



# Master's degree thesis

**LOG950 Logistics**

**Sustainable Development and Citizen Participation**

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# Preface

This master thesis has been undertaken as a part of Molde University College Specialized University in Logistics. Where both authors are studying Master of Science in Logistics, specializing in Supply Chain Management. After an intense semester with 10 different seminars in autumn 2021 our interest was growing for both sustainability, circular economy and the smart city concepts. Because of excellent lectures creating a big enthusiasm about the importance of these topics, we chose to direct our focus on sustainable development for our thesis. Our supervisor Steinar Kristoffersen had great ideas for us to write about Sustainable City Development and Citizen Participation. We worked together with Kristoffersen to create a good base for our research.

We would like to thank our supervisor, Steinar Kristoffersen for his extraordinary guidance, insight, cooperation and support throughout our journey. You have introduced us to a very captivating field in which you have a lot of knowledge and interesting insight. Regardless of your busy schedule as Rector of Molde University College - Specialized University of Logistics, you have always responded quickly to our emails and followed up on our research with monthly meetings. Good discussions and your insightful criticism, based on both personal experience and research, have had a substantial and important impact on this thesis. We would also like to thank our co-supervisor Halvard Arntzen for taking their time to give us feedback and interesting viewpoints.

We would also want to thank all the participants from the various departments for participating in the data collecting and supplying us with vital information despite your hectic schedules and other responsibilities.

Lastly, we want to thank each other for a great semester with excellent cooperation and working evenly together over the last six months. We have learned some much from each other and all the people we have meet through this experience. Even more, we had a lot of fun and have created a solid friendship throughout these last months.

Molde 23.05.2022

Vilde Sønju Bårnes

Burak Pordoğan

## Abstract

Sustainable city development and smart solutions is a shift happening in many cities around the world. Norway have conducted the UN Sustainable development goals for the people and the planet to stop the climate change within 2030.

For smart cities to create successful smart city projects, citizen lab and increase the citizen participation, some important factors need to be fulfilled. It is highly recommended from literature to put the citizen in center of a smart city approach. This study will take a closer look at 4 different smart cities, 3 located in Norway and 1 in Sweden. The Norwegian cities have a quite similar base where they want to become a better city for people to work and live in, while our chosen Swedish city has more challenges regarding crime, high unemployment rate, gang violence and democratic issues. For our thesis we have done qualitative research where we have collected data from our chosen cities through interviews as well as earlier documented studies. We have selected four Smart cities, Molde, Bodø, Trondheim and Malmö for comparison and analysis. Based on this we are presenting a traffic light assessment model and linear weighting model where the goal is to easily locate where changes can be made and where they are succeeding or failing in their projects. The idea behind the models is for future research to minimize the risk involved with smart city projects as well as helping them measure the quality of the projects. Furthermore, we are proposing some suggestions on how we think a citizen lab should be. The study gives insight on how to measure the success of a smart city project based on four chosen criteria's Sustainability, Accessibility, Incentives and cost.

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## **1.0 Introduction**

### **1.1 Motivation and background**

Increased urbanization, rapid population growth, climate change, scarcity of resources, socio-economic disparity, technological innovations and governance and participation requirements, has caused Smart City concept to get lot of academic and practical attention in recent years. Over half of the world population now live in urban areas or within close vicinity and according to United Nation by 2050 70% of the world's population will live in the urban areas (Nations, 2014). ICTs are being adapted to maximize the effective interaction between diverse systems and services in the city, and to produce a sustainable urban environment in the process. A smart city in Norway wants to put citizen in center of the approach, create a sustainable city for the citizen to live and work. Additionally, a smart city approach is about being innovative and to use technology in a progressive and revolutionary way. Literature focuses on the cruciality of participation from citizens to achieve these goals. The Smart City concept is still developing and is still a new concept for many cities in Norway (Stenstadvold, 2019).

The focus for Norwegian municipalities over the recent years have shifted to citizen participation. In the development processes it has been found out that one way to do so is by creating citizen labs. The participation of the citizens in the labs that have already been established vary, and research on the results of the citizens lab is not thoroughly investigated. The United Nations' members agreed on a set of 17 goals for sustainable development to reach by 2030. The environmental, economical, and social development are all entwined in these objectives. They are universally applicable and serve as a roadmap for worldwide efforts to achieve sustainable development. The national roadmap for smart city in Norway emphasizes sustainability Goal 11, which aims to make cities and communities more inclusive, safer, resilient, and sustainable. Sustainability goal 9 and 11 also plays key role in smart city efforts, where goal number 9 relate to innovation and infrastructure and sustainability goal number 11 focus on collaboration(DOGA, 2019).

## **1.2 Research objectives**

The purpose of the thesis is to research citizen labs, citizen participation and smart cities.

Based on the purpose, the following research question was formulated:

*In which way will a citizen lab contribute to better smart city projects, a smarter city and more sustainable future for the municipalities?*

Other than the concrete research question presented above, we have added some additional questions to help find the solution for our research question.

- What can be done to improve the projects in the municipalities?
- What is the idea behind citizen labs and citizen participation?
- What is the best way to improve the citizen participation?

## **1.3 Structure**

The first chapter presented is an introduction to the thesis, motivation and background for the thesis and the research objectives we are investigating. The second chapter consists of the literature review, where previous relevant work has been collected and reviewed. Moreover, literature review, our theoretical framework - stakeholder theory is presented and a literature summary where our own smart city definition is given. Chapter three shows an overview of the methodology used, as well as the reason why we chose the particular smart cities for our thesis. Further on, chapter four is case description, where all the smart city projects, citizens labs and some facts about the cities are provided. In chapter five, our traffic light assessment model is presented with results. Following this in chapter six, findings from the interviews conducted as well as information gathered through papers and reports are presented. Furthermore, in chapter seven an analysis of all the information gathered from literature and from the interviews are discussed as well as some suggestions are presented. The last chapter consists of our conclusion, limitations, and future research.

## **2.0 Literature review**

For the literature review we have identified and selected what we think is the articles with highest quality to answer our research questions. We have chosen articles based on relevance to find the correct information for our research. We have found research about the smart city concept, definitions, citizen involvement, sustainability and other related factors that play a role in the process. An example of how we have been selecting relevant articles is by using Google Scholar and selecting based on the authors credibility, past work, year of publication and amount of citation to determine the choice of paper. This was done to get a sense of what is known in the area and to discover an acceptable gap in which to place this study. Smart city is a popular topic where it's possible to find many articles where the smart city concept is researched. We have researched about citizen involvement, quadruple helix, circular economy, sustainability, climate change, technology and so on. We have gotten an overview of the topic by analyzing many papers to try to provide the best foundation for this project.

### **2.1 Smart Cities**

#### **2.1.1 Smart City Definitions**

When reading scientific literature about smart city and searching for a description of the idea, it immediately becomes clear that there is no complete definition of the phrase "smart city" that is widely acknowledged by the scientific communities and organizations. That is because the concept of a smart city is still in its immaturity, and work on defining and conceiving it is ongoing. The notion is used in diverse terminologies, settings, and meanings across the world. Hollands (2008)) is identifying the usage of the term "smart city" as an urban labeling phenomenon, revealing that the term "smart city" is a notion that is used in a variety of ways. Several definitions have been proposed and recognized for application in both practical and academic contexts. This overload of definitions has prompted requests for more conceptual studies in this field. We have collected some definitions in the table below to show the variety and ambiguity in how to define a Smart City.

Source	Definition
(TWI, 2021)	“A smart city uses information and communication technology (ICT) to improve operational efficiency, share information with the public and provide a better quality of government service and citizen welfare.”
(Giffinger et al., 2007)	“A city well performing in a forward-looking way in economy, people, governance, mobility, environment, and living, built on the smart combination of endowments and activities of self-decisive, independent and aware citizens.”
(Harrison et al., 2010)	A city “connecting the physical infrastructure, the IT infrastructure, the social infrastructure, and the business infrastructure to leverage the collective intelligence of the city”
(Toppeta, 2010)	A city “combining ICT and Web 2.0 technology with other organizational, design and planning efforts to de-materialize and speed up bureaucratic processes and help to identify new, innovative solutions to city management complexity, in order to improve sustainability and livability.”
(DOGA, 2019)	“Smart cities and communities focus on people, while using new technology, innovative methods, collaboration and co-creation to become more sustainable, attractive, productive and resilient.”
(Nagaraj, 2020)	“A developed urban area that creates sustainable economic development and high quality of life by excelling or becoming “smart” in multiple key areas; economy, mobility, environment, people, living, and government.”

*Table 1: Different Smart City Definitions*

### **2.1.2 The rise of smart city concepts**

“The basic concept of the smart cities is that the city should be “green,” more “accessible,” and more “livable.””(Kumar & Rattan, 2020)

A smart city can be explained as a technologically based infrastructure that initiates to protect the environment. To have public transportation that is both efficient and useful as well as city plans that are forward-thinking. Smart city is about the people living and working in the city and how they benefit from the city's resources. Usually, a common goal for becoming a smart city is to improve citizens' welfare and efficiencies in the urban areas, to give them an urban environment that offers citizens high quality of life while also driving economic growth (TWI, 2021).

“Recent interest in smart cities is motivated by major challenges, including climate change, economic restructuring, and the move to online retail and entertainment, ageing populations, and pressures on public finances.”(Nagaraj, 2020)

This is especially crucial in view of future urban population increase, which will create a more effective use of infrastructure and the cities assets. Smart city enhancements also add value to existing infrastructure by generating new revenue sources and improving operational efficiencies, all of which help to save money for both the government and the citizens (TWI, 2021).

Maja Nilssen creates a smart city initiative typology based on the scope and types of technologies included (Nilssen, 2019). The typology is organized as a smart city continuum with four innovation dimensions: (1) technology, (2) organizational, (3) collaborative, and (4) experimental. She focuses on how the different dimensions included in the smart city concept and how this can be connected to innovation and how the smart cities can be innovative. She illustrates her typology by analyzing Bodø municipality smart city. Smart cities are often looked upon as cities being technologically dominant. They are considered as cities that are revolutionized by datafication, instrumentation, and computation which are essentially “key mode of production for smart cities” (Bibri & Krogstie, 2020).

However, it has been emphasized that smart cities are more than just using technology. Technology is a great tool for a city to become smarter (Nilssen, 2019).

The field of smart sustainable cities, which combines sustainable development with urbanization challenges, has piqued the interest of researchers, educators, policymakers, and entrepreneurs from all walks of life. Scientific publications, university teaching, research programs, and university departments dedicated to sustainable urban development may all be found in academia (Yigitcanlar et al., 2019).

As mentioned in the introduction urbanization and urban growth are expected to continue increasing (Höjer & Wangel, 2014). This significant transformation is accompanied with a growing awareness and concerns for sustainability, transportation, and natural resources. When almost half of the world's population lives in cities, the energy consumption and other resources are progressively being used most in these areas. As the world's population continues to congregate in cities, these places will become increasingly crucial in solving concerns of sustainable development. To put it another way, Höjer and Wangel (2014) emphasizes that sustainable urban development has become a requirement for long-term growth.

Future smart sustainable development may contribute to happiness to provide citizens with opportunities for meaningful and long-term fulfillment (Cloutier et al., 2014). Happiness is defined as a long-lasting experience of pleasure accompanied by more positive emotions than negative emotions rooted in human societies (Cloutier et al., 2014). This research is examining the relationships between four consistent and comprehensive sustainability indices and self-reported happiness in urban regions across the United States. They discovered that all four sustainability indices had positive connections with self-reported happiness, two of which were statistically significant. The findings show that towns pursuing sustainability may provide more possibilities for inhabitants to be happy (Cloutier et al., 2014). This study is the first step toward a bigger goal of determining the links between happiness and smart sustainable development, two notions that may play a critical role in the long-term health and well-being of the global population, either individually or collectively (Cloutier et al., 2014).

### 2.1.3 Framework of smart cities

Cities are dense environments and the systems that is required for transformation to a smarter city cannot operate in isolation (Alavibelman & Fazekas, 2018). Municipalities must encourage an integration of various systems (public transportation, electrical grids, energy production, public education, health care, buildings, infrastructure, food, water, and public safety) of a city simultaneously and apply a holistic approach to have measurable impact on sustainable development of the region (Albino et al., 2015). The six dimensions of the smart city framework are Smart mobility, Smart Environment, Smart People, Smart living, Smart Governance, Smart Economy. Some dimension may be an outcome of other dimension, which further proves the interconnection between them.

**Smart Mobility:** The application of ICT in current transportation technology to improve urban traffic is referred to as smart mobility.

**Smart Environment:** The application of technology and sustainable methods to preserve, maintain, manage natural resources, and reduce pollution and protect the environment (Al Sharif & Pokharel, 2021).

**Smart People:** Human capital and social capital are at the heart of a smart city's social infrastructure. It values the abilities and proficiencies of groups or individuals, and connection of people to social organizations (Al Sharif & Pokharel, 2021).

**Smart Living:** The growth and protection of natural, economic, and human capitals are all considered as parts of smart living in the OECD Better-Life Initiative framework (OECD, 2017).

**Smart Governance:** Smart governance entails including a wide range of stakeholders in decision-making and public services. ICT-mediated governance, also known as e-government, is critical for bringing smart city projects to residents and maintaining transparency in the decision-making and implementation process (Albino et al., 2015).

**Smart Economy:** The smart economy has been linked to the ICT-related sectors or the use of ICT in manufacturing processes (Albino et al., 2015).

In the table below we have organized important factors based on literature in to the six different dimensions (Kumar & Rattan, 2020), (Al Sharif & Pokharel, 2021), (Albino et al., 2015), (Alavibelman & Fazekas, 2018), (Abusaada & Elshater, 2021).



<b>Smart Mobility</b>	<b>Smart Environment</b>	<b>Smart People</b>
<ul style="list-style-type: none"> <li>• Information and communication technologies (ICT)</li> <li>• Smart, safe, effective and innovative transportation</li> <li>• Internet of Vehicles (IoV)</li> <li>• Sustainability</li> </ul>	<ul style="list-style-type: none"> <li>• UN sustainable goals</li> <li>• Pollution control</li> <li>• Circular Economy</li> <li>• Smart Grids</li> <li>• Waste discarding</li> <li>• Energy management</li> <li>• Housing and facility management</li> <li>• Emission monitoring</li> <li>• Air and water quality</li> <li>• Green space expansion</li> </ul>	<ul style="list-style-type: none"> <li>• Flexibility</li> <li>• Technology savvy</li> <li>• Sustainable aware</li> <li>• Values human rights</li> <li>• Creativity</li> <li>• Tolerance</li> <li>• Cosmopolitanism,</li> <li>• Participation in public life</li> </ul>
<b>Smart Living</b>	<b>Smart Governance</b>	<b>Smart Economy</b>
<ul style="list-style-type: none"> <li>• Healthcare facilities</li> <li>• Education</li> <li>• Quality of living</li> <li>• Affordable and quality housing</li> <li>• Availability of cultural services</li> <li>• Tourist attractions</li> <li>• Personal safety</li> </ul>	<ul style="list-style-type: none"> <li>• Urban Management</li> <li>• Collaboration</li> <li>• Communication</li> <li>• Participation</li> <li>• Transparency</li> <li>• Services and applications</li> </ul>	<ul style="list-style-type: none"> <li>• Innovation</li> <li>• Productivity</li> <li>• Entrepreneurship</li> <li>• Citizen participation</li> <li>• Creativity</li> <li>• Sharing economy</li> <li>• E-commerce initiatives</li> </ul>

Table 2: Smart City Dimensions

### 2.1.4 Barriers and opportunities

One of the primary barriers to a successful smart city deployment is the expenditure of design and maintenance (Silva et al., 2018). As a result, the lower the design expenses, the greater the likelihood of real-world adoption. Operational costs as are often explained as costs that are a part of the ongoing day-to-day expenses of running a business, like selling, administrative and general expenses. Operational costs are incurred as a result of day-to-day urban management and upkeep. Minimal operational expenses are essential for ensuring the

long-term viability of service supply without putting further financial strain on municipalities (Silva et al., 2018).

An important component of any smart city construction is data privacy. According to Stone (2018) one of the most important barriers is the proper management and security of the implementations. The urban network collects a wide range of data, including extremely sensitive civilian information, which in itself is prone to a number of security concerns like malware, Emotet, and data leakage. Protecting privacy has become an important concern, that has had been addressed by academics (Papadimitriou & Garcia-Molina, 2011), (Vogt et al., 2007), (Yang et al., 2004).

A major challenge of smart city designs is heterogeneity. Interoperability is critical in a smart city because it allows devices to communicate with one other using multiple communication methods at the application layer (Mehmood et al., 2017). The potential to integrate and interconnect at the application layer is hampered through system limitations caused by heterogeneity (Silva et al., 2018). Interoperability across devices from many areas is a key hurdle to IoT success, according to the World Economic Forum, due to the absence of universally accepted standards (Agenda, 2015).

Due to environmental degradation and land filling, waste management is another major concern in modern smart cities. Smart cities are concerned about preserving the city environment and resources for succeeding generations by reducing carbon emissions and sustainably managing natural resources (Authority, 2016).

Smart cities that link abundant of devices will consequently generate a tremendous volume of data and information that can be analyzed. Appropriate tools, approaches and algorithms are required to process this data (Mehmood et al., 2017). According to Silva et al. (2018) the ability to transport, store, retrieve, and analyze large amounts of data is extremely important for a smart city's continuous and flawless functioning.

Furthermore, Stone (2018) identified barriers that a smart city is facing as infrastructure, security and hackers, privacy concerns, educating and engaging the community and being socially inclusive. All these barriers smart cities are facing are possible to overcome, most people believe that smart technology has the potential to make our lives easier – especially in populated metropolitan areas. Developers and tech businesses must examine how the solution will influence the people that encounter it, rather than only focusing on what it can

achieve. A city becomes smart when technology, local government, and communities of people work together to improve the quality of life for everyone involved (Stone, 2018). Moreover, the deployment of an ICT infrastructure is crucial for the development of a smart city and is dependent on a number of elements, such as its performance and availability. Ebrahim and Irani (2005) developed a list of elements that influence ICT integration. According to them IT infrastructure, security and privacy, and operational costs can be considered as barriers during the implementation phase of a smart city. As we can see based on the literature analysis above, most of the authors are concerned about the same factors. These elements cover technological, financial, and environmental dimensions and accepted requirements. However, the social and technological worlds are inextricably linked in any social setting, and that focusing solely on technology development and innovation can lead to solutions that fall short of expectations (Andreani et al., 2018).

Once research has been carried out, it is easier to evaluate the current initiatives and use the barriers as a cue of change and improvement. Therefore, challenges that they face in the present time can help them learn lessons and push them towards continuous improvement which can ultimately result in perfect systematic development. In the table below, a presentation of barriers and advantages of important factors are showed and explained.

<b>Factors</b>	<b>Barriers</b>	<b>Advantages</b>
<b>Economic factors</b>	High Investment costs	More profitable industries Benefits the economy
<b>Citizens and society factors</b>	Long adaptation period by society  Uncertainty: <ul style="list-style-type: none"> <li>• Lack of knowledge</li> <li>• Do not know what smart city is</li> <li>• Not interest in the idea of change</li> </ul>	Welfare increase  Decrease of crime
<b>Technological factors</b>	Security issues  Privacy concerns	Facilities day to day activates in a better way, transportation, healthcare, governance etc.
<b>Environmental factors</b>	Uninformed citizens  Climate change deniers  Capitalists cooperate structure	Reduces: <ul style="list-style-type: none"> <li>• Environmental footprint</li> <li>• Pollution</li> </ul> UN Sustainable Development goals

Table 3: Smart City Factors

### **2.1.5 Differences between a “smart” and a traditional/conventional city**

“Smart cities demand carefully planning at early ages, it is important the city will fulfill the requirements of government and citizen. A clear strategy must address two key factors: “functions” and “purposes,” the function refers to aesthetical appearance and operations of a city, and “purposes” refers to the benefits promised by a smart city model” (*Kumar & Rattan, 2020*)

Traditional cities can be explained as cities with no or very little plan or strategy for investment in place, no designated industrial or economic plans, and no municipal identity. They seldom have a vision for energy efficient buildings and systems, green buildings, renewable energy regulations, and no strong policies for sustainability, environmental preservation, and resource management (*Nagaraj, 2020*).

In a conventional city the citizens often suffer with bad quality of life, such as access to water and water issues, electricity issues, bad education systems, safety, security, lack of opportunities for work, bad health care etc. Often in these cities they do not use renewable energy solutions and lack proper management for garbage and pollution (*Kumar & Rattan, 2020*).

To overcome these problems, the conventional city should transfer to a “Smart City” approach, by doing this the city should follow a roadmap. The roadmap should contain following four stages, Assessment, Vision, Project Plan and Metrics (*Nagaraj, 2020*).

