in the future."

"Students and businesses gain from working with genuine company scenarios. Students gain invaluable experience working directly with end users through real-world business cases. Additionally, it offers businesses brand-new suggestions and answers from students. I am pleased of the entire team at Metropolia since they did such a terrific job executing the client's vision, says Senior Lecturer Heini Puuska."(Innovative Mobile Facility Management App Being Launched by Gamified Cohousing and Metropolia University of Applied Sciences, 2021)

Living together with others is a crucial lesson in how to resolve conflicts and become political beings for both adults and children.

Living with others can be accomplished in a variety of ways, from democratic government to sociocracy. By creating economies out of vacant buildings, this group at the Gamified Cohousing is attempting to address the loneliness of cities and the waste of resources. Over 10% of buildings in Finland are vacant, representing an untapped market worth 800 million euros, they said. They listed a few causes behind this and said they wanted to change it by following their four principles:

-“ Minimalistic renovation (with lean construction technologies)
- 50/50 cohousing + coworking spaces (Shared spaces are great investments) - Modular Design solutions (Rooms on wheels!)
- Gamified Facility Management (imagine living in a Sims game!)”

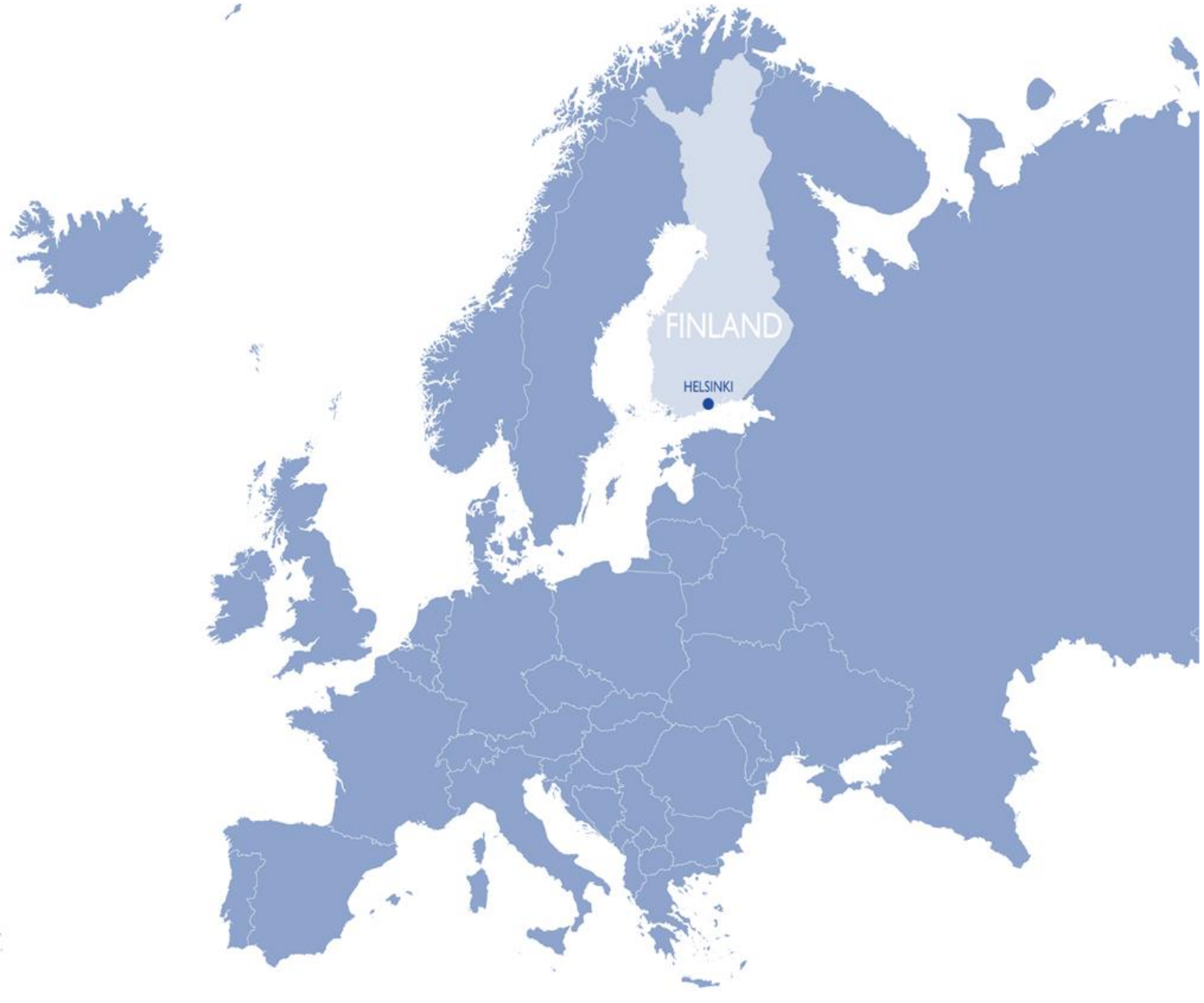
In order to make these regions livable and draw people for the potential of the internal economy, they provide property owners with a lease solution. The way they make money is by taking a cut of every transaction. This will not only bring back these nostalgic old locations, strengthening local links, but it will also build communities of people who can spontaneously organize themselves using game principles.

They claim that this solution is easily adaptable to current coworking spaces, co housings, and even regular residences and offices that are looking for better ways to organize their internal social lives and their jobs. ("Mehr Als Wohnen" Meets "Gamified Cohousing," n.d.).

Their catchphrase, "We convert empty buildings into economies," was developed as a result of study on architectural democracy and it aims to solve two significant issues in cities: loneliness and the exploitation of natural resources. Regardless of location, they guarantee that they can transform any vacant property into a vibrant, resilient cohousing and coworking community using their business model of service co-development and its five-step implementation plan. People may work and live in current standards with a mix of private and shared areas by using the facility management software, where daily tasks or rentals can be simply managed in a fun way (Gamified Cohousing, n.d.).

-What major targets does GAMIFIED COHOUSING have?

- Combat loneliness (Preventive health)
- Don't develop new structures close to vacant ones (environment)
- Upgrade existing structures or add on to them (heritage)
- Compile data, carry out research, and organize public discussions
- Change architecture from being a product-based service to being a process.
- -Measure the ecological footprints of the cohousing, gamers, and residents; adopt various home ownership schemes to minimize housing market speculation.
- -implement AI for improved living and working behaviors in cohousing and co-working spaces (user has the data ownership).
- Develop economically, environmentally, and socially viable living and working communities where individuals negotiate differences locally (political literacy), with adaptive physical and social design that allows users to learn their own social rules inside that community using game mechanics. (Gamified Cohousing, n.d.)


FINLAND
HELSINKI

6- Smart Helsinki

6-1- Helsinki Main Overview

Helsinki, Swedish Helsingfors, capital of Finland, is the most vital seaport and industrial city in the country. Helsinki is in Finland's far south, on a peninsula surrounded by beautiful natural harbours that protrude into the Gulf of Finland. It is the northernmost capital of continental Europe. Because many of its buildings are made of local light-colored granite, it is called as "white city of the north." (The Editors of Encyclopedia Britannica, 2019)

In order to compete with the city of Reval, King Gustav I Vasa of Sweden established Helsinki in 1550. (Now Tallinn, Estonia). The King then ordered the residents of Rauma, Ulvila, Porvoo, and Tammisaari to migrate to Helsinki; the date of this order, 12.6.1550, is recognized as the founding date of the city. (The Editors of Encyclopedia Britannica, 2019)

However, the town expanded slowly, and in the 1600s, the city center of Helsinki was relocated to its current site. To confront the increasing danger from Russia, Sweden began building the Suomenlinna Maritime Fortress off the coast of Helsinki in 1748. The huge project delivered the town more wealth, residents, and businesses. Russia invaded Finland in 1809. Three years later, Helsinki was elevated to the rank of capital of the independent Grand Duchy of Finland. To symbolize Russia's and the Tsar's authority, a massive Empire-style city design was created. In 1917, Finland gained independence, and Helsinki undertook the challenging new role of capital of the fledgling country. Classicism and Functionalism were prominent in city planning. In 1952, Helsinki hosted the Summer Olympics as it recovered from the war's difficulties. Helsinki gained a global reputation as an efficient and welcoming host city as a result of the games. (History of Helsinki in a Nutshell, n.d.)

In the postwar years, agrarian Finland was soon transformed into a modern industrial land in only a few decades. People came to the cities of Southern Finland and the Helsinki Region in vast numbers, fleeing the rural areas. In order to meet the growing demand for housing, Helsinki soon established suburbs such as Herttoniemi and Maunula in the 1950s and Pihlajamäki in the 1960s. In 1995, Finland became a member of the European Union, beginning a new era for the capital yet again. During the year 2000, Helsinki was named one of nine European Cities of Culture. Helsinki also celebrated its 450th anniversary in that year. (City of Helsinki, 2021)

Helsinki, together with Espoo, Vantaa, Kauniainen, and Lahti, was awarded World Design Capital 2012 in 2012. (WDC, World Design Capital). Open Helsinki - Embedding Design in Life was the subject of World Design Capital Helsinki 2012. In 2014, Helsinki applied to join the UNESCO Creative Cities Network as a City of Design and was accepted. Due to partnership with other Cities of Design, Helsinki has been able to share its experiences and interact regarding the use of creative approaches and design in the development of the city. Helsinki is among one of the few cities in the world to hire a Chief Design Officer, and it was the first city in Europe to do so. In 2016, the city of Helsinki employed the first Chief Design Officer. The Chief Design Officer is responsible for strengthening Helsinki's strategic development, the use of design in the creation of public services and the resident experience, and the work to raise Helsinki's international design profile. Hanna Harris has been Helsinki's second Chief Design Officer since 2020. Helsinki Lab, the city's internal design team that promotes the use of design in urban development, assists the Chief Design Officer. (J. 2021, June 24th. Helsinki's design journey. Design Helsinki.) Helsinki is not just a city but also a hub of communities with a lively atmosphere that nurtures all kinds of creative development and experimentation. The city emphasizes well-functioning urban planning and has the courage to give space to unique architecture. For the past decade, Helsinki's population has increased by roughly 1% every year. According to the city's official statistics, the city's desirability as a location to live and work is partially explained by its appeal as an appealing place to work and visit.

The development approach of Helsinki is built on openness and transparency. According to mayor Jari-Matti Saaremaa (Juhlämäki), the city actively forms relationships with NGOs and anybody interested in the city's development and enrichment.

Citizens are well-educated, and the English language is sufficient for getting around the city and in the workplace. Helsinki's metropolitan setting provides an excellent growth platform for firms to concentrate on innovation. It also draws an increasing number of foreign businesses, investments, experts, and visitors.

The presence of the water and the buzz brought in by sea routes have a significant impact on the capital region. In 2018, Helsinki surpassed Shanghai as the world's busiest passenger port. Tallinn and Stockholm are both direct daily routes from Helsinki. (Maarit Kivistö, n.d.)
The city of Helsinki is officially split into eight primary districts, each of which is subdivided into 34 subdistricts (simply called districts). These are further subdivided into a plethora of smaller divisions. The city may be split into 60 separate regions, similar to how districts are divided. (Maarit Kivistö, n.d.-b)

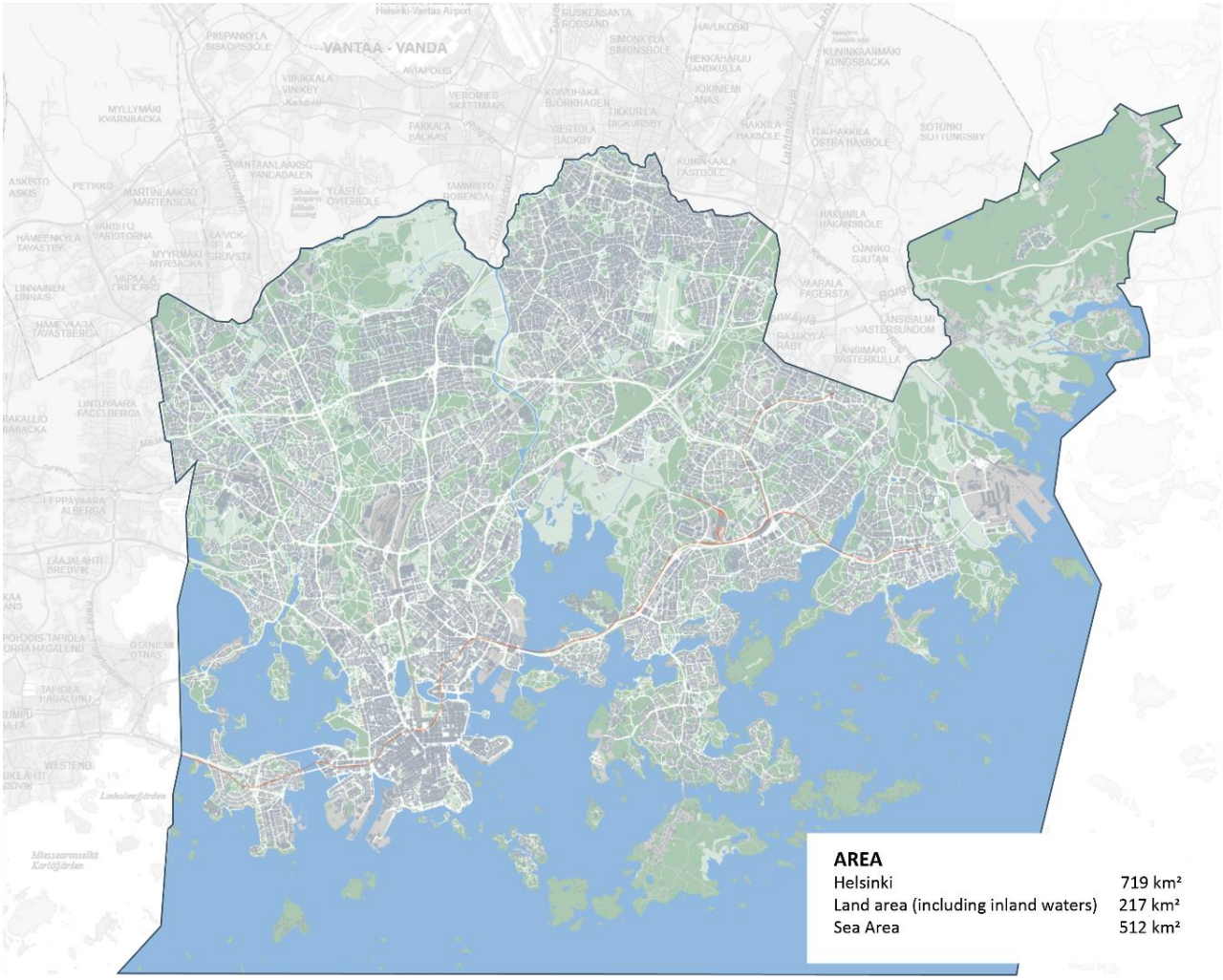


Fig 11. Map of Helsinki. ©city of Helsinki

6-2- Demography Of Helsinki

Based on latest population data of Helsinki on 2021 ,the population of Helsinki on 31 December 2021 were 658,457 which is 11.9% of Finland's population.52.4% of this number are women and 47.6% are men.
According to population statistics done by city of Helsinki city had 0.2% increased in population and they anticipate reaching to over 750,000 by 2035.
The major age group of people living in Helsinki are 30-34 years old and the average age of people in Helsinki is 41,1 which is almost 2.5 year younger than the average age in whole finland.68000 of Helsinki's residents are holding a foreign citizenship which is around 23% of all of them in Finland.
According to statistics from 2020 almost 49.9% of households are one-person households,30.1% two-person,9.8% three-person and about 10% four or more persons. So, the average size of households in Helsinki is 1.9 person and they are 42.6% owner-occupied and 47.3% Rented and about 10% other solutions.
Density of Helsinki's housing is 34.5m^2 which is 7m^2 less than the average size in all Finland.

	Helsinki	Finland
Average rent, €/m^2/month	18.6	14.1
Average price per m^2 of old dwellings, €/m^2	4.775	2.179
Most expensive zones, €/m^2	9.355	9.355
Least expensive zones, €/m^2	2.395	330

Table 4. Housing cost comparisons of Helsinki and Finland in 2021.

6-3- Helsinki as a Smart City

The concept of a smart city has been a popular phenomenon, and multiple cities worldwide have adopted smart city practices in urban development. Further, information and communication technologies (ICTs) and novel digital technologies such as Internet-of-Things (IoT), artificial intelligence (AI), and data analytics play an integral role in the implementation of the concept of a smart city. The European Union (EU) defines a smart city as a place where traditional networks and services are made more efficient with the use of digital and telecommunication technologies for the benefit of its inhabitants and business. Alternatively, a smart city is defined as a city in which ICT is merged with traditional infrastructures, coordinated, and integrated using new digital technologies' (Batty et al., 2012). Caragliu, Del Bo, and Nijkamp (2011) define a city as smart 'when investments in human and social capital and traditional (transport) and modern ICT communication infrastructure fuel sustainable economic growth and a high quality of life, with a wise management of natural resources, through participatory government.' The ITU-T Focus group (2015) and ISO (2015) summarize that a smart city is an innovative city that uses ICTs to improve the quality of life of residents, thereby enhancing the efficiency of urban operations and services and improving sustainable socio-economic and environmental outcomes by responding to the challenges of urbanization. The objectives of smart city initiatives and the use of digital technologies enable the streamlining of city processes and not only make city services more accessible for residents but also enhance the resource management and efficiency within the city (Aguilera, Peña, Belmonte, & López-de-Ipiña, 2017). Further, smart city practices aim to reduce the costs of city services and improve the return on investments (Vilajosana et al., 2013), accelerate economic growth, competitiveness, and transparency, as well as stakeholder participatory in the cities (Abella, Ortiz-De-Urbina-Criado, & De-Pablos-Heredero, 2017; Perez, Poncela, Moreno-Roldan, & Memon, 2015; Yo- 3 vanof & Hazapis, 2009). New digital technologies applied in 'soft' city domains such as education, health, and social care, and city administration (Petersen, Grazia & Oliveira, 2015) aim to foster knowledge creation and enable the emergence of new knowledge-based businesses and digital innovations (Baccarne, Mechant, & Schuurman, 2014; Li, Nucciarelli, Roden, & Graham, 2016). Smart city initiatives also aim to enhance social inclusion and prevent inequality among the citizens.

