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# **Factors influence the development of information system strategies in Finnish smart cities**

School of Technology and Innovations  
Master thesis in Information Systems Science  
Master's program in Information system management

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**VAASAN YLIOPISTO****School of Technology and Innovations**

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<b>Tutkielman nimi:</b>	Factors influence the development of information system strategies in Finnish smart cities		
<b>Tutkinto:</b>	Master of Science in Economics and business administration		
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<b>Työn ohjaaja:</b>	Duong Dang		
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**ABSTRACT:**

This study is initiated by the global phenomena of growth of smart cities based on urbanization and the accompanying prediction for digital changes in cities, demographic of the population and in information system strategies related to future cities. The aim of the study is to study the phenomena through the achievements of the Innovatiiviset kaupungit (INKA) and Kuutoskaupungit (6AIKA) projects previously implemented in Finland to increase and evaluate the understanding of the strategic factors that influences the development of information systems of Finnish smart cities. The research will focus on exploring the issue through stakeholders that are influencing smart city planning.

A similar development of urbanization is predicted to follow Finland as well, it is estimated that by 2040, most of the Finnish population 90% will live in urban agglomerations. At the same time the digitalization in the world will continue, urbanization, ecological and public sustainability gaps will require more attention in the future as well as reorganization. In this thesis we study the factors that influence the planning of information systems strategies for Finnish smart cities. Planning that guides the work of different actors in the future, how to support citizens that live in cities more involved in development and what methods are used to manage the knowledge of a smart city. The aim of this study is to identify the factors that effect in the information system strategies of a smart city. Information systems pretend to be designed to meet strategic objectives. Who are involved in the planning and what is their role? In this thesis, we start the examination from the phenomena of smart city development in Finland.

The study has been carried out as a traditional literature review, supplemented by a qualitative and an interpretative case study and interviewing 6AIKA city representatives, system suppliers and technology experts. A comparison of INKA and 6AIKA projects which were previously project for Finnish cities, has been used as ground source of data. Literature research has been complemented by researching international smart city studies and information system strategies. Information systems being formal socio-technical organizational systems for collecting, processing, storing, and sharing information, have a role in organize the actions, from a socio-technical perspective, information systems consist of tasks, people, structure, and technology. Information system scanning is defined as the integration of components for the collection, storage and processing of data, the data of which is used to generate data, add data, and use digital products that facilitate decision-making.

The research has brought following implications: cities operate primarily in the role of enabler and not directly produce the necessary information systems themselves, instead outsource the production to selected partners of their choice, often to solve single use cases rather than resolve larger systems. The internal autonomy of the city departments tends to decentralize information systems more than combine them, one single design model was not found to be in use, instead several information systems were found in use. Another founding is the lower-than-

expected level of participation of urban residents in the co-creation of services for them. The fourth argument is the disconnection of different expert areas, even though the strategic objective is to achieve the same outcome that is stated in the city strategy.

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**KEYWORDS:** Smart cities, information systems, strategies, stakeholders, urbanization