The 'Traditional' cities may become 'Smart' and satisfy the performance objectives for Economy, Environment, Government, Governance/Public Participation, Living, Mobility, and People by efficiently combining Smart City plans and components (*Nagaraj, 2020*).

### **2.1.6 Reasoning for becoming a Smart City**

The basic purpose of a smart city is to use smart technology and data analysis to optimize city activities and boost economic growth while also increasing the people living in the city's quality of life (Andreani et al., 2018).

Vehicle congestion is a big problem in cities and have a negative impact on travel time, travel distance, fuel consumption and air pollution. When the number of vehicles continuously increase on the road network, the problem of traffic congestion does as well, making the development of congestion avoidance algorithms a critical issue (Amer et al., 2018).

Andreani et al. (2018) emphasized the ineffectiveness of transportation infrastructure and suggested that a shift from static to dynamic, adaptable street environments based on the needs of society. For example, dynamic autonomous adjustments of traffic lanes, bike lanes, and pedestrian's sidewalks based on congestions caused by corresponding transportation mode.

A smart city can also reduce climate change and air pollution and prevent crime in high-risk areas or use sensors for warning of natural disasters, floods, landslides, and earthquakes etc. Additionally, smart parking technologies could help drivers find a parking spot in timely and safe manner (Andreani et al., 2018).

The idea of a smart city may also include its ambient environment and physical lay-out, such as buildings, noise, accessibility, lighting, etc. Andreani et al. (2018) have envisioned a concept in which the luminosity of urban lighting would adjust based on the human behavior. The purpose of this innovation is to enhance the safety of citizens walking in dark alleys, because it has been assumed by the authors that street with low lighting is where the crime and assaults happen, and this initiative would be a prevention of such unfortunate events. The authors suggested autonomous flying drone to play a role as safety companions. They conceptualized it in a way that the drones would be on idle during the daytime and activate themselves during the night once they suspect any unusual potential criminal behavior. Furthermore, once the potential frightened citizen detected, the drone would fly over to the citizen/or in some cases to the suspect and light them up. The psychological

pressure of being visible and perhaps being surveilled could make the suspects back down from their initial intents (Andreani et al., 2018).

For cities at large to be thought of as smart, data from a great number of sensors may need to be considered, for instance, dynamic responses of the build environment. Continuing with Andreani et al. (2018)'s research; They highlighted the dynamic responses of the built environment; space usage efficiency, traffic estimates, and peak hour analysis are all variables that are assessable and measurable metrics for optimization. For instance, they analyzed a retail store's activity level and human behavior based on how the shelves were arranged, products were organized, and store was structured. By quantifying these variables, they found out that it would be possible for store managers to optimize it in a way that that both parties involved would get the most out of the interaction. They mentioned that this quantification would be possible by using sensors, cameras, and other information communication technology (ICT) tools. Authors also pointed out that this approach would create a new perspective for architects and civil engineers so that they could create blueprints in a most efficient way (Andreani et al., 2018).

Andreani et al. (2018) created a design research framework with the purpose of providing a guide for smart city endeavors and to be used by researchers, urban designers and architects to facilitate their understanding of emerging technologies and utilization of them. The framework consists of three components.

- (1) Grounded vision: highlighting an innovative approach based on the problems that may arise in the future.
- (2) Embraced technology: explaining the role of technological advancements in urban areas.
- (3) promoting collaborative actions taken by stakeholders for impactful innovation (government, academia, industry, society) (Andreani et al., 2018).

The concepts above employ a holistic and human centric approach in utilization of technology in a responsive and interactive manner in urban spaces to maximize the efficiency and safety measures of day-to-day activities of citizens.

### 2.1.7 Quadruple Helix

Smart cities success relies on the relationship between different important partners in the society, like private and public sector (TWI, 2021). The quadruple Helix could be a helpful framework for a Smart city, because the model recognizes the four important actors in the innovation system: government, community, industry and academic research. As a result of this model, an increasing number of governments are promoting public participation in innovation processes (Schütz et al., 2019). Public participation from a political point of view seems to be necessary as it can be helpful to solve major challenges for the society. It will also contribute to the community with new innovative ideas (Schütz et al., 2019).

The importance of citizen participation is to invite citizen to participate with different ideas and solution and for the municipality to take those ideas seriously be open, transparent and admissible (Schütz et al., 2019).

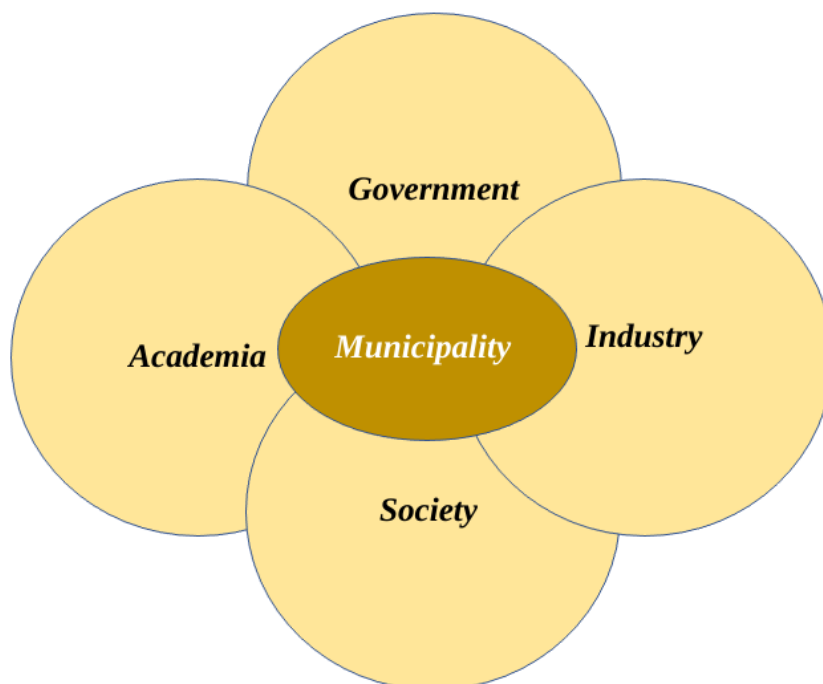


Figure 1: Quadruple Helix

Kalyazina et al. (2018) presents an overview of citizen participation options for addressing environmental issues and ensuring long-term growth in large cities, this means that it is vital to draw people's attention to the difficulties of urbanization and to demonstrate the



advantages of participating in problem-solving efforts. Cities face several dangers, worries, and difficulties as the global urban population grows rapidly: for example, physical hazards such as poor air quality and transportation conditions, as well as economic risks such as unemployment.

Digitalization of governance, infrastructure, economy, environment, mobility are the corner stones for utilization of smart cities, and according to the article this might result in more profitable industries, benefit the economy and reduce the environmental footprint (Halepoto et al., 2015). Data extraction and integration of real-world data can be accomplished via sensors, personal devices, smart appliances, web data sources, data-acquisition and monitoring systems (Halepoto et al., 2015). Based on a SWOT analysis made in this article, this study seeks to identify aspects for each step of smart city transformation. The results from the SWOT analysis show that one of the weaknesses is that; Human engagement and cooperation are the foundation for transitioning to a better and smarter future; governments will face significant setbacks if they are unable to enlist public support for their initiatives (Halepoto et al., 2015).

### 2.1.8 Design Thinking

Design thinking is a problem-solving method that prioritizes the demands of the customer above anything else. It is based on watching how people interact with their surroundings with empathy and using an iterative, hands-on approach to develop unique solutions. Design thinking may help better urban society and strengthen shared ideals (Nielsen et al., 2019).

Design thinking is a five-step process that involves five different phases, the first phase is to **Emphasize**, in this phase the goal is to try to understand the problem usually through user research, interviews or observations. The next phase is to **Define**, define the core problem and state what the users need. The third phase is to **Ideate**, ready to start generating ideas, where brainstorming could be a good tool. The fourth phase is **Prototype**, here you are ready to make your ideas into solutions. The last phase is to **Test**, prototypes are ready to be tested, in this phase the results could be redefined or changed because it's possible to see what's working and not (Dam & Siang, 2018).

Design thinking is a tool that helps tackling “Wicked problems” which are problems that are ill-defined or unrevealed. Because the design thinking looks at the problems in a human-centric way, that allows the designer to focus on the most important issues for the users and the end customers (Nielsen et al., 2019) .

Further research from the field of sustainability transitions and transition management has been used to show how design thinking is a critical part of it. Society needs to make a transition to a zero-emission built environment, and this can only be achieved by completely renewable energy systems, electric and shared mobility, inclusive economies, sustainable food production and consumption as well as affordable and human-based health care (Mulder & Loorbach, 2016).

Moreover, just like Design thinking, Quadruple helix approach also emphasize a human-centered orientation is critical for involving stakeholders from the public sector, industry, education, and research, as well as people, in a shared knowledge generation process in which they collectively envisage desirable future cities.

The previous description is agreed by van Waart et al. (2016); They are also highlighting that participatory design approach attempts to establish a new situation in which initiative comes from a group of people rather than from a single stakeholder with a specific interest. They wanted to explore the ways of including different stakeholders in complex settings so that they can have impact on development and implementation process. Additionally, this results in advancement of understanding, collaboration, and vision among stakeholders to achieve a products or solutions that are collectively created. Therefore, van Waart et al. (2016) put together a participatory design and design prototyping events with underlying reason of capturing the thoughts and views of the end users, who will ultimately be the user of the product. In the first event, participants from industry, government and university were asked to develop and present wearable technology concepts that may potentially be used in smart cities to the juries from different expertise and background. In the second event, rather than creating something out of thin air, this was based on building upon and improving something that is already being used, that is, public service (van Waart et al., 2016).

Authors remarked, the difficulties society go through while trying to understand the technologies and how they benefit out of it. And lastly, they think such settings with networking possibilities, within a collaborative environment is crucial in creation process of smart cities (van Waart et al., 2016).

## **2.1.9 Citizen involvement**

Focusing solely on information technology by itself to create smart cities will not work, progression can be achieved if we consider the human-capital of the equation in the big picture (van Waart et al., 2016). Governments are trying to utilize inclusive initiatives to ease the adaptation of ICT tools by people, participatory prototyping approach can benefit all stakeholders that are involved. According to van Waart et al. (2016) systematic change can fix the underlying issue that causes some stakeholders to feel alienated by the change. The extent and frequency of relationships between stakeholders need to be fostered (van Waart et al., 2016). There are plenty of difficulties society go through while trying to understand the technologies and how they can benefit out of it. Settings with networking possibilities such as citizen labs, within a collaborative environment are crucial in creation process of smart cities (van Waart et al., 2016).

### **2.1.10 Citizen lab – role of citizens**

The citizen lab is a multi-stage process for engaging with communities and developing citizen-led projects that benefit them. The role of the citizens in a smart city project is very important and in this article the authors describe their strategy to assisting people in taking an active role in urban innovation, from crowdsourcing original ideas to promoting public participation in the implementation of community initiatives (Gooch et al., 2015).

The citizen lab is an interdisciplinary research, development, and high-level strategic policy and legal engagement lab based at the Munk School of Global Affairs & Public Policy at the University of Toronto, focusing on the intersection of information and communication technologies, human rights, and global security (Deibert et al., 2019). Citizen lab wants with their toolboxes to make it easier for the municipality to reach out and engage with the residents in the society and cities. It is a platform where they make the communication easier and more available, where they can collect ideas and get feedback from the society (Deibert et al., 2019).

Traditional smart cities attempt to better the citizens' life with top-down innovations. This strategy either fails to catch the public imagination or results in citizens rejecting the

changes. Also, this approach tends to fail to consider what the citizens really want and recognize their interest and needs (Gooch et al., 2015).

Smart cities should start with the people, rather than only on technology to develop smart cities. Some have suggested that this engagement may take the shape of a system that allows citizens to participate in the co-creation of products or services. This approach extends beyond using citizens as a data source to use them as a source of ideas (Gooch et al., 2015). It has been emphasized that it is difficult to discover examples of how academics and projects have succeeded in integrating citizens in the innovation process. Empirical study regarding the nature and qualities of incorporating residents in smart city projects is still limited, as other researchers also have pointed out (Gooch et al., 2015).

For instance, Milton Keynes smart city in the United Kingdom has put community involvement initiatives at the center of its approach, in addition to many technology solutions. These engagement initiatives are intended to involve individuals in the innovation process not just through an outreach campaign, but also through the construction of a Citizen Lab, which will engage the community in innovation-centric decision-making processes (Gooch et al., 2015).

Gooch et al. (2015) made a four stages figure, that will involve the citizens and each of these initiatives necessitates a higher level of civic engagement.

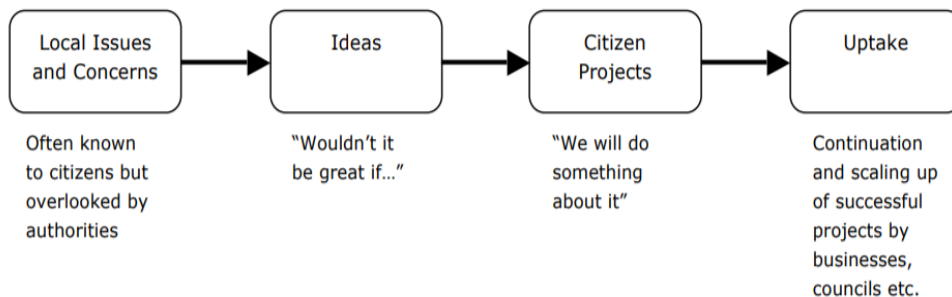


Figure 2: The various stages of addressing local issues

Source: (Gooch et al., 2015)

In the model they emphasize that getting the citizens involved in the ideas and issues is the easy stage but continuing in the project which rely on citizens involvement even further can be difficult. One of the primary flaws of this method is that, while citizen science encourages participation in science initiatives, it does not require individuals to provide any analysis or interpretation.

Gooch et al. (2015) devised a multi-stage process for interacting with citizens and moving citizen-led innovation from concept to action. Citizens and other stakeholders are communicated through a variety of face-to-face and online interactions aimed at moving residents from their first ideas to the point where a group of citizens collaborates to implement a community project. Projects reach their full sustainability at the final stage. At the time of writing, the Milton Keynes smart citizen lab is only getting started with soliciting ideas and building citizen groups to effect change. Although Gooch et al. (2015) method broadens the use of crowdsourcing to include projects and activities in addition to ideas, it is constrained - a workshop-based approach is simply not scalable

## **2.2 Sustainability**

### **2.2.1 Sustainable development**

Sustainability is one of the main topics that need focus in city development in the world we live in. Given wealthy countries' inconsiderate resource consumption and waste creation, as well as the rapid pace of urbanization, particularly in developing countries, cities must become more self-sustaining ecosystems to avert major ecological breakdowns (Wilkinson et al., 2001). On the other hand, population growth, inherent limitations and over-exploitation of non-renewable resources, diminished species variety caused by poaching, rising exotoxins, incentive structures encouraging waste and damage, and excessive wealth disparities are the other factors contributing to cumulative crises that points to unsustainable development (Wilkinson et al., 2001).

Therefore, in the worldwide push for sustainability, making existing cities and future urban development more environmentally friendly and livable is a top goal (Kenworthy, 2006). However, before continuing we would like to present the definition of sustainable development to eliminate any confusion in understanding the ideology. Sustainable development was defined by The Brundtland Commission, formerly known as the World Commission on Environment and Development as:

“Development that meets the needs of the present without compromising the ability of future generations to meet their own needs.” (UNESCO, n.d.)

The main emphasis by this United Nations' dismissed organization is not merely on ecological and environmental point of view, but from a broader perspective that also includes both social and economic aspects (Butlin, 1989). Additionally, to be relevant, the term "sustainability" must allude to the preservation, renewal, or restoration of something specific (Sutton, 1999). United Nations have laid down foundations of a brighter, better, and equal future for all and set 17 goals to escape unsustainable dystopia we live in.

### **2.2.2 Greener future**

In the literature, we could see different approaches embraced by different authors regarding mitigation of unsustainable development. For example, according to Sroufe et al. (2000) innovation is key to environmental sustainability, and is key to stand out and gain competitive edge in the industry as the customers now are environment savvy and prefer brands and companies that also operate with the same norms (Moore & Miller, 1995).

Additionally, according to Kenworthy (2006), technological advancements in renewable energy generation, localizing water management, educating citizens on resource consumption, and incentivizing to reduce their household waste output will facilitate a greener future. Also, better and accessible healthcare, public education, affordable housing, easy employment, recreational activities, infrastructure, urban design quality and community creation will increase livability and result in more sustainable future (Kenworthy, 2006).

On the other hand, personal vehicles are significantly harmful mode of transport yet so easy to hedge against. Improvement of local and national railway, road, cycling paths, pedestrian streets, and other public transport infrastructures – more frequent bus departures, punctual bus arrivals, user-friendly public transportation applications to find a route, buy a ticket and track your ride on real time – are factors that must be prioritized by ministry of transport. Authors have found out in their public transport usage research, that without changing the habits and automobile dependence of citizens, sustainability will become a goal that is harder to reach (Kenworthy, 2006). Moreover, this approach would reduce the transportation time significantly. However, some nations are still trying to curb the traffic problems by increasing the road capacity, though, the only thing that approach does is accommodating more vehicles and thus incentivizing citizens to use personal vehicles and subsequently emitting poisonous gasses.



### **2.2.3 The United Nations' Sustainable Development Goals.**

The United Nations' (UN) sustainable development goals are a shared roadmap for peace and prosperity for the people and the planet to stop the climate change within 2030 (Norway, 2022). It's important to understand that eradicating poverty and other forms of deprivation must be combined with efforts to enhance health and education, decrease inequality, and boost economic growth – all while combating climate change and protecting our oceans and forests (Nations, 2015b).

There are 17 Sustainable Development Goals (SDGs), and they represent an urgent call to action for all countries - developed and developing - to work together in a global partnership. 10 million people contributed all over the world with their opinion in a survey of what was important for them, and the insight have created 169 subgoals and the 17 main goals at the end. One of the main principals with the UN sustainable development goals is “Leaving no one behind” (Nations, 2015a). And with this saying the most important thing is to prioritize the most vulnerable part of our population. Disabled persons, refugees, ethnic and religious minorities, females, and indigenous people are only a few examples of excluded groups that is in need for extra attention(Nations, 2015a).

The UN sustainable development goals apply to all countries, both rich and poor across the whole world. The objectives have a significant effect on Norwegian politics, both in municipalities and local communities, as well as at the national level. Erna Solberg, the former Prime Minister of Norway, is the UN's driving force for sustainability goals. Although many of the goals have been reached in Norway, there is still more work to be done. Goal 12, for example, is about responsible consumption and production, and it requires decrease in food waste. Norway must lower its emissions in order to meet target 13's goal of halting climate change (Norway, 2022).

## SUSTAINABLE DEVELOPMENT GOALS



Figure 3: Sustainable Development Goals

Source: (Norway, 2022)

### 2.2.4 Supply Chain

A supply chain is a network that connects a corporation with its suppliers to manufacture and deliver a specific product to the end user. Different activities, people, entities, information, and resources are all part of this network. The supply chain also refers to the stages involved in getting a product or service from its initial condition to its destination (Kenton, 2021). A supply chain is a set of actions that lead to the delivery of a product or service to a consumer. Moving and processing raw materials into completed goods, transporting those items, and distributing them to end-users are all part of the process.

Sustainability programs are gaining widespread support from the public, the government, and even businesses, who recognize that they must act to defend their brands. Both stakeholders and customers are increasingly focusing more on their responsibility in environmental impacts and the social impact on a product they purchase (Closs et al., 2011).

Supply chain management has long been thought of as only operational, with a strong will to reduce costs. But over the recent years, this point of view has shifted significantly as businesses recognize that good supply chain strategies will help their competitiveness in the market (Closs et al., 2011). Good supply chain process can give a firm several financial and social benefits like reduced inventory costs, strong relationship and collaboration with

suppliers, quality control, improved sustainability, this can be shown with reducing waste, reuse of resources, circular economy and a more agile firm.

UN Sustainability development goals have a significant impact on component selection, materials sourcing, manufacture, packaging, distribution, and recycling decisions throughout the supply chain. It is very important for a company to address the cross-functional marketing and supply chain interactions of value-added activities to push a sustainability agenda into its markets (Closs et al., 2011). How a business prepares and respond for possible global risks is very reflected into their supply chain. Product development, channel selection, market decisions, sourcing, manufacturing complexity, transportation, government and industry regulation, resource availability, talent management, alternative energy platforms, and security are all risks that require significant marketing and supply chain considerations (Closs et al., 2011).