Employing novel digital technologies across an organization's activities is a long-term process that impacts an organization's structures, capabilities, and existing IT infrastructures and systems (Davenport & Westerman, 2018). Thus, the design, management, and governance of digitalized and interconnected smart city operations and ecosystems are not a trivial task. Research has identified that numerous smart city initiatives tend to fade away when project funding is used (Diaconita, Bologa, & Bologa, 2018; Hämäläinen & Torvinen, 2016). The objective of this paper is to shed light on the elements that are relevant for robust digital transformation, ecosystem creation, and orchestration in a smart city. The smart city design framework is founded on four dimensions—strategy, technology, governance, and stakeholders and is complemented by sub-dimensions. The smart city framework aims to improve the process of digital transformation within the city and assist smart city stakeholders in the private and public sectors to clarify complex smart city governance, ownership, orchestration, and decision-making procedures. The framework also highlights the importance of technological compatibility, appropriate skills, and resource allocation in smart cities to ensure robust and well-grounded smart city implementation.

Helsinki aspires to be the world's most functioning city, according to Helsinki City Strategy 2017-2021. Helsinki is working toward this aim through digitizing services and implementing smart city solutions. Helsinki uses digital technologies to enhance the quality of life of its residents. These solutions also contribute to Helsinki's objective of being carbon-neutral by 2035. Helsinki is known for developing urban solutions in collaboration with corporations, research institutes, and residents. Kalasatama, Jätkäsaari, the Maria 01 startup campus, and Otaniemi are all examples of Helsinki's smart city development (Helsinki Partners, 2020).

Helsinki is making rapid progress toward its objectives. In recent years, Helsinki has been ranked among the world's top cities in worldwide smart city rankings, and the city's digitization of services has received international attention. In a long piece published in October 2020, the prestigious American publication The New York Times lauded Helsinki's climate efforts and smart city development. In October, Helsinki earned The Year in Infrastructure 2020 Conference's Going Digital Award, the main honor in the Digital Cities category. Greater Helsinki is one of Europe's most appealing investment destinations.Kalasatama, a new residential neighborhood built on former docklands, is the showcase for Helsinki's smart city development.in next chapter I will discuss about kalasatama urban living lab(Helsinki Partners, 2020).
Helsinki is well-known for its innovative mobility solutions. In particular, the Mobility-as-a-Service (MaaS) idea was created in Helsinki. The MaaS program allows city inhabitants to buy whole, seamless transportation chains from their front door to their destination, eliminating the need to own a car. Jätkäsaari is the Helsinki smart mobility test area. Sensible 4, a globalizing Finnish firm focusing in software development for autonomous cars, was born out of a community-led innovation effort, among others.In regards of data, Helsinki follows the MyData principle, which states that people and city residents control the data that pertains to them. This is a European principle as well (Helsinki Partners, 2020).
Helsinki has made a long-term commitment to its development as a smart city. The Economic Development division's Innovations and New Experiments section establishes the city as a suitable testbed setting for businesses and promotes the region's wide ecosystem to encourage innovation and commercial activity. Forum Virium Helsinki, the city's innovation firm, collaborates on future digital and data-driven urban solutions. The city also collaborates closely with corporations, scientific groups, and citizens to offer comprehensive services. The City of Helsinki's digitisation progress may be tracked on the Digital Helsinki website, which collects news, events, goals, and practical tasks related to the city's digital growth. “The goal of Helsinki’s ambitious digitalisation programme is to be a city that anticipates people’s need for services on their terms (City of Helsinki, 2020). Over the last few years, we have launched several digitalisation projects that are related to the development of services, as well as the city’s development of its cultural, organisational, leadership and staff competencies,” says Mikko Rusama, Helsinki’s chief digital officer(City of Helsinki, 2020).

6-4- Helsinki City Strategy 2013-2021

Helsinki publishes its city strategy for each four years and they introduce the main vision they have for those years and the main goals of it. They also publish facts and figures of each year on the citiy’s website with all statistics and graphs related. Here the visions of three recent strategies they have published are mentioned.

2013-2016:

Vision :

1-“Helsinki is a community for all its residents and a capital with good services,open decision-making and flourishing science,art and creativity scenes.”
2-“Helsinki is a worl-class business and innovation Center and its success will benefit the resident’s wellbeing and the whole country.”
3- “The metropolitan area will be developed as a uniformly operating area, surrounded by `nature,i.e. a good place to live, work and study and do business.” (CITY OF HELSINKI ECONOMIC AND PLANNING CENTRE, 2013)

Values:

“- Resident orientation
- Ecological approach
- Fairness and equality
- Economy
- Safety
- Involvement and participation
- Enterprise-friendliness” (CITY OF HELSINKI ECONOMIC AND PLANNING CENTRE, 2013)

2017-2021:

1-“The most functional city” in order to “create the best conditions possible for urban life for its residents and for visitors”
2-“securing sustainable growth, the most essential task of the city;”
3-“developing services”
4-“responsible management of finances, the foundation of a prosperous city
5-Helsinki strengthens and diversifies its promotion of interests
6-Responsible management of finances, The foundation of a Prosperous City” (CITY OF HELSINKI ECONOMIC AND PLANNING CENTRE, 2017)

Values:

“-A living and captivatingly original city
-a faster and more agile organizational culture through controlled change of rhythm
-supporting every young person and prevent social exclusion
-being international, living and captivating Helsinki of events,
-being the world’s most impactful place for learning
-Modern climate responsibility
-Moving and healthy city for all
-Living, Distinctive and safe neighborhoods” (CITY OF HELSINKI ECONOMIC AND PLANNING CENTRE, 2017)

6-5- Helsinki City Strategy 2021-2025; A place for Growth

Helsinki has grown rapidly in recent years, owing to decision-makers' cooperation and the city's ambitious expansion. Helsinki is putting its ambition of being the world's most functional city into action. On the other hand, the city's adequate population density has a beneficial effect in that it creates a market and demand for a variety of commercial operations. Even highly specialized industries will find enough clients if there are enough inhabitants, and when the industry is diversified, the city will be a desirable location to live. The city and its inhabitants will have a greater chance of coping in a worldwide world if their livelihoods are diversified. Helsinki's future is bright if it is built on a foundation of long-term growth. Sustainable growth is consistent with natural boundary conditions and leads to long-term social, economic, and cultural well-being. The UN Sustainable Development Goals govern and assess Helsinki's development. Inequality is a worldwide megatrend that Finland has managed to keep under control so far. It is up to policymakers to assist individuals and combat poverty and inequality. The city works hard to guarantee those discrepancies across districts in Helsinki do not worsen, and those disparities are actively addressed. Helsinki’s strength is voluntary urban culture. Helsinki's development is built on long-term zoning and urban planning, which allows for the construction of new houses and businesses each year. Decision-makers in cities do not cause migration, but they can facilitate it. Helsinki's development helps the whole country, but it is most importantly home to current and future Helsinki inhabitants. People may use the city to establish long-term conditions for their life and to identify with settings and groups that they like. Helsinki's grandeur lies in its ability to be and do things together, as well as in everyone's freedom to live their own lives. Finland's Prime Minister, Juha Sipiläämäki: Helsinki, has already met its target of carbon neutrality by 2035, which was established during the previous administration, and now we're increasing the bar. The loss of biodiversity and extinction of species has developed in tandem with climate change, another expression of the earth's and nature's constraints. Nature's diversity and versatility are wonderful in and of themselves, but they are also essential to people's mental and physical well-being. It is simple to live in cities that are climate- and environmentally sustainable; thus, urbanization is a good force for nature. We want Finns and Helsinki inhabitants to be able to age gracefully and happily. The decline in the working-age population has a negative impact on the collection of taxes and social security contributions. In the next years, Helsinki's decision-makers must be able to exert effective lobbying in the direction of government. The state must fund statutory services while also considering the unique characteristics of the major metropolis. Aging is also reflected in the fact that several of the most important service industries are having a hard time recruiting enough workers (City of Helsinki, 2021c).

6-5-1- Sustainable growth of Helsinki:

Every Helsinki resident must benefit from Helsinki's long-term progress. At work, in schools, in parks, and in art events and festivals, everyone should be able to feel Helsinki. As Helsinki's population expands, the relevance of early childhood education and school will be highlighted. In Helsinki, we're considering how to infuse the city with energy. Demand for traditional office space is anticipated to fall because of the digital change in employment and technology. Offices and business spaces will not go away, although demand for them may decline. The importance of being able to use space in a variety of ways may be highlighted. (City of Helsinki, 2021c)

The previous Helsinki urban strategy is good, and there is no need to rehash anything it states. However, the present strategy examines how our decision-makers should assist the city's growth in the next years, as well as what new options are available. Cultural institutions, restaurants, and the event business, as well as their employees, have been suffering. Staff in social and health care, teachers, early childhood educators, and a variety of other professions have all had to work extremely hard. More people are reporting mental health issues, and many ailments are being untreated. These issues must be addressed head-on, and the benefit debt must be eliminated. In four years, we feel we will be able to be even more proud of our beloved hometown. (City of Helsinki, 2021c).

6-5-1- **Choices, programs, and priorities**

The Helsinki City Strategy for 2021-2025 has 13 priority areas. (City of Helsinki, 2021i)

1- "The best and most equal place in the world to learn
2- Ambitious climate responsibility and nature conservation
3- Art and culture are the enablers of a good life
4- Equal and international Helsinki
5- The distinctiveness and security of Helsinki's districts will be cherished
6- Functional and beautiful city
7- Intelligent transport solutions are the basis of a smooth everyday life
8- The well-being and health of Helsinki residents are improving
9- A responsible economy as a basis for sustainable growth
10- An attractive Helsinki for staff
11- Smart Helsinki is managed with knowledge and utilization of digitalization
12- Helsinki is attractive for experts and companies
13- National lobbying and international cooperation."

6-5-2- Strategy implementation - indicators and monitoring

Qualitative and numerical indicators are used to track the urban strategy's goals. In the middle of the council term, we will report to the City Council on the strategy's execution and, if required, re-evaluate the implementation techniques. (City of Helsinki, 2021j)

6-5-3- Monitoring and implementation of the strategy:

The city's industries and services execute the urban strategy as part of their daily operations. We monitor key objectives and indicators during the strategy period to guarantee the success and effectiveness of the urban strategy. (City of Helsinki, 2021j)

6-5-4- Indicators and their development:

Citizens, city employees, and city decision-makers must have access to and compare information that is critical to the city's administration and development. We promote awareness of the development needs of services and operations by freely providing up-to-date information. The City Group's industries and subsidiaries' yearly reports, as well as the indicators and important data contained within them, are evaluated and amended. We want to establish the circumstances for the city's operations to be evaluated over time, in comparison to other cities and with market players, using transparency and comparability. The strategy's key objectives are a useful starting point for a more comprehensive analysis. (City of Helsinki, 2021j)

6-6- New Horizons in Helsinki

Maintaining Helsinki's development vision is a primary national concern in Finland. to follow daily achievement, the city is constructing new houses, day-care centers, schools, parks, and streets as new districts are developed and old neighborhoods are rejuvenated in various ways (uuttahelsinkia,2021).

Honkasuo

Although Hokkasuo is largely a residential area, there is space for small companies and pilot projects to develop co-working. The project's goal is to convert the Honkasuo forest and meadow region into a village with a population of 2000 people. A park, urban agricultural plots, a playground, and natural ponds to absorb rainwater are all part of this project. Residents began relocating in 2016 when part of the complex was built, but the landscaped embankment is anticipated to be completed in 2022 (Honkasuo, 2019).

Kuninkaantammi

Kuninkaantammi will be a new neighborhood in the heart of Helsinki, Finland's largest city. It will be designed in a spiral shape evocative of ancient medieval cities, with a focus on walkability and community involvement. The region has a history as a bustling industrial district, and some of the old buildings will survive (City of Helsinki, 2021a).

Koivusaari

Koivusaari is expected to grow into a district with 5,000 inhabitants and over 4,000 jobs. The sea will be filled to make room for development. In a few minutes, you may be in Tapiola, Otaniemi campus, or the Keilaniemi job cluster, thanks to the metro. For Koivusaari, a local master plan concept was developed and approved in 2017. The process of land use planning is underway (City of Helsinki, 2021).

Pasila

Pasila is the most accessible location in Finland, having good links by all forms of transportation from all parts of the nation. By 2040, the number of employments in Pasila will have doubled, reaching 50,000, and the population will have almost tripled to 30,000. Pasila station is on its way to become Finland's most popular station, with an estimated 47 million people passing through each year (City of Helsinki, 2021b).

Jätkäsaari

Jätkäsaari is being developed as a western expansion to Helsinki City Center, directly on the water. Jätkäsaari will have a population of 21,000 people and 6,000 jobs. One-fifth of the district's 100-hectare total area will be set aside for parks and leisure. The area has a distinctively urban atmosphere, with compact residential blocks and ambitious construction, street-level cafés and restaurants, and handy amenities. By 2030, Jätkäsaari will be completed (City of Helsinki, 2021a).

Hernesaari

Hernesaari, a new waterfront development in southern Inner Helsinki, will be a significant tourist destination, a thriving community with housing, tourism, and leisure, where most houses (for 7,500 inhabitants) will be constructed, as well as workplaces (around 4,000 jobs). The overarching concept is to compliment Inner Helsinki's current urban layout while also providing tram public transportation. Infrastructure for pedestrians and cyclists to promote a sustainable urban structure. The majority of Hernesaari's construction will take place in the 2020s (City of Helsinki, 2021a).

Telakkaranta

Telakkaranta is located between Hernesaari and the Inner Helsinki neighborhood blocks. The old industrial site was previously closed to the public, but it will soon be open to everybody. The region will connect to the parkland and lanes that run along Helsinki's southern beaches. There will be house for more than 300 and gather different commercials to the area. Most of the homes in Telakkaranta will be new construction. The plan for the region follows Helsinki's historic street grid (City of Helsinki, 2021a).

Kruunuvuorenranta

Kruunuvuorenranta is located on the eastern bank of Kruunuvuorenselkä, directly across from the city. Kruunuvuorenranta will have 13,500 inhabitants by 2030, and 800 new job opportunities will be generated. A school, a day-care center, and a small business center are all within walking distance (City of Helsinki, 2021).

Laajasalo

Laajasalo is a growing green zone on an island just east of Helsinki's central business district. The Kruunusillat (Crown Bridges) will be completed in 2026, providing excellent tram links to and from downtown Helsinki. There are now 16,000 people living in the region, with ambitions to increase to 20,000 by 2030. Simultaneously, the decision was taken to develop the Yliskylä region as the community's focal point. This implies that commercial actors, large and small, will have a variety of options (City of Helsinki, 2021g).

Myllypuro

Myllypuro is a multi-purpose district along the metro line. Starting with the Myllypuro center, Myllypuro is now undergoing a "beauty treatment." The revitalized Myllypuro metro station serves as the catalyst for a new type of urban hub that brings together the Metropolia Campus, a shopping mall, a healthcare facility, a sports center, and residential options. As the Myllypuro area gets revitalized over the next several years, there will be lots of possibilities for both large and small businesses, particularly in the service industry. The Metropolia University of Applied Sciences' new campus, which is now under development, aims to inject new life into the city (City of Helsinki, 2021e).

Östersundom

Östersundom is a collaborative project including three municipalities: Helsinki, Vantaa, and Sipoo. The goal is to create a new "affiliate city" for Helsinki that will have 80,000-100,000 residents and 30,000 jobs, with a concentration on cleantech businesses. Östersundom is also a national development project, since it is intended to play a significant role in accomplishing the objective of the Finnish government program, which is to make Finland a real leader in bio/circular economies. This Aim also contributes to the Helsinki Metropolitan Area's goal of becoming a "leading cleantech metropolis." (City of Helsinki, 2019a).

City center

Around the heart of Helsinki, particularly in Eteläsatama, Katajanokka, Töölönlahti, and Hakaniemi, as well as surrounding the Olympic Stadium, new development is being planned and built. The city of Helsinki intends to extend its pedestrian zone, improve the vibrancy of central city blocks, and revitalize its parks. There are a variety of recreational and event options. In the city center, new flats are continuously being constructed. Commuters and visitors from all over Finland and the world use well-functioning public transportation to get to the city center (City of Helsinki, 2021d).

Kalasatama

Kalasatama is one of Helsinki's largest new neighborhoods, with development scheduled to run until the late 2030s. The former port and industrial region have already become a thriving neighborhood with over 5,000 residents and thousands of new jobs. Along coastal promenade will run along the beaches and canals in the future, and the Mustikkamaa recreation sites will be accessible through Isoisänsilta. More than 25,000 people will live in the 170-hectare coastal region in the eastern portion of the inner city, and more than 10,000 jobs will be created. The metro station's immediate neighborhood has already developed into a significant employment and service center. Suvilahti has a thriving cultural scene, and Tukkutori in Teurastamo has become a culinary and event center. At Kalasatama, you may walk to your home, services, employment, and play (City of Helsinki, 2021a).

6-7- Development Methods in Helsinki

In December 2014, the Helsinki-Uusimaa regional plan on smart specialization for the period 2014-2020 was adopted. It is a forward-looking document in terms of the envisioned RIS3 operating model, which is expressly founded on "Quadruple Helix thinking." The strategy aims to help the area achieve its long-term goals of being the most competitive region in the Baltic Sea and a major innovation hub. This dynamic appears to improve the region's ability to convert obstacles into opportunities. The recent financial and economic crisis, for example, has resulted in a rise in immigration to the Helsinki region, particularly from Estonia. However, as a generator of new demand (e.g., housing, services), this appears to have had a favorable influence on the surrounding economy.