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**TIIVISTELMÄ:**

Tämän tutkimuksen alullepanija on maailmanlaajuinen kaupungistumisen kasvu ja sen mukana tuomat tietoyhteiskunnan muutostarpeet. Tutkimuksen tavoitteena on tutkia Suomessa aikaisemmin toteutettujen Innovatiiviset kaupungit INKA ja Kuutoskaupungit 6AIKA projektien saavutuksia ja lisätä ymmärrystä niistä yksittäisistä strategisista tekijöistä, jotka vaikuttavat Suomalaisten älykaupunkien tietojärjestelmien kehittämiseen. Tutkimuksessa keskitytään tutkimaan asiaa älykaupunkien tietojärjestelmien suunnitteluun vaikuttavien sidosryhmien kautta. Kaupungistumisen ennustetaan kehittyvän myös Suomessa. On ennustettu, että vuonna 2040 suurin osa 90 % Suomalaisista tulee asumaan kaupunkimaisissa taajamissa, samaan aikaan maailman digitalisaatio kehitys jatkuu ja samalla sekä kaupungistuminen, ekologinen että julkinen kestävyysvaje nähdään vaativan enemmän huomiota ja osittain uudelleen järjestämistä. Tässä tutkielmassa tarkastellaan niitä tekijöitä, jotka vaikuttavat Suomalaisten älykkäiden kaupunkien tietojärjestelmien strategioiden suunnitteluun. Suunnitteluun, jolla ohjataan eri sidosryhmien työtä tulevaisuudessa. Miten kaupungeissa asuvat kansalaiset saadaan kiinteämmin osallistumaan kehitykseen ja millaisilla tekijöillä älykkään kaupungin tietoa hallitaan. Tämän tutkimuksen tavoite on tuoda esiin niitä lähtökohtia, joista tulevaisuuden älykaupunkien tietojärjestelmät voidaan suunnitella vastaamaan strategisia tavoitteita, ketkä suunnitteluun osallistuvat ja millaisissa rooleissa. Tässä opinnäytetyössä tutkimme asiaa Suomessa yleisesti käynnissä olevan älykaupunki kehityksen kautta. Tutkimus on toteutettu perinteisenä kirjallisuustutkimuksena, jota on täydennetty kvalitatiivisella haastattelututkimuksella tapaustutkimukseksi, haastatteleamalla 6AIKA kaupungin edustajia, järjestelmätoimittajia ja teknologia asiantuntijoita. Lähdeaineistona on käytetty Suomalaisista kaupungeissa aikaisemmin toteutetuista INKA ja 6AIKA hankkeista julkaistuja raportteja. Kirjallisuustutkimusta on täydennetty ajankohtaisilla kansainvälisillä älykaupunkitutkimuksilla. Tietojärjestelmät ovat muodollisia Sosio-tekniisiä organisaatiojärjestelmiä tiedon keräämiseksi, käsittelemiseksi, tallentamiseksi ja jakamiseksi. Sosio-teknisestä näkökulmasta tietojärjestelmät koostuvat tehtävistä, ihmisistä, rakenteesta ja tekniikasta. Tietojärjestelmäskannaus määrittellään tietojen keräämiseen, tallentamiseen ja käsittelyyn tarkoitettujen komponenttien integraatioksi, jonka tietoja käytetään tiedon tuottamiseen, tiedon lisäämiseen sekä päätöksentekoa helpottavien digitaalisten tuotteiden käyttämisellä.

Tutkimuksessa havaittiin seuraavia keskeisiä vaikuttimia, 1) kaupungit ovat ensisijaisesti tilaajan roolissa ja eivät itse suoraan tai harvoin toteuta tarvittavia tietojärjestelmiä. Vaan toimeksi antavat ne valitsemilleen kumppaneille, usein ratkaisemaan ensisijaisesti

yhtä käyttötapausta. 2) Samaan aikaan kaupungin sisäinen hallinnon autonomia eri osastojen välillä hajauttaa tietojärjestelmien suunnittelua enemmän kuin yhdistää niitä, myöskään yhtä standardisoitua suunnittelumallia ei havaittu olevan tutkimuksen aikana käytössä, sen sijaan havaittiin useassa tapauksessa käytössä olevan useita suunnittelu malleja ja tietojärjestelmiä. 3) Havaintona on myös kaupunkilaisten oletettua matalampi osallistumistaso heitä koskevien palveluiden suunnitteluun. 4) Havainto on eri asiantuntija alueiden toisiinsa kytkeytyminen tai irrallisuus huolimatta siitä, että tavoitteena on palvella samaa strategista lopputavoitetta. Näistä syistä tutkimuksessa keskitytään strategiaan syihin, jotka vaikuttavat tietojärjestelmien suunnitteluun.