### **2.2.5 Value Chain**

“The interrelated operating activities businesses perform during the process of converting raw materials into finished products” (*Porter, 2011*)

The idea behind value chain is for the company to add value to the product in every stage of the process for the lowest cost to optimize the profit for the company. Companies should analyze the value they provide to maintain their competitive edge in the face of increased competition for great pricing, excellent goods, and loyalty for their customers. A value chain may assist a corporation in identifying inefficient sections of its business and then implementing ways to optimize its operations for optimum efficiency and profitability (Tardi, 2022).

## 2.2.6 Circular Economy

“The circular economy offers practical opportunities for a transition to a waste-free, resilient economic system. New business models make this possible. The essence of the circular philosophy is the need to move from a linear ‘take-make-waste’ economy to a circular economy.” (Kubbinga et al., 2018)

Transitioning to circular economy can result in lower rates of extraction and more of use of natural resources (OECD, 2018). “Circular Economy is the optimal point of sustainability, given that it offers a set of practices capable of generating more sustainable operations, making sustainability feasible in organizations” (Rossi et al., 2020)

Moreover, circular economy has three main goals, the first environmental goal is to cut down on raw material and non-renewable energy usage, as well as waste and emissions. The economic goal is to decrease environmental costs and risks, while also innovating new product ideas and market ideas for firms. The last goal is the sharing economy, increasing employment, participatory democratic decision-making, and a collaborative culture are the societal goals. Circular economy, as an economic system, promotes long-term development (Rossi et al., 2020). One of the most known definitions of circular economy is: “As an economy that is restorative and regenerative by design and aims to keep products, components, and materials at their highest utility and value at all Times”.(Schulze, 2016)

The circular economy concept is determined by a set of different principles. First, it tries to reduce the use of scarce resources while focusing on more renewable ones. Second, the notion strives to maximize the use of sources, materials, and components by not squandering any of the benefits they may bring. Third, the notion aspires to maximize efficiency by eliminating all negative externalities. The circular economy is a concept that improves resource efficiency by extending material life spans and closing material and energy flow loops, resulting in waste being eliminated from a system (Schulze, 2016).

Furthermore, the circular economy model is an excellent notion for reducing costs that have an impact on the environment and society. The approach has advantages for businesses and result in prosperous outcomes. Furthermore, circular economy is there to replace the linear economy that is as often used today, the take-make-dispose model and considers the life

cycle of raw materials as well whereas a linear economy, sustainability is focused on efficiency with the take-make-dispose model (Kjaer et al., 2019).

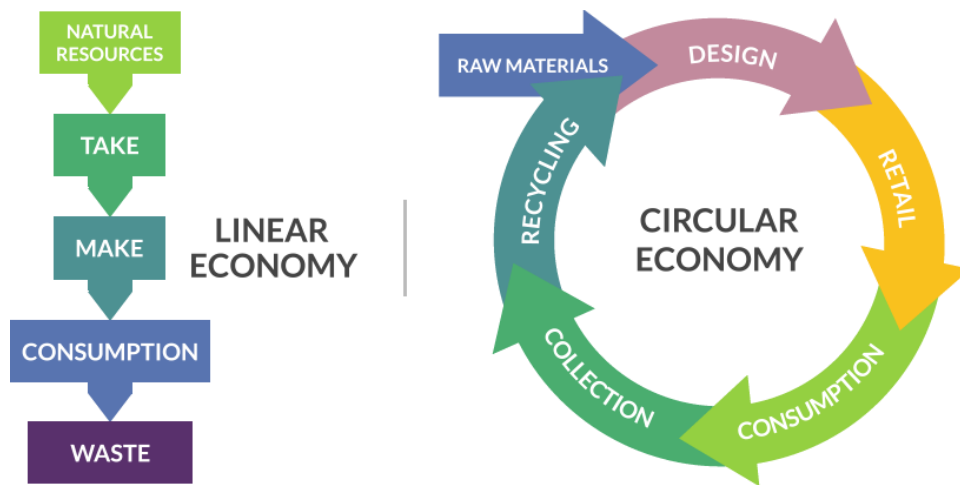


Figure 4: Linear Economy & Circular Economy

Source: (Harrow, 2020)

### 2.2.7 Sharing economy

The sharing economy is about gathering more access to goods and services, rather rent than own, and to utilize assets more effectively. Airbnb, Couchsurfing and Nabobil are great examples of popular sharing services (Rammen, 2018). Sharing economy uses IT-based technology to share of underutilized assets (Görög, 2018). Motivations to participate in sharing economy, to have trust in it, e-business, and online feedback systems, as well as its uncontrolled market settings, are the most prominent study fields in the sharing economy. Because this is a relatively new study topic, it is critical to grasp the fundamental approach and its context. It's crucial from both an academic and a commercial standpoint, since this new business model is putting more and more organizations in jeopardy, and they need to adapt. Managers should be aware of the most recent technical advancements and breakthroughs to secure their businesses and respond to difficulties (Görög, 2018).

## **2.3 Technology**

### **2.3.1 Technology Integration**

By exploiting developments in new technology, the smart cities may become an intelligent civilization in the digital era (Singh et al., 2020). The importance of a smart city using technology in the most cost-effective and productive way is stressed (Zhuhadar et al., 2017). All new business models and infrastructures have adapted to globalization and the internet; the capacity for individuals to connect with technology will be the next wave of innovation. For future education, the capacity to collect and process massive volumes of data will be important (Zhuhadar et al., 2017). Education as a key is the fourth out of six different parts that Zhuhadar et al. (2017) are focusing, it is stated that education is one of the most important points of becoming a Smart city.

Moreover, Sepasgozar et al. (2019) emphasizes that access to growth and economic prospects can be provided by the development of appropriate smart city technology. For example, M-Pesa, the mobile phone-based money transfer and microfinancing business, is one of the most well-known instances of a breakthrough technology for developing countries. These digital technologies have significantly increased access to finance, reduced transaction costs, and made a variety of other sectors more feasible (Sepasgozar et al., 2019).

### **2.3.2 Information and Communication Technologies**

ICT is utilized in the smart city to improve the quality, efficiency, and interactivity of urban services, lower costs and consumption of resources, stakeholder communication and information dissemination. Smart city apps are built on top of ICT infrastructure to control urban flows and provide real-time data to improve people's life and help accomplish a variety of sustainable development goals (Telesis, n.d.).

ICT is accepted as an enabler of smartness in technological sense and key to detect and solve the problems (Bifulco et al., 2016). It is consequently possible to see ICT in many definitions of smart city in the literature, since it has a significant contribution in transformation to a smarter city. From literature the usage areas and benefits of ICT are gathered (Camera & Alba, 2019):

- Production of knowledge
- Dissemination of information
- E-commerce
- Smart industrial processes
- Smart metering
- Smart grids
- Monitoring of energy use
- Smart buildings
- Incorporation ICT to government's administrative processes
- Distribution information to citizens (ballot details, health information, stimulus package, and many more economic and legal information)
- Digital goods and service
- Facilitates public and private transportation (digital bus tickets in real time schedule, online parking spot payment)
- Develops new forms of logistics (carpooling, e-scooters)
- E-learning platforms

### **2.3.3 E-governance**

Information and communication technologies are the backbone of creating desirable e-governance. According to Heeks (2001), it can cause a significant increase in governmental efficiency and reliability and bring many other benefits too. e-Government provides a new path forward, assisting in the improvement of government procedures, the connection of citizens, and the development of society (Heeks, 2001). Possibilities of improvement in intergovernmental interactions and interactions between citizens and governments can bring prosperity and accelerate the shift towards a smart city. There are 3 potential areas of change that citizens can benefit from e-governance; Automation, informatization and transformation (Heeks, 2001). These potential areas of improvement in wide array of governance processes can play as a crucial asset. Heeks (2001) highlights three main domains of e-governance: Improving government processes, connecting citizens, building interactions with and within civil society. Benefits of E-governance are as follow:

- Reducing process costs: Increase in the possibility of automation to cut financial and/or time costs. Subsequently, this utilization of ICT tools to automatize some of the processes can increase efficiency and productivity.
- Managing process performance: ICT gives an opportunity to increase in the measurability of processes. Subsequently this provides managers an overview about which tasks are depleting more resources than what they should. Therefore, controlling and managing resources (financial, human, time and etc.) and deriving decisions on effective allocation of resources is another possibility.
- Making strategic connections in government: E-governance strengthens development, investigation, and implementation of government processes by connecting data and information flow between different branches of government.
- Talking to citizens: Creates new ways/modes of information flow from government to society. Informing citizens about public sector activities and embracing a more inclusive approach on government decisions and actions, subsequently, making citizens feel more liable and accountable.
- Listening to citizens: Accounting for citizens ideas and opinions as inputs during policy making.



- Improves public service: advancements in the public service in terms of quality, accessibility, reliability, cost and convenience. Saving citizens time and money that would otherwise be wasted.
- Cooperating with businesses: Establishing a more agile relationship between the government and the private sector
- Community development: Enhancing local communities' social and economic capabilities.

However, there are two main challenges that governments face to achieve e-governance and obtain the benefits. The first one lacks readiness; Some communities might be more technology savvy and can adapt to change easier than others. Therefore, governments should test infrastructure developments in certain areas, such as, data, legal, institutional, human, and technological to make sure the e-governance initiatives' outcomes are fruitful. The second challenge is Design-Reality gaps, in other words the gap between design concepts and operational realities. Based on the studies conducted by Heeks (2001) larger the gap between design and reality, greater the odds of failure of a project. Overall, e-governance has a positive impact on quality of life, that is why it has been getting tremendous amount of attention over the past years (De Guimarães et al., 2020).

### **2.3.4 Blockchain**

The Internet of Things (IoT) and blockchain technologies are pervasive in our daily lives. According to the Gartner research, \$3.1 trillion in corporate value will be added by 2030 (Lovelock et al., 2017). As a response to the 2008 global financial crisis, an anonymous individual or team produced a white paper called "Bitcoin: A peer-to-peer electronic cash system," which was the first time blockchain technology was used to verify the integrity of documents (Nakamoto, 2008).

“Digital, decentralized and distributed ledger in which transactions are logged and added in chronological order with the goal of creating permanent and tamperproof records” (Treiblmaier, 2018)

According to Biswas and Muthukkumarasamy (2016) a smart city is subject to a variety of security and privacy vulnerabilities. Moreover, some concerns and limitations that are tightly attached with the current understanding of blockchain was also mentioned by (Singh et al., 2020). It is important to mention that Singh et al. (2020) specified scalability and efficiency addition to security and privacy concerns. Which is why blockchain technology has piqued the curiosity of smart-city academics and developers, (Ferraro et al., 2018). Other than cryptocurrencies, there are several blockchain projects that have extensive effects across variety of industries, and hence have an influence on sustainable smart city development. Some Authors suggest that combination of both Artificial Intelligence (AI) and blockchain technology can revolutionize smart cities and, allow for the creation of sustainable ecosystems that can open up a broad range of opportunities (Singh et al., 2020).

New actions can be taken to automate business processes with only affordable and simple information technology infrastructure by utilizing blockchain in the IoT network. This will aid in the development of communication between devices and users, the reduction of the risk of mis presentation and cost, the elimination of intermediaries, and the reduction of transaction time. Blockchain-based IoT solutions are suitable for improving company operations, reducing costs and improving the user experience(Sharma & Park, 2018). Biswas and Muthukkumarasamy (2016) stated the main advantages of Blockchain by saying that; It has a variety of distinct advantages, including increased reliability, enhanced fault tolerance, better, faster and more efficient operation, and scalability. As a result, combining blockchain technology with smart city devices will establish an integrated platform on which

all devices will be able to safely interact in a decentralized network. During our in-depth literature analysis, we detected a contradiction between Biswas and Muthukkumarasamy (2016) Singh et al. (2020), in terms of whether the blockchain technology is scalable and efficient. It is a debatable topic whether which statement is correct or incorrect but, this was the only article that mentioned scalability issues of blockchain. Ultimately consensus is that it is scalable, but very energy inefficient/consuming.

Some examples of Blockchain usage in smart cities by academics are as follows: Real time communication and data exchange between self-driving cars. An artificially intelligent blockchain would be used in a driverless automobile system, self-learning cars, and a smart city transportation system, according to the concept by Singha et al., thus helping vehicles to learn and develop through machine learning technology, and ultimately resulting to significant time savings, reducing human error in traffic and, increasing efficiency (Singh et al., 2020). Furthermore, so called Parkchain project was created to solve the problem of locating parking spots. This project planned to create a parking pool by providing a platform where people can lease parking land for a certain period of time (Jennath et al., 2019).

Another example is the usage of smart contracts which is a contract type that is built through Blockchain technology. Leiding et al. (2016) proposed a hybrid of obligatory and voluntary applications for car ad hoc networks. Mandatory applications are traffic control, vehicle tax and, vehicle insurance while optional applications are updates on traffic jams and weather forecasts.

To conclude blockchain has the potential to help smart cities overcome a variety of issues relating to infrastructural factors in general, such as the technological, social, and financial environments, as well as the lack of connection between these elements (Ismagilova et al., 2019). Main nine application fields of blockchain for smarter cities are identified by (Treiblmaier, 2018): (1) healthcare, (2) logistics and supply chains, (3) mobility, (4) energy, (5) administration and services, (6) e-voting, (7) factory, (8) home and (9) education.

## **2.4 Theoretical framework**

### **2.4.1 Stakeholder theory**

Stakeholder theory was first described by Dr. F. Edward Freeman, that shareholders are just one of company's many stakeholders. According to this notion, the stakeholder ecosystem includes anybody who is invested in, interested with, or affected by the company: employees, environmentalists surrounding the company's factories, vendors, governmental agencies, and others. According to Freeman's idea, a company's true success comes from pleasing all its stakeholders, not just those who stand to profit from its shares (*Simon, 2016*). Stakeholder theory has a broader view over the value creation, meaning that all stakeholders are equally important for a firm (Donaldson & Preston, 1995). According to Freeman, value creation is a joint effort in partnerships between all its stakeholders that benefits the central company and all the different stakeholders involved. Freeman emphasized the importance of with and for whom value is being created (Freudenreich et al., 2020).

Furthermore, stakeholder theory is used a lot in management studies, the theory mainly focuses on how an organization should strive to maximize value for all its stakeholders by emphasizing the connections between the organization and all the actors that have a stake in it. Examples on different stakeholder can be customers, sponsors, workers, the community, shareholders, suppliers, media, society, employers and volunteers to name some, it could be a person, organization or firm that can directly or indirectly be impacted or can make an impact on the firms' operations. The theory focuses on that the organization have a responsibility to all its stakeholders as well as to take care of all their different stakeholder, to achieve competitive advantages (Donaldson & Preston, 1995). Freeman emphasized that managers could not design strategies that would garner the support required for the firm's continuous survival, let alone competitive advantage, unless they first understood the expectations of stakeholders (Elms et al., 2011). The stakeholder theory forced people to understand and see the importance of the relationship between the firm and the stakeholders and focused on how this could influence the firm in both positive and negative ways. Freeman says that the value of the good relationship with the stakeholder shows the success of a firm (Elms et al., 2011).

The stakeholders have been categorized into two groups, (1) Internal stakeholders, which are the group of people that are directly impacted by the actions taken by the corporate management, they may play significant role in decision making and thus effect the prosperity of the organization. (2) External stakeholders, they are the people who do not work for the company but are impacted by its actions and consequences in some way. Stakeholder theory is a way of thinking in a professional setting. The fundamental ideology behind the concept is that businesses financial and managerial decisions impact not only the business itself but the other entities around it too. The theory revolves around identification of groups of stakeholders that are involved with the company and describes and suggests how to take care of them (Fernando, 2021).

A stakeholder map depicts the ecosystem of stakeholders engaged in a consumer experience. It aids in determining who is involved, revealing existing formal and informal relationships between stakeholders, identifying frictions between them, and new business opportunities through the formation of new relationships, the nurturing of existing ones, or the creation of alternatives (Cramer, 2019). Stakeholder maps may be used to examine and comprehend who is involved in a project or organization, as well as how these individuals, organizations, and elements are linked. A huge number of various stakeholders have an impact on most initiatives. Understanding their points of view and how they are related might aid in better managing the various expectations(Cramer, 2019).

A Traditional stakeholder map that Freeman originally made shows the firm in the center and the stakeholders around it, as you can see in the table below.



Figure 5: Common Stakeholders

Friedman's shareholder theory is the opposite of the stakeholder theory; "The only stakeholders a company should care about are its shareholders - and thus, its bottom line. Friedman's view is that companies are compelled to make a profit, to satisfy their shareholders, and to continue growth." (*Simon, 2016*)

Freeman, on the other hand, believes that everyone who is touched by the firm is a stakeholder. When you listen to a large number of people's comments and viewpoints on anything, their influence may assist shape the project in a better way, giving the company a competitive edge and a stronger market position. According to Freeman, if you don't care for all of your stakeholders, your company will fail (*Simon, 2016*). The success for a company should not only be measured through profit, but also through performance and results on how they impact the society, employees etc.

There are three theoretical approaches of stakeholder theory: a descriptive approach, an instrumental approach, and a normative approach (Stakeholdermap, n.d.), (De Colle, 2005), (Donaldson & Preston, 1995):

<b>Approaches</b>	<b>Explanation of approach</b>
<b>A descriptive approach</b>	<p>The stakeholder model is descriptive in a way where it gives language and different concepts to describe organizations, how they operate and the effects an organization can have on the environment.</p> <p>The major goal of this method is to better knowledge of the complicated interactions between various stakeholder groups by identifying and summarizing the most common issues at hand.</p>
<b>An instrumental approach</b>	<p>The stakeholder model is instrumental regarding an organization achievement in reaching goals they have set, like profit, growth and sustainability.</p> <p>It implies that neglecting stakeholder interests might pose a risk to the company. Relationships with stakeholders are viewed as critical to the firm's financial performance.</p>
<b>A normative approach</b>	<p>The last approach in the stakeholder model emphasizes the belief that all stakeholders have a great value.</p> <p>It implies that managers should consider stakeholder interests regardless of the firm's implications since there is an ethical need to respond to a variety of genuine stakeholder demands.</p> <p>Donaldson and Preston explain that all stakeholders should have a legitimate interest in the organization and that this gives them value.</p>

*Table 4: Theoretical Approaches of Stakeholder Theory*

Donaldson and Preston (1995) emphasized that the three approaches of stakeholder theory are mutually supporting each other, and the theory's normative foundation—which incorporates the current idea of property rights—is crucial.

## **2.4.2 Challenges regarding Stakeholder Theory**

There are some challenges regarding the theory that should be emphasized. Some of the stakeholders have more capacity and strength to influence than other stakeholders, this can create a gap between the stakeholders in an organization. Therefore, some people criticize Stakeholder theory because of the inequality between the stakeholders. Stakeholder theory represents a big and diverse group of stakeholders which often results in that one or multiple people get a back seat in the process (McAbee, 2021).

One other difficult challenge of Stakeholder Theory could be to persuading people that the economic gains are real. It is important for the firm to present a stronger argument for the economic benefits of good firm stakeholder relationships, that they can earn money while also being good, and maybe make more money than they would otherwise (Stakeholdermap, n.d.).

## **2.4.3 Differences between Stakeholder Theory and Quadruple Helix**

As mentioned earlier stakeholder theory splits the stakeholders into two groups, internal and external stakeholders. Internal stakeholders are the group that are directly impacted while the external stakeholders do not work for the company but will be impacted by their decisions somehow. While quadruple helix focuses on the four groups government, industry, academia and society, under each of this groups there are subgroups, under industry it could be contractors, shop owners, real estate developers, etc. Another example of subgroups could be under academia architects, engineers, researchers, doctors and health professionals, geographers, teachers, education and research institutions.

Stakeholder theory and Quadruple Helix both emphasizes the importance of all actors effected by the outcome of the company or the organization should have a saying in the process. The significance of involving stakeholders in long-term value development has become a focal point of stakeholder theory (McAdam et al., 2018). Quadruple Helix have similar goals where they want to create value for the people living in a city they are developing.



Despite that they have similarities, they view things from different angles. Stakeholder theory emphasize that taking care of all the stakeholders effected by the company will give the company competitive advantage, while quadruple helix focuses on that this could help the organization or municipality creating new innovative ideas and a greater responsibility for good collaboration across and the use of new forms of collaboration to achieve the goals they have made in advanced. Stakeholder theory is more focused on earning a profit, despite that stakeholder theory says that only focusing on profit will not give them a competitive advantage. As well as this Quadruple Helix says that all people go under society, which means that they look at citizens as one group. While in stakeholder theory, they emphasize the differences between its stakeholders.

## **2.5 Literature summary**

### **2.5.1 Our own definition of smart city**

To make our own definition of Smart City, we have analyzed the meaning of the words “Smart” and “City, to combine the meaning with the idea of what we think a smart city is and should be. Smart can be defined as intelligent or bright and a city can be defined as a place with a larger population, a greater size and a place that can impact more than a village (Merriam-Webster, n.d.).