The Helsinki Regional Infoshare (HRI) has a stated goal of enhancing public awareness, involvement, and engagement. Despite the fact that HRI is regarded as a success, the project's impact has never been measured. Svahn (2015) identifies the following types of impact based on a city-level investigation conducted

in 2014: efficiency improvements, which may add value in social and commercial terms; enhanced transparency, which leads to information, participation, engagement, and commitment, as well as better government administration and efficiency; new possibilities for the creative use and visualization of data, as well as crowdsourcing; new opportunities for partner engagement (Volpe et al., 2016).

6-8- Open Data in Helsinki

The European Data Portal (EDP) sponsored a Webinar on November 8th titled "Open Data in Smart Cities, Link opens in a new window" to explore efforts from throughout Europe. Smart Cities cannot be realized without open data. People may use Open Data to fully use the Data's potential and offer solutions to problems like acquiring event information or locating a parking spot. This is one of the reasons why the EDP actively encourages the EU Member States and communities to share their data and encourages data re-use to maximize effect (Outcome of EDP's Webinar: Open Data in Smart Cities | Data.Europa.Eu, 2018).

Because of the wide range of terminology and industries covered, data in Smart Cities, as well as the notion of a Smart City, can be interpreted in several ways. Furthermore, depending on one's experience and expertise of the issue, these notions might be construed in a variety of ways, making discussion challenging. Data, for instance. Though it is widely agreed that Data is a must for a Smart City, there is still debate on how to make it available and how government agencies, companies, academics, and residents may benefit from it (Outcome of EDP's Webinar: Open Data in Smart Cities | Data.Europa.Eu, 2018).

In their 2017-2021 plan, Helsinki was seeking to become the world's most functioning city by leveraging urban Open Data. Key drivers to achieving this goal include the use of open urban data and active community interaction between the City of Helsinki and communities in Helsinki (Outcome of EDP's Webinar: Open Data in Smart Cities | Data.Europa.Eu, 2018).

Currently, there is a strong mandate to continue working on urban data and to develop a more collaborative communication model that improves efficiency for customers in finding services and aids citizens and government entities in making decisions (Outcome of EDP's Webinar: Open Data in Smart Cities | Data.Europa.Eu, 2018).

Cities have a wealth of data on everything from day-care and education to air quality, public transportation, and parking. Municipalities play an important role in supplying and utilizing these datasets. The municipality of Helsinki has almost 900 separate API systems that collect large quantities of data, which is subsequently processed, analyzed, and turned into services for its inhabitants (Outcome of EDP's Webinar: Open Data in Smart Cities | Data.Europa.Eu, 2018).

Tanja Lahti and her colleagues, for example, launched the Helsinki Region Infoshare (hri.fi), an Open Data service, in spring 2011 that allows individuals to discover public data in Helsinki and the surrounding cities of Espoo, Vantaa, and Kauniainen. This site offers Open Data catalogs with articles on data, use, and events in Finland, as well as guidance on how to exploit, distribute, and re-use Open Data. This database is being used by several stakeholders in Helsinki to arrange and promote public events in the city, as well as to distribute information as urban data to add value to the region (Outcome of EDP's Webinar: Open Data in Smart Cities | Data.Europa.Eu, 2018; 10 Years of Open Data in Helsinki Metropolitan Area, 2021).

Although public-sector information in Finland is quite open, until the early 2000s, it was difficult to get for personal use. Anyone sitting on their couch may now research public procurements in cities thanks to open data. Users may obtain city procurement data, which ranges from small-scale commodities purchases to multimillion-dollar building projects (10 Years of Open Data in Helsinki Metropolitan Area, 2021).APIs are being built into our cities' data systems to allow machine-readable data to be sent to other apps. According to Hami Kekkonen, Project Manager of the HRI service, open APIs make it easier to access data both within local administrations and in third-party apps. For example, the Whim all-in-one mobility app and dozens of other mobile apps made by application developers already make substantial use of open data on cities' public transportation (10 Years of Open Data in Helsinki Metropolitan Area, 2021).

Furthermore, once a month, the City of Helsinki hosts 'Helsinki Loves Developers,' a forum for open communication between the municipality and the community. This effort began with the goal of encouraging individuals to actively debate and promote urban data in order to generate interest and effect. Every meeting

has a unique theme, ranging from cultural and leisure data to how to increase data flow in Helsinki (Outcome of EDP's Webinar: Open Data in Smart Cities | Data.Europa.Eu, 2018).

The City of Helsinki is constantly upgrading its database and information in order to give current, if not real-time, Open Data, and is constantly leveraging data to innovate and generate influence in the city (Outcome of EDP's Webinar: Open Data in Smart Cities | Data.Europa.Eu, 2018).

6-8-1- Helsinki Region Infoshare Open Data Service

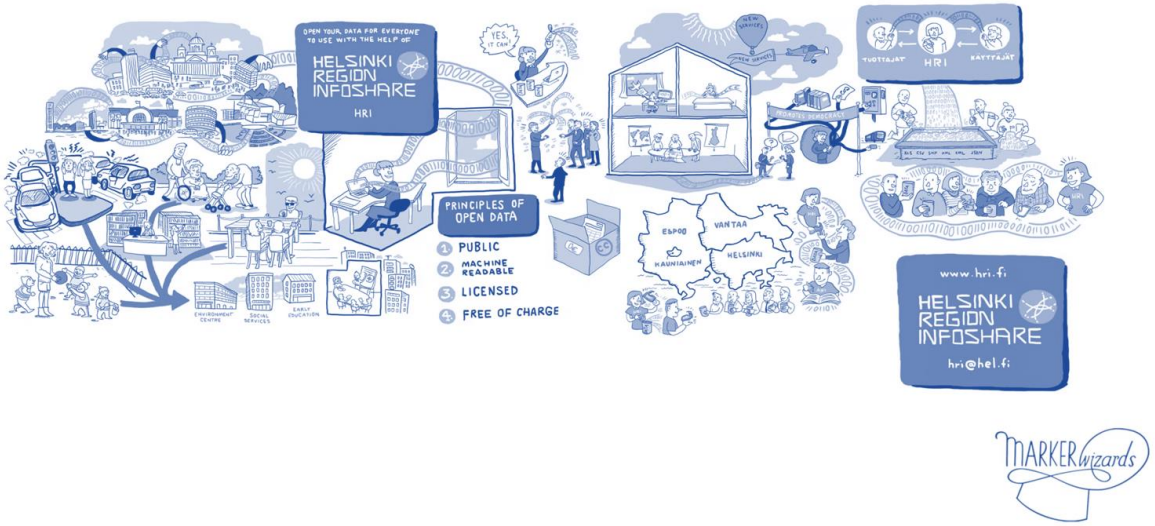


Figure 12. (*Helsinki Region Infoshare Service*, 2014)

The open government, and the open city, rely heavily on pen data. In May 2010, the city councils of Helsinki, Espoo, Vantaa, and Kauniainen (the four main cities of the greater Helsinki Region that make up the Helsinki Metropolitan Area) approved a new open data policy and the Helsinki Region Infoshare project (Jaakola et al., 2015). The Helsinki Region Infoshare (HRI) open data service was launched by Forum Virium Helsinki, the City of Helsinki Urban Facts, and the cities of Helsinki, Espoo, Vantaa, and Kauniainen. The project's implementation was overseen by a directive board comprised of the project's financial and executive partners, as well as the City of Helsinki Urban Facts (who served as chairman) and Forum Virium Helsinki (Jaakola et al., 2015). The directing board continues to support the open data service's maintenance and development. Helsinki, Espoo, Vantaa, and Kauniainen all contribute to the HRI service. The development phase was funded in part by the Finnish Innovation Fund Sitra. Through a municipality cooperation grant, the Finnish Ministry of Finance sponsored the service during the project preparation phase (Jaakola et al., 2015).

The Mayor of the City of Helsinki officially opened the Helsinki Region Infoshare open data service www.hri.fi on March 18, 2011 [4, p. 44]. Around 1,100 open data sets were available through the Helsinki Region Infoshare program in December 2014 (Jaakola et al., 2015). The information provided is primarily statistical, providing a broad and varied perspective on several urban phenomena such as living conditions, economics and well-being, employment, and transportation. The service provides GIS-based data for a large chunk of its data. The data can be downloaded as files, and some data sets can also be accessed as raw data through open application programming interfaces (API) (Jaakola et al., 2015).

Figure 13. (*Helsinki Region Infoshare Service*, 2014)

The HRI service primarily runs in four operating areas: creating data, opening data, sharing data, and utilizing data. The major operational actions are to assist information producers in opening their data and increasing its use by engaging with the open data community and developers through multi-channel communication and engagement (Jaakola et al., 2015).

Importantly, multiple city government bodies are collaborating to use their own open data. City of Helsinki Urban Facts is in charge of the clearing house function.

The HRI service has continued to open additional public data in a methodical manner, as well as enhancing the service's functionality, analyzing what data diverse users want to see available, and working with the open data community, developers, research, and education. In 2013, the European Union Prize for Innovation in Public Administration was granted to HRI's open data offering. The reward of 100,000 euros was critical to the service's development (Jaakola et al., 2015).

The article "Helsinki Region Infoshare. 2 Years of Open Public Data" documents the experiences of creating the open data service Helsinki Region Infoshare. HRI, Helsinki Region Infoshare, has also contributed applications based on open data to the publication. HRI not only provides open data but also maintains an application gallery with over one hundred different applications, which should motivate developers, businesses, researchers, and open data aficionados to create more. Winners of the annual Apps4Finland competition [20], which has been held since 2009, are among the applications (Jaakola et al., 2015).

6-8-2- Open Mobility as a service in Helsinki

The Helsinki Regional Transport Authority (HSL) makes its data available as Open Data on platforms including Digi-transit, Reittiopas, and the HSL mobile app. These services generate a travel planner for consumers and present them with information on the best possible route using HSL's open data, open APIs, and open-source scripts (Outcome of EDP's Webinar: Open Data in Smart Cities | Data.Europa.Eu, 2018). At the moment, HSL is pushing Open Mobility as a Service, or OpenMaaS. Mobility as a Service (MaaS) is a concept that intends to improve seamless public transportation infrastructure and integrate bike and automobile sharing services, such as taxi-car sharing, to provide adequate alternative means of transportation and eliminate the demand for cars. With the goal of decreasing the barrier to new enterprises, OpenMaaS is an open interface that incorporates route planner services from platforms such as Reittiopas and HSL's mobile application (Outcome of EDP's Webinar: Open Data in Smart Cities | Data.Europa.Eu, 2018). A consumer can, for example, purchase a ticket using HSL's mobile application and then sell it over the OpenMaaS API. (Outcome of EDP's Webinar: Open Data in Smart Cities | Data.Europa.Eu, 2018). HSL

continues to create new technological capabilities, ticket kinds, and payment choices to boost Open Data awareness, use, and re-use in Helsinki (Outcome of EDP's Webinar: Open Data in Smart Cities | Data.Europa.Eu, 2018).

As previously said, Open Data is critical to the development of Smart Cities since it can give insights and solve problems that people face on a daily basis (Outcome of EDP's Webinar: Open Data in Smart Cities | Data.Europa.Eu, 2018).

However, there are several impediments. To begin, development requires a clear mandate and interest and support from municipal governments, companies, and communities. A greater understanding of the importance of Open Data, how it works, and how it may be used to benefit cities and society is required. Furthermore, collaboration and ongoing conversation across many institutions and actors are critical for fostering innovation and creating and maintaining influence. (Outcome of EDP's Webinar: Open Data in Smart Cities | Data.Europa.Eu, 2018)

Figure 14. Smart mobility in Helsinki

6-9- Helsinki and IoT Technology

Helsinki is a leader not just in terms of open data but also in terms of testing and deploying Internet of Things (IoT) technologies (Lahti, 2021). This was evident during the Helsinki Loves Developers event held on March 7th at Kalasatama Urban Lab in Helsinki. The attendees got an excellent overview of the active initiatives in the areas of IoT, sensors, and 5G during this open session. Forum Virium Helsinki (FVH), the totally city-owned innovation and foresight corporation, is a significant player and driver behind these projects (Lahti, 2021).

The availability of accessible public data sparked Helsinki's transformation into a smart city. Individuals, the academic sector, government, corporations, and research institutes can all access this information. More than 1030 datasets covering a wide variety of urban phenomena, such as transportation, economy, conditions, jobs, and well-being, were made available in 2013. One of the first open urban data systems is the Helsinki Region Info Share Project. In the area of citizen empowerment, the platform was recently awarded the European Prize for Innovation in Public Administration. According to the jury report, citizens have a significant chance to be substantially involved in public decision-making by opening decision-making

information via an electronic case management system (Caragliu et al., 2011; Manville et al., 2014; Hashemet al., 2016).

6-6- Forum Virium Helsinki

Figure 15. Forum Virium Helsinki

According to a presentation by Forum Virium Helsinki about Open Smart City loT Lab, Forum Virium Helsinki (FVH) is an innovation unit founded in 2005 that develops future urban solutions, Smart mobility, robots, artificial intelligence, data, and the Internet of Things are among them. The City of Helsinki owns 100% of this non-profit limited liability firm. There are 35 top professionals on staff of FVH, and the unit's operations are supported by the City of Helsinki and other EU programs, with an annual budget of around EUR 5 million (Forum Virium Helsinki, 2020).

> “Municipal or regional governments naturally do not have the DNA to develop, procure, and deploy smart city technology effectively. Therefore, if Helsinki was going to truly become a smart city, the government decided that they, with input from their stakeholders, must design a completely new entity, one that operates alongside the City itself so to remain grounded in delivering outcomes for the public good but also one that is completely independent so not inhibit its ability to work with, adopt, procure, and develop smart city innovation and technology.” Juhani Kantola, CIO of Forum Virium Helsinki (Hanvey, 2019).

Forum Virium Helsinki runs Smart city projects in Finland and EU countries collaborating with different companies and the scientific community and stakeholders. FVH is in response to the digitalization of Helsinki. They have succeeded in making Helsinki open data to the public and turning Kalasatama into a Smart city district as an urban lab, which I will discuss in the next chapter. Their current project is bringing robot buses (self-drive buses) onto Helsinki's streets (Forum Virium Helsinki, 2020).Helsinki Open Smart City loT Lab is based on three blocks (Forum Virium Helsinki, 2020):

1- "Data and technologies as supporters
2-Competence building to ensure skills for utilization Ur

3- Support for piloting, validating, and scaling."

750 enterprises, 170 research centers, and sixty partner towns are involved in 81 initiatives for co-created smart city solutions, according to Forum Virium Helsinki (Virium, 2020). Forum Virium's many projects are loosely grouped under four main headlines: IoT, Smart City, Smart Mobility, and Forum Virium, the fourth headline, which includes two projects focusing on the development of a European AI ecosystem and the cooperation of the smart city development of Finland's six largest cities (Shamsuzzoha et al., 2021). FVH's Aim is to make Helsinki "the most functional Smart City in the world in collaboration with its stakeholders, scientific community and companies through open IoT ecosystem" (Forum Virium Helsinki, 2020).

6-7- Citizen's Participation

The City of Helsinki's operations relies heavily on participation. The participation paradigm, values, and practices of the City of Helsinki are presented on this page. You can search the technique library for a range of practical ways to encourage engagement in your own work and the city's activities. (City of Helsinki, 2020)

Helsinki welcomes its citizens and partners to help shape the city, its services, and its neighborhoods. Helsinki is a city of community, powerful deeds, and chance meetings. The city's decision-making process is transparent and participatory. Good service culture and interactive communication also contribute to a great city experience. All the City of Helsinki's activities incorporate participation promotion, and all the city's workers are responsible for it. To serve as participation structures, the participation and interaction model was developed, and it is now being deployed throughout all divisions (City of Helsinki, 2020).

6-8- Helsinki as a landowner and land provider

The Helsinki land transfer standards and directions for their application, which were enacted by the city in 2019, govern the leasing and sale of plots. The Housing and Land Use Program defines the city's housing policy objectives. Its primary objectives are to provide a varied and high-quality housing stock and prevent residential segregation.

The city owns 63% of land area of Helsinki and 60-70% of annually granted building rights are on pilots provided by the city,Helsinki currently stated that they have reserved residential plots for constructing more than 25K apartments . in Helsinki over 70% of residential plots are leased and the rect are sold. Helsink's goal is to build 7k new apartments each year and want to reach to 8k apartments from 2023 according to city of Helsinki's report.

6-8-1- This is how Helsinki leases and sells

- **How can a residential plot be obtained for professional development purposes?**

through numerous public lotteries and competitions, as well as direct reservations in extraordinary situations, a plot can be assigned to one of the following:

- **Through a residential plots draw**,

which is expected to be done at least once a year. The recipient of a residential plot is prioritized for:

- new applicants who have never obtained land from the city's housing development programs
- developing or implementing land use or housing policy objectives in the area
- applications for regulated housing land by developers and building consultants

- **Through registration and consultation procedure:**

These are smaller-scale yearly operations than ordinary housing plot drawings. They might be directed against certain types of housing projects or builders, such as real estate investment trusts.

- **Through competitive bidding for price or quality:**

Most recipients of uncontrolled dwelling plots are chosen through a pricing competition. The city manages the house building development by holding many high-quality contests. They are held in particular for places that are important to the cityscape or are at the start of developing a specific region. Quality contests might focus on a specific issue, such as carbon-neutral solutions.

- **Through a continuous plot search:**

Residential plots that have remained unclaimed after a public draw or bidding competition are typically moved to a continuous plot search and made publicly available on the city's website.

- **Through direct reservation without an open application procedure or competition:**

Direct reservations can only be given for specific reasons, such as to the renter of a plot and/or a nominated partner, to expedite the completion of work on the plot, or to develop projects that have been approved as part of the Re-thinking Urban Housing program and offer actual novelty value. The plot reservation decision establishes the following criteria for plot planning and development: The form of funding and whether or not the land is owned. Buildings in the apartment sector must at the very least exceed the criteria of energy efficiency class A2018. Family apartments must make up at least 40–70% of the total apartment space in owner-occupied apartment complexes. Two or more bedrooms are included in family flats, with an average living area of 70–80 m2. Residential developments may be required to fulfill contractual requirements to have an architectural competition.