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**AVAINSANAT:** Älykkäät kaupungit, strategia, sidosryhmät, tietojärjestelmät, kaupunkikehitys

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## Abbreviations

3G	Third generation wireless digital cellular network technology
4G	Fourth generation wireless digital cellular network technology
5G	Fifth generation wireless digital cellular network technology
AI	Artificial intelligence
ANN	Artificial neural networks
API	Application programming interface
CaaP	City as a platform
CAD	Canadian Dollar
CANN	Cascaded artificial neural network
CAV	Connected and autonomous vehicles
CI	Community informatics
CKAN	Comprehensive knowledge archive network
CO2	Carbon dioxide
EC	European Commission
EIP-SCC	European Innovation Partnership on Smart Cities and Communities
ENoLL	European Network of Living Labs
FaaS	Freight as a service
GBP	Pound sterling
GDP	Gross domestic product
GNSS	Global navigation satellite systems
GPS	Global Positioning System
HRI	Helsinki Region Info share 7



HSY	Helsingin seudun ympäristöpalvelut, Helsinki Region Environmental Services Authority
IC	Information and communication
ICT	Information and communication technology
IMD	International Institute for Management Development
IMDA	Infocom Media Development Authority
IoT	Internet of things
IS	Information systems
ISS	Information systems science
ISO	International Organization for Standardization
LL	Living lab
LoRa	Long-range, low-power wide-area network technology
MaaS	Mobility as a service
NFC	Near-field communication
NGO	Non-governmental organisation
ODI	Open Data Institute
OIP	Open Innovation Platform
OT	Operational technology
PIR	Private information retrieval
PPDM	Privacy-preserving data mining
QoL	Quality of life
R&D	Research and development
RFID	Radio-frequency identification
SDC	Statistical disclosure control
SMLL	Smart Mobility Living Lab
SCIS	Smart City Information System
TfL	Transport for London
TTP	Trusted third party
UN	United Nations
USD	United States Dollar
WCCD	World Council on City Data
Wi-Fi	Wireless local access network technology

## 1 Introduction

The topic of this thesis is to understand what factors influence the development of information system strategies in the Finnish smart cities. The aim of the study is to study through the achievements of the INKA and 6AIKA projects previously implemented in Finland to increase the understanding of the individual strategic factors that affect the development of information systems in Finnish smart cities. The research will focus on exploring the issue through stakeholders influencing smart city planning.

The global phenomena of growth of urbanization and the accompanying prediction for change. A similar development is forecast to follow in Finland as well, it is estimated that by 2040, most of the Finnish population 60% will live in urban agglomerations. The concept of the smart cities is often defined a city in which the ICT is merged with traditional infrastructures and coordinated and integrated using new digital technologies. (Ismagilova et al., 2019, p. 90).

In this research I focus on studying the factors that influences the strategy of the information systems of a smart city. (Schuurman et al. 2012, p. 51) The implication is that recognizing the influences is possible to build or bring effectiveness in strategy when building information systems for the smart cities. The implication is that the development of the smart cities has concentrated on reorganize the cities from a technological and administrative aspect rather than a socio-technological point of development. (Rana et al. 2018, p.1)

Second implication is that there is a clear possibility to research what and how the economy i.e., local, or last mile economy can be developed. The lack of studies in the area creates a clear research gap. (Batty et al., 2012, p. 481).

The concept of the smart city emerged during the last decade as a fusion of ideas about how information and communications technologies might improve the

functioning of cities, enhancing their efficiency, improving their competitiveness, and providing new ways in which problems of poverty, social deprivation, and poor environment might be addressed. (Anttiroiko, 2016, p.8) In Finland the question of smart cities is related to the general development of digitalization, urbanization, and demographical change.

The definition of smart city in the context of the Finnish 6AIKA project is to develop new services and process that enable smarter cities to enable improvements in public services to enable to provide the statutory services, in which the demographic change is estimated to effect, private companies and in manage the carbon neutrality of the cities in which urbanization is estimated to affect, in the future more citizens are living in the Finnish cities and less people on the countryside. Cities cannot solve these problems alone and solutions must involve citizens, businesses, and research as well.

The question that we approach in this research is related to information, information systems and the strategies from they are designed. How the information that is needed is collected and managed, with which information systems by whom and from what strategical point, strategy being the commonly agreed greater cause of the actions.