When we combine the meaning of the words “Smart” and “City” with the guidelines of what the National roadmap for smart and sustainable cities and communities says a smart city should include we have made our definition. The roadmap emphasizes the importance of citizen and focuses on a citizen centric approach, they also focus on climate and sustainability, emphasizes also inclusion and co-creation, focus on the next generation of businesses, share and use open data, focus on competence development, restructuring and Innovation, start locally but think globally and think holistically (DOGA, 2019). Additionally, we think that intelligent is a word that has a narrower approach than smart, it describes being goal driven. Also, intelligent means to think critically, solve problems, learn and reason. In addition to this, we have chosen to use the word intelligent in our definition. With all this in mind, we want to present our definition.

*Smart City is a concept where the goal is to be an intelligent city for the citizen to live and work in. The citizen should be placed in the center of the approach and technology, sustainability and innovative ideas are crucial for becoming a Smart City.*

## **3.0 Methodology & Data**

### **3.1 Introduction**

Methodology tells us about how we should work to obtain or test knowledge. It is a tool that can help us solve problems and create new knowledge (Dalland, 2017). The Methodology chapter represented here will give an overview of the analyzing process of smart city concepts and citizens involvement. In the literature section, different aspects that are important to our thesis have been described, where some articles have things in common and some have different view on the importance of a thing, an example here is that the phrases "smart city" have a broad range of intellectual foundations and meanings, depending on the perspectives of the various stakeholders. In this chapter, we will provide a methodology of the smart city concept analysis and the cities that will be researched.

### **3.2 Selection of Methodology**

The method is our tool in meeting something we want to investigate. The method helps us to collect data, to find the information we need for our research (Dalland, 2017). We looked at the differences with quantitative method and qualitative method before we made our decision on what would be the best fit for our thesis. The quantitative method has the advantage that they give data in the form of measurable units, by collecting data through numerical analysis, surveys and questioners (Dalland, 2017). While the Qualitative research design usually tends to be a bit less rigidly defined. The qualitative methods aim to capture meaning and experience that cannot be quantified or measured (Dalland, 2017). Both quantitative and qualitative oriented methods each contribute in their own way to a better understanding of the society we live in, and of how individuals, groups, institutions act and interact (Dalland, 2017). The reason for choosing the particular method is that we believe that this method is best suited to illuminate the question or issue we have in the best possible way. For our research question we were most curious about the plans for the smart cities and their goals for increasing citizen participation. Because of this, qualitative research with in-depth interviews was the best fit.

In the thesis we are comparing four smart cities in Norway with currently operating citizen labs or have used citizen labs at least once in the past, to analyze the citizens involvement and their achievements as a Smart City. We will compare and look at their projects and analyze the results and the citizen participation. We will do a qualitative research design where we will collect data from subject interviewees that we initially thought could benefit the academic world. We will also collect information about projects and results from data the municipalities involved have already gathered. The purpose of the qualitative research interview is to obtain the interviewee's own description of the life situation he or she is in.

We will use the twelve aspects method by Brinkmann and Kvale (2015) describe the concept of understanding in the qualitative research interview (Dalland, 2017).

When looking at the different aspects of qualitative interview research method, it does not focus on the different types of an interview, but about different sides of an interview. The first aspect is the world of life, where the interview is targeting the interviewees world of life and their relationship to that. The second aspect is opinion, the interviewer wants to interpret the meaning of central topics. The third aspect is qualitative, and it has the goal to obtain qualitative knowledge, expressed in the ordinary language. The fourth aspect is the descriptive, where the interviewer wants to gather nuanced descriptions from the interviewee. The fifth one is specificity, where the goal is to gather concrete description of specific situations. The sixth aspect is deliberate naivety, where the goal is to be open minded to new things. The seventh aspect is focused on specific topic. The eighth is ambiguity, answers can sometimes be ambiguous, and one should try to ask specific questions to the interviewed object in order to minimize the odds of receiving ambiguous answers. The ninth aspect is that the interviewee can change his or her own descriptions and interpretations. The tenth aspect is sensitivity, where the interviewee can show statements connected to his or her connection to the topic. The eleventh aspect is interpersonal situation, where the interviewee and the interviewer can influence each other. The last aspect is that a successful interview could be a positive experience for the interviewed person who could get new insights. All of these aspects are equally important when having a research-based interview (Dalland, 2017).

### 3.3 Research Design

Brinkmann and Kvale (2015) say that the interviewer and the interviewee is together creating knowledge. The interaction between them is crucial in the way that the interviewer should show empathy and respect to the interviewee. In a qualitative research-based interview the interviewer is the instrument and the results achieved is based on the questions prepared in advance. The purpose with qualitative research is to obtain descriptions of the interviewee’s opinions and point of views (Dalland, 2017).

We did a semi structured in-depth, one to one interview, were the approach lets the researcher to collect open-ended data, dive deeply into personal and often sensitive themes, and investigate participant ideas, feelings, and opinions about a certain topic. This is a narrative qualitative research design type, that explores situations, scenarios and processes through interviews and documents (Chigbu, 2019).

Types	Approach to Research or Enquiries	Data Collection Methods	Data Analysis Methods	Forms in Scientific Writing	Epistemological Foundations
Narrative	Explores situations, scenarios and processes	Interviews and documents	Storytelling, content review and theme (meaning development)	In-depth narration of events or situations	Objectivism, postmodernism, social constructionism, feminism and constructivism (including interpretive and reflexive) in positivist and post-positivist perspectives
Case study	Examination of episodic events with focus on answering "how" questions	Interviews, observations, document contents and physical inspections	Detailed identification of themes and development of narratives	In-depth study of possible lessons learned from a case or cases	
Grounded theory	Investigates procedures	Interviews and questionnaire	Data coding, categorisation of themes and description of implications	Theory and theoretical models	
Historical	Description of past events	Interviews, surveys and documents	Description of events development	Historical reports	
Phenomenological	Understand or explain experiences	Interviews, surveys and observations	Description of experiences, examination of meanings and theme development	Contextualisation and reporting of experience	
Ethnographic	Describes and interprets social grouping or cultural situation	Interviews, observations and active participation	Description and interpretation of data and theme development	Detailed reporting of interpreted data	

Table 5: Qualitative Research Types and Their Methodological and Epistemological Features

Source: (Chigbu, 2019)

We prepared an interview guide in advance where we split our questions into four different subject boxes, to try to direct the interview towards more into a good conversation. The first subject was Smart City, where we wanted to know how they defined a smart city, why they wanted to transform their city into a smart city, the idea behind developing a smart city and a citizen lab. Our next subject was citizen participation, where we wanted information about their citizen lab projects, what framework they were using and what kind of feedback they had gotten from the citizens so far. The third box was about the smart city projects, what kind of projects do the city have, how will they use citizen lab to get them involved in the projects, what they think is their most important project. And then we had a last box with some additional questions, if they had some projects they were planning, if they had seen some results from the citizen lab so far and what could be changed to be better.

A successful interview would give us valuable material which in a relevant way could shed light on the research question. There are several conditions that affect the quality of the interview. The subject needs to engage both the interviewer and the interviewee, the interviewer needs to inspire the interviewee to talk freely with the least possible impact of other. The interview process lays a lot on the qualifications and knowledge of the interviewer, but also the interviewee must have something to say and the ability to put it into words. By having the interview guide, it prepared us both professionally and mentally for the interview, to handle follow up questions and other challenges that could come (Dalland, 2017).

### **3.4 Reason for selecting Bodø, Molde, Trondheim and Malmö**

We have selected three smart cities in Norway and one smart city in Sweden that are working on or have already established citizen labs, to improve the citizen participation and involvement in decision-making processes. The cities chosen are small to medium sized cities in Norway who have goals to becoming a better city for its citizens to live in, while the city in Malmö is the biggest city among the cities chosen, for that reason there are more significant problems and need for radical changes.

We strategically narrowed down the people who are working with the smart city projects or citizen involvement and contacted the key people in the municipality. We also had interviews with a consultancy company, who is consulting or have consulted some projects of municipalities we have chosen for our thesis. Our research questions have the goal to look closer at the citizen involvement and if citizen lab has an impact on this, for this reason we thought that having interviews with the municipalities and looking at the concrete results from their projects and how this effect the citizens will give us a broader intel on how the citizens are participating.

**Bodø** is a city in northern Norway with 42,351 residents and are ranked Norway`s 14<sup>th</sup> biggest city in terms of population (Thorsnæs, 2022). Smart Bodø is an ongoing process in the research and innovation development in the making of a better version of the municipality. Their goal is to take advantage of the possibilities they already have and make them greener. Their main focus is about; which citizens should be in the center of development, a greener shift and participation. They want to become a city where the citizens like living in it, that focuses on citizens involvement and a city who uses new technology to solve societal challenges, which include climate and environmental issues. They want their city to be smart and sustainable for the future (Bodø, n.d.-b). Bodø have had a physical citizen lab at the public library in the city since 2018, where they have had some challenges.

**Molde** is a city located in the west side of Norway by the ocean with 21,215 inhabitants and is ranked Norway's 23<sup>rd</sup> biggest city in terms of population (Thorsnæs, 2022). Smart Molde project is a solution for Molde to become a more sustainable city, they are collaborating with businesses, academia, volunteers, citizens, and the public sector to make a framework for the continues development. The smart city project is based on the needs of the citizens, and they are using sustainable methods and solutions to make Molde a better place to live and work for the citizens (M. Kommune, n.d.-b). Smart Molde is creating three citizens labs in the Molde region, where they want to involve the citizens more and include them in different processes.

**Trondheim** is a big city in Norway and the biggest city we have selected for our thesis with 191,771 residents, making this city the 4<sup>th</sup> biggest city in Norway (Thorsnæs, 2022). Smart Trondheim wants to create a greener energy positive city by cooperating with local business and the citizens living there. They are focusing on a citizen centric approach, they want to enable citizen ownership and participation in the move to a positive energy city, they are doing this with multiple citizen lab located in different areas of the city (T. Kommune, n.d.).

**Malmö** is the last city that we are examining, it is located in Sweden with 317,245 residents, making it the 3<sup>rd</sup> biggest city in Sweden (Mæhlum, n.d.). Malmö city is the fastest growing city in Sweden, with almost half of the population under the age of 25 and from 183 different nationalities (Stad, n.d.). The city of Malmö has some challenges with inequality in public health, unemployment is significant problem especially with young people. Despite this, Malmö offers assets such as a youthful, vibrant university, enterprising firms, a strong civic society, and innovative industries that wish to contribute to the city's development. Smart Malmö wants to promote a deeper interplay between technology, places, and people in the city (NSCN, n.d.).



### **3.5 Validity and Reliability**

When performing or analyzing research, it's critical to assess the validity and reliability of the data gathering techniques in other words instruments (Heale & Twycross, 2015). The degree of knowledge about a research area and how it matches to the actual reality of a subject are referred to as validity in qualitative analysis (Cho & Trent, 2006). Validity may be divided into three categories (Heale & Twycross, 2015): Content validity is the first category. This category assesses if the instrument appropriately includes the entire domain associated to the variable. The second category is construct validity of a test; It refers to how effectively it measures the idea it was intended to evaluate (Bhandari, 2022). Construct validity is very crucial when researching a topic that can't be immediately observed or quantified such as citizen welfare, individual perception of value and sustainability to some extent. To measure such components, you'll need a variety of observable or quantifiable indicators, such as several criterion and interviews subjects with different perspectives of the researched topic. Criterion validity is the last measure of validity; Any other instrument that assesses the same variable is referred to be a criterion. It is to correlate different instruments to observe whether one can obtain the same results.

According to research conducted by Dr. Joseph A. Maxwell of University of Chicago certain challenges to validity exist in qualitative research, such as researcher bias and situational reactivity (Maxwell, 2008).

We have taken precautions and mitigated these risks in our thesis by employing strategies to identify threats to validity. One of the main strategies that were used to mitigate such risk was Triangulation, which refers to the use and integration of various research methodologies in the study of the same phenomena (Sari & Bogdan, 1992). Throughout the interview process, we continually sought clarification from the interviewees so that the data collected would not be misunderstood or overshadowed by the interviewer's prejudices (Maxwell, 2008).

We tried to have conversational, friendly and neutral environment to increase the contribution of our subject. Furthermore, in the beginning of each interview we declared our research intentions and goals.

Additionally, all the participants were told that there will be no negative consequences for them if they choose not to participate or later decide to withdraw from the project.

The accuracy of an instrument, or reliability, is the second measure of quality in research. In other words, the consistency with which a research method produces the same results when employed in the same scenario repeatedly (Heale & Twycross, 2015). There are several challenges to reliability, including participant and researcher inaccuracies and biases. As a result, it is very important that the work and data collected in this study are published in a completely open manner, allowing others to evaluate the results and reproduce the study on their own (Saunders et al., 2009).

## **4.0 Case description**

### **4.1 Introduction**

In the following chapter, the smart city concepts of Bodø, Molde, Trondheim and Malmö and our case description are presented,

First, we will describe the national roadmap for smart cities in Norway, which is a guideline for the smart city development for Norwegian municipalities. Then describe the different smart city concepts. After that we will carefully describe all the projects and their citizen labs in a concrete way for the readers to understand and have a clear insight of the different smart cities we are analyzing.

### **4.2 National roadmap for smart cities in Norway**

The national roadmap for smart cities in Norway was established as a guideline for smart city development in Norway. It is a shared set of values and principles that municipalities and other stakeholders can follow. The principles are to put the citizens in the center, think holistically, prioritize climate change and environment, emphasize inclusion and co-creation, focus on the next generation of businesses, share and use open data, focus on competence development, restructuring and innovation and start working locally, but think globally on the whole picture (DOGA, 2019). All the Norwegian municipalities chosen for this thesis uses the roadmap for their decision making and help for solving issues.

The eight principles outlined in this roadmap are intended to assist Norway in meeting the United Nations Sustainable Development Goals. The UN sustainable goals emphasized in the roadmap is among others goal number 11 where cities and communities will be more inclusive, safer, resistant, and sustainable. The second goal they emphasize is goal number 9 which is related to innovation and infrastructure, the last goal is number 17 where it pertains to collaboration to achieve the sustainability goals (DOGA, 2019).

Smart city definition derived from National roadmap is, “Smart cities and communities focus on people, while using new technology, innovative methods, collaboration and co-creation to become more sustainable, attractive, productive and resilient” (DOGA, 2019).

The roadmap's ultimate purpose is to support the development of cities and communities that are sustainable, productive, and adaptive.

### **4.3 Describing the different smart city concepts**

There are many reasons to become a smart city, it may vary and can be tailored based on the society's needs and government's implementation capabilities. It is meaningless to dedicate government's resources to infrastructure if they already have a very comprehensive and accessible one. We can use Los Angeles as an example, it is luxuries city that reflects prosperity, welfare, freedom, equality to the outer world. However, they city is facing dramatic public infrastructure problems. According to the Innovation and Performance Commission of Los Angeles, Los Angeles region has been dealing with; Aging water infrastructure, water scarcity, dependency on imported water, poor air quality, traffic congestion, deteriorated roads, rising energy consumption, outdated electric distribution systems (Commission, n.d.).

These challenges are masked behind the beauty of famous districts of Los Angeles; however, those people are not the one that's affected by these challenges. The income and wealth inequality have been manifesting over the years in Los Angeles. The lower and middle class are the ones who suffer from the addressed challenges. On the other hand, if we take a look at Vienna, the capital of Austria, we can see pretty much the opposite of what is happening in Los Angeles. Vienna consistently leads the charts as the city with the finest quality of life in the world, according to polls issued by the consulting firm MERCER Survey and several international rankings (Washington, n.d.).

They have free and high-quality healthcare, reliable telecommunications and internet networks, excellent transportation routes and a large public transportation network, and an amazing public housing and hopefully some attempts to decommoify the housing market in the future (Schweitzer, 2020).

Furthermore, in general the strategic use of digital information, for example, in areas such as human health, mobility, energy consumption, education, knowledge transfer, and urban government, are the causes of smart cities (Deakin, 2013), (Townsend, 2013). In our comprehensive research we found out that there are many reasons for cities to become smarter, but the most agreed and leading reasons/purposes are as such:

1. To reduce the challenges caused by rapid urbanization and urban population increase (Chourabi et al., 2012).
2. Utilizing of technology to improve sustainability and natural resource management (Chourabi et al., 2012).
3. To promote entrepreneurship and innovation (Lab, 2016).

4. To boost cultural, economic, and social growth by attracting international investments while promoting local advantage.
5. To improve the quality of urban life by increasing urban development and bettering urban landscape.
6. To shift to a knowledge economy.
7. To facilitate service delivery.
8. To increase social commodity and build a community mindset.
9. To reduce the emission of detrimental gasses and prevent overexploitation of resources (Cocchia, 2014).

### **4.3.1 Bodø**

Smart Bodø is a structure of the municipality's research and innovation projects connected to the development of today's city. Smart Bodø will prepare them to take advantage of the opportunity space that arises in the development of existing city. Smart Bodø is based on the three main focus areas, citizens centric approach, participation and the green shift for the future. Bodø's goal is to become a city that is a more human and environmentally friendly city, where the citizens enjoy living, are heard and involved in the development process and where new technology is used to address societal challenges such as climate and environmental issues. Mainly the smart city projects are connected to one of the four main areas that is energy efficiency, transportation, citizen involvement, climate and environment (Bodø, n.d.-b).

**Projects of Bodø** (Bodø, 2021), (Bodø, n.d.-a)

#### **1. Smart Transportation**

The goal of this project is to reduce climate change, emissions, making it easier for the citizens to access more relevant information about several travelling options and increase the use of walking, cycling and public transport as a means of travel by changing people travelling habits. They will offer a seamless travel experience and give the public access to information and services that contribute to more efficient transport. By offering open data, they will also lay a foundation for local and regional innovation. Smart Bodø is cooperating with Nordland County, Telenor and Avinor on this project to make the best use of traveling options in the city (Bodø, 2021).

## **2. Smart architecture Bodø**

This project works on how to make the blue light services smarter, through data collection and sharing and by including IoT data and statistical data. In the blue light services, the focus regarding this project is how to use this data in connection with planning, training and emergency response. The project is based on the current city with existing infrastructure (Bodø, 2021).

## **3. Use of Sensors and IOT systems**

Smart Bodø has placed some sensors across the city as part of a effort to evaluate air quality, among other things. The measures made from the sensors, saves Bodø time and effort while also providing the citizen with useful information. The sensor network serves as the foundation for the development of even more beneficial services, where they have not started researching yet. The sensors can be used to automate manual processes, as well the sensors are quite easy to maintain and there are low costs associated with the sensors. Today, the sensors are used for a warning of airborne dust, detecting studded tire use and bath temperature (because they want people to use the outdoor areas in Bodø) (Bodø, 2021).

## **4. Carpooling and bike scheme**

The sharing economy plays a critical role in attaining long-term urban and communal development. This is a practical instrument that may help to bridge social divides, boost individual economics, and be environmentally friendly. Their goal of this project is to change people's travelling habits and reduce pollution, among other things they want people who are in a two cars household to see the sustainable advantages of cutting down to only have one car (Bodø, 2021).

## **5. Smart Bodø pilot area**

The pilot area provides a space for the municipality, citizens, and companies to try out different smart solutions. There is a lot of space for maneuvering, and there are most likely a lot of interesting ideas that the municipality hasn't considered yet. They are looking for solutions that have never been seen or used by municipalities previously in different smart city projects. It can be both physical objects or services that make Bodø a better place to live

and work. Their main goal of this project is if the experiments and ideas would create lasting jobs for the citizens and export from Bodø to the rest of the world (Bodø, 2021).

## **6. EU project**

They also collaborate with researchers in regional, national, and international settings. As a consequence, they currently have many projects in the "Champions League" of research - the EU's research and development framework programs. Some of these projects are zero emission neighborhood, sustainable cleaning and reuse of concrete, city loops, digital twin and citizen involvement and B-water smart (Bodø, 2021).

## **7. Smart and green waste management**

The city has put out six solar-powered garbage cans, which reduce the requirement for waste collection and the danger of soiling for the town. They have a garbage container that compresses waste continually and alerts you when it's full. It also incorporates a foot pedal for opening a hands-free seagull/crow-safe throw-in hatch. It is desirable to build smart sensors for garbage bins and an application for emptying municipal garbage bins in collaboration with local companies. Emptying is the responsibility of Byteknikk Park (Bodø, 2021).

## **8. Digital Twin**

A digital twin is a digital replica of something that already exists in the real world. Digital twins will be used by the municipality of Bodø to create new forms of planning, participation, area, and mobility solutions, as well as to visualize them in a simulator environment.

The digital twin project is under the EU-projects CityLoops and is a Horizon-2020 financed project consisting of 28 academic and public partners, spread across seven different cities in Europe. The projects in the cities are different, but they have a common goal to contribute to a more circular practice.