- **Sale or leasing?**

With the exception of very desirable plots, most residential plots are rented. The idea of purchasing additional residential plots might also be discussed, for example, if the plot sale supports the supplemental building of an already built and leased plot. Due to poor interest, the plot was sent to a continuous plot search after a bidding competition ended in a tie.

6-8-2- How much do residential plots cost?

In the City of Helsinki, sites for uncontrolled dwelling production are priced according to their market worth. The plot's selling or rental price is determined either through price competition or by an external valuer's appraisal. The approach for pricing plots approved by the House Finance and Development Centre of Finland is followed in state-subsidized housing production (ARA).

In Helsinki, plot reservations are free. The project should proceed to the construction permit phase after the reserve period, which is typically two years.

This is how the procedure is carried out:

Plots are awarded on a case-by-case basis, but the process is as follows:

Phase 1:

of the search General plot drawings or competitions, a continuous plot search, or direct reservation are all used to find the plot.

Phase 2:

Permits The site will be leased to the beneficiary for a short period after the reservation decision is issued to apply for a construction permit.

Phase 3:

Handover of the plot is either leased, sold, or leased with a buy option to the plot receiver.

Phase 4:

Construction The site's lessee or owner begins building.

- **How to obtain a plot for a detached house?**

Detached home plots are typically given on an individual basis through detached house plot drawings. Every two or three years, the city plans to hold a drawing for detached housing plots. Each drawing consists of 50–100 plots. The receiver of the plot must be a Helsinki resident with at least one kid under the age of sixteen. The plot receivers are chosen by drawing lots based on their applications, and the plots are leased to them. A pricing competition can also be used to allocate plots. Plots that haven't found a buyer in the detached home plot draw or competition will be moved to the city's website for a continual plot search.

- **Learn more about supplementary construction:**

Supplementary construction accounts for almost 40% of all buildings in Helsinki. Efforts are being made to expand this even further since it is a cost-effective method of constructing Helsinki in terms of climate change mitigation. The supplemental building will be encouraged at rail hubs where new urban centers are being established.

The city's land transfer practices encourage supplementary construction by allowing direct reservation of plots of land for the tenant of an already built plot and/or a nominated partner for the development of a housing project sale rather than leasing a plot if it helps to complete a supplementary construction project. In addition, the city has other land policy tools to encourage infill residential construction.

6-9- Helsinki's Affordable Housing Program

As mentioned in section 5-12,Helsinki owns large number of public housing units, and the rent of these ones are cost based and regulated which makes them more affordable than private market(Eerola & Saarimaa, 2017). By dispersing buildings among neighborhoods and allowing relatively well-off households to inhabit a public housing unit, the policy explicitly tries to prevent spatial concentration of disadvantaged households(Eerola & Saarimaa, 2017). Helsinki's place-based program, which has analyzed by Eerola and Saarimaa in 2017,started from mid-1940's and includes various subsidy programs for rental housing development and restoration. The Housing Finance and Development Centre of Finland (ARA), an off-budget state body under the Ministry of Environment's administration, is in charge of implementing the initiative. Municipally owned public housing and privately owned subsidized housing owned by non-profit corporations and organizations are both covered by the same scheme. The policy's contents, as well as its declared goals, have evolved throughout time. Currently, the main goal is to provide low-income families with affordable homes. In terms of household composition, the initiative also strives to create socially balanced communities and diverse buildings. Furthermore, a portion of the shares is earmarked for special in citizens such as disabled, elderly and students (Eerola & Saarimaa, 2017).

By 2017, Helsinki had 350,000 housing units available, with about half of them being rental flats. ARA sponsored over 20% of the total housing supply through various programmes. Nearly 70% of the subsidized housing units were held by the city of Helsinki. Different types of regulation apply to those units. The rentals are cost-based and are determined by the building's capital and maintenance expenditures. The buildings in Helsinki are located on city-owned lots that the city rents at a reduced rate. The lot rent discount lowers the building's capital cost, which is subsequently passed on to tenants in the form of cheaper rates. Furthermore, the rules imply that the rent paid by the tenant is unaffected by the tenant's characteristics (Eerola & Saarimaa, 2017).

Housing allowance is a means-tested subsidy that covers up to 80% of rent up to a certain limit. If the rent exceeds the rent ceiling, the housing allowance is computed using the rent ceiling rather than the actual rent. The rent ceiling is greater in the more expensive groupings, which are divided into four affordability levels (Eerola & Saarimaa, 2017). In addition, if household income exceeds an income ceiling based on household size, the allowance includes a deductible. Although tenure is not a requirement for eligibility, 95 percent of housing allowance users live in rented homes. The housing allowance is also available to inhabitants of public housing (Eerola & Saarimaa, 2017).

The system is comparable to housing benefit systems in other European nations, but it differs in some keyways from the US housing voucher system. First, in Finland, housing allowances are a right, whereas in the United States, not every qualifying household receives a voucher. Second, the Finnish program places no restrictions on the quality or rentals of the beneficiary households' apartments. Typically, the landlord is uninformed of whether or not the renter is receiving a housing allowance(Eerola & Saarimaa, 2017).

Based on analysis done on the relative merits of large place-based and tenant-based programs in Helsinki by comparing affects of housing affordability and neighborhood quality by Essi Eerola and Tuukka Saarimaa in 2017 in VATT Institute for economic research, they anticipated that households living in public housing units in Helsinki will save a significant amount of money on rent, comparable to the housing allowance, the major tenant-based housing program. This public housing subsidy is determined by the unit's physical characteristics, particularly its location. As the distance to the central business area increase, it drops significantly. When they compared the distribution of the public housing subsidy to the distribution of the means-tested housing allowance, we can see that the public housing subsidy is clearly less geared towards low-income households (Eerola & Saarimaa, 2017). Furthermore, their findings show that low-income public

housing tenants live in poorer, less educated, and lower-quality communities (as defined by zip code or building level) than comparable private rental housing tenants in the same income quintile. Even when neighborhood mixing is an express goal of the program, this study implies that public housing projects may lead to more segregation than tenant-based alternatives (Eerola & Saarimaa, 2017).

6-10- Conclusion

Helsinki's government built an open and transparent development approach. Helsinki is working on digitizing services and implementing smart city solutions. it has enhanced the quality of life of its residents by using digital technologies. These solutions also contribute to Helsinki's objective of being carbon-neutral by 2035. Helsinki has made a long-term commitment to its development as a smart city and it is now ranked among the world's top cities in worldwide smart city.

Helsinki is well-known for its innovative mobility solutions. In specific, the Mobility-as-a-Service (MaaS) idea was made in Helsinki. The MaaS program allows city inhabitants to buy whole, seamless transportation chains from their front door to their destination, eliminating the need to own a car.

The Helsinki City Strategy for 2021-2025 has 13 priority areas. (City of Helsinki, 2021i)

1- "The best and most equal place in the world to learn
2- Ambitious climate responsibility and nature conservation
3- Art and culture are the enablers of a good life
4- Equal and international Helsinki
5- The distinctiveness and security of Helsinki's districts will be cherished
6- Functional and beautiful city
7- Intelligent transport solutions are the basis of a smooth everyday life
8- The well-being and health of Helsinki residents are improving
9- A responsible economy as a basis for sustainable growth
10- An attractive Helsinki for staff
11- Smart Helsinki is managed with knowledge and utilization of digitalization
12- Helsinki is attractive for experts and companies
13- National lobbying and international cooperation."

In December 2014, the Helsinki-Uusimaa regional plan on smart specialization for the period 2014-2020 was adopted. The strategy aims to help the area achieve its long-term goals of being the most competitive region in the Baltic Sea and a major innovation hub.

In their 2017-2021 plan, Helsinki was seeking to become the world's most functioning city by leveraging urban Open Data. Key drivers to achieving this goal include the use of open urban data and active community interaction between the City of Helsinki and communities in Helsinki. Tanja Lahti and her colleagues, for example, launched the Helsinki Region Infoshare (hri.fi), an Open Data service, in the spring 2011 that allows individuals to discover public data in Helsinki and the surrounding cities of Espoo, Vantaa, and Kauniainen. This site offers Open Data catalogues with articles on data, use, and events in Finland, as well as guidance on how to exploit, distribute, and re-use Open Data.

Furthermore, once a month, the City of Helsinki hosts 'Helsinki Loves Developers,' a forum for open communication between the municipality and the community. This effort began with the goal of encouraging individuals to actively debate and promote urban data in order to generate interest and effect. 750 enterprises, 170 research centers, and sixty partner towns are involved in eighty-one initiatives for co-created smart city solutions, according to Forum Virium Helsinki.

The Helsinki Region Infoshare (HRI) service primarily runs in four operating areas: creating data, opening data, sharing data, and utilizing data. The major operational actions are to assist information producers in opening their data and increasing its use by engaging with the open data community and developers through multi-channel communication and engagement.

Open Data is critical to the development of Smart Cities since it can give insights and solve problems that people face on a daily basis. The Helsinki Regional Transport Authority (HSL) makes its data available as Open Data on platforms including Digi-transit, Reittiopas, and the HSL mobile app. These services generate a travel planner for consumers and present them with information on the best possible route using HSL's open data, open APIs, and open-source scripts.

Mobility as a Service (MaaS) is a concept that intends to improve seamless public transportation infrastructure and integrate bike and automobile sharing services, such as taxi-car sharing, to provide adequate alternative means of transportation and eliminate the demand for cars.

Helsinki is a leader not just in terms of open data but also in terms of testing and deploying Internet of Things (IoT) technologies. According to a presentation by Forum Virium Helsinki about Open Smart City loT Lab, Forum Virium Helsinki (FVH) is an innovation unit founded in 2005 that develops future urban solutions, Smart mobility, robots, artificial intelligence, data, and the Internet of Things are among them. FVH is in response to the digitalization of Helsinki. . Their current project is bringing robot buses (self-drive buses) onto Helsinki's streets.

The City of Helsinki's operations relies heavily on participation. Helsinki welcomes its citizens and partners to help shape the city, its services, and its neighborhoods. Helsinki is a city of community, powerful deeds, and chance meetings. The city's decision-making process is transparent and participatory.

Helsinki owns considerable number of public housing units, and the rent of these ones are cost based and regulated which makes them more affordable than private market. The main goal is to provide low-income families with affordable homes. In terms of household composition, the initiative also strives to create socially balanced communities and diverse buildings. Furthermore, a portion of the shares is earmarked for special in citizens such as disabled, elderly and students.

The Helsinki’s system is comparable to housing benefit systems in other European nations, but it differs in some keyways from the US housing voucher system. First, in Finland, housing allowances are a right, whereas in the United States, not every qualifying household receives a voucher. Second, the Finnish program places no restrictions on the quality or rentals of the beneficiary households' apartments. Typically, the landlord is uninformed of whether or not the renter is receiving a housing allowance.

7- Kalasatama District

Figure 16. Kalasatama District 2019. Photo by: Suomen ilmakuva Oy-2019

7-1- Kalasatama Main Overview

Since the late 1800s, the Kalasatama region has been used for industrial and port purposes. At the end of 2008, the port was relocated to Vuosaari. There is still a sliver of industry remaining. The beach area has been extended by landfills throughout the years. Kyläsaari, Iso and Pieni Verkkosaari, Sompasaari, and Hanasaari are among the islands buried beneath the present Kalasatama(City of Helsinki, 2020).

Pre-construction work will be done prior to the building's construction, including soil strengthening, cleanup of polluted land, and filling and dredging of coastal regions (City of Helsinki, 2020).

The fishing port is mostly constructed in sections. In the autumn of 2012, the first inhabitants arrived in Kalasatama. The first Sörnäistenniemi area has been completed and is ready for home building. In Sompasaari, the southern half of Verkkosaari, Red, and the Workshop area, housing building is now ongoing (City of Helsinki, 2020).

Kalasatama is in the heart of the city, near to amenities and public transportation. Many directions have strong transportation links. The sea is all around us. When the region is finished, a six-kilometer-long beach path will ring the beaches of Kalasatama. Pedestrians and cyclists have access to the outdoor areas of Mustikkamaa along the Isoisänsilta, which runs from Sörnäistenniemi to Mustikkamaa, where they may discover jogging paths, playgrounds, and a dog park, among other things. The fishing port park features a small playground, which is frozen in the winter if the weather permits, as well as a playground and a grilling area. On Sompasaari, a sheltered Loviseholminpuisto will be created, and in the northern half of the region, a large Hermann beach park will be built at the end of the Kalasatama development (City of Helsinki, 2020a).

7-2- Demography Of Kalasatama

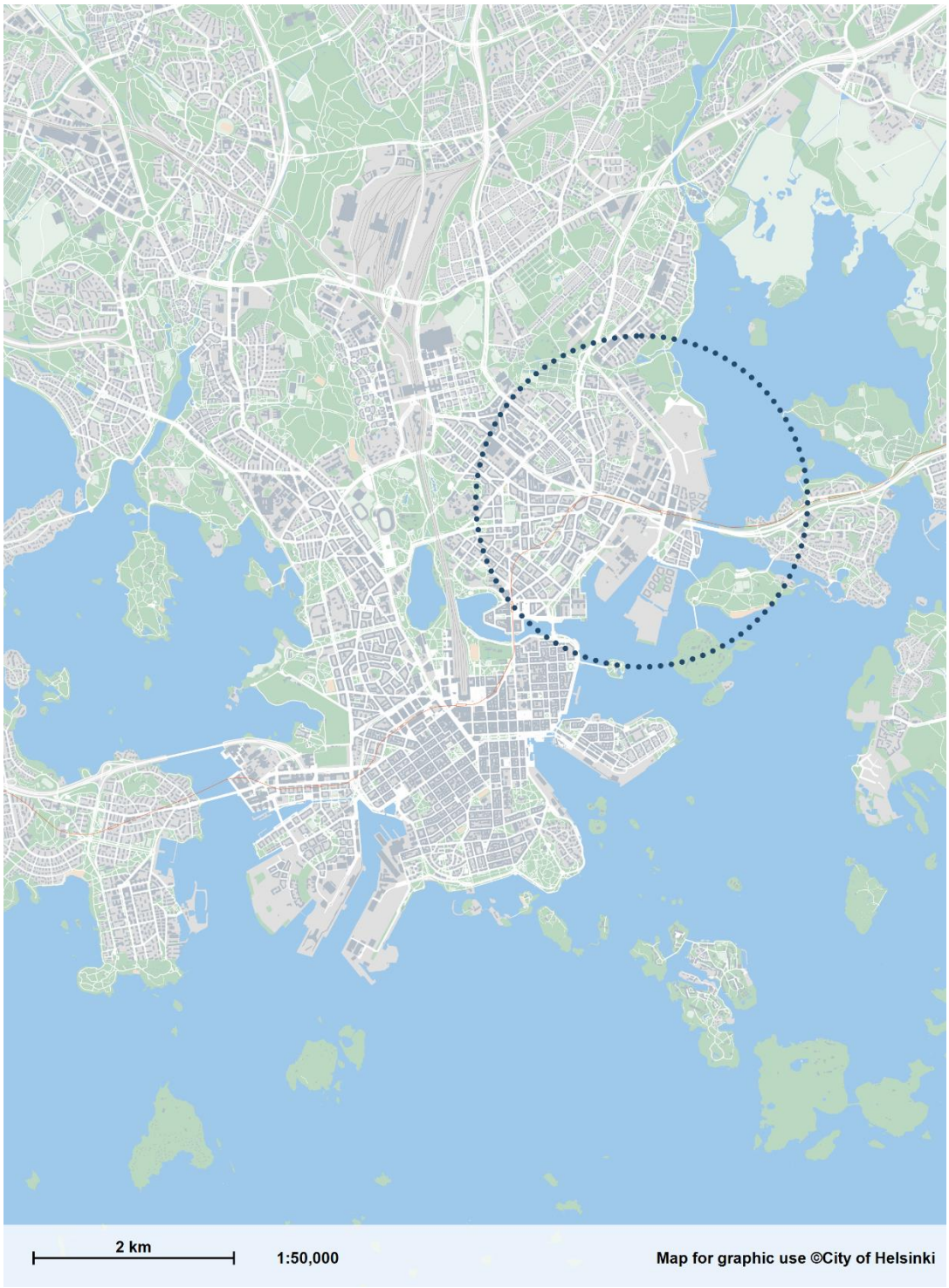


Figure 17. Helsinki map , kalasatama district location

Kalasatama, the smart district of Helsinki is located on eastern side of central Helsinki ,a former harbor is which now is an active smart city experimentation and innovation district in order to improve and create smart and sustainable urban infrastructure and urban services with its stakeholders.

Kalasatama will have 25000 residents by 2040 according to city of Helsinki's brochure provided about smart kalasatama, and also, they have promised to reach ten thousand job opportunities by 2040 .

Kalasatama is 1.75 km^2,with 6km new shoreline.

Kalasatama district's slogan is "smart energy, smart living25/7,smart mobility". Kalasatama' s strategy is to provide one more hour a day.

The construction of this urban lab started on 2009 and in 2012 the first residents moved in , and by 2030 the project will be completed.