In Bodø they are making a new city district as their demonstration project, where they are cooperating with Bodø Municipality, Nordlandsforskning and IRIS (Bodø, n.d.-a).

They designed a 3D visualization tool for the Bod project that simplifies and shows vast volumes of data, highlights areas for development, and gives a stronger foundation for decision-making. Masses, materials, structures, amount, recycling potential, and

sustainability values may all be shown and measured using the application. Data on pollution, traffic, housing, jobs, noise, and temperatures, as well as proposals from the public, may all be analyzed using the digital twin. Because of these factors, CityLoops is a vital aspect of Bod's Smart By project (Bodø, n.d.-a).

### **Citizen lab Bodø**

Bodø made a public library into their citizen lab, called ByLab, where citizens were urged to offer their ideas, suggestions, criticisms, and protests to building a better city. As well as this they could develop a conversation with the municipality on problems that they cared about. More viewpoints, thoughts, and voices were sought by the municipality to establish a new and larger understanding framework around how they wanted their city to look (Bodø, 2020).

The citizen lab was located at the public library in the city center, the library was not the correct place for the bylab in the city, because it resulted in too much noise and activity that was disturbing for the users of the library as well as it didn't attract new citizens to participate in the process. When the pandemic came, they were looking for new locations to relocate their citizen lab. But informant **D** project manager in Smart Bodø said that they are now focusing on using digital platforms in a combination with a physical location. And they want to incorporate both the physical and the digital platform into the "Kraft-senter" that is for sustainable development and social development (Kraft, n.d.).



### **4.3.2 Molde**

Smart Molde is a program that will contribute to Molde becoming a more sustainable society. It is a project in collaboration with businesses, academia, volunteers, citizens, and the public sector. The project is based on the needs of the inhabitants and of use sustainable methods and solutions to make Molde a better place to live and work. Molde municipality has selected six focus areas where they have particularly good conditions for developing projects that benefit society. The six areas are: Smart energy, Smart buildings and housing, Smart water, Smart health and public services, Smart mobility, Smart interaction (Arne et al., 2020).

#### **Projects of Molde**

##### **1. Circular Value Chain**

The circular Value Chain project highlights the importance of reducing food wastage and mentions that only 2,4% of Norwegian economy is circular and the rest is made up of linear consumerism model. This means that almost all the materials that is consumed are end up in landfills, trash or being destroyed. This is not sustainable; therefore, they had to establish a measurement system and launch pilot project to reduce household food waste. They examined 27 families over a period to find out how much food they are throwing away and the reasons behind it. The participating families had received many good tips on how to reduce food waste to make the project as beneficial as possible both financially for them and environmentally for the planet. One of the goals of United Nations sustainability goals is to reduce world food waste by 50% by 2030 and this project was intended to show how easy it is to make change one house at a time and shed a light on the benefits of circularity. At the end of the project, it has been found that 14 families that participated reduced their average food waste by more than 59% (M. Kommune, n.d.-a).

##### **2. Smart Data**

In the Smart Data project, the municipality developed a platform where they can collect data from various sources in order to gain better and more comprehensive insight from citizens. The purpose of this project is to take advantage of 21<sup>st</sup> century's big data and serve citizens

in a most efficient way by utilizing historical data. By using data science methods to improve decision making one of the ultimate goals of businesses which is efficiency, productivity and profitability can be reached. Principles, procedures, and strategies for comprehending automated data analysis are all part of data science (Provost & Fawcett, 2013). It has been found out by Economist Erik Brynjolfsson and his colleagues that firms that are using data driven decision making methods are more likely to perform better than firms that base their decision on purely intuitions (Brynjolfsson & Kim, 2010). One of the projects that uses their data driven research and improvement is so called “Digital Twin”. Digital twin is an augmented 3D model of the city where it is possible to visualize the consequences of various measures and scenarios (Molde, 2022g).

### **3. Lillekollen kindergarten**

Lillekollen is an ongoing project that is eventually aimed to be a small test area for sustainable residential areas with social, economic and environmental sustainability. The municipality is looking at the possibility of building a learning environment and a meeting place that is open to everyone. They are planning to utilize the building as a multipurpose structure where people can book rooms, have meetings and carry out trainings after the standard operation hours as a kindergarten. In addition, their purpose is to build the building in a most smart way possible. They are considering several innovative and concrete measures in and around the building, including solar cells on the roof and other energy saving initiatives, electric car charging, better facilities for bicycles, and an organic outdoor area with a kitchen garden (Molde, 2022e).

### **4. Valuable - a social sustainability project.**

The project’s main goal is inclusiveness, opportunities, and innovation. It is about value creation by and for everyone, without excluding young generation. The younger generation is more socially conscious and has a goal-oriented approach to sustainable development. They are more worried about tomorrow’s world than older generation, mainly because they will be the one living in it, therefore they want to preserve every natural aspect as much as possible. Additionally younger generation and students in some areas are more knowledgeable and have greater abilities to access information than the preceding generation. To incorporate the students to use their knowledge, Molde municipality is

including students in the development of Molde's public and private business to a greater extent and considering run an internship scheme (Molde, 2022i).

## **5. The energy of the future**

In the “Energy of the future” project Molde municipality wants to test and implement new energy solutions and models to see how they can benefit the whole community. The main goals are: (1) To reduce overall energy consumption. (2) Increase the level of renewable energy in society. (3) Increase the competence and commitment around sustainable energy in different groups in society. The project will be carried out in three different stages; stage one will start with installation of digital interface for flexible energy management and a device that adjusts charging systems/charging points for cars according to the available current in the system in private households. In the second stage the municipality will establish an energy park with demonstration of various renewable energy sources such as wind turbines, solar cells and biogas that can operate attractive functions such as street lighting and charging of electric bicycles. And lastly in the third step, Molde municipality will establish a local energy community and market, where local neighborhoods will be involved with energy production, dissemination and usage, the goal is to provide the local community with environmental, economic and social benefits (Molde, 2022c). Protecting the climate and the environment by creating and switching to a more renewable energy is a significant motivation in this project. Local energy communities have economic and social ramifications as well. It will become economically possible for more people to create their own power when a bigger number of private persons and larger players join forces. And lastly local energy communities can be a more cost-effective alternative to standard grid maintenance and investment, with favorable economic implications even for people outside of such communities (Brubæk, 2021).

## **6. Smart mobility**

In the “Smart Mobility” project, the municipality is investigating how to interact in/with the relevant locations/areas within the city and how to get people to think differently when making a choice of travel mode. The project’s aim is to increase the availability/efficiency of options so that the inhabitants can travel with the lowest possible risk in traffic and highest availability of public transport in and around the sports park. Through the project, they want to find smart solutions, so that the area can become a safer and more environmentally

friendly place to travel, with better traffic flow and less congestion. To achieve smarter mobility measures that are planned to be taken are as follows: a new walking and cycling path, bicycle parking, better traffic signs and guidance scheme, a digital platform that collects and provides an overview of what happens when and where in real time, promote carpooling, better utilization of natural surroundings and increased focus on the social and the health benefits of leaving the car (Molde, 2021c).

### **7. Electrification of boat traffic and exit point on Hjertøya**

The study will look at how electrification of local boat traffic connected to Molde harbor can be used to connect to Hjertøya island. The project will study the use of renewable technology for local transport at sea. The aforementioned island is among many islands that can be promoted and marketed to tourists and locals as an attractive excursion destination. However, there is one downside of the Hjertøya island and that is inaccessibility. Currently main visitors of the island are the people who own a private boat. However, the island belongs to all the people regardless of whether one can afford a boat or not therefore the tourism industry and public actors have collaborated and contributed to Hjertøya becoming more accessible to all residents and visitors. Though the municipality, other public players, and private investors have engaged in the endeavors to make the island more accessible to minimize the visible wealth inequality in the municipality, the public transportation to the island can always be improved. The projects leaders are desiring to achieve more frequent boat departures/arrivals so that people can even visit the island in the evening and will not be affected by the time constraints. Additionally, as mentioned they desire to ditch out the boats with traditional combustion engines and utilize full electric boats to minimize the negative impact on agriculture, marine life, and air quality (Molde, 2021a).

### **8. Digitalization of existing buildings**

The current situation of digitalization of existing buildings is characterized by existing staff, construction, project members associated with the building making little use of relevant and accessible data in management, operation, maintenance, and development (FDVU). The idea was a dashboard implementation that visualizes existing data in FDVU in small and medium-sized companies and municipalities. The visualization is presented based on the users' need. For example, a caretaker will see information about the ventilation system, power consumption and other technical data, while cleaning staff will be able see the

movements in the room over a period of time and determine whether the room requires more or less cleaning. Another example is a research project conducted at St. Olav's hospital in Trondheim, Norway, it has been discovered that integrating data from a scooters' location sensor with 3D models of the building might provide valuable insight into how contagious diseases spread in hospitals (Molde, 2022b).

## **9. Smart assistive technology management**

According to research conducted by World Health Organization more than a billion people worldwide require one or more assistive devices. Only one out of every ten people in need has access to assistive technology today. The purpose of this project is to store and provide assistive devices for residents with temporary needs, as well as services related to assistive devices in case of permanent needs so that they can sustain or increase a person's functionality and independence, ultimately enhancing their well-being (WHO, 2018). According to the Molde municipality there are 3500 users in need either of permanent or for some periods of necessary devices (Molde, 2022h). If we refer to data gathered by the Norwegian statistics bureau, we can see that there are 32002 inhabitants as of 2022, thus, citizens that have lent assistive devices make up 11% of the Molde municipality (Sentralbyrå, n.d.).

## **10. Circular economy in practice**

Through this project, Smart Molde analyze how the value chain for furniture, fixtures, and equipment can become circular. The main goal of this research project is to develop a smarter purchasing methodology for furniture, fixtures, and equipment for Molde municipality. The goal is to contribute to cost savings and reduce environmental footprint through reuse, refurbishing and reducing purchases of new furniture, fixtures, and equipment. One of the findings so far in the project shows the differences between a teaching room in a consumer economy, and in a reuse economy, both in terms of environmental footprint and costs. By assuming that a standard classroom would need 30 chairs and 30 desks, they calculated the difference in the impact of purchasing habits of the municipality. They found that the transition from a consumer economy, where everything is new, to a circular economy, where you can reuse and "refresh" used furniture, leads to an 80% reduction in greenhouse gas emissions and almost a 50% reduction in costs (Molde, 2021b).

## **11. Digital water meter**

With installation of smart water meters, there will be a system where customers pay for water based on their consumption. Additionally, water leaks can be located more easily and in real time. Moreover, sensors would notify users in case of high consumption of water and if the water tank storage is about to freeze. The main purpose of installation of such system is to increase water awareness in the society (Molde, 2022a). We believe that it might be good for municipalities to publicly disclose household water consumption online in a website, so that this might result in social pressure on some people, and they might feel remorse due to high water consumption in comparison to their neighbors. This would trigger a Hawthorne effect, which occurs when people behave differently because they know they are being watched (Spencer EA & Mahtani K, 2017).

## **12. Bike path sensors**

The sensors collect and transmit current information on air temperature, ground temperature, dew point, and humidity, as well as indicating whether it is slippery in these areas. Residents and the municipality will have access to this information. You may want to verify if it's slippery before cycling to work, school, or a leisure activity by checking it online to minimize the risk involved with cycling. The current idea is to test on a modest basis first. Therefore, they are examining extremely precise areas of application to ensure that this works (Molde, 2022f).

## **Citizen lab Molde**

The Citizens' Lab will be an open, living and inclusive space where the public sector, citizens, businesses, academia and volunteers can meet to gather input from the inhabitants for ongoing and future work. Their citizen lab will have several physical locations, and it will also have digital channels and tools. It has not yet been decided where the citizen lab will be located, this will be determined through the preliminary project that is currently underway. It is planned to have Citizen Labs located in the center of Molde, Eidsvåg and Midsund (Molde, 2022d).

### **4.3.3 Trondheim**

Trondheim's smart city is a group of different initiatives aimed at making the municipality of Trondheim more sustainable via the use of smart technology and open data. Trondheim municipality works in many areas to take advantage of the opportunities that lie in large amounts of data, technology and new solutions (Trondheim, 2022a). Smart Trondheim have many different focus areas, their main project is CityXchange where they are a part of an EU-project. Through the EU-project Trondheim wants to use less power than what they produce, to achieve this they need to develop new and smart solutions (Trondheim, 2022c).

#### **Projects of Trondheim**

##### **1. CityXchange**

Trondheim municipality is a part of an EU-project to accelerate the transition to local clean energy. In the CityxChange project, Trondheim municipality has established city labs at Sluppen, Elgeseter, in Midtbyen, at Brattøra and in Nyhavna to engage citizens, collect data and enable an innovation sandbox. The solutions that are now being developed will revolutionize the way we produce and consume energy and enable us to utilize energy and energy sources in a far more efficient way than before. An important part of the work is to develop so-called "Positive Energy Blocks"; neighborhoods that consume less energy than those produced locally (Trondheim, n.d.-d).

##### **2. Mobility/ Carsharing**

Trondheim municipality have developed an application Mobee that is an easily accessible application for people living in Trondheim and visiting the city. It's an overview of where the nearest city bike, scooter, rental car or bus stop is no matter where you are in the city. For promoting this project, they have made a test called "Bilpool-testen" where it's gets calculated how many hours of rental car can you afford for the money you spend on owning a car in a year (Trondheim, 2022b).

##### **3. Project Powerhouse**

Powerhouse Brattørkaia is Norway's largest newly built plus house. It has been designed according to the principle form follows the environment and will through the operational phase generate more energy than what was used for production of building materials, construction, operation and disposal of the building. It is an office building, where the comfort is very good with a lot of light and air (Powerhouse, n.d.).

#### **4. Project Sluppen**

Within two years, six buildings at Sluppen as well as the three buildings at Brattøra, will be a positive energy block. The energy consumption in the buildings will be lower than what is produced than local energy. The + CityxChange project will continue to work on the remaining buildings with the goal of making Sluppen energy-positive within 2030 (Trondheim, n.d.-a).

#### **5. The new energy society**

Today you can sell your surplus electricity back to the electricity grid as a private individual, but you cannot sell it to your neighbor. Trondheim wants the present restrictions to be altered if regarding selling energy to your neighbor. If they are to accomplish this, this could then result in a flexible market. This change needs to come from EU, and Norway's national authorities must then implement that decision. + CityxChange has now received permission from national authorities to test local energy markets where energy is utilized in a better way. This has never been done before, neither in Norway or in the rest of the world, where one produces, and invoices locally produced surplus energy. Many buildings with solar cells today produce more electricity than they consume themselves. With current legislation, you cannot sell the surplus power to consumers in the neighborhood. Through + CityxChange, Trondheim can now be the first in the world to test a system that makes this possible. Electricity is fresh produced, which means that it either needs to be used now or it can be forwarded or stored in batteries. Solar cell or electricity stored in batteries can become the new normal and then Trondheim wants the rules and regulations regarding this to be changed (Trondheim, n.d.-b).

#### **6. Smart water meters**

In 2021 Trondheim Municipality tested smart water meters in two different areas, Byneset and Tiller where the goal is for people to pay for actual consumption monthly and not an



estimated price once a year. While at the same time they want the consumer to have more insight on what they are using and a more reasonable invoice. The smart water meter will give the citizen a more understandable invoice and notify them if there is a suspicion of leak. As well as economic benefits, smart water meters reduce water spill. the smart water meter sends automatic readings to a computer system daily, so the citizen does not have to do anything (Trondheim, 2021).

### **Citizen lab Trondheim**

Trondheim municipality have four different meeting arenas across the city, where the goal is to increase citizen participation in the process of becoming a greener, more sustainable, and smarter city. These places are made for citizen, where they can read books, explore new food and gain insight into the municipality's sustainable development work. Lager 11 is one of the four meeting arenas which is located at Sluppen, where they want to create a food court with a mix of different food experiences from different cultures. The goal is to involve founders from different immigrant backgrounds. As well as this Lager 11 are renting out office's spaces to many creative souls from Trondheim, where they do shows and so on. Books and Bylab at Elgeseter, is supposed to be a different library, in Teknobyen's environmental building. The room is also a meeting place for the citizens whether they want to talk, develop ideas, or collaborate across districts. The shelves are filled with discarded books from the public library, and the room also serves as a meeting place for the citizens whether they want to talk, develop ideas, or collaborate across districts. The idea is to breathe new life into old literature while also making the neighborhood more attractive, dynamic, and sustainable. At Bytorget they are now working on making an information center, where small groups of people can come in and explore digital solutions. The last meeting arena is the powerhouse at Brattøra, which is a digital display center for showings (Trondheim, n.d.-a).

### **4.4.3 Malmö**

Malmö's main goal as a sustainable city is to become a socially, ecologically, and economically attractive city for people to live and work in. The city should be able to continue to expand, necessitating additional housing, employment opportunities, and service. The goal is to build a strong and long-term sustainable urban structure to accommodate a growing population, green growth, and the enhancement of Malmö's attractiveness (Malmö, 2021e).

In 2018 they made a comprehensive plan on how the city can reach its goals over the next 20 years. This was made as a strategic document focusing on the long-term plan of what to do with water, land and environment (Malmö, 2018).

Malmö city made the UN sustainable goals into their own and wants to achieve four things by 2030, end extreme poverty, reduce inequality and injustice, promote peace and equality and solve the climate crisis (Malmö, 2021c).

### **Projects of Malmö**

#### **1. Augustenborg Eco-City**

Augustenborg district in Malmö is a very successful sustainably adapted neighborhood in other words ecological city example. The project revolves around 3 main objectives, to manage flooding problems, to overcome socioeconomic challenges and increase the sustainable lifestyle in urbanization. The initiative is a cooperation between MKB, a public housing firm, and the city of Malmö, but it also involves many other organizations and local businesses. Project's scope was determined in response to residents' needs and requests. In the project, they built the greenhouse apartment building which has 14 floors and 56 apartments. Smart and sustainable solutions were seamlessly incorporated with the building itself. Some of the features of the building are, cultivation balconies, a shared roof garden with greenhouses, green roofs, renewable energy generation through solar cells, a cargo bike pool, simple solutions for waste management and separate metering and billing of hot water and electricity. Additionally, citizens that are not living in the building can visit and get a tour of the roof garden made up of about 10,00 square meters, where they can get informed about the benefits of greening their roofs. Furthermore, people will be educated about

infrastructural conditions required for transformation of the buildings. Some of the measurable findings after launching the project are (Sweden, n.d.-a), (Sweden, n.d.-b):

1. Energy efficiency has grown by around 10% since 1998 and is now by 35% greater than when the buildings were initially constructed.
2. Tenancy turnover has dropped by about 20%.
3. The buildings' environmental impact has lowered by around 20%.

## **2. Sege Park**

Sege Park is an experimental area of smart housing utilized with climate friendly solutions and technologies that is in the eastern Malmö. In Sege Park, the city of Malmö is collaborating with a variety of developers to build roughly 1000 dwellings. Long-term sustainability, economic urban development initiatives, in particular sharing economy and ecological development, such as, growing their own fruits and vegetables – attempting transform into a self-sufficient region – localizing what you can. The project's tasks are (Malmö, 2021d):

1. Supplying is with renewable and recycled energy.
2. Installing solar panels to increase energy efficiency.
3. Water preservation via rainwater collection and usage.
4. Electrification of bicycles in the region.
5. Availability of carpooling.

## **3. Recycling Park**

One of the greatest examples of the Swedish waste management system is the Kristianstad recycling park. The present rate of material and energy recycling is 97 percent, with the objective of reaching 100 percent in the near future. The amount of material dumped has been reduced by 40,000 tons by increasing the volume of material recycled. The landfill was decommissioned in 2001, and the facility was built to replace it at that time (CTCN, n.d.).

## **4. Comprehensive waste management**

The project aims to decompose and recycle organic waste to fertilizer to be used in industrially in agriculture or personally in households. In less than eight weeks, more than a third of the waste was transformed into rich compost just with 13 recycling houses that are

close to the residential buildings. Augustenborg was chosen as a demonstration location for sorting food waste to produce biogas in 2008, a plan that has now expanded to encompass the entire city (Malmö, 2021f).

### **5. Climate Smart Hyllie**

Hyllie is Malmö's innovative and sustainable district development project. This project's ultimate goal is to create a testbed district that is 100% sustained by renewable energy in the long run. Hyllie served as the launchpad for a digital smart grid platform that optimizes district heating flows by factoring in weather and energy demand, as well as smart building technologies. Moreover, citizens are provided free membership in a carpool and a free bus card as soon as they move to Hyllie in order to discourage automobile ownership (Malmö, 2021a).

### **6. Smart Cities accelerator**

Power peaks can have unfavorable consequences for residents and businesses in towns or neighborhoods with an inflexible or inadequate power system and a lack of locally supplied energy sources. The goal of this project is to facilitate knowledge sharing and creation of projects that can help municipalities establish more sustainable energy systems via the usage of cloud-based solutions and data analytics. Project will assist the creation of greener solutions by integrating research settings encompassing data, behavior, law/regulations, and learnings (Accelerator, n.d.), (Center, n.d.), (Climate-KIC, 2019).

### **7. Sustainable Rosengård**

The project includes creation of new social arenas for gatherings and events, sustainable housing, new job opportunities and a better infrastructure. An active interaction with stakeholders interested in developing Rosengård in an environmentally, socially, and economically sustainable manner was a crucial component of the process. This includes consultations, workshops, and other activities (Malmö, 2021b).

**Malmö Living Lab:**

The Malmö Living Lab is a municipal experiment aimed at revealing methods to improve the city's residents' lives. The city problems will be prototyped there for citizens to test. Furthermore, they decentralized part of the public administration in specialized established labs so that they could be closer to some of the specific communities where there are certain issues regarding crime, gang and other municipal issues (Medium, n.d.).

Malmö has a long history of living labs and established there first one in 2014 (Network, n.d.). They've also established a data lab as a way to improve people' quality of life by allowing the municipality to better understand their complex needs and providing value-creating public services to meet them. The Data Lab was divided into two sections: one that looked at the requirements for data coordination from a legal standpoint, and another that looked at it from the perspective of citizens and users (University, 2022). Moreover, they are using a Facebook page to reach out to their citizens where they ask questions, share videos uploaded on YouTube and adds for different job opportunities.

## 4.4 Overview of all projects

Cities	Bodø	Molde	Trondheim	Malmö
No.				
1	Smart Transportation	Circular Value Chain	CityXchange	Augustenborg Eco-City
2	Smart Architecture	Smart Data	Mobility/Carsharing	Sege Park
3	Use of sensors and IOT systems	Lillekollen Kindergarten	Project Powerhouse	Recycling Park
4	Carpooling and Bike scheme	Valuable- A social sustainability project	Project Sluppen	Comprehensive waste management
5	Smart Bodø Pilot area	The energy of the future	The new energy society	Climate smart Hyllie
6	EU-project	Smart Mobility	Smart water meters	Smart city accelerator
7	Smart Green waste management	Electrification of boat traffic and exit point on Hjertøya	Citizen lab	Sustainable Rosengård
8	Digital Twin	Digitalization of existing buildings		
9	Citizen lab	Smart assistive technology management		
10		Circular economy in practice		
11		Digital water meters		
12		Bike path sensors		
13		Citizen lab		

Table 6: Overview of All Projects

## **5.0 Findings**

In this chapter we will present our findings gathered from interviews and document studies done by the municipality or earlier research for Molde, Bodø, Trondheim and Malmö.

In our research we have done several digital interviews with Informant **A** who works in Smart Molde. We have had one interview with Informant **B** about Smart Malmö who is a former employee of the municipality, but who is now working as an advisor in Smart Molde. We had one digital interview with Informant **C** who is an employee in Smart City Trondheim and had some conversations via email. We had one interview with Informant **D** who works in Smart Bodø as well as some conversations via email. As well as with the four chosen municipalities we had a very interesting interview with the founder of a Consulting company Informant **E** and his colleague Informant **F**. The consulting company works with understanding the potential and the value of a place. As mentioned in chapter 3 we made an interview guide to prepare us for those in-depth interviews with the interviewees. The interviews turned more into a conversation and as well as we asked our prepared questions, they contributed with even more than we asked. As well as interviews we have researched for document studies to contribute with information about the municipalities, where we were lacking information from the interviewees.

### **5.1 Observation through interviews & research documents**

#### **5.1.1 Smart City**

Our interview guide is presented in the appendices, we started out the interview with asking all the different interview objects how they would define a smart city and what role a citizen lab could play for a smart city. As well as we also asked what their ideas, goals and reasons for becoming a smart city. Molde, Bodø, Trondheim and Malmö had quite similar answers, they wanted to make their city into a better place for people to live and work in. Informant **A** emphasized that she wanted an attractive city for people to move to and to live in, she wanted to increase the population growth. Bodø as well as the other cities focuses on giving the citizen a better place to live and work, Informant **D** who is working in Smart Bodø wants to make sure that the municipality works in a sustainable manner, they want to create local value to the global sustainability goals. The municipality works closely with the rest of the municipalities in the county Nordland as well as this they have other partners internationally,

regionally, and nationally. Informant **D** also mentioned a new project they are working on, where the focus is to integrate and include people immigrating to Bodø.

All Norwegian cities involved in this research follow the national roadmap for their Smart city projects, the eight principles in this roadmap will contribute to Norway, achieving the UN's sustainability goals. The guidelines emphasize the importance of a citizen centric approach (DOGA, 2019). Informant **A** from Molde municipality called the roadmap their bible and emphasized the importance to follow the guidelines given. The main purpose of this roadmap is to support the development of cities and communities that are sustainable, productive, and adaptive.

Informant **C** from Smart Trondheim said that a smart city is how they use technology and data to meet to UN sustainable goals, as well as this he emphasized that smart city is a tool and that he thought that most important thing is to be sustainable. Molde, Bodø, Trondheim and Malmö have adopted the UN Sustainable development goals into their smart projects to reach the UN goals through their projects. Smart Molde have made an overview on their webpage about their different projects and which development goals they are reaching by doing the project.

As well as this, the Norwegian municipalities had the same answer in defining a smart city. All the municipalities used the definition from the national roadmap for smart cities in Norway,

“Smart cities and communities focus on people, while using new technology, innovative methods, collaboration and co-creation to become more sustainable, attractive, productive and resilient.”(DOGA, 2019)

Malmö defines a smart city as, “Smart City aims to enable a closer interplay between technology, places and people by increasing the digital transformation in the physical space of the city.” (NSCN, n.d.)

In all the interviews conducted with Molde, Bodø, Trondheim and Malmö they all said that one of the reasons for transitioning to a smart city was to increase the population in the municipality. In the table below you can see the population growth for the four cities chosen for our thesis.



		2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
<b>Molde</b>	<b>Persons</b>	30480	30941	31085	31435	31790	31870	31895	31976	31967	31870	32002
<b>Trondheim</b>	<b>Persons</b>	182278	185631	188005	190955	193420	196514	199595	202235	205163	207595	210496
<b>Bodø</b>	<b>Persons</b>	48422	49203	49731	50185	50488	51022	51558	52024	52357	52560	52803
<b>Malmö</b>	<b>Persons</b>	287000	291000	296000	300000	305000	310000	315000	319000	322000	326000	330000

Table 7<sup>1</sup> (Macrotrends, 2022), (Sentralbyrå, n.d.)

All the cities had a small increase in the population. Over the last 10 years Molde have barely had any increase in their population. Informant **A** from Smart Molde explained to us that she wants Molde to become an attractive place to live and work and hopes that becoming a smart city with many sustainable solutions and creating more jobs will attract more people to move to the city. Molde has around 2500 students each year and creating jobs that are attractive to newly educated young people and getting them to stay in the city is a goal that they are working on.

Trondheim is the third biggest city in Norway and is a popular city to study in with 33.000 students (NTNU, n.d.). There are many people living in Trondheim in the age between 25 and 29 years old (Sentralbyrå, 2022). Informant **C** explained that it seems like people move back to their hometowns after they finish their degree and so on.

Malmö is the biggest city we have chosen for our thesis, Informant **B** former employee in Malmö explained to us that they have significant problems involving high unemployment rate, a lot of crime in some specific areas. But at the same time Malmö is a popular city to move to, with around 24,000 students. Which makes Malmö a big and popular city for students to move to. (StudyEU, n.d.). Which may be the reason behind high unemployment rate among young people.

As well as this Malmö have people living in the city from all over the world. Some who struggles with understanding the language and have cultural differences. Therefore, some of immigrants in the city fall outside the society. Informant **B** also said that the employees in the municipality physically showed up in some specific neighborhoods with an interpreter to try to get them involved in the community and include them in decisions making process in the municipality. She also told us that Malmö has a long history of working with democratization and social sustainability. Where the focus has been on urban development

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<sup>1</sup> “The entire time series is calculated from the municipality boundaries in 2020. Expired municipality Klæbu is therefore included before 2020.” (Macrotrends, 2022), (Sentralbyrå, n.d.)

projects, how to design new neighborhoods, to get people with different income to live together, to mainly mix up the neighborhoods.

In 2017 the city's digitalization program started, and they identified smart city as one of their focus areas. There they wanted to use digitalization and data to improve the development towards becoming a smart and sustainable city. They had a lot of projects with sensors, they were mostly installed in new neighborhoods, to try out different innovative solutions for water management, citizens engagement, urban management like city operations in the physical spaces. Here the focus is on both citizens engagement and digitalization and data. She explained to us that they have many different neighborhoods targeting smart city development, but they are not labeled smart city projects. Some of these neighborhoods are Nyhamnen, Rosengård and Hyllie.

Rosengård is one of the areas that has had problem with segregations, high criminality among the youth, many gangs, low education and where the dropout rate is high. Informant **B** said that Malmö has a long history of welcoming immigrants and historically they have been in these neighborhoods, because it is cheaper to live there. The city has tried to change these neighborhoods, with youth programs and renovating the buildings and moving different companies to the areas.

Based on a conducted interview with the consulting company, we have attained plenty of information about value chains in smart cities and the crucial part of strategic stakeholder participation and involvement to develop urban economics - bringing goods and services to city centers to change the old city structures. For economic and social development of a particular area, Informant **E** from the consulting company highlighted different kinds of value spheres and how they interconnect to make the development possible. In the process, natural value spheres (e.g., natural resource) and human value spheres (e.g., all the citizens, landowners, business owners and other people) should be taken into consideration to achieve economic success and increase societal wellbeing.

When it comes to Value creation for society; Informant **E** mentioned that value chains always bring natural resources to human need or market segment through market and societal systems. If one can apply sustainable value principles with right type of involvement and participation into a place making process and engage and educate residents, inhabitants, corporates, businesses, and public servants and public organizations with this new perspective of how you create sustainable value over time in local place, one can make a

massive improvement. Furthermore, there was one particular point about value creation and development that Informant **E** put extra emphasis on: Localize what you can and globalize what you have to, to increase the resilience of the society.

### **5.1.2 Citizen labs**

All the municipalities had challenges regarding involvement of citizens into the decision-making process. Because of this, the chosen municipalities wanted to create or had already created citizen labs. Informant **E** from the consulting company mentioned that participation is about involvement of people who are having consequences of the planning that is going on. Creating engagement and open discussions about participation is very healthy for community and can make people feel involved. They work with a holistic approach and utilize multi stakeholder management/mapping in all their project because if you miss out on strategic involvement you may stumble in the projects. Informant **E** also mentions that citizen engagement is the most crucial human resource of a place, because of the inhabitants.

Molde, Bodø, Trondheim and Malmö all promote public participation in the innovation process and their way to meet the public interest will mainly be through the Citizen lab projects for Molde, Trondheim, Bodø and Malmö. Informant **A** expects that their citizen labs will be an arena where the citizens are equally heard and involved. She explained to us that they have received 1.3 million Norwegian kroners in funding for the citizens lab project. They will make three physical citizens lab located in Molde, Eidsvaag and Midsund. She wants the citizen lab project to be appealing for the citizen and an attractive place to be, where the citizen can be creative, learn about new things and be social. As well as this she wants it to be a place where the public, citizens, business, culture, volunteering and academia can gather to share knowledge and co-create solutions. People are different and have different opinions and interests, we wanted to know if Informant **A** thought that all citizens should be categorized as one group. She explained to us that citizens may have different needs and desires, so they may have ideas that may conflict with each other's desires. What they have in common is that they are citizens of the municipality, and they are governed by what the municipal council decides. She also thinks that the citizens represent themselves and their needs, but sometimes they also represent, for example, the business community they own or work in. To summarize, she thinks that citizens can have different "hats" based on what and who they represent.

Informant **C** from Smart Trondheim explained that their citizen labs projects are the biggest smart city projects they have. He emphasized that the main purpose of the citizen labs is to get people involved, getting them engage in the development of a sustainable city and making Trondheim a city, where the citizens don't want to move out. They have created four different labs in the city with different characteristics to attract different people with different interests. He explained that they have made one that is a showroom where the focus is on education, another one which is a waiting arena for a food court, a neighborhood pub and one about the different projects.

While Bodø on the other hand has already tried involving in the public in the municipality with their citizen lab in the public library. Informant **D** explained to us that in 2018 Bodø opened Bodø Bylab, where citizens were invited to express their ideas, input, comments, and protests, as well as engage in discourse with the municipality on matters that interest them. The municipality wanted more perspectives, thoughts and voices in order to establish a new and bigger understanding of how Bodø city should be for the citizen to live and work (Hunstad, 2018).

The Bylab was placed at the public library in the center of the city. Informant **D** explained that one of their problems with the Bylab was that it did not attract a diverse group of people. Most of the people who came there, were citizens who already was engaged in the community. Another problem she explained was that the Bylab became disturbing for the users of the public library, who were not interested in participating. Right before COVID-19 came Informant **D** and her colleagues were looking for new locations for the Bylab. Because of the pandemic they have a desire to use digital platforms to a greater extent in combination with a physical location. They are today working on incorporating both the physical Bylab and the digital Bylab into the “Kraft-senteret” for sustainable social development. Kraft is an arena for sustainable social development, where Kraft will contribute to smart city development by encouraging collaboration and innovation among key commercial players, the public sector, academia, non-profit organizations, teams and associations, and society. Kraft will serve as a platform for innovation, drive, and sustainability, helping to place Northern Norway on the map for sustainable urban and social development. Informant **E** also mentioned that digital platforms are important as well, to involve the participation online.

Malmö city have created many civic labs as an experiment for improving the way of life for the citizens. As well as this they have also created a data lab, as a method to improve citizens' quality of life, the municipality would be able to better understand their complicated demands and provide value-creating public services to fulfill them. Informant **B** also explained to us that as well as the specific established labs, they decentralized some of the public administration, so they could come closer to some of the specific neighborhoods there were some challenges in. She also emphasized that Malmö wants to promote a deeper interplay between technology, places, and people in the city. It wishes to be a sustainable city; they want the city to continue growing as well as to build a strong and long-term sustainable urban structure to accommodate a growing population, green growth, and the enhancement of Malmö's attractiveness.

Because Malmö has been doing the citizen lab project for a long time, we wanted Informant **B** to share some concrete results with us. She explained that it's difficult to get people involved in the processes, she emphasized that it is hard to get people motivated to use their time to participate. But she still said that they had gotten positive results, that people in the city are participating, but the group has not been as diverse as they would have liked it. She emphasized the importance of a balance between where the municipality need help and which impact while directly go to the citizens. She had experienced that citizen could say, why do you need my help with this, you are the one working with it. So, she said that to not ask to get people involved to much but ask in the right projects.

Informant **B** was a former employee of Malmö municipality and is now working in Smart Molde, we wanted to know if she could explain the differences with the smart cities. She explained to us that one basic similarity between Molde and Malmö regarding the citizen labs was that the principles of being a safe arena in an open field where they can discuss things neutrally. However, a big difference is their challenges in the city. Informant **A** explained to us that the reasoning for Molde to get a citizen lab is to increase the citizens participation, make the city a better place for the citizen to live and work in.

While Informant **B** explained that the reasoning for Malmö to create the citizens labs was to increase the democracy, as well as that the citizens lab were not supposed to focus on data and technology, but more that the people living in Malmö could participate in planning.

We asked all the municipalities what kind of features a citizen's lab should have, Informant **B** mentioned that a citizen lab should be a natural arena to be at, friendly and that the location is very important, the more convenient the better. And that the incentives for going there

should be emphasized, like if there is an issue very closed to hear for a person, if this could possibly impact their life in a positive way, that everything is relevant. Informant **A** emphasized that the citizen lab should be “sexy”, meaning an attractive place for the citizens to be. Informant **E** focuses on that the citizen lab should have an identity, attractivity and be a good and sustainable place for the future. Informant **C** from Smart Trondheim emphasizes that the citizen lab should be a positive city exchange and be attractive for different types of people with diverse interests.

### **5.1.3 Framework**

Informant **E** from the consulting company said that the most important thing is to define something that the municipality and stakeholders really need.

All cities chosen for our thesis used quadruple helix as their framework to involve all the actors, which is academia, government, industry and community., except Trondheim.

Informant **C** explained that Trondheim on the other hand had made their own framework The Bold city vision for societal involvement, the framework links local politics, citizen-driven innovation and business development to the UN sustainable development goals. The framework is supposed to guide the users through a sustainable development process. The Bold city vision has won an innovation price for it work (Trondheim, n.d.-d).

## 6.0 Traffic light assessment model

Below, four tables of all different projects in the four different cities we are evaluated with a criteria system we have made. These cities have been evaluated by us with four different criteria, that we thought was a good way to measure the success of their projects. We have given the cities scores based on different factors presented below. Furthermore, we have scored them based on our personal unbiased judgement, perception and literature. We have decided to use a traffic light model by color-coding the scores that are given by us. There are three colors in the model.

**The color green** is used if the smarty city project was successful, beneficial for society or having high chances of succeeding (in case the project is still on-going) in respect to criterion they are being judged for.

**The color yellow** is used if the project has had neutral outcomes or not enough data was found for us to make a clear judgement about it.

And lastly, **the color red** is used if the project's outcome for that particular criterion is something that may have not been/will not be very impactful for the society. Below our criteria is presented with an explanation of what we emphasize.

## 6.1 Criteria

### 6.1.1 Sustainability

As we have mentioned already in our literature review the term sustainability can be extremely ambiguous, sustainability is about meeting our needs in the society today without compromising anything for the people in the future to meet their needs. The National roadmap for Smart City projects is emphasizing the importance of getting involved and reaching the UN Sustainable Development Goals. Most of the projects have different sustainability goals they want to achieve through their different Smart City projects.

In order to minimize the confusion and narrow down the scope of the term we will consider the criterion in two contexts. (1) The sustainability of the physical things such as buildings, construction, and infrastructure: To achieve a high score for this criterion a project must be carried out by sustainable construction means, by minimizing energy consumption and waste production, constructing with renewable and recyclable materials. The fundamental purpose of the sustainable building process is to minimize its environmental impact. Moreover, it does not end there after the construction has been completed the building should be self-sufficient in terms of food, energy, water and air quality. (2) Transforming the city to a more livable space: By increasing job creation, improving road infrastructure, affordable housing, better schooling, and healthcare, cities can become more attractive place for citizens. The elements covered above require production, manufacturing, distribution, consumption therefore it can increase the welfare of citizens and consequently create value for them. Additionally, it can attract more businesses to open shops in the area which will boost economy by increasing the amount of money in circulation.





### **6.1.2 Incentives**

Human beings are driven by motives and outcomes. In every action our brain tries to predict potential outcomes before engaging in a particular behavior. For instance, one of the very first things, many people do when they get up is to check social media on their phone, the incentive behind this particular action is the feeling of fulfillment, seeking approval and being a part of the whole. The ideology behind attendance and participation to events that occur under the roof of citizen labs revolve around the same principles. It can be the economic incentives that are attached to participation by ensuring that idea owners' contributions will be hashed into the public blockchain by using cryptographic hash function and then be rewarded. This theory is somewhat similar to intellectual property rights, and we believe can be implemented as an incentive to contributions.

However, not all incentives are financial. The project outcome expectation in other words the perceived benefit of the projects can also be considered as an incentive for the citizens. Some citizens contribute to project development to better the place they live in. Since, they consider their cities as home, it is logical for them to play a role in fixing the urban problems of the city. Or, from another perspective, it might be that you overheard that your neighbors, friends, or colleagues have participated in such gatherings, and you do not want to be excluded – desire to avoid social disapproval can shape the human behavior (Fehr & Falk, 2002). Additionally, other small incentives could be the free coffee, candies, and a piece of chocolate you may receive in the facility. These may not sound sufficiently influential to conduct an act, but it is among one of the most important factors when it comes to art of persuasion, and that is the tendency to reciprocate. Companies that use reciprocity, according to Dr. Robert Cialdini, have a better chance of succeeding (Cialdini, 1993).

### **6.1.3 Accessibility**

Accessibility is our third criteria. We emphasize that Smart projects should focus on how accessible the projects are for the citizens, how this affects the citizens and how it possibly can influence them. We are giving scores based on how accessible the outcome of a project is for all citizens living and working in the city.

For projects that are physical such as workshops, events, and citizen labs localizations must be easily accessible with public transportation and so on. They should not be in remote locations or suburbs where public transportation and departure frequency are unreliable and inefficient. Municipalities should discourage the access via private transportation mode by taking into consideration of accessibility by everyone, due to the fact that not everyone has financial stability to afford and maintain private vehicles.