7-3- Development of Kalasatama waterfront

The relocation of container harbor, gas, and oil terminal activities from the Eastern Harbor, West Harbor, and Kruunuvuorenranta, all near to the city center, to the more peripherally constructed Vuosaari harbor in 2008 kicked off the development of the Helsinki waterfront in earnest. (Ameel, 2021)

The relocation decision, which had been in the process for decades, had first been announced in the City Plan of 1992 and then implemented in the City Plan of 2002. (Helsinki City 1992; Othengrafen [2012] 2016, 147). The Vuosaari harbor was built throughout 2003 and 2008, and it has been officially opened in 2008. All harbor operations in Kalasatama have halted, whereas Jätkäsaari remains to be a hub for active passenger and roll-on roll-off traffic. The passenger port has continued to expand - Helsinki is Europe's busiest passenger port – posing traffic and infrastructural difficulties. (Ameel, 2021)

Kalasatama is located to the north-east of Helsinki's central business district. This old container port, which was formerly a mixed working-class neighborhood, is being renovated into a working and residential environment for 10,000 people. Construction began in 2011 and is expected to be completed by 2040. (see Helsinki City 2018a). The city, like Jätkäsaari and other new development zones, seeks for a diversified and mixed housing mix, containing private, social, and subsidized housing. (Ameel, 2021)

The construction of the Kalasatama metro station in 2007, the rebuilding of the old gas works site Suvilahti, right adjacent to Kalasatama, into a cultural center (see Krivy 2013), and the imaginative temporary use of the site have all played important roles in the area's growth (Hernberg 2012; Ameel, 2021)

The Teurastamo area, which was converted into a mini-meatpacking district, and the operational power plant Hanasaari near the southern edge of Kalasatama are both adjacent to or within the limits of Kalasatama. To the east of the region lies Helsinki's outdoor zoo, as well as Mustikkamaa, a recreational area that was joined to Kalasatama by a new pedestrian bridge built in 2016. (Ameel, 2021)

The construction of Kalasatama has parallels with worldwide models of waterfront revitalization in numerous ways. Contaminated soils, the dereliction of underused post-industrial zones, questions of public access, and the promise of upscale housing close to an urban center with ballooning housing prices are some of the key challenges and opportunities here, as they are in Hamburg's HafenCity, New York's urban waterfront, the London Docklands, and other developing waterfronts: The city planners made explicit connections to foreign models. A tribute to New York is the designation of neighboring Teurastamo as a "meatpacking" district. The public ownership of the Helsinki waterfront (which is mostly held by the state and the city) and the fact that Kalasatama is one of several large-scale waterfront areas being built simultaneously along the Helsinki coast stand out in contrast to comparable foreign counterparts. In materials written by the Helsinki City Planning Department (Ameel, 2021).

Forum virium Helsinki’s strategy framework is divided in three main parts:

a. City community: citizenz,public sector, companies
b. Developers business models and value networks: service concepts and experiments
c. Enablers and innovation environments: Open, linked data and APIs,Living Labs and digital City platforms (Open data and open API’s, my Data,robotization,smart mobility and Maas, City as an interface and IoT) (Olivennes, 2018)

Figure 18. Lieven Ameel. (2015). Kalasatama under construction [Photograph]. In The Narrative Turn in Urban Planning (Plotting the Helsinki Waterfront) (1st ed., p. 29).

7-4- Urban Renaissance of The Helsinki's Shoreline

The planning and development of the Helsinki shoreline has coincided with decades that have seen what has been termed a "urban renaissance" or even a "triumph of the city" (Glaeser 2011), with renewed expansion and growth of inner cities, a shift in lifestyle preferences towards urban environments (ranging from consumption and transportation to living preferences, especially among the well-educated middle classes), and a belief that "the city" (Glaeser 2011).

However, this urban renaissance has been critiqued as a "neoliberal policy doctrine" that legitimizes targeting disadvantaged neighborhoods and assesses success "mainly by the growth in property values" (Porter and Shaw 2009, 4).

Thus, urban renaissance "encapsulates a jumble of ideas of social, cultural, economic, environmental, and political sustainability," according to some (ibid., 3;Ameel, 2021)Helsinki, like other post-industrial seaside towns, faces new difficulties such as the privatization and austerity-driven restructuring of its port environment, as well as the threat of catastrophic climate change and increasing sea levels. The emergence of the environmental party in Helsinki to become the second largest (from 2000 onwards) is one noticeable change throughout these decades - urban planning is one prominent political subject adopted by the Helsinki Greens. (Ameel, 2021)

7-5- Functional Kalasatama

Figure 19. Kalasatama district

Helsinki launched the Smart Kalasatama project in fall 2013, with the objective of making Kalasatama a model region for smart urban planning and the Smart City portion of Helsinki. Residents, businesses, the city, and other players are working together to develop the neighborhood in a flexible and experimental manner (City of Helsinki, 2020d).

The objective is to build a resource-conscious neighborhood that saves inhabitants an hour of their daily time. At the same time, new urban services and innovations are being developed, as well as new commercial opportunities. The emergence of services is aided by ICT technology and open data (City of Helsinki, 2020d).

The Smart Kalasatama project is testing new sorts of smart city services in one of Helsinki's new neighborhoods, Kalasatama. The city and businesses bring their own experiments to Kalasatama, where they will be developed in collaboration with the locals. The fishing port is also experimenting with several smart daily services, including shared use rooms and a remote-control service for home electrical equipment, among other things (City of Helsinki, 2020c).

Kalasatama is a smart city development platform that evaluates innovative smart city technologies. Residents, businesses, and city professionals are working together to create new services. Kalasatama has developed an innovative automated trash collecting system based on pipelines. In only a few seconds, trash flows down a subterranean pipeline to the collecting station, where it becomes recyclable raw material, combustible energy waste, or composted soil. Flexible spaces, such as community rooms in residential buildings, are also available in Kalasatama for different societies, such as hobby clubs, to use when the space is available. Reservations are made using an online service, and the smart locks on the premises may be unlocked with a code or by using a smartphone.

7-6- Smart District of Helsinki

The new Kalasatama area of Helsinki is an innovation platform to co-create smart urban infrastructure and services. Centrally located old harbour area is developed flexibly and through piloting, in close co-operation with residents, companies, city officials and other stakeholders. The city and the enterprises use Kalasatama as their testbed to pilot large infrastructure solutions to be scaled up elsewhere. Smart Kalasatama Living Lab hosts Innovators' Club and Programme for Agile Piloting to engage stakeholders co-developing smart solutions. Smart Kalasatama aims to be a worldclass district of smart living, demonstrating

how digital solutions embedded in urban infrastructure enrich everyday life and make it sustainable. The vision of Kalasatama is to offer smart, time saving solutions and become so resource-wise that residents will gain one more hour of own time every day. By the beginning of the 2030s, Kalasatama district will offer a home for about 20,000 Helsinki residents and jobs for 8,000 people. Currently, 2,000 people live in the area.

7-6-1- Explore Kalasatama District

This map shows the smart services and future solutions that can already be found in the area.

1. New Forms of Housing

Floating apartments bring color to cityscape. Complemented by joint building ventures allowing customized houses.

2. Health and Wellbeing Centre

Digital health services and new practices are already being piloted to be part of the center's future offering (city of Helsinki, 2017).

3. Tower Blocks

Eight tower blocks, bustling metro and massive shopping center will form REDI. Living Lab showroom in Suvilahti currently simulates future tower house living (city of Helsinki, 2017).

4. Shared Electric New Forms of Vehicles

No need to keep your own car – residents of this house can use shared electric cars from their garage. Cheap, green, and easy! (City of Helsinki, 2017).

5. Co-Created Senior House

Planned and co-created by active seniors living in the house, this building offers 500m2 of shared spaces (city of Helsinki, 2017).

6. Future School

During daytime a hub for new ways of teaching and learning supported by latest learning technologies. In the evening, a meeting place for residents (city of Helsinki, 2017).

7. HIMA Smart Metering

Hima Smart metering and home remote-control service allows residents to connect and operate their appliances with mobile devices (city of Helsinki, 2017).

8. Waste Collection System

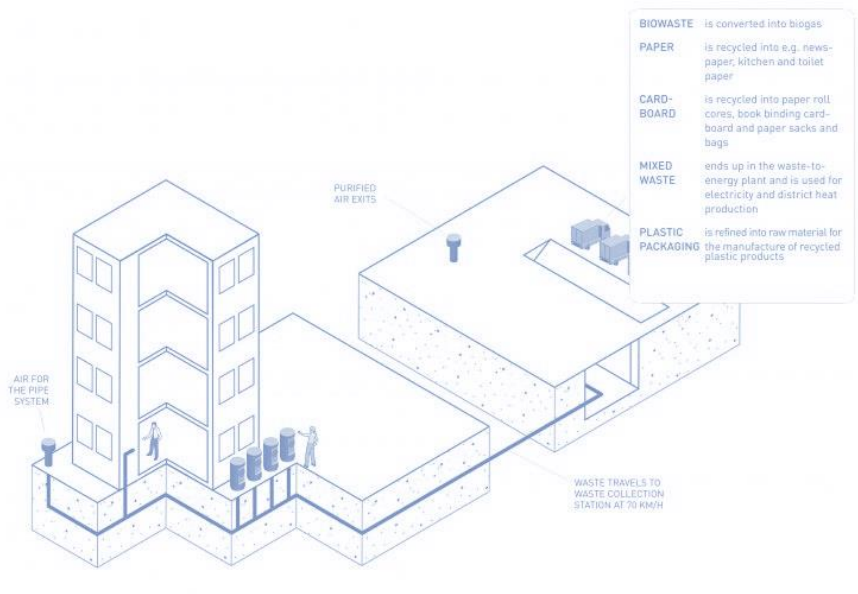


Figure 20. Kalasatama waste collection system diagram (IMU, n.d.)

Sucked by a vacuum into underground pipelines, trashes whizz into the local waste management facility at a speed of up to seventy kilometers per hour (city of Helsinki, 2017).

9. Smart Lightning, Edible Park

Outdoor route with smart lighting takes you to the open garden with mushrooms, berries, and fruits. Come and collect your own! (City of Helsinki, 2017).

10. Carbon-Neutral Smart Zoo

Helsinki Zoo aims to be smart and carbon-neutral. Kalasatama' s school plans to use Korkeasaari as its experimentation platform (city of Helsinki, 2017).

11. DIAK Kalasatama

Modern campus serving 1,500 students and 140 employees. The new facilities have been inspired values like openness, user-driven innovation, internationality, and communality (city of Helsinki, 2017).

12. Abattoir, Pop-up Factory

Lively venue of events, new business, and food culture. Place for students to learn entrepreneurial skills and test their ideas in real-life context together with local businesses (city of Helsinki, 2017).

13. Suvilahti

This old power plant produces culture nowadays. The area also hosts Telecity Group's data center using seawater for cooling and providing heating for houses in Helsinki (city of Helsinki, 2017).

14. Solar Park, Electricity Energy Storage

Customers crowdfunded the panels and enjoy from solar power produced by their designated panel. The megawatt-scale energy storage balances the electricity supply (city of Helsinki, 2017).

15. Fisuverkko

This resident portal saves each apartment's construction and renovation documents. It also shares news on what is happening in Kalasatama (city of Helsinki, 2017).

16. Surf Park

Finnish technology innovation creating waves in natural waters. Brings art, city life, design, and surfing into one urban set-up (city of Helsinki, 2017).

7-7- Kalasatama Urban Living Lab

Figure 21. Kalasatama Urban Living Lab_co-creating urban futures

Forum Virium Helsinki has been coordinating innovation platform activities in Kalasatama, Helsinki's smart city model area, since 2013. Smart Kalasatama is an Urban Living Lab whose goal is to accelerate Helsinki's smart city development. By 2035, the Kalasatama area will have 25,000 people living there and 10,000 people working there. The population of the region is now 4,500 people. Smart Kalasatama is being created in close collaboration with over 200 partners, including residents, businesses, municipal authorities, and researchers, via co-creation and piloting (Laurea-ammattikorkeakoulu, in press).

All operations are directed by a common goal: smart services save citizens one hour each day. In Kalasatama, co-creation and experimental activities have been carried out in the areas of welfare, mobility, education, energy, waste management, and so forth (Smart Kalasatama n.d.) 71 The agile piloting program concept was created to expedite new smart services and public-private partnership while also allowing smaller participants, such as start-ups and small and medium-sized businesses, to participate (SMEs) (Laurea-ammattikorkeakoulu, in press).

The goal is to get as much knowledge as possible while also co-creating value with all partners. Experimentation is a valuable tool for dealing with an uncertain future. The Agile Piloting Program is a wonderful way to start anything new to find the best solutions and learn how people interact with the service. Agile piloting is a technique for facilitating multi-stakeholder cooperation and turning the city's infrastructure, data, and services into a test bed for new ideas. Through an open call, the program allows start-ups and SMEs to test and co-develop their services in a real-world setting for 3–6 months. The initiative procures pilots for a nominal fee (e.g., 1,000–10,000 Euros) to help smaller players. Furthermore, it provides businesses and start-ups with a true real-world setting in which to test and improve their services in collaboration with locals who engage in the process as daily experts. Citizens and consumers of the services are involved in the process as pilot initiators, co-developers, and users to give learnings about smart city development. The orchestrator, who engages the many stakeholders in the process at various phases, is required to provide intense facilitation. In multi-stakeholder innovation processes, the process begins with the selection of the subject or issue to be solved. The orchestrator then announces an open request for a piloting round that will span 1.5 months. The experimental processes last for a maximum of 6 months once the pilots are chosen (usually 4–6). The procedure concludes with a step of assessment. Mustonen, Spilling, and Bergström (2018); Spilling, Rinne, and Hämäläinen 2019;Laurea-ammattikorkeakoulu, in press).

7-7-1- Kalasatama: Smart City District to drive innovation (Mustonen et al., 2018)

As cities compete in smartness rankings, smart city development has become the worldwide trend. Smart city solutions imply urban digitization, or the transformation of physical infrastructure and urban services by data and innovative technological solutions. Though smart cities have been discussed for more

than two decades, progress has been slow for a variety of reasons, including the fact that technology providers' smart city solutions frequently fail to fulfill the demands of communities. The necessity to reorganize urban development and innovation has been raised by recent waves of smart city development. The core business model is as follows: (tech) businesses create and propose innovative solutions, some of which are disruptive. Access to current (or growing) infrastructure may be denied by public authorities, who are often the gatekeepers. Some novel ideas are being tested with academics and consumers, but they will need to be incorporated into regular urban life to become widely adopted (Mustonen et al., 2018).

7-7-2- New business strategies

These integrations frequently fail. As a result, private-sector digital services or ecosystems, rather than public-sector ones, are the focus of most smart city success stories. Companies believe three hurdles face them when it comes to conducting business in smart cities: public regulation, public decision-making on integrating new digital services (particularly at the municipal level), and the shift in customer behavior required to adopt new business models. Better means to cooperatively create innovative solutions are needed as cities and the public sector struggle to battle climate change, air pollution, and growing public healthcare spending, all of which may be better handled with transformational technology(Mustonen et al., 2018).

7-7-3- A RESEARCH AND DEVELOPMENT LABORATORY FOR NEW SOLUTIONS AND SERVICES

The Helsinki region is quickly expanding, with an estimated population increase of 490,000 persons in the next 35 years. In order to promote innovative sustainable urban solutions, Helsinki City Council voted in 2013 to designate Kalasatama, one of the new districts under construction, as a smart city development model. By 2035, a former harbor and industrial zone on the riverfront east of the city center will have 25,000 residents and 10,000 jobs. There are now 3,000 people living there. One of Kalasatama' s main goals is to serve as a testing ground for innovative ideas and services. The objective is to create a smart and sustainable urban environment via collaboration and experimentation. The entire neighborhood in Smart Kalasatama functions as an innovation platform, an Urban Lab where innovative ideas may be developed and tested. The Kalasatama school, the vacuum-based pipeline waste collection system, the energy network, and the health and wellness center are all included in the Living Lab environment. In the neighborhood, there is a co-creation space that may be used for meetings and networking(Mustonen et al., 2018).

7-7-4- Innovator's club

Local networks, such as the Smart Kalasatama Innovator's Club, which brings together local businesses, organizations, and citizens to help define requirements and test new services, are a key aspect of the development platform.

Smart Kalasatama is being built with over two hundred stakeholders, including citizens, businesses, municipal authorities, and researchers, in a flexible manner. Developers, the local energy supplier, IT firms, smart city startups, and consultants are among the businesses that operate in the area. All areas of Helsinki are involved, including the city environment, social and healthcare, education, culture, and leisure. All of the institutions in the Helsinki region are involved in a variety of research initiatives in the area. The EU Regional Development Fund is funding the Smart Kalasatama Program from 2014 to 2018. The initiative is administered by the City of Helsinki, with Forum Virium Helsinki in charge of coordination. Kalasatama and Helsinki have become a unique, worldwide inspirational example of a smart community co-created with people, thanks to this living experiment and active communications. The goal is to make everyday living simpler for residents by saving them at least an hour every day (Mustonen et al., 2018).

As a result, the Kalasatama initiative is all about the user experience and promoting local participation in finding methods to improve municipal services using technology. This is how Smart Kalasatama encourages creativity(Mustonen et al., 2018):

- "Test smart services in the real world with real people.
- Start and run new initiatives and company development
- Run an agile startup piloting program
- Bring together large and small businesses, entrepreneurs, researchers, the public sector, and citizens" (Mustonen et al., 2018).

Smart Kalasatama is a testing ground for businesses, startups, colleges, and a variety of other organizations to collaborate with people, government agencies, and other stakeholders. Companies, colleges, and others use these multifunctional activities as a Living Lab, research, and testing environment. The term "Living Lab" refers to the following(Mustonen et al., 2018):

- “Neighborhoods and critical locations for new service development
- Open innovation platforms and ecosystems
- Networks built by individuals and other stakeholders” (Mustonen et al., 2018).

The Smart Kalasatama initiative is a large-scale platform with over thirty unique projects in the works. It also conducts an agile piloting program, in which companies collaborate with locals to produce smart solution prototypes. Several initiatives, for example, have been done to test smart waste management, smart grids for electricity, and mobility as a service ‘MaaS’ (Mustonen et al., 2018).