### **6.1.4 Cost**

We have evaluated cost with the information we have found, if the projects have gotten funding, if there are many IOT systems or technology pieces that needs to be installed or implemented to start the project, if the investment costs have been big etc.

## 6.2 Bodø

Criteria	Bodø	Score	Smart city Dimensions
Sustainability	Smart Transportation	Smart transportation is reducing climate emission and	Smart Mobility Smart Environment
Incentives		Making travel habits more effective and cost efficient	
Cost		They received 50 million in fundings for the project	
Accessibility		It's supposed to be easy to access for all people in Bodø and travelling to Bodø	
Sustainability	Smart Architecture	Making the blue light services smarter, will reduce in unnecessary climate emission	Smart Mobility Smart Environment Smart Governance
Incentives		Faster help for citizens	
Cost		Investment and implementing cost for installing the IOT systems	
Accessibility		Accessible for the blue light service	
Sustainability	Use of Sensor and IOT systems	Clean air, less pollution	Smart Mobility
Incentives		Better quality of life	
Cost		Implementation cost for installing the sensors	

Accessibility		Citizens will have access to the data	
Sustainability	Carpooling and Bike Scheme	Sharing economy of cars is reducing climate emission	Smart Mobility Smart Environment Smart Economy
Incentives		Even out social differences	
Cost		Platform for sharing	
Accessibility		Available for all citizens in Bodø	
Sustainability	Smart Bodø Pilot area	Using an area in Bodø to test out different activities that could give sustainable benefits	Smart Environment Smart Economy Smart Government Smart Living
Incentives		Citizen can get inspired and see if projects are working, easier to involve citizen if they have more knowledge	
Cost		Implementation cost of all projects	
Accessibility		Easily accessible for people living in the pilot area	
Sustainability	Smart and Green Waste Management	It doesn't reduce waste	Smart Environment Smart Economy Smart Government
Incentives		Reduces fouling and making the city cleaner	
Cost		Cost of buying new garbing can, but reduces work for the ones emptying them	

Accessibility		Easily accessible for the citizen and easy for the ones working with emptying	
Sustainability	Digital Twin	Build a new district that will have zero emission	Smart Environment Smart Living
Incentives		Better life quality with less emission	
Cost		Implementation cost of all projects	
Accessibility		For people living in those areas	

Table 8: Bodø Smart City Projects

### 6.3 Molde

Criteria	Molde	Score	Smart City Dimensions
Sustainability	Circular Value Chain	Reduce food waste	Smart Environment Smart Living Smart Economy
Incentives		With enough knowledge people can save money with less food waste	
Cost		Will give more benefits than what it costs	
Accessibility		Citizen involvement for reducing waste	
Sustainability	Smart Data	Using data to collect materials on how the different stakeholders can change	Smart Mobility
Incentives		The goal of this project is that the data will be more accessible	
Cost		Collecting the data will take some time, which will result in more expenses	
Accessibility		For all stakeholders, if the data gets accessible	
Sustainability	Lillekollen Kindergarten	Circular economy is beneficial for sustainability	Smart Living Smart Economy Smart Governance
Incentives		This project doesn't benefit that many people	
Cost		By recycling and using things already accessible will cut costs	

Accessibility		It is not accessible to that many people	
Sustainability	Bike Path Sensors	Motivate people to choose their bike	Smart Mobility
Incentives		Information that is very helpful for citizen who likes to bike	
Cost		Cost regarding the webpage	
Accessibility		Available for everyone	
Sustainability	Digital Water Meters	Reduces water spillage	Smart Environment Smart Living
Incentives		It can be beneficial for some citizens, but also impact specific group negative.	
Cost		Installation of the water meters	
Accessibility		Easily accessible for people living in the area	
Sustainability	Smart Mobility	Smart Mobility reduces climate emission	Smart Mobility Smart Environment
Incentives		Makes living in Molde easier, by making transportation smart, safe and sustainable	
Cost		Implementing smart technology and digital solutions	
Accessibility			

		Very accessible for all people living in Molde	
Sustainability	Electrification of boat traffic and exit point on Hjertøya	Reduces climate emission with electric boat	Smart Mobility
Incentives		You can go to Hjertøya without needing a private boat	
Cost		However, the municipality got a funding from Enova that will pay for half of the costs	
Accessibility		All citizen living in Molde and people on vacation can use the boat to go to Hjertøya	
Sustainability	Digitalization of existing buildings	Take more advantage of the possibilities the existing buildings have	Smart Living Smart Environment Smart Governance
Incentives		Most beneficial for company owners and the ones owning the buildings	
Cost		Implementing a technology system that gives access to data that is needed	
Accessibility		For people or companies owning those buildings	
Sustainability	Smart assistive technology management	Manufacture less and reduces unnecessary waste by changing ownership of the product	Smart Governance
Incentives		Develop and streamline the service to all its citizen	



Cost		It will probably reduce cost from what it is today, because of the changes and the efficiency improvement	
Accessibility		There are 3500 people in Molde in need for this service, this will make it easier for them	
Sustainability	Circular Economy in Practice	Circular economy is a great tool to become more sustainable	Smart Environment
Incentives		Saving money for the citizen by recycling or reusing things	
Cost		Circular economy will reduce cost	
Accessibility		This project doesn't affect that many people, but could potentially educate more people about Circular economy	

Table 9: Molde Smart City Projects

## 6.4 Trondheim

Criteria	Trondheim	Score	Smart city Dimensions
Sustainability	Mobility/Carpooling	Carsharing and making public transport easier, reduces climate emissions.	Smart Mobility Smart Economy Smart Environment
Incentives		Makes living in Trondheim easier, by making transportation smart, safe and sustainable	
Cost		Implementing smart technology and digital solutions	
Accessibility		Very accessible for all people living in Trondheim	
Sustainability	Project Powerhouse	The plus house has been built in a sustainable way with great energy solutions.	Smart Economy Smart Environment
Incentives		Office building and nice architecture, do not affect that many people	
Cost		Savings from good and sustainable energy solutions	
Accessibility		For people and businesses that use the office building	
Sustainability	The New Energy Society	The use of power locally necessitates the use of battery storage. This is beneficial to both the economy and the environment. Energy losses will be reduced because of buying and selling energy in communities.	Smart Environment Smart Economy
Incentives		This will be beneficial for both the economy and the environment. This may result in cheaper electricity bills.	
Cost			

		Implementation costs are high	
Accessibility		If the regulations will be changed, it is very accessible for all people.	
Sustainability	Smart Water Meters	Reduces water spillage	Smart Living Smart Economy Smart Environment
Incentives		It can be beneficial for some citizens, but also impact specific group negative.	
Cost		Installation of the water meters	
Accessibility		Easily accessible for people living in the area	

Table 10: Trondheim Smart City Projects

## 6.5 Malmö

Criteria	Malmö	Score	Smart City Dimensions
Sustainability	Sege Park	Smart housing with climate friendly solutions and technology. Localize what you can and globalize what you have to	Smart Living Smart Environment Smart People
Incentives		Sharing economy, circular economy and urban development can benefit the citizens	
Cost		Cost of building an apartment complex is high, but in return rent and cost saving in sustainable solutions are good	
Accessibility		Accessible for people living in the area	
Sustainability	Recycling Park	Waste management that results in reducing the amount of material dumped	Smart Environment
Incentives		Reduces fooling and can make the city a cleaner place for citizens	
Cost		Cost of building the recycling park	
Accessibility		Accessible for all people living in Malmö	
Sustainability	The Eco-City Augustenborg	The building has smart and sustainable technologies. Some of them are cultivation balconies, a shared roof garden with greenhouses, green roofing, renewable energy generation through solar cells, a cargo bike pool, simplified	Smart Living Smart Environment Smart People

		waste management solutions, and independent metering and invoicing of hot water and electricity are some of the building's features.	
Incentives		Augustenborg is based on citizens needs and request.	
Cost		Cost of building an apartment complex is high, but in return rent and cost saving in sustainable solutions are good.	
Accessibility		Citizen who doesn't live in the area, can go visit and learn about the benefits about green roofing.	
Sustainability	Comprehensive waste management	Recycle organic waste and use this in a sustainable way	Smart Environment
Incentives		Switch to Biogas	
Cost		Decompose the garbage to biogas	
Accessibility		The goal is for this to expand to the whole city. Now it is in the Eco-City Augustenborg	
Sustainability	Climate-smart Hyllie	The goal of the area is supposed to be 100 percent sustained by renewable energy solutions	Smart Environment Smart Living Smart Mobility
Incentives		This will be beneficial for both the economy and the environment. This may result in cheaper electricity bills.	

Cost		Implementation cost of new technology is high	
Accessibility		Citizens are provided free membership in a carpool and a free bus card as soon as they move to Hyllie to discourage automobile ownership	
Sustainability	Smart city accelerator	Creating sustainable energy systems	Smart Environment Smart Economy
Incentives		Greener solutions that can eventually better the environment and create a more flexible and adequate power system	
Cost		Implementation cost of new technology is high	
Accessibility		Accessible for businesses and citizens	
Sustainability	Sustainable Rosengård	Creating a sustainable environment	Smart Environment Smart Governance
Incentives		Social gatherings, events, sustainable housing, job opportunities and better infrastructure	
Cost		Implementation cost of new technology is high	
Accessibility		The area will have consultations, workshops and other activities that is available for the citizens	

Table 11: Malmö Smart City Projects

## **6.6 Results of traffic light assessment model**

After a detailed explanation of the smart city projects of Molde, Trondheim, Bodø, and Malmö in chapter 4, an evaluation was conducted for every criterion in the traffic light model for every city's smart project in chapter 6.

Our traffic light assessment model gives the readers an overview of how each cities' projects look like.

Based on our Model we observe that all of Malmö's projects sustain a sustainable success with all green lights. As well as this Malmö is the city that reaches most citizens with accessibility and incentives criteria. Malmö has zero red lights and their projects over all are achieving both sustainable, economic, and social gain. While in the other cities the results tend to vary. We observe that most of Molde's projects have green lights on the sustainability criterion, but on the other side they have less successful outcomes on accessibility where many of the projects only reach a limited amount of people. Bodø has more yellow lights on their sustainability criteria, but on the other side they achieved successful results from their incentives and accessibility. Trondheim and Malmö have a continuous success with all green lights in sustainability criteria. As well as this Trondheim achieves a quite good success in both incentives and accessibility, where the projects reach many people and are motivating.

Additionally, if we look at the summary table given below, we can observe that Molde has the highest probability of receiving a green light in a random criterion. Malmö is in the second place with 57% in terms of the probability of receiving a green light in their projects' criteria. In the meantime, Trondheim and Bodø share same probability of getting a green light with 50%. In an assessment with different number of projects, probability calculation is more valid and accurate because we are using number of criteria in our calculations. And lastly, readers might think that Molde's projects have been the most successful one so far, however, it is hard to come to a conclusion like that since we do not exactly know the difference in impact of receiving red and yellow.

## Traffic Light Assessment Model Summary Table

	Number of Criteria	Green	Yellow	Red	Green Ratio	Yellow Ratio	Red Ratio
Bodø	28	14	9	5	50%	32%	18%
Molde	40	24	11	5	60%	28%	13%
Trondheim	16	8	6	2	50%	38%	13%
Malmö	28	16	12	0	57%	43%	0%

*Table 12: Traffic Light Assessment Model Summary Table*



## 7.0 Discussion

In this chapter our discussion as well as our suggestions is presented. We will use the findings from the previous chapter combined with the theoretical framework and literature to answer our research question:

*In which way will a citizen lab contribute to better smart city projects, a smarter city and more sustainable future for the municipalities?*

As well as our research question we have formulated some additional questions we want to answer:

- What can be done to improve the projects in the municipalities?
- What is the idea behind citizen labs and citizen participation?
- What is the best way to improve the citizen participation?

Furthermore, we will start chapter 7 presenting an analysis where our observations combined with data and literature is examined. At the end of this chapter some suggestions are made on how to optimize a citizen lab with help off design thinking, some other important remarks by us and blockchain conceptual suggestion. As well as this we have optimized our traffic light model into a linear weighting model for future research and project development.

## 7.1 Analysis

As presented in chapter 1, the motivation for this research is to investigate the effects of citizen labs and how this can create better citizen participation through researching four different Smart Cities, three in Norway and one in Sweden. From our literature summary we made a Smart City definition that we think is accurate of how a Smart City should be

*Smart City is a concept where the goal is to be an intelligent city for the citizen to live and work in. The citizen should be placed in the center of the approach and technology, sustainability and innovative ideas are crucial for becoming a Smart City.*

Our definition fits with our traffic light models factors, where the citizen should be in the center and sustainability, technology are crucial factors for smart city projects.

According to the findings of the Norwegian Smart Cities, all used the national roadmap as a guideline, so how the cities define a smart city was similar. Considering literature, we found many different definitions of smart cities, that explains the diversity of defining a smart city. The main similarity between the definitions was that they usually talk about combining ICT solutions to finding new innovative sustainable development solutions. ICT's role was already mentioned in our literature and referred to as key enabler of smart cities, afterwards, finding out that interviewees also have the same point of view reassured us that we are on the right track.

Referring to the literature, cities should transition into a smarter city to increase welfare and efficiencies in the urban areas for the people living there. This reflects to what one of the goals represented by the municipalities in the findings, where they expressed that they wanted to create a better place to live and work for the citizen. Moreover, the Norwegian cities chosen for our research are not metropol cities. They do not have significant big city issues, regarding crime, healthcare provision, education level and unemployment rate, infrastructure, food, water and waste management.

According to literature the reason for becoming a smart city can be motivated by major challenges in climate change, a shift to a more digital retail and entertainment, ageing population and pressure from the public finances. Furthermore, urbanization is likely to accelerate, with most of the population living in more develop areas.

Additionally, cities will become increasingly important in addressing issues about sustainable development as the world's population continues to grow. Referring to our

findings and literature, Norwegian Smart city's main goal is that they want to become a more attractive place to live and work and that they want their population to grow.

As explained in chapter 4 Malmö is the biggest city in our research, where it was described, that Malmö had more metropolitan challenges than Norwegian cities regarding high crime rate, discrimination, gang involvement in specific areas and high unemployment rate especially among young people. Despite this Malmö is still a popular city to move to with young population. Furthermore, their population has many immigrants that struggle with the language and integrating into the society. On the other hand, the Norwegian cities do not have many metropolitan challenges; literature says that transitioning into a Smart City will result in a better way to tackle problems like climate change, use of local resources, reduction of the environmental footprint, promoting economic development and building eco-friendly buildings. The smart cities investigated for our thesis want to take advantage of opportunity spaces that arises in the development of a smart city. They also emphasized that they wanted to use technology to tackle climate change and reduce emission. Despite this, our traffic light model shows that both Smart Molde projects and Smart Bodø projects vary in the success of sustainability in their projects. While Malmö and Trondheim scores green light on all their sustainability success.

Some barriers described in the literature regarding development of smart cities matches with the challenges that Malmö is facing, sustainable development needs a long adaption period for the society, uninformed citizens and uncertainty, citizens' lack of knowledge about the concept and the idea behind a smart city and citizens may not be interested in the idea of change. These challenges are still affecting Malmö, despite this, our traffic light model presented in chapter 6 shows that Smart Malmö has many sustainable and accessible projects that reach many of the citizens. In addition, literature says that sustainability is one of the focus areas regarding smart city development. Based on our literature, sustainable development is development you do to today that will not jeopardize the future generations possibility to meet their needs. Another key fact to remember is that sustainable development may contribute to happiness to provide citizens with opportunities for meaningful and long-term fulfillment.

Also, literature emphasized that a Smart city would facilitate your day-to-day activities in a better way, reduces environmental footprint, working on reaching the UN Sustainable development goals, benefits the economy and can result in more profitable industries. As

already mentioned, the traffic light model shows that most of smart cities get high score on the sustainability, but many of their projects do not facilitate the citizens day-to-day activities.

As presented in the literature, Stakeholder theory and Quadruple Helix emphasizes that every stakeholder is equally important for the firm or an organization. When we were collecting data from the municipalities through interviews, the main issue for the municipalities was involvement of citizens in the development process of a smart city. Based on our traffic light model the cities vary in result regarding incentives and accessibility. A typical problem here is that the projects do not target diverse groups, which results in that the incentives can be quite narrow. Some main issues highlighted in the theory regarding the involvement of all the stakeholders is that some stakeholders might have more capacity and strength to influence the firm or the organization than others. This can lead to inequality in between the stakeholders and is a significant problem for the municipalities. Based on the issues Bodø had with their citizen lab, that they did not attract a diverse group of people, stakeholder theory is correct.

On the other hand, there are many benefits to the theory as well. If a firm or an organization equally cares about all its stakeholders, this could lead to motivated employees, happy customers, reputation, investment and cost reduction. Furthermore, Quadruple Helix categorizes the citizens as one group which can result in challenges. Our findings propose that citizens are different with different needs and different motivation to get involved and that it is difficult to categorize the citizens as one group. Literature on the other hand says that Quadruple Helix needs to involve every part of the quadruple helix framework, and that this could result in creating new innovative ideas and a greater responsibility for good collaboration across and the use of new forms of collaboration to achieve the goals they have made in advance.

Furthermore, literature says that smart cities should start with the people, rather than only technology and that people can contribute with great ideas through a design thinking process. Despite this, the theory also emphasizes that it is difficult to discover examples of how academics and projects have succeeded in integrating citizens in the innovation process. We found literature that said it was easier to get the citizens involved in the brainstorming process, but that interest often decreases after that stage. Based on our findings both Bodø and Malmö had challenges in the involvement process of getting a diverse group of people to participate in the citizen labs. Explained in our literature, Citizen Lab is a multi-stage approach for connecting with communities and generating community-led projects. Citizens

play an essential role in smart city projects and in the literature, they outline that supporting people in playing an active role in urban innovation, from crowdsourcing original ideas to fostering public engagement in the execution of community initiatives.

Moreover, our findings propose that the most important thing for participation is to define something that the people think that the municipality really need.

This particular point of view has already been observed, exemplified and confirmed in our extensive case description in chapter 4. Unfortunately, one size fits all ideology is not applicable for smart city projects. Cities and countries have different levels of urban infrastructure, well-being, healthcare that play a role in determining their goals and objectives. The things that the various cities prioritize differ from each other.

In chapter 4 our case description is explained where all the projects the smart cities are involved is presented in a detailed way. Circular economy, sharing economy, technology and sustainability is important factors in the different projects, where intelligent solutions are made to make life easier for their citizens and create value for them. This was also mentioned by Informant **E** from the consulting company “Localize what you can and globalize what you have to” principles support the idea of increasing the money in circulation in local and regional level, thus facilitating nation’s abilities in terms of value creation, economic prosperity, and sustainable development.

Based on our gathered findings and literature, data privacy is a sensitive topic regarding smart cities. Literature emphasize technology is a crucial tool to making a city smart and sustainable, as well as the importance of using technology in the most cost-efficient and productive way. E-governance is also presented in the literature has the potential to significantly improve government efficiency and dependability, also it provides several other advantages. E-Governance offers a new road ahead, aiding in the enhancement of government operations, citizen connectivity, and societal progress. On the other hand, technology can feel invasive and controlling for people living in the cities. Because of this, some ICT solutions can be difficult to implement.

Based on the plans the cities have for their citizen lab or have already been involved in, blockchain has the ability to assist smart cities in overcoming a range of challenges related to infrastructure variables in general, such as technical, social, and financial contexts, as well as the lack of connectivity between these elements. To construct smart cities, focusing simply on information technology will not work; instead, they must address the human-

capital side of the equation in the larger picture. Governments are attempting to use inclusive efforts to make it easier for people to adapt to ICT technologies. A participatory prototyping method can benefit all parties involved. The value of technology is determined by how it is utilized rather than how much of it is accessible.

All the cities we research for our thesis are in Scandinavia subregion. We found out in our literature review that citizen participation/inclusiveness in smart city initiatives to increase both the outcome of the projects and citizen welfare is crucial. Additionally, we choose four smart city projects that had similar outcomes, because of this the results from our traffic light model vary from earlier research, most likely because Trondheim, Molde and Bodø do not have big challenges regarding social and economic development. Country's economic and political systems may unethically (what is ethical and unethical is a debatable topic and open to one's own judgement) enforce citizens to increase participation and contribution in smart city plans. For instance, China (People's Republic of China) can enforce citizen participation through their social credit system and national blacklist via their mass surveillance systems. In fact, they have had quite strict bans and repercussion for those citizens who misbehave, disturb the peace, and involve in activities that are threatening the regime and so on. On the contrary the Scandinavian cities chosen for our research live in a democratic area where people have the choice to participate, choice to vote and so on.