7-8- Kalasatama’ s Smart Infrastructures

- **Smart Grid**
  The smart energy grid supports electric vehicle use, new energy storage facilities, and energy efficient building automation as well as local energy production (city of Helsinki, 2017).
- **Smart Space Share**
  The smart space share pilot aims to provide all available room to be utilized by the citizens for work, play and leisure, just as Airbnb does (city of Helsinki, 2017).
- **Internet of Things & My Data**
  As part of the EU-supported bIoTope project, Kalasatama is also a place to run various Internet of Things trials and pilots. Combined with personal data they enable personalized services and customized solutions (city of Helsinki, 2017).
- **Agile Piloting**
  Smart Kalasatama’ s Program for Agile Piloting is buying small pilots that provide new innovative services for residents and can be tested in real life setting. The first four pilots are running, and in the next round, we look services for health and wellbeing (city of Helsinki, 2017).

7-9- Digital Twin project of Kalasatama

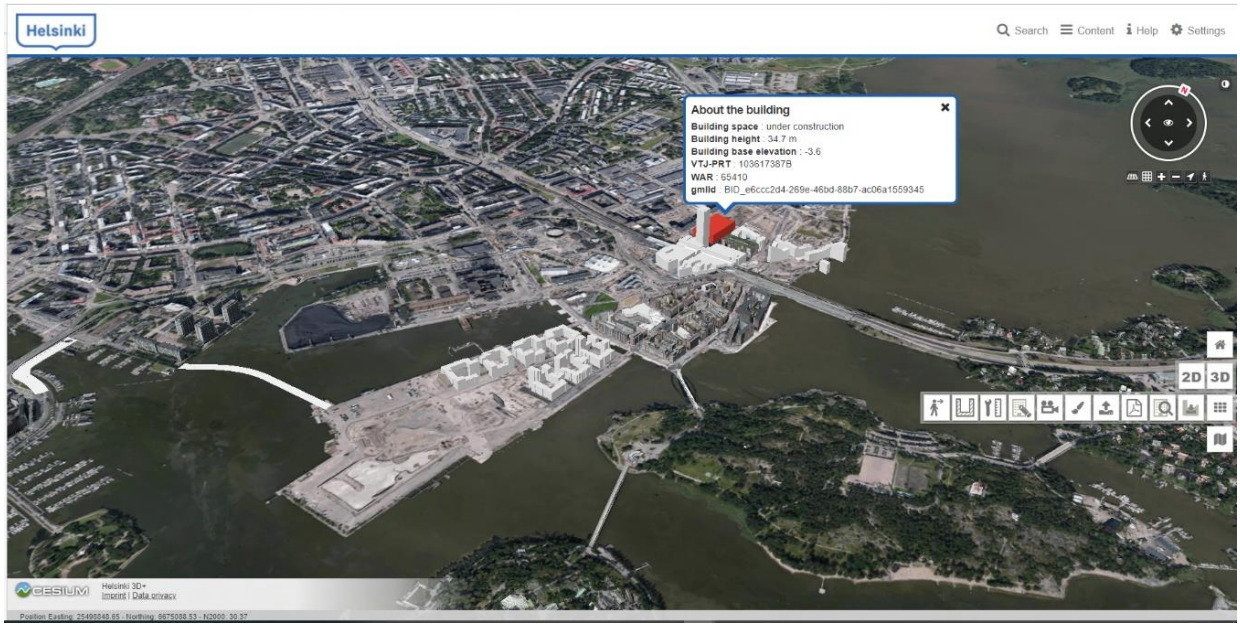


Figure 22. Kalasatama, Helsinki digital twin platform

In Helsinki, the Kalasatama neighborhood is a strategic smart city development region. The Kalasatama digital twin initiative's main goals were to create high-quality 3D models and make them available to the public as open data (Hämäläinen, 2020). Other goals included incorporating digital twin models into existing urban development projects and testing new digital technologies with high-resolution 3D models (Hämäläinen, 2020). The Kalasatama digital twin program aims to use digital twin technology in the future design of city procedures and services (2019 KIRA-digi project report; Hamalainen, 2020).

When compared to industrial design, the usage of digital twins in a city concept is a broader vision. The Internet of Things, interactivity between digital twins and the real world, sensor systems, simulations and analysis of current and planned city environments, maintenance and administration systems, emergency planning and management, and the construction production chain, to name a few, are all intertwined in the Smart City and digital twin concepts. The Kalasatama project in Helsinki uses digital twins to provide high-quality 3D city models as free data to all operators (The Kalasatama Digital Twins Project, the Final Report of KIRA-Digi Pilot Project, 2019).

The project team anticipates that these city model platforms will foster a variety of product creation, research, teaching, and innovation opportunities (The Kalasatama Digital Twins Project, the Final Report of KIRA-Digi Pilot Project, 2019).

The Kalasatama district's first digital twin project goal was realized by generating and applying semantic city data models and realistic mesh models. A global CityGML standard was used for semantic city data models. CityGML (Open Geospatial Consortium) is an open standardized data type for storing and exchanging virtual 3D city models. Data from existing aerial pictures, point cloud datasets, and laser scanning were used to create realistic mesh models (Hämäläinen, 2020). Finally, both reality mesh models and semantic city data models were made publicly available as open data. The city hopes to attract construction and real estate companies as a result of this, which will boost Kalasatama’ s digital twin. (2019 KIRA-digi project report; Hämäläinen, 2020) The city level digital twin virtual platform's long-term objective is to support city operations and overall local service development, innovation, and enterprises in the region (Helsinki city, 2019; Hämäläinen, 2020). Integrating the Kalasatama digital twin with other Smart Kalasatama projects benefits the region's overall growth. To connect additional Smart Kalasatama projects into the virtual digital twin environment, a special program called "Open Cities planner" was created (Hämäläinen, 2020). The Open Cities planner allowed the other Smart Kalasatama initiatives to be visualized, tested, and experimented in a virtual environment before being implemented. The Kalasatama digital twin was also useful for implementing simulations in the Kalasatama district, such as wind and sun simulations. (2019 KIRA-digi project report;Hämäläinen, 2020).

7-9-1- Project’s Objectives

The project's overall goal was to create high-quality digital twin city models of the Kalasatama area that could be shared as open data. The models are used to develop, test, apply, and maintain the built environment over its full lifecycle. The project's progress was separated into five intermediate goals.

The first goal was to produce the models in general. The project's second goal was to make the 3D city models available as open data. There are hundreds of uses for city models, but a lack of a proper scale and sophisticated development platform has stymied progress. The goal of the project's second milestone is to help alleviate this bottleneck and allow open-source technologies to be used to create the platform (The Kalasatama Digital Twins Project, the Final Report of KIRA-Digi Pilot Project, 2019).

The third goal was to work together with the project's key partner, Smart Kalasatama. The Smart Kalasatama initiative, which provides a platform for innovation and development, includes the digital twins. On the 3D model platform, the project created an online platform for activities in Kalasatama and contact with the locals(The Kalasatama Digital Twins Project, the Final Report of KIRA-Digi Pilot Project, 2019).

The fourth goal was to experiment with the most up-to-date methods for modeling, testing, and deploying 3D city models. Simulations and analyses using CityGML models, in particular, are in an advanced stage of development. This intermediate goal implements the basic concept of digital twins: "create, test, and construct digitally first."

The fifth goal was to encourage the use of digital twins in city procedures and service delivery. The creation of processes, procedures, and services based on 3D technology will be enabled by an accurate, up-to-date model of an existing city structure and future ambitions.

7-9-2- Results

7-9-2-1- Benefits that have been observed:

By carrying out the project in Kalasatama, where many other experimental projects are taking place at the same time, synergy gains are realized. The advantages of open data will be realized over a longer period of time. We currently do not have comprehensive data on ongoing open data projects.

At the outset, connecting the city model with the Smart Kalasatama urban development and related programs proved to be beneficial. Game engine streaming expands the developer base for model data and opens up new possibilities for its application. The wind analysis tool's user experiences and results have been quite good, and the need for the tool was recognized by many of the important parties during the regional planning stage.

The spread of toxic pollutants and smoke gases from fires can also be predicted using wind simulation.

Point cloud data generated by UAV flights for small areas can be utilized to maintain the city information model. This is a cost-effective strategy that enables for quick responses to changes in the city.

7-9-2-2- Efficacy:

Both Finnish and foreign operators have expressed strong interest in the ongoing work: the coupling of a city model with Smart urban development is a novel concept.

The report is translated into English because there is a demand for it: the issues of urban development are worldwide, and open cooperation is justified. The work done had a direct impact on the content of the draft for Helsinki's digitalization program, and the digital twin is one of the core projects in the program. The project's effectiveness should be assessed over time: there are currently no practical reports on digital twin experiments conducted at the city model level. Open data and an open CityGML database dump have long-term consequences. Iterative benefits are generated by the utilization of data in training, in particular.

Through actual examples, the growth of the digital twin operating model to the municipal level could result in a completely new operational culture. In the best-case scenario, everyone involved in the urban planning value chain will think about and invent new ways to use a digital twin in their own activities(The Kalasatama Digital Twins Project, the Final Report of KIRA-Digi Pilot Project, 2019).

7-9-2-3-Needs:

Simpler applications and operating chains would improve the modeling technologies employed in both the CityGML and realistic mesh models. In addition, model maintenance technology, standardization, and seamless integration of the BIM and GIS environments would require years of worldwide development (The Kalasatama Digital Twins Project, the Final Report of KIRA-Digi Pilot Project, 2019).

Universities should offer training on the CityGML city information model as part of their degree programs at the national level. Without sound foundational knowledge, it is impossible to establish internationally viable products or service concepts (The Kalasatama Digital Twins Project, the Final Report of KIRA-Digi Pilot Project, 2019).

7-10- Integration of stakeholders on digital twin platforms

Smart city digital twin platforms serve as virtual conventions for a variety of stakeholders. Smart City developers and project owners may easily incorporate heterogeneous stakeholders such as architects, engineers, constructors, property owners, and managers into the Smart World Pro and Open Cities planning platforms. As a result, smart city digital twin platforms improve collaboration and co-development among smart city stakeholders. Stakeholders such as architects, urban designers, and engineers, for example, may quickly model and test alternative scenarios to see how changes in city factors such as speed restrictions affect air quality, noise levels, and people flow in specific areas (Ruohomäki et al., 2018). Citizens can also be more integrated into urban development by using digital twins and visual 3D settings. Local individuals have been able to share their knowledge and experience through the Open Cities planning platform.

It's also employed in the city to crowdsource idea generation. The virtual replica of the city and digital twin platforms, from the standpoint of municipal governance, improve the governance and outcomes of smart city development activities. (2019 KIRA digi project report.)

7-11- Experimental Zone with Low Threshold

The ease of ordinary living is the beginning point for a smart city in Kalasatama. The initiatives have a strong emphasis on service design, user-orientation, and citizen-involved co-planning. In Kalasatama, there

is a Living Lab, which comprises of the area, the co-operation networks that operate there, and the co-development space (City of Helsinki, 2020d).

Smart Kalasatama (SK) is an urban development initiative that describes itself as an "open innovation testbed for people' sustainable smart city services" (Spilling, personal communications, March 2nd, 2020). It is also defined as an experimental platform where businesses collaborate with individuals and the government to generate new ideas. SK is a facilitator of public opinion as well as a facilitator of communication between the city and private enterprises. The way people from FVH talk about the project and how it is being conveyed publicly reflects their interest in resident-centric development. SK was founded to co-develop the city with inhabitants and other local actors, employing the living lab concept and the Kalasatama Urban Lab as a physical co-working and testing facility. Bergström (2015) describes Kalasatama as "a kind of laboratory" where numerous experimental projects and services are evaluated in real life. Following Boyd Cohen's concept of the progression of smart cities from technology centric to user centric to co-created, residents of SK are considered as co-creators of innovation. Citizens, he claims, are "participants in the co-creation of enhanced quality of life," rather than "recipients of services" (as cited in Forum Virium Helsinki, 2020;Nader Sayun Michel, 2020).

SK is a "Smart city experimental innovation platform to co-create smart and clean urban infrastructure and services," according to FVH (Forum Virium Helsinki, 2020). FVH worked on a co-creation workplace and a large-scale experimental project dubbed Agile Piloting, among other initiatives both inside and outside of SK. This became one of SK's most recognizable creations. When the pilots were successful and tested in Kalasatama, they were to be strategically scaled up in collaboration with corporate sector and academic partners. The rapid piloting initiative looked for technology concepts in Helsinki and linked them with prospective funders to help them prototype them (Nader Sayun Michel, 2020).

This is an example of how the city may be used as an experimental platform for the development of new services that rely on the community's current assets and are designed to foster innovation and economic progress. SK may be envisioned as a testing ground for businesses to co-create new services and compare them to the public sector and other businesses (Mustonen, Spilling, & Bergström, N.D. Last print 2019; Nader Sayun Michel, 2020).

7-12- Conclusion

Since the late 1800s, the Kalasatama region has been used for industrial and port purposes. At the end of 2008, the port was relocated to Vuosaari. In the autumn of 2012, the first inhabitants arrived in Kalasatama. The first Sörnäistenniemi area has been completed and is ready for home building. In Sompasaari, the southern half of Verkkosaari, Red, and the Workshop area, housing building is now ongoing. Kalasatama is in the heart of the city, near to amenities and public transportation. Many directions have strong transportation links.

Helsinki launched the Smart Kalasatama project in fall 2013, with the objective of making Kalasatama a model region for smart urban planning and the Smart City portion of Helsinki. Residents, businesses, the city, and other players are working together to develop the neighborhood in a flexible and experimental manner.

The objective is to build a resource-conscious neighborhood that saves inhabitants an hour of their daily time. At the same time, new urban services and innovations are being developed, as well as new commercial opportunities. The emergence of services is aided by ICT technology and open data.

Kalasatama has developed many smart services which are listed below:

1. The fishing port of Kalasatama is experimenting with several smart daily services, including shared use rooms and a remote-control service for home electrical equipment, among other things.
2. Kalasatama has developed an innovative automated trash collecting system based on pipelines. In only a few seconds, trash flows down a subterranean pipeline to the collecting station, where it becomes recyclable raw material, combustible energy waste, or composted soil.
3. Flexible spaces, such as community rooms in residential buildings, are also available in Kalasatama for different societies, such as hobby clubs, to use when the space is available.
4. Reservations are made using an online service, and the smart locks on the premises may be unlocked with a code or by using a smartphone.

Smart Kalasatama Living Lab hosts Innovators' Club and Program for Agile Piloting to engage stakeholders co-developing smart solutions. The vision of Kalasatama is to offer smart, time saving solutions and become so resource-wise that residents will gain one more hour of own time every day.

7-12-1- The Kalasatama' s future solutions:

1. New Forms of Housing: like floating apartments
2. Health and Wellbeing Centre: like Digital health services
3. Tower Blocks: Eight tower blocks, bustling metro and massive shopping centre will form REDI.
4. Shared Electric New Forms of Vehicles: residents of this house can use shared electric cars from their garage.
5. Co-Created Senior House: this building offers 500m2 of shared spaces
6. Future School: teaching and learning supported by latest learning technologies.
7. HIMA Smart Metering: allows residents to connect and operate their appliances with mobile devices.
8. Waste Collection System: Sucked by a vacuum into underground pipelines.
9. Smart Lighting Edible Park: Outdoor route with smart lighting takes you to the open garden
10. Carbon-Neutral Smart Zoo: Helsinki Zoo aims to be smart and carbon-neutral.
11. DIAK Kalasatama: Modern campus serving 1,500 students and 140 employees.
12. Abattoir, Pop-up Factory: Lively venue of events, new business, and food culture. Place for students to learn entrepreneurial skills and test their ideas in real-life context together with local businesses.
13. Suvilahti: This old power plant produces culture nowadays. The area also hosts Telecity Group's data center using seawater for cooling and providing heating for houses in Helsinki.
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15. Fisuverkko: This resident portal saves each apartment's construction and renovation documents. It also shares news on what's happening in Kalasatama.
16. Surf Park: Finnish technology innovation creating waves in natural waters. Brings art, city life, design and surfing into one urban set-up.

Smart Kalasatama is an Urban Living Lab whose goal is to accelerate Helsinki's smart city development. By 2035, the Kalasatama area will have 25,000 people living there and 10,000 people working there.

The Agile Piloting Program is a wonderful way to start anything new to find the best solutions and learn how people interact with the service. Agile piloting is a technique for facilitating multi-stakeholder cooperation and turning the city's infrastructure, data, and services into a test bed for new ideas. Furthermore, it provides businesses and start-ups with a true real-world setting in which to test and improve their services in collaboration with locals who engage in the process as daily experts.

Smart Kalasatama is being built with over 200 stakeholders, including citizens, businesses, municipal authorities, and researchers, in a flexible manner. Developers, the local energy supplier, IT firms, smart city startups, and consultants are among the businesses that operate in the area.

Kalasatama' s Smart Infrastructures:

1. Smart Grid: The smart energy grid supports electric vehicle use, new energy storage facilities, and energy efficient building automation.
2. Smart Space Share: aims to provide all available room to be utilized by the citizens for work, play and leisure, just as Airbnb does.
3. Internet of Things & My Data: Combined with personal data they enable personalized services and customized solutions.
4. Agile Piloting: buying small pilots that provide new innovative services for residents and can be tested in real life setting.

The Kalasatama digital twin initiative's main goals were to create high-quality 3D models and make them available to the public as open data. The Kalasatama digital twin program aims to use digital twin technology in the future design of city procedures and services.

Integrating the Kalasatama digital twin with other Smart Kalasatama projects benefits the region's overall growth. To connect additional Smart Kalasatama projects into the virtual digital twin environment, a special program called "Open Cities planner" was created (Hämäläinen, 2020). The Open Cities planner

allowed the other Smart Kalasatama initiatives to be visualized, tested, and experimented in a virtual environment before being implemented. The Kalasatama digital twin was also useful for implementing simulations in the Kalasatama district, such as wind and sun simulations.

Objectives of the Kalasatama digital twins project:

1. Production of the twin models
2. Sharing the twin models as open data
3. Twin models as a smart development platform
4. Twin models as a simulation platform
5. Twin models in city processes

In total the most important point it that kalasatama is providing a platform to experience new solutions and test them in real life urban zone and involves its stakeholders in decision making process and this way they make major city decisions fast easier to scale up them. In the next chapter the process of project proposals and selecting processes is explained as well as some current or past projects in kalasatama with vast detail of every step of them .