## **7.2 Suggestions**

In chapter 5 we evaluated all the smart city projects for our chosen cities based on a criteria system. However, one should not oversee the fact that every city had different number of projects in our traffic light assessment model. Besides this the traffic light models gives us a nice overview over the project's success. Developing the model even further can give even more concrete results.

Therefore, they should be evaluated on equal grounds, in other words, a project that all cities have in common. We wanted to go one step further and analyze with further develop model targeting specifically Citizen labs in each city. Additionally, we will make some suggestions for citizen labs and explain how one can increase citizen participation. And lastly, we will introduce our conceptual idea for integrating blockchain technology to increase citizen participation, contribution and involvement in project development.

### **7.2.1 Contribution to citizen labs and citizen participation**

We want to present a suggestion on how we think a citizen lab should be based on our gathered data, theoretical framework and literature review. If we refer to literature a citizen lab is a multi-stage process to reach out and engage the citizen in participating for developing a better place to live. It's difficult to find instances of academics and programs that have successfully included citizens in the innovation process. As other scholars have noted out, empirical research about the nature and quality of including inhabitants in Smart City initiatives is still scarce.

Moreover, we have some suggestions on what we think will make a citizen lab successful and attract people to participate.

Based on our data and literature we don't think that categorizing citizen under one group is a successful strategy. People have different incentives and reasons for participating, so citizen may have ideas that may conflict with other desires. What all citizens have in common is they are residents of the municipality and are governed by what the municipal council decides. Additionally, they can represent themselves and their needs, but as well they can sometimes represent the business community they work in, their neighborhood and so on. Considering this it's important to create a citizen lab that attracts different people with different incentives and reasoning for participation.

Furthermore, there are some factors that we define as critical to create a successful lab, the first factor is location(accessibility), the second factor is design(attractiveness), and the third factor is incentives, and the last factor is sustainability. In the table below, we have listed the factors and the explanation for why we think they are critical factor.

<b>Factors</b>	<b>Explanation</b>
<b>Location(accessibility)</b>	The lab should be located where people are moving. It needs to be well known for the people living in the city and an arena where different activities and events are happening.
<b>Design(attractiveness)</b>	The lab should have an attractive appearance. Where design plays a critical role, it should be a place where people want to hang out, where they have the opportunity to use technology in an innovative way.
<b>Incentives</b>	The lab should have incentives that motivate and encourage a diverse group of people living in the city. The lab should be an arena for social events, where they can be creative, educate themselves and learn about new things.
<b>Sustainability</b>	Sustainability could be an important incentive to motivate and encourage people to participate, because sustainability is a popular and important topic that is growing. Sustainability is a term that nowadays typically refers to something that adheres to the goal of long-term growth. Sustainable development is development that meets the current needs of people without jeopardizing future generations' capacity to satisfy their own.

*Table 13: Factor That Play Role In Creating Successful Labs*

The linear weighting model presented in the next section is a great tool to evaluate the success of a citizen lab, with the factors that we define as success criteria.



In addition to the important factors, we propose that all citizen labs implement design thinking, which is a five-step process to create new and innovative ideas.

In the table below, the design thinking process is presented with the factors that are important to include in each step, which we think will lead to participation of citizens.

<b>Step 1</b>	<b>Step 2</b>	<b>Step 3</b>	<b>Step 4</b>	<b>Step 5</b>
<b>Empathize</b>	<b>Define</b>	<b>Ideate</b>	<b>Prototype</b>	<b>Test</b>
In the first step immerse yourself in other people's experiences. Wear several hats metaphorically. Try to see yourself in the shoes of your consumer. Discover obstacles, aches, and pains.	The second step is about defining the issue, finding the problem that needs to be solved.	The third step is starting to create ideas. A good way to do this is to start with the wildest idea and then go back towards and from that point choose the idea that you think is most impactful.	The fourth step is about finding out if the ideas that have been made have value. Try to bring the ideas to life.	At the last step you can bring in the citizens again and ask they can test the ideas and get feedback on what they are thinking.

*Table 14: Design Thinking Process*

The challenges with asking the citizens directly what they want or what they think needs to be changed, can end with the citizen struggling with defining their problem. Therefore, a design thinking process, can involve a more diverse group of citizens in a way where the issue is investigated for them, but they still get involved in the process.

Additionally, we think that some people who have specific ideas or want the possibility to retain their anonymity needs something to protect this in the best possible way therefor under this chapter, a blockchain technology is presented. This is a part of our suggestions to increase in participating in the Smart City projects. We have created this solution because we think that this is a way to increase the incentives for the citizens who wants to retain their privacy or to get something back from their ideas.

## **7.2.2 A conceptual idea of Blockchain technology in citizen labs**

If we refer back to the literature of blockchain technology and possibilities that may arise via the usage of it, such as: increased reliability, enhanced fault tolerance, better, faster and more efficient operation, and scalability. However, most of the projects are conceptual creations yet to be implemented in real life. There are abundance of industries and business processes that may benefit from incorporation of blockchain technology. Therefore, in addition to the existing theories and projects in the literature we wanted to propose a usage scenario/area that may have fruitful impact on citizen participation.

Based on the empirical evidence, gathered through our extensive interview process with the targeted municipalities, our observations helped us uncover the struggle municipalities have with citizen participation in citizen labs. It was already mentioned that the odds of project being successful positively correlates with citizen participation, after all projects are for citizen by citizens.

Imagine a white collared citizen, who has an 8 to 4 job, a family, and a house. Contribution from an ordinary citizen to increase in welfare of the society is minimal. If we exclude the tax payment it is eliminated as a whole. This person may have some amazing ideas but the setting in which she can disclose these ideas may not feel appealing to her. Of course, an ordinary citizen would want to fix, repair, and make better of the region that they live in. But that exact person also has a family to take care of, and a full-time job. Therefore, in this situation all we need is a little push – giving a reason to citizens to bring those ideas to surface. Thus, we would propose a conceptual model which incentivizes citizens to share and contribute their ideas with a reward system. Municipality officials or an outsider organization can be responsible with ensuring that the idea belongs to a person, or a group of people by using a distributed, decentralized, publicly visible database - Blockchain. This can be easily achievable by hiring staff members who carry the necessary programming skillset. We think that the main project contributor/developer can be the first block in the blockchain - also referred to as Genesis block. A rewarding system that is made up of multiple levels, each level containing more reward than the previous one and levels are achievable based on the number of people/times your project is being used. Furthermore, we envisioned that people who contribute and build upon to the initial main idea will succeed the Genesis block and will also be able to get something out of the rewarding system, based on the contributions' quality and usage.

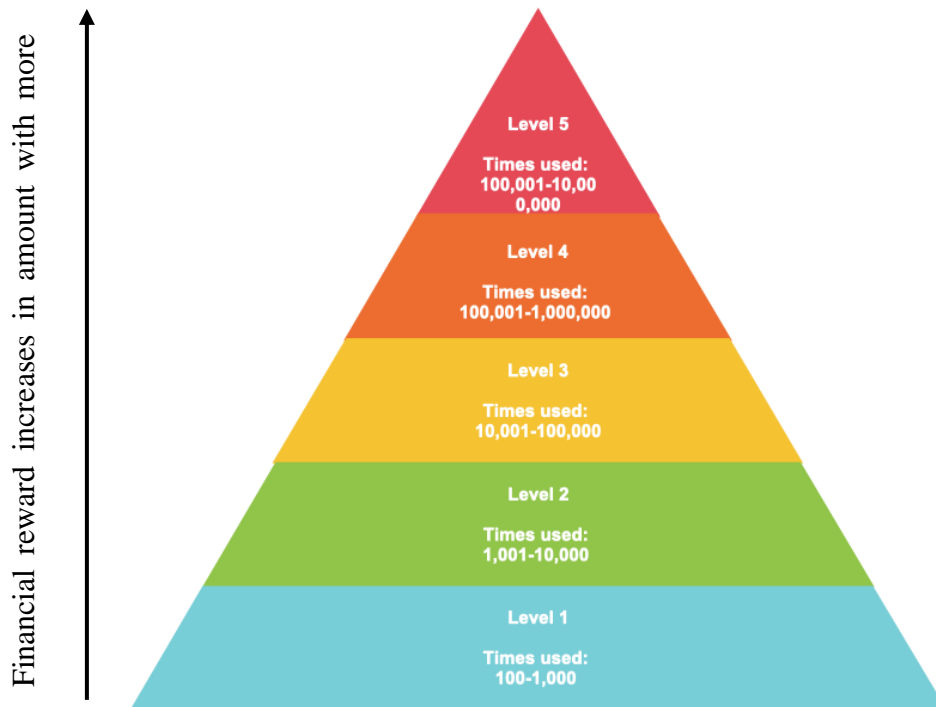


Table 15: Contribution Rewarding Pyramid

Furthermore, as an additional dimension, we believe that there should be an option to promote for those who do not to be identified. Some people might come with improvement or ideas where they feel protected and anonymous. This feature would help people feel more private and unidentifiable both for contributions that they are unsure about and for criticizing the ongoing operations of municipalities.

### **7.2.3 Linear weighting model of citizen labs**

In this section we will use linear weighting model also referred to as weighted sum model to compare and evaluate among the citizen labs of different cities. The linear weighting model is based on our traffic light model presented in chapter 6. In this section we want to present how the traffic light model has been detailed further and for future research it can be possible to use the linear model for quantitatively research. We will start with determining the additional two critical selection criteria that haven't been defined in our model, then we will assign weights to the criteria according to what we think is more important. We will then rate each citizen lab, multiply ratings in the matrix by weights and compare the sums of weighted scores and select the most successful project in terms of criterion – sustainability, design, accessibility, budget, and incentives (Mwesiumo, 2022). Citizen lab projects are very complex and costly, after all they are construction projects with noncommercial goals at the end. We believe that the linear weighting model can be used as a tool to evaluate the expensive projects and minimize the risk involved with starting one. By having some ideas about the success rate of a project, project managers might accumulate a bigger sum from investors to support and oversee the project.

#### **7.2.3.1 Additional Criteria**

Under this subsection we have defined additional criteria that fits better for this model while using the applicable predefined criteria from our traffic light assessment model.

##### **Design**

Design has an impact that goes beyond the performance of the actors immediately involved in product manufacturing. Through design customization and adjustments individuals' perception of products can be changed (d'Ippolito, 2014). Design is the most important factor in our Linear Weighting Model of Citizen Labs; Therefore, we have decided to assign a weight of 0,3. We believe that to maximize the participation, engagement and attendance the designers should incorporate number of strategies and tactics. Additionally, based on the insights we have obtained through conducting interviews with municipalities, we found out that municipality of Molde also considers design as one of the most important factors in citizen lab projects. Additionally, managers can harmonize the exterior design of a building with its surroundings and make it fit to the environment in a better way to attract more by-

passers, locals and even tourists. The properties we would expect from the exterior design of a building to attract more people are color, decoration, how modern it is and the size of the location.

### Incentives

Based on the reasons given above, we believe that this criterion is significantly important and therefore, we have decided to assign a weight of 0,2 to it.

### Budget

The entire estimated cost of performing each project activity during each phase of a project is referred to as a project budget. It's crucial since it helps to define spending expectations and is required for project approval, ensuring funds are available on schedule, and monitoring performance (AIPM, 2021). Project Budget consists of labor, material, procurement, logistics, fixed, variable costs etc. Our assumption is that, if a project receives more budget, there will be more money for resources, therefore the overall quality of the project will increase. In conclusion project is more likely to attract more people if the budget assigned to it is high. We believe that this is somewhat less important than the other criteria because high budget does not necessarily mean high quality. There is logically some correlation, but we cannot say one causing another.

Linear Weighting Model of Citizen Labs									
Criterion	Weight	Bodø		Molde		Trondheim		Malmö	
		Score	Weighted Score	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
Sustainability	0,2	5	1	5	1	5	1	4	0,8
Design	0,3	2	0,6	5	1,5	5	1,5	3	0,9
Accessibility	0,2	4	0,8	5	1	5	1	4	0,8
Budget	0,1	3	0,3	4	0,4	5	0,5	5	0,5
Incentives	0,2	3	0,6	3	0,6	4	0,8	4	0,8
Total Weighted score	1		3,3		4,5		4,8		3,8

Table 16: Linear Weighting Model of Citizen Labs

### **7.2.3.2 Results from Linear weighting model**

Bodø has not started their new citizen lab yet. So, we will give them scores based on their previous citizen lab that was in the city's public library. We will give them a high score on sustainability, because they were using a location that was already there. While on design, nothing revolutionary was done, because of this design will receive a low score. Furthermore, in terms of accessibility we believe that it was in an accessible place but, it wasn't the most suitable one considering the attendance to city lab would have to discuss things and this created unwanted noise for people using the library. We assume that their budget was not that high, because they need convert their public library into the citizen lab. For incentives we believed that Bodø deserves medium rating, because initially they had planned to have an environment where people could have a conversation with the municipality with problems that they cared about. However, they had problems with execution and therefore failed gathering a diverse group of people.

Molde has a great location in the middle of the city, close to the bus terminal where people walk by. Also, they are using circular economy values for purchasing materials in the citizen lab. This means that every furniture and technology equipment are already used materials, they either redesign or use how it is. As mentioned in chapter 5, they have received funding for the project of 1.3 million Norwegian kroners for two trial period. We think that this amount combined with circular economy values will create the result they are wishing for. They aim to be a citizen lab that attracts a diverse group from youngsters to elderly- teach a lot of stuff from technology to seminars about hospital care and so on. However, there is difficult to give them a high score on incentives because they have not started the lab yet. We had the opportunity to see the interior design blueprints and we think it will be a spacious, modern and attractive building.

Trondheim is the biggest Norwegian city chosen for our research; therefore, they have a bigger budget than Molde and Bodø. This can be proven by the amount (four citizen labs) of citizen lab created. On incentives we chose to give them a high score because they have different labs with distinctly dissimilar purposes. In terms of design, we gave Trondheim 5 out of 5, first of all in 2017 they won a SXSW's "Best place by Design" prize for their city lab project. As well as this, the labs are designed in an attractive way with modern and green

solutions. Trondheim aim to be a green city; the labs have sustainable solutions and green technology therefore receive a high on score sustainability (Trondheim, n.d.-c).

Malmö is the biggest city chosen for our project who struggles with more metropolitan issues regarding crime, high unemployment rate and gang violence. In addition, Malmö is also the city with the longest history of working with Citizen labs. They have a high focus on sustainability regarding their smart city projects, but the citizen lab mostly focuses on equality and democratize because this is a big issue in the city. In terms of design, it seems like there focus is mostly on gathering people to have discussion and to use Design Thinking processes in a paper and pen direction, therefor we give them the score 3. There citizen labs are scattered around the city. Some areas have bigger challenges and Smart Malmö have worked directly on engaging a more diverse group of people from different neighborhoods, because of this we give them a high score.

For budget criterion, they seem to get funded either from the Swedish government or the European Union, we do not know exact amount of budget they received for their living labs however, we assume that they must have received good sum of money because they engaged in a lot of sustainable district and community creation projects in the past. Lastly on the criteria incentives we give them a high score because they have skill training, design education and they help people get back in the job market.

To conclude Trondheim is the city with the highest score in total and have the most successful citizen labs based on our linear weighting model.

## **8.0 Limitations, Future Research and Conclusion**

### **8.1 Conclusion**

Our thesis aims to address the research question,

*In which way will a citizen lab contribute to better smart city projects, a smarter city and more sustainable future for the municipalities?*

As well as our additional research questions:

- What can be done to improve the projects in the municipalities?
- What is the idea behind citizen labs and citizen participation?
- What is the best way to improve the citizen participation?

Based on our research, a framework is critical to create successful smart city projects. Quadruple Helix is the framework that three out of four of the municipalities analyzed in our thesis are using. Our concern about this framework is that we believe that treating every stakeholder individually in the society is crucial. Quadruple Helix aims to be a framework that supports organizations or municipalities in creating new innovative ideas and increase collaboration within the four groups society, academia, government and industry. We believe that for this to be a successful framework for smart cities, it needs to be recognized by the users as an important tool that brings diverse group of citizens together. In the instances, where the citizens are not categorized as one group, Quadruple Helix is crucial for increasing the participation and creating new innovative ideas.

A citizen lab will create an open environment between the people working and living in the municipality. It can be a meeting arena where people from society, academia, government and industry meet. Additionally, the citizen lab should be an arena that invites a diverse group of people to attend different events, where it will be possible to address issues regarding the city in an open and friendly environment. The idea behind a citizen lab is to be an arena for city development and brainstorming processes for the citizen and other important actors to get involved. It will be possible to better both the smart projects and to create a more sustainable future for the municipality if the citizen lab is used in an optimal way.



Design thinking is a great tool for involvement when the citizen is not sure what kind of changes they want in their city, or if they have difficulties explaining their problems.

While our blockchain technology solution is thought as an incentive for people having many ideas but for some reason either want to maintain their anonymity or to secure their ideas. Also, we emphasize that it is a fine line between asking the citizen too much and too little. The people working in the municipality is there to deliver value for the citizens and this is their job. The involvement of the citizens needs to be delivered in a way that this is resourceful for both the citizens and the municipality without compromising their free time and privacy.

Moreover, many of the smart projects presented in this thesis have sustainable goals adopted from the UN sustainable development goals. Climate change and pollution is very important topic for many citizens. Using a citizen lab for brainstorming or testing different sustainable solutions will create a more sustainable future. Molde was conducting a testing project with some citizen about decreasing household waste. This project created concrete results that is easy and understandable for citizens to see and are motivating for being more sustainable as well. We believe that doing projects that can really involve the citizens and effect their day-to-day life is a great way to go with.

We believe that there is a gap in the literature regarding how to evaluate smart city projects and citizen labs. Because of this, we first developed a traffic light model and after that we observed that the model was a nice way to evaluate projects. Despite this, it still had some flaws. Therefore, we further developed the model into a linear weighting model that had two additional criteria. Our main goal of the linear weighting model was to evaluate expenses and minimize the risk involved in developing citizen labs. This could be a great tool for municipalities wanting to create citizen labs, with the model they could learn from earlier mistakes and eliminate risk.

Lastly, we concluded that citizen labs can contribute to better smart city projects, a smarter and a more sustainable city. If it is used in a way in which it creates value for everyone living and working in the city. Meaning that the citizen lab should generate new innovative ideas that will both benefit the city and the citizens. Also, it should teach new technologies and different things to the citizens continuously.

## **8.2 Limitations and Future Research Suggestions**

All things considered there are some limitations to the study. When collecting literature, it was challenging to find concrete results on how to measure the success of smart city projects and if a citizen lab is a successful strategy. Due to the Covid-19 pandemic all our interviews were conducted digitally. In addition, some of our interview objects were ill for a long period because of Covid-19 and other reasons, this resulted in some challenges regarding communication and a lot of delay on answering our questions.

Our research was done with four different Smart Cities, where our focus was on how they presume their own city, this can give biased results. If we had more time, we could have collected data from people living in the cities as well. Additionally, we could have gathered on site data by visiting citizen labs and other smart city initiatives. However, due to project budget and time constraints we were not able to do it. It would have resulted in more concrete findings. Additionally, both authors of this thesis have been a bit unlucky this semester and are using crutches as this moment, because of a broken ankle and a torn of ACL and a rift in the meniscus. Which lead to surgery for both authors of this thesis.

For future research we think that further developing the linear weighting model can give more concrete results on whether Smart City projects are achieving their goals. Furthermore, we think that switching to quantitative research where they can gather data from the citizens, rather than only from project managers can be a successful strategy to go with.

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# Appendices

## **Interview guide**

### **Smart City**

1. What is a smart city and which role will a citizen lab (CL) play in it?
2. What is the reason, idea and goal behind making your city smart?
3. How will the CL contribute? What makes your city smart?

### **Citizen Participation**

4. Do you plan to use CL to involve citizens in decision and policy making of smart cities? How?
5. Will the CL make it easier/possible to use the quadruple helix or another framework or model for becoming a smart city? How?
6. Do you think every stakeholder equally heard and valued? In which way will the CL, eventually, contribute?
7. Is the citizen giving feedback? Do they want to be involved in the projects?

### **Projects**

8. What are the current projects, how do you plan to use the CL to enhance and promote the projects?
9. How many current ongoing projects do you have? How would you rank them based on importance level and cost? (1 to 6, one being the least important/cheapest, six being the most important/most expensive) Will the CL change the ranking do you think?
10. How are the current projects and upcoming developments affecting the welfare of public? Are the public aware and involved? Will the CL change this in any way? How?
11. Do you think you have sufficient financial ability to undertake this project?
12. How may the CL streamline/facilitate the implementation, do you think?

13. What are the barriers you are facing during implementation process? How may the CL reduce them?

**Additional questions**

14. Are there any envisioned projects in future?
15. Any new projects that would be made possible by the CL?
16. Do you see any concrete results from the projects?