8- Agile Piloting Program in Kalasatama

8-1- Agile Pilots in Kalasatama 2015-2017

Between 2015 and 2017, Smart Kalasatama and its collaborators procured, organized, and participated in twenty pilots. The major purpose of the pilots was to hasten the development of smart services in a normally sluggish metropolitan environment. Another objective was to provide a real-world setting for small businesses to test their ideas. The businesses had the opportunity to establish themselves in the market, collect actual customer input, and expand their services in collaboration with the city and inhabitants. The goal was to come up with and demonstrate creative, practical solutions that were climate-friendly, resource-efficient, and increased people's well-being. The program's pilots were chosen as answers to future difficulties and are directly related to Helsinki's objectives (Mustonen et al., 2018).

8-1-1- Get to know Kalasatama' s pilots

8-1-1-1- Round I

Resource-wise solutions: fifty-two offers, 4 pilots

Tuup Oy, Smart everyday Mobility: a smart mobility planning service for households that aims to connect various modes of transportation in a way that is as simple as driving a car. During their trial in Kalasatama, Tuup tested the idea of Mobility as a Service (MaaS) with end-users for the first time (Mustonen et al., 2018).

Kalasataman Palvelu and housing companies, smart trash bins: Smart garbage bins were installed in Kalasatama' s streets and yards, and sensors were used to optimize waste logistics (Mustonen et al., 2018).

Yhteismaa (Nifty Neighbour and Mesenaatti.me), hyperlocal neighborhood initiatives: Nifty Neighbor is a social online service that is built on maps and locations. Nifty Neighbour investigated how the service might assist Kalasatama locals in generating and testing ideas for improving the area, as well as enabling activities through crowdsourcing (Mustonen et al., 2018).

Link Design Oy, Foller: Using modern technology to reduce food waste and sharing food with neighbors (Mustonen et al., 2018).

8-1-1-2- Round II

Local services to boost wellbeing in cooperation with City of Helsinki Social Services and Health Care: thirty-seven offers, 2 pilots

The Rehabilitation Foundation & Movendos, Fit Friends: The pilot created a paradigm for integrating peer-instructed exercise with a digital service with the goal of getting elders more involved in groups and everyday life (Mustonen et al., 2018).

Auntie Solutions, digital therapy: Auntie provides clients with low-cost digital therapeutic services. Auntie tested two new service concepts with consumers and service suppliers during the experiment (Mustonen et al., 2018).

Helsinki Climate Street, 17 tenders, 3 pilots Co-facilitated with Smart Kalasatama: Existing Buildings with Sustainable Meal Resources There will be no food waste (Mustonen et al., 2018).

8-1-1-3- Round III

Climate-positive pilots in cooperation with the Smart & Clean foundation: thirty-four offers, 5 pilots

Innogreen oy, City oasis – A vertical garden system that manages greywater while also attracting butterflies and biodiversity to the school grounds (Mustonen et al., 2018).

Parkkisähkö Oy, Smart mini grid: To encourage residents to use electric vehicles, the pilot integrated EV charging with solar electricity (Mustonen et al., 2018).

Witrafi Oy, Rent-a-Park: a peer-to-peer parking spot leasing business that links space suppliers with drivers. When they are not in use, parking spot owners can rent their spaces to others (Mustonen et al., 2018).

Elwedo, solar energy service for residents and small companies: The pilot looked into how solar electricity could be used more efficiently in residential units (Mustonen et al., 2018).

The Natural Step, Home carbon: Real-time carbon footprint data, everyday decisions, and local sharing economy opportunities were all merged in the trial. The pilot, which was co-created with local residents, resulted in climate-smart habits and incentives (Mustonen et al., 2018).

8-1-1-4- Round IV

Get moving! Program run by Helsinki Social and Health service sector, facilitated by Smart Kalasatama: 18 offers, 2 pilots

Kalasatama Health skills. Kisakallio and Coach 4Pro: Through a digital coaching program and group sessions with a wellness mentor, residents were given the tools they needed to live an active lifestyle. Changes in motivation levels were constantly examined to observe how the application and group coaching affected them (Mustonen et al., 2018).

Kalasatama On the Move, Laurea University of Applied Science: A collaborative approach was created with Laurea University of applied science physiotherapy. With their pilot neighborhood groups, the students received actual experience encouraging people to live active lives and testing novel solutions using digital training tools (Mustonen et al., 2018).

MORE PILOTING: Laurea University of Applied Sciences, Helsinki Social and Health Service Sector, SRV, Kesko, and CGI Finland collaborated on the Kalasatama Wellbeing initiative in 2018 (Mustonen et al., 2018).

8-2- Selection criteria

Challenges for open calls have been published in Kalasatama in partnership with partnered organizations. The selection criteria were developed one at a time to meet the chosen topic and the aims of the piloting round. Some of the most common Kalasatama pilot requirements are as follows (Mustonen et al., 2018):

8-3- Piloting Program Step by Step

Setting goals and choosing the program partners and theme

It is vital to correctly establish the objectives and topic for agile piloting to tackle the right problems (s). What is the challenge, and how does it connect to the city plan, the aims of the innovation platforms, and other comparable projects? It is crucial to pick the right strategic partners to work with on the program (Mustonen et al., 2018).

Program partners that make the call together include city departments, significant corporations, and research partners. The program gives public-sector organizations a new way to engage with private-sector companies. The first step in selecting the suitable pilots is to plan the piloting program and organize an open call. In consultation with the partners, the challenge for the piloting round should be developed and summarized. As a consequence, the open call subject will be used to guide potential pilot ideas. Data, interfaces, platforms, and locations should all be recognized as potential resources for the pilots (Mustonen et al., 2018).

8-3-1- OPEN CALL

The purpose of the open call phase is to make the challenge, goals, engagement of program partners, and available resources for pilots known. A good open call lasts about a month and a half, during which time communication channels are actively used. To raise visibility for the open call, a variety of venues are leveraged, including websites, social media, linked events, and stakeholder channels. The open call for bids may be aired across national networks for procurement reasons. Use social media to promote the call and team up with accelerators, business incubators, research partners, and developer and innovator networks.

Open information sessions are available for businesses to learn more about the experimental platform's features. These sessions may also be used to get input on how to enhance your ideas (Mustonen et al., 2018).

- a "experimentation clinic," for example, to get last-minute feedback on pilot concepts before the open call closes.
- a "co-creation jam" for the ten most promising proposals to get feedback from partners and stakeholders, find potential partners for a combined offer, and refine their concepts.
- Plan ahead of time how you'll approach and communicate with the companies you wish to partner with (Mustonen et al., 2018).

8-3-2- SELECTION OF THE PILOTS

The selection criteria are used to evaluate the pilot offerings. The selection procedure is overseen by an expert jury comprised of key stakeholders. This is also an excellent method to get the networks involved. When the trial stage begins, it's critical to fine-tuning the pilots even further. This is the reality check stage, when you'll work together to identify the piloting concepts you're working on. The finest sorts of pi-lots do not represent progress too precisely or in a linear manner because the goal of the pi-lots is to advance through piloting sprints (Mustonen et al., 2018).

8-3-3- CLOSING THE CONTRACTS

Procurement agreement The pilot agreement is signed with the chosen teams. This contract defines procurement as an all-encompassing service and establishes a timeline. The intellectual property rights of the pilot are permanently retained by the entities that are running it. Payments can be tied to pilot reporting, such as the first half with the intermediate report and the second half with the final report (Mustonen et al., 2018).

8-3-4- KICK-OFF

The testing phase begins with a team-wide kick-off meeting. The goal of a kick-off event is to assist selected pilots in refining their plans and learning more about what piloting entails in practice, how the program is progressing, and meeting the important networks involved. It's also an opportunity for the program's teams to get to know one another (Mustonen et al., 2018).

8-3-5- RECRUITING USERS

The target groups for the pilot are determined by the teams. If needed, the facilitating team can assist with recruitment planning and reaching out to the appropriate user groups.

It's critical to agree on the quantity of users and a recruitment schedule. Local relationships and networks are a wonderful approach to connect with the right users.

In most cases, 15–20 users will participate in a pilot; however this varies depending on the experiment. Larger groups can be engaged in different ways, such as responding to user surveys, in addition to small groups that participate in co-development. The ideal number of participants is determined by the pilot's goals. Rather of doing an approximate survey of a wider population, it's ideal to seek for rich input from a smaller, more varied set of respondents during the pilot.

Begin by determining target groups and how to reach out to them when it comes to user recruitment. Stakeholder communication channels, for example, can be utilized for this. The most effective communication tool is the one that the target audience prefers, whether it's social media, paper, or anything else. Users should be aware of what is expected of them and how much time they will need.

Collecting user feedback at the conclusion of the pilot is beneficial. This may be accomplished through a survey that encourages consumers to provide input that will aid in the development of the product or service (Mustonen et al., 2018).

8-4- How to involve networks in the pilot

8-4-1- Informal gatherings:

Aim to bring together teams and people from important subject networks during the experimentation. Arrange casual meetings for the teams, facilitators, and stakeholders around the experimental round's midpoint. Facilitators can provide guidance on how to proceed and assist teams in overcoming challenges. The progress of the pilots is visible to the rest of the network (Mustonen et al., 2018).

8-4-2- Co-creation workshops:

Co-creation workshops are a great approach to get the network and inhabitants more involved in pilots. They also provide a discussion board and a platform to get your ideas off the ground.

The Living Lab at Smart Kalasatama has planned one workshop per pilot. The workshop's objectives are decided upon in collaboration with the rest of the team. Around 15 experts, users, and other key stakeholders are invited to participate in an ideal workshop. If the subjects overlap, it may be possible to conduct combined pilot workshops (Mustonen et al., 2018).

8-4-3- Gathering

Collect input from users and partners on how the piloting program, individual pilots, and facilitation perform while running agile pilots. The input is intended to assist you in developing your piloting program methods and evaluating the pilots.

8-5- User engagement

Users can engage in the piloting program in a variety of ways. Residents of the city, representatives of organizations, building maintenance personnel, instructors, and healthcare workers are all potential consumers of the piloted services. When the testing phase is up and running, it's critical to take advantage of each opportunity for user interaction. This is an excellent opportunity to obtain user feedback. Do they comprehend the notion of service? Do they have any reservations about anything? The Living Lab team should encourage and assist enterprises and organizations that are conducting pilots to reach out to users and devote time in gathering feedback (Mustonen et al., 2018).

8-5-1- Users as co-developers

Users can also serve as active collaborators in co-developing a service, depending on the pilot and its emphasis. A service design approach is often required for a larger level of user participation. It would be worth considering partnering with a service design education institution on a program level to receive assistance for user participation. Consumers often do not pay to participate in pilots, but in some situations, charging a fee might help users learn the perceived value of services. Teams may want to consider giving participants a modest gift as a thank you for their time. Citizens are drawn to pilots for a variety of reasons. Users who wish to be among the first to influence new development in this field are interested in new technologies and the ability to impact services. Others are driven by their values: knowing that a service supports an ecologically responsible way of life, for example, may encourage people to join. Users may also benefit from social incentives, such as getting to know their surroundings, participating in events, or learning something new (Mustonen et al., 2018).

8-6- Lessons for Helsinki

Experimentation, co-development, and new networks are all attractive to local officials and enterprises of all sizes. The pilots helped to advance concepts that were already in the works in a larger framework. Finally, the resources required for pilots startled the teams. Learning is the most crucial aspect of pilots. As a result, it's critical to collect learning from all stakeholders in a methodical manner throughout and after the trials. Only recollections of a pilot endure if it is not documented. Research cooperation may aid in the summarization and analysis of more in-depth lessons learnt from pilots, which can then be summarized and efficiently shared with networks, so increasing the value of the pilots. When the flying team effectively utilizes the experimental stage, it learns the most valuable lessons.

The platform facilitators urge the teams to conduct more targeted pilots and to take advantage of their existing networks. Pilots work best with startups, for example, who need to get their own business off the ground quickly. It's difficult to predict how long it will take to find a suitable location and the necessary resources for the pilot. Human variables such as dropout in test groups owing to shifting schedules and

personal conditions also have an impact on the pilots. As a result, it's critical to start recruiting users early and alerting participants about the amount of time they'll need to devote. Individual pilots, according to the agile pilots in Kalasatama, are a better kind of piloting than a program. We've learned the following things from running pilots in programs (Mustonen et al., 2018):

- …" Pilots support each other.
- The pilots produce new understanding, and the products and services being developed make great progress.
- The co-creation workshops organized around the pilots are a good way to involve a wider ecosystem and make progress on ideas connected with the theme.
- The pilots have communicative value: sometimes the greatest value of a pilot is the story communicated through photos and videos and by gathering comments and testimonials. Even a small example from real life can convince the right cooperation partner.
- In piloting, the facilitators' role is to remove barriers and deal with bureaucracy in order to help the piloting teams to proceed. These demands will and persistence. "…(Mustonen et al., 2018)

8-7- Next steps

On its website, the Helsinki municipality has released a booklet titled "Cookbook Recipes for Agile Pilots," which provides a fundamental structure for an agile piloting program. This framework was piloted and evaluated in Helsinki's Smart Kalasatama. To satisfy individual demands, the framework may be stretched and improved. The following points provide useful guidance for experimental programs (Mustonen et al., 2018):

1. A business accelerator has agreed to participate in the piloting program as a partner.
2. A university research group that will offer data and oversee the pilots' evaluation is another potential piloting program partner.
3. A piloting program may end up being part of a future larger publicly funded project. In this case, the program should have a clear goal of creating understanding about a new field (e.g., smart parking), technologies, challenges, and main players in the field before any procurement are made (Mustonen et al., 2018).

8-8- Lessons that agile piloting teaches about smart city development:

Agile piloting allows the entire urban population to learn as much as possible over the course of six months. Here are some crucial points to remember (Mustonen et al., 2018) :

1. A better knowledge of the sorts of services that residents enjoy was gained:
   - Peer solutions that brought them into contact with others via a defined activity or aim were residents' favorites (such as group exercise or reducing their carbon footprint). People were eager to participate in these kinds of pilots.
   - New technological solutions that did not provide a major financial or time-related benefit or that did not have a social component did not pique residents' interest.
   - People were interested in services that provided a clear advantage, were simple to use, and were close by (e.g. shared spaces nearby, online services) (Mustonen et al., 2018).
2. The problems of distributing innovative smart solutions were demonstrated in the agile pilots:
   - The majority of developing smart city solutions face the same challenges: a lack of business eco-systems, outdated laws, a lack of business models, the integration of new solutions into legacy systems, system compatibility, and user behavior change takes time...
   - The agile pilots provide a thorough grasp of the state-of-the-art.
   - The majority of the pilots represented state-of-the-art solutions in their respective sectors.
   - The teams were able to solve "go-to-market" challenges for the first time — even from a worldwide standpoint. (Mustonen et al., 2018).
   - The piloting will pave the path for modern technologies and markets in the future.
3. The agile pilots aid in the knowledge of smart city development's systemic constraints and opportunities.

- Challenges with system compatibility include data quality and maintenance issues, as well as the necessity for data operators and other new intermediate operators.
- Slowness of systemic change, which disruptive solutions frequently necessitate (Mustonen et al., 2018).

Piloting is an excellent method to get started with anything, whether an activity or a change. The lessons learned in the pilots live on in a variety of ways long after the program has ended. The pilots benefit all parties involved, and they may use what they've learned in their own operations in one way or another.

Following the event, some of the participating firms soon expanded abroad. Other businesses take their time to process what they've learned, possibly because they've realized their concept or business model isn't yet lucrative. Negative lessons are frequently used to propel progress ahead. They generate fresh avenues and concepts that might be built up in a few years (Mustonen et al., 2018).

Agile Piloting is arguably the shortest way to obtain more insight into issues, make them visible, and include a variety of stakeholders. Agile piloting is well worth the effort! (Mustonen et al., 2018).

8-9- How to scale up

Agile piloting makes the problems transparent and includes a diverse group of people. Facilitation is required throughout the piloting phase to scale up. Dedicated stakeholders help to scale up results and lessons learned (Mustonen et al., 2018).

Scaling up may be observed from a variety of angles. Individual service scaling may be one of a program's goals, but it isn't the sole one. Although the immediate effect of small pilots may be modest, the outcomes, lessons learned, and formed relationships may substantially impact how cities and collaborators act and collaborate, plan, and drive change in their daily processes. Agile pilots, as early-stage prototypes, offer firms valuable insights into the development of a service. Cities gain from larger-scale planning, policymaking, and implementation expertise, and they foster a culture of experimentation and innovation in the public sector. The approach serves as a neutral platform for collaboration with a larger ecosystem. Experimenting in a real-world setting reveals the hurdles to adopting new technologies and services while allowing all parties involved to learn. The obstacles are generally comparable, such as a lack of business ecosystems, legislative and regulatory concerns, lack of interoperability, and users' reluctance to adjust to new services. Before additional resources are committed to more thorough planning or investments, agile piloting may uncover crucial pain areas and potentials of a solution. Unexpected insights acquired through real-world testing have shown to be highly beneficial to both private and public entities. Although an agile pilot does not guarantee procurement, it may lead to partnership! Agile piloting is a way for smaller businesses to learn more about the city's needs and how to engage with them effectively. Although potential procurement is always a distinct process, favorable encounters may lead to a future purchase decision (Mustonen et al., 2018).

8-9-1- Prepare the groundwork for scaling up

- Associate the piloting program with the City's strategic goals and current development projects.
- As a result of devoted organizations and individuals, the outcomes scale up.
- Consider the pilot's potential outcomes (finance, collaborative partners, city relationships).
- Create a strategy for sharing program results via networks, events, and publications.
- Promote the formation of new partnerships and collaborations as part of the piloting process. (Mustonen et al., 2018).

9- Conclusion

definition of a smart city and the relationship of smart cities with open data and its characteristics as technology is one of the most principal factors in city development in our era. IOT (internet of things) plays an important role and enhances human life quality and in this rapidly growing world of technology and digital items, the number of items that are connected to the internet is more than the number of people. Iot allows getting big data. As governments make these data available for everyone to access enhances the chance for having more innovative solutions in every field specifically for urban designers and urban planners. As urban implementations and developments are time-consuming processes by means of big data, we can create a digital twin of our cities to have a live model of the city to test every innovative solution in different fields such as transportation or waste management.

In other words, Digital twins, the Internet of Things (IoT), blockchains, and artificial intelligence (AI) may reshape our understanding of globalization in the future. Digital Twin will most certainly have an impact on most businesses throughout the world since it replicates the physical model for remote monitoring, viewing, and control in a digital version. It is a live model of a physical system that adjusts to operational changes based on real-time data from various IoT sensors and devices and anticipates the future of the physical equivalents using machine learning/artificial intelligence (Farsi et al., 2019).

But to enhance the engagement of citizens in decision makings and studying the citizen's interaction with different solutions we need an urban living lab in order to get our solutions a live experiment in a small scale. in the next chapter of this thesis, the concept of the urban living lab and its impacts are explained in detail. the starting point of a smart city is the needs of its stakeholders and technology is an enabler to meet those needs so a smart city can have different definitions based on how its stakeholders choose to define them. and as we make a city smarter we actually gain many advantages in different categories such as production, control, utility, services, transit, and public safety like reducing the cost of delivery of products, water management, smart waste management, and recycling, and reaching to the circular economy, 24-hour access to different services online, smart roads and intelligent rail and transit solutions, remote security monitoring and emergency response which each of these can help us to cut back costs of living.

One of the most important aspects of smart cities which was talked about is urban living lab which by this mean stakeholders and policy makers can make common decisions in small scale and get new ideas into practice in real life and then after analyzing its pros and cons they can decide about scaling up and also considering that implementing any changes or implementing any sort of solutions in city scale is very time consuming by this mean new ideas can be tested in small scale and get into result within shorter time.

So to conclude all together smart cities which are focused on open data policy are providing vast opportunity for all organizations and startups , ets to become more innovative by having access to all sort of data and then by providing digital twin technology they are facilitating the first experiments for each idea and also by their platforms all stakeholders have the opportunity to give their feedback over each proposal and then in this way a decision is going to be made by complete collaboration among people, organizations and government which is the most important aim of smart cities and also by this means they are preventing waste of money and energy over failing projects such as we all have seen in our life empty buildings or parks which there is no body inside them ever.

By means of internet of things and implementing this policy in our cities we can cut back on many expenses which we everyday face such as finding a parking space. By means of open data and IoT we can implement sensors for parking slots and by providing an app each driver can be able to find and reserve its parking spot beforehand instead of looking for a spot for a long time and wasting a lot of time and energy. Which is already happening in several smart cities. And many other examples of magnificent benefits of big data in urban life.

After getting detailed research about all opportunities and feasibilities that a smart city can provide in order to answer the main question of this thesis it was needed to get detailed information and research about the relationship between open data and affordable living and smart cities to be done which has been led to highlight the potential benefits—as well as the considerable challenges—of employing new data aggregation and analytic techniques to enhance affordable housing policy and to clear out the meaning of affordable living and living costs. There is the undeniable promise at the very least to make better decisions, whether informing siting decisions, understanding the regional housing market consequences of local zoning policy, transforming management and resident services, or other areas of affordable housing, and

recognizing the practical barriers to implementation (Davidson, N. M.,2017).In this area, we are starting to see a cycle where law encourages the collection of data that can be pooled across various domains to offer a fuller picture of the effects of public investments and other policy choices. Other legal demands, particularly regarding enforcement, can be driven by this data. As previously stated, we must proceed with caution in adopting these new tools because they will always be limited in their ability to accurately capture ground-level reality, and they must be used with a keen appreciation for the people whose lives are being measured and whose voices are all too often ignored. The alternative, though, is much less appealing: continuing to muddle through (Davidson, N. M.,2017).

According to studies, there are three areas where smart cities may save money: local government, citizens, and businesses. The local government may save money in a variety of ways, including by using smart street lighting to use less electricity. "It's crucial to make a distinction between the cost reductions achieved by switching to LED technology from conventional lighting and creating smart, linked systems for streetlights. While adding connection services can result in an additional 30% cost savings, LED lighting alone can save up to 50% or more on energy costs, according to the whitepaper. The majority of this cost reduction is made possible by intelligent, centralized trimming (on/off cycles). Energy savings are also made possible via activity-based triggering and adaptive dimming at night. Through sophisticated, real-time diagnostics, smart street lighting may reduce repair and maintenance expenses by 30% in addition to saving energy. (William Pao, a&s International, 2018)

The study lists transportation, where smart traffic lights and mobility-as-a-service may assist optimize road usage and transportation infrastructure, as well as artificial intelligence, as other areas where municipal governments might realize greater cost reductions. The whitepaper stated that closed-loop demand-response technologies, which automatically adapt and reconfigure systems and networks to fit variable demand levels, will also be crucial to cutting costs by lowering the number of staff. "From the standpoint of a (city) administration, obtaining cost savings through automation-enabled labor reduction frequently comes at the expense of diminished political capital with both unions and citizens. On the other side, technological adoption has demonstrated that it always leads to economic development, which is a major factor in the deployment of smart cities and balances off the direct loss of government-paid employment with new jobs produced in the private sector (William Pao, a&s International, 2018).

9-1- Smart city Cost reductions for both homes and enterprises

Smart house and home sharing technology, remote healthcare, online education, and other innovations can all help inhabitants of smart cities save money. The report stated that "a variety of smart home technologies are emerging, allowing owners to minimize costs for security, heating, cooling, lighting, energy, and water." "House sharing services can relieve the strain on the available housing, particularly for transient residents, guests, and tourists. The goal of initiatives like Airbnb is to maximize home occupancy rates, particularly during event (William Pao, a&s International, 2018).

Although many of the cost-saving benefits of smart city technology for individuals also apply to businesses, the study highlighted that there are a number of special, extra opportunities. Transportation of freight, administration of office buildings, and advanced industrial facilities are some of these(William Pao, a&s International, 2018).

This dissertation stated that prospects for IoT and smart city ecosystems abound amid the smart city boom. According to the report, "high concentrations of people and businesses in an increasing number of megacities and a general shift towards urbanization allow unlocking the power of service and sharing paradigms, achieving higher asset utilization rates, obtaining economies of scale, and ultimately a more sustainable environment on a level never seen before." "For technology vendors, this creates a significant opportunity to position solutions and justify smart city deployments by providing quick returns on investment (ROI) driven by direct cost reductions." (William Pao, a&s International, 2018)

Chourabi et al. (2012) propose a framework on internal and external elements that impact the design, execution, and usage of smart cities projects in their study "Understanding Smart Cities: An Integrative

Framework". They selected eight areas that have a noteworthy influence on endeavors to conceive and construct smart communities. These include government, policy, people and communities, technology, management and organization, economics, infrastructure, and the environment. (Martin, 2019b)

civil society is suggested as the fourth helix by t. Lombardi et al. (2012). The interplay between the four sectors—universities, business, government, and civil society—as well as the key elements of a smart city—smart mobility, smart people, smart environment, and smart governance—determines a city's ability to become smart and to implement smart projects (Ibid.). (Martin, 2019b)

In order to map the success elements that would affect the outcome of a smart city project, Kogan (2014) studied 13 smart cities in her master's thesis, "Exploratory research on success factors and obstacles of Smart City initiatives." The degree of public participation, along with governance, infrastructure, and information and communications technology (ICT), is the most crucial component that affects a Smart City project's success, according to her study. According to Kogan, the state of ICT development can only be viewed in this context as a tool for improving the efficiency of service design, production, and delivery, which will enable citizens to become more involved in daily life (Ibid.) (Martin, 2019b)

To summarize, there are four types of changes that the smart city strategy must bring about in order for the projects and the smart city to succeed (UN 2015). As ICT is the facilitator of smart services, there must first be a clear and sufficient technological transformation. Second, a smart city's industrial transformation requires the adoption of fresh strategies for connecting networks of technology developers and standardizing smart applications. Thirdly, social transformation to bring about change in end users, behavior, values, and desires. The policies of the local administration must also alter in order to combine governance with services. This shift in policy may involve, among other things, modifying laws, financial instruments, systems of government, and contracts. And as It is crucial that the outcomes and performance of the city may be tracked through open systems since the goal of the (smart) city should be to deliver a more effective, safer, and happier environment for its inhabitants. (UN 2015; Martin, 2019b).

9-2- Final conclusion

A network of living labs known as Forum Virium Helsinki in the City of Helsinki has been providing a testing and experimentation environment for the creation of innovative smart city services by the city government, the private sector, other public sector organizations, and Helsinki residents in the Helsinki Metropolitan Area (GSMA 2012;Martin, 2019b)). Six fundamental areas are covered by its projects: smart cities, wellbeing, new media, inventive public procurement, innovation communities, and growth services (Helsinki-Uusimaa Regional Council 2015; Martin, 2019b). Finland's capital and most populated municipality is Helsinki, which has little under 650 000 residents. The city is the most significant hub for politics, education, finance, culture, and research in the nation. 2018c (Wikipedia; Martin, 2019b). As the 16th-ranked city on The Global Livability Index 2018, Helsinki may also be regarded to have incredibly good standards of life (The Economist Intelligence Unit 2018; Martin, 2019b). Over eighty of the top one hundred largest Finnish corporations have their headquarters in the Greater Helsinki metropolitan region, which includes the cities of Espoo, Vantaa, and Kauniainen and accounts for over one third of Finland's GDP (Wikipedia 2018c; Martin, 2019b).

The Helsinki Smart Region program aims to be a pioneer in the usage of innovative goods and services and to double the regional effect of research and innovation. Urban cleantech, health and wellbeing, digitalizing industry, and citizen city are the initiative's focal points. (Homepage for Helsinki Smart in 2018). However, it is crucial to remember that the Helsinki Smart Region initiative is managed by the Helsinki-Uusimaa Regional Council, and that its program, "Research and Innovation Strategy for Smart Specialization," serves as a framework for the region to achieve its goals in developing smart city initiatives (Helsinki-Uusimaa Regional Council 2015; Martin, 2019b).

The Smart Specialization plan for the Helsinki-Uusimaa Region seeks to foster sustainable growth via the generation of value through research and innovation projects and activities through collaboration between various stakeholders, actors, universities, and municipalities (Helsinki-Uusimaa Regional Council 2015; Martin, 2019b).

The following steps have been suggested in order to do this:

1. To aggressively encourage regional collaboration in order to make progress on a global scale.
2. Combine and make use of local experience and knowledge as a shared foundation for innovation.

3. To bring together multiple players on cooperative platforms and combine knowledge, resources, and technology to address shared problems.
4. To make research and innovation efforts more productive, predictable, and reliant on long-term strategies.
5. To foster better networking (Martin, 2019b).
6. Concentrating on theme goals that encourage cooperation and look for answers to the problems that people in the Helsinki-Uusimaa Region face on a daily and professional basis (Helsinki-Uusimaa Regional Council 2015; Martin, 2019b).

The Regional Cooperation Committee directs the entire process and, when the Board of the Helsinki-Uusimaa Regional Council has approved the RIS3 plan, also organizes and conducts the required measures. The RIS3 plan is in line with the Europe 2020 strategy, and as a result, it also affects the financial instruments and policies that support it. (Ibid.).
Nevertheless, it is crucial to consider the objectives stated by the RIS3 plan and the specific wise initiatives started by the City of Helsinki on a more regional level. Here, Helsinki has put an emphasis on using mobile technology, interacting with residents, and making public sector data available to anybody who is interested (GSMA 2012;Martin, 2019b). In order to create new digital services that are based on the actual needs of users in cooperation with private businesses, the city, other public sector organizations, and Helsinki residents, the City of Helsinki and several ICT companies, including Elisa, Nokia, TeliaSonera, Tieto, and YLE, founded Forum Virium Helsinki as early as in 2005.Six main areas are covered by FVH's projects:

1. smart cities,
2. wellbeing,
3. new media,
4. inventive public procurement,
5. innovation communities,
6. and growth services.

In the Helsinki Metropolitan Area, a network of living labs has been offering test environments where various players may cooperate to produce smart city services since 2007. (GSMA 2012; Martin, 2019b). For instance, Forum Virium Helsinki was in charge of the initiative to create an urban digital environment Software Development Kit (SDK). In the framework of the initiative, Helsinki has made its data systems accessible and provided assistance to private developers looking to create city services.

By exposing and unifying APIs, the EU-funded CitySDK project—now known as the Connected Smart Towns Network—has improved collaboration in various European cities (Application Program Interface). For instance, Rome and Amsterdam both employ city services that were designed in Helsinki. Over a thousand data sets produced using public money are currently available for free and open use. Helsinki Forum Virium, n.d.
End users are considered a useful resource when developing new concepts and ideas for smart city services. As part of the process, end users and citizens are engaged as equal partners with the public and private sectors as well as academia to identify needs at the early phases of development. Following, private or public enterprises that develop products and services work with the towns and financiers to develop the final product based on the input and data gathered and analyzed.
In the last phases of the process, the steering committee names a working group to design and test the services through trials and to establish the operational direction of the project. The strategy also encourages startups to participate in smart city initiatives to assist SMEs in creating worldwide growth strategies, get investment, and market their services. (GSMA 2012; Martin, 2019b).
In conclusion, Forum Virium Helsinki's main goals are to identify and develop better services and to give local businesses access to new domestic and worldwide markets. Its function ranges from advising services to full project management, developing strategy, starting, coordinating, and assessing smart city projects over the course of their lifetime. Additionally, it contributes to the development of the smart city ecosystem by involving users and offering assistance to startups and developers. (GSMA 2012;Martin, 2019b)
The city of Helsinki's main objective from the perspective of municipal governance is to be a leader in the use of new products and services. Their strategy is a network of living labs that serve as test settings for

developing smart city services. Additionally, their job might range from consulting services to full project management, strategy definition, project initiation, coordination, and evaluation. Private or public firms develop in conjunction with municipalities and financiers to input to testing from end-uses. The steering committee assesses the projects, and its target audiences include private businesses, the city, other public sectors, and locals (Martin, 2019b).

On the one side, the RIS3 strategy directs Helsinki Smart City, and on the other, Forum Virium, Helsinki's innovation agency, oversees the implementation of actual smart initiatives. Helsinki has made over 1000 data sets freely and openly accessible in order to develop new smart services. Helsinki has also created its own SDK specifically for the urban digital environment. As a result, the innovation in smart cities is driven by the integration of systems and infrastructures as well as the usage of open data (Martin, 2019b).

In order to promote communal interests and participate on all social levels, citizen involvement, technology, which may be used as an innovation tool, and policy, which can create an enabling environment, are the three most crucial components of Helsinki's open governance model (Martin, 2019b).

The utilization and accessibility of public data, as well as the integration of systems and infrastructures, are crucial components of the Helsinki governance model city solution's effectiveness. directing and monitoring the processes and projects. including all necessary parties, including residents, public and private businesses. And finally, openness and transparency of the government to raise citizen involvement and trust (Martin, 2019b).

Open data, excellent design, connectivity, and interesting startups power Helsinki SmartCity. A district on the eastern outskirts of the city center known as Kalasatama has been designated a smart district because it strives to quickly address the problems presented by an expanding city. Through co-creation, agile piloting, local smart services, and resource efficiency, the objective for this urban region is to allow residents escape from their daily duties for an additional hour each day.

The goal of Smart Kalasatama is to co-create smart infrastructure and services. Garbage cans self-empty, energy and information flow in both directions on the smart grid, and a massive energy storage system with a capacity equal to the peak production of roughly four thousand solar panels is in the works. (Post et al., 2020)

With more than two hundred participants, Smart Kalasatama aims to promote smart, clean services that can be expanded abroad. They comprise more than thirty city departments, locals, community groups, business, startups, and small and medium-sized companies (SMEs). A total of 20,000 people will be able to live there, and 8,000 jobs will be created when it is fully finished in 2030, but 3,000 pioneering inhabitants currently call it home. (Post et al., 2020)

In general, considering different needs of each person during their life and comparisons done from different cities cost distributions a major cost is spend on housing sector although as mentioned before smart city will save a lot of money in urban scale such as smart public transport , smart waste management and energy savings but also by also gives architects and urban planners more courage to try more innovative solutions . Kalasatama as an urban living lab with its smart citizens can provide a test bed for startups such as gamified co housing, there are several co housing, co living projects in the area but not in this way.

Specially after the covid 19 period and considering the aging population of local people in Helsinki and increasing number of diversities in this city which is caused by increasing number of job opportunities there which invites foreign people and young peoples to go to Helsinki for living gamified co housing have the potential to increase the social interaction, reduce loneliness and create affordable community . people will help each other in daily chores and in same time earn money. Most of peoples need will be achieved within the circle of their community only throw an application. This way they will save on energy and living costs also construction wise instead of spending too much energy on constructing new social housing or etc. or they provide a minimal renovation, and they turn the abandoned buildings into a gamified co housings.

In Turin also there are several abandoned industrial buildings and high demand for housing specially with vast number of student and young workers that Turin has every year this can be a huge change in housing market of Turin and brings a new sight to reduce diversity in Turin and also to reduce the living costs for elderly people,foreigners,students, and young workers.

Although still there is no certain solution to make life affordable for everyone and there are a lot of difference variant in analyzing them and even the definition of affordability and its limit will be varied by each person lifestyle and many other factors in this research it is tried to consider the majority of people's needs and average income models. In this thesis has been tried to investigate different solutions we can access to make life more affordable and more sustainable at the same time by considering not only cost graphs but also its social impacts and by focusing of the citizens.

By piloting this startup in different ULL all over Europe we can reach to much more clear results of the impacts of gamified co housing and how it will work in longer period and prepare the test bed to scale up this innovative solution in urban scale.

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