Due to the complex and contradictory nature of smart city projects, current smart city research and development is not fully able to meet the challenges posed by these contradictions and interdependencies, current smart city research is also not scientifically sufficiently multidisciplinary. (Nam & Nam, 2011, p. 283)

Based on this research, in the future the development of smart cities could be based more on the utilization of information system science research methodologies, thus better perceiving, covering, and evaluating the socio-technical and multidisciplinary perspectives required by smart cities. In the future, research is also needed on how effectively multidisciplinary smart city research can succeed. (Ferrara, R., 2015, p.8)

A smart city uses digital technologies to enhance performance and well-being, to reduce costs and resource consumption and to engage more effectively and actively with the citizens. Key smart sectors include transport, energy, health care, water, and waste. A smart city should be able to respond faster to urban and global challenges than one with a simple 'transactional' relationship with its citizens. (Priporas et al.2017, p. 374)

Based on existing literature and the conducted case study among the six biggest Finnish cities can be identified challenges in the collection of information from different stakeholders, management challenges do to spars technology and governance, due to democratic autonomy, avoidance of over surveillance, economic resources and political decision making. In this research we do not cover the political decision making and we limit the research to city officials, industry experts, industry technical suppliers.

Already is estimated that urbanization as a phenomenon is increasing all over the world (UN) 68% estimation of people living in urban areas by 2050 in Finland is estimated that 60% of the Finnish population will live in urban areas by 2040 (Tilastokeskus, 2021) Increase of urbanization need to be approached with smartness at the same time with the evolvement of digitalization will create both possibilities and new problematics if not rightly managed from the first starting phases.

The objective of this study is to study trough the achievements of the INKA and 6AIKA projects previously implemented in Finland to increase the understanding of the individual strategic factors that affect the development of information systems in Finnish smart cities. The research will focus on exploring the issue through stakeholders influencing smart city planning.

Improvement of participation, improvement of public governance, services, improvement of operational technology or technological infrastructure in Finland.

This thesis adds to knowledge, the theoretical structures of the factors which influences in the development of information systems in smart cities in Finland.

The concept of the smart cities is often defined a city in which the ICT is merged whit traditional infrastructures and coordinated and integrated using new digital technologies. In my research I focus on studying the possibilities that lies for the car retailers by merging the needed factors in a wider ICT based ecosystem to emphasize the economic effects. The base for creating a merge in the ICT based ecosystems lies in designing the architecture of the knowledge needed to be transmitted to stakeholders in a way that it creates economic efficiency and possibilities to create new business possibilities. The implication is that the development of the smart cities has concentrated on reorganize the cities from a social and administrative aspect rather than a commercial point of development. Second implication is that there is a clear possibility to research what and how the retailing e.g., of cars can be developed. The lack of studies of the area creates from the researchers point of understanding a research gap.

## 2 Background

In this research the focus is on the how the strategy of information system is designed and build and what are the factors that could be improved to support the information system development (i.e., accessibility, quality, usability) of the urban area of 6AIKA cities great Helsinki area, that includes cities of Espoo, Helsinki and Vantaa, Tampere, Turku and Vantaa which are the most populated area in Finland 33% of the population, 2021 (Tilastokeskus).

This research will be done to contribute and bring into light the factors that influence the information systems and can be used to develop information systems for the smart cities in Finland in the future. The connection of strategy to question of possible benefits or business and economical possibilities of the smart cities, the factors that support the societal development of the future smart cities and its habitants, the industries that operates in the smart cities, and the city environment.

Megatrends like urbanization are present and recognized in several parts of the world and it is assumed that major part of the populations will live in metropolitan and urban areas in the future cities being the central point of them. (UN, 2022).

The concept and practice of smart cities has the potential to deliver many of the UN's sustainable development goals. (Ismagilova et al., 2019, p. 93)

Developing and connect new areas to be vibrant areas also need the development of their information systems to be able to support the infrastructure of different stakeholders and society. The implication being that new cities aim to be smarter in order to be able to manage the increased amount of population.(Öberg et al., 2017,p 8.)

Smartness of the city can mean various things or manifest in many activities, it could be an arrangement of public transportation to be more effective, it could be a logistical

solution, a service, a technical improvement in distributing data, energy or heat, education, health care or environmental improvement. (Ismagilova et al., 2019. p. 92)

Due to the nature of societies and their decision-making process the development of the smart cities is a collaboration between public and private parties (Public, private partnership) (Osei-Kyei & Chan, 2015) projects need often founding from several parties and political decisions by the governments. Since governments do not have vast resources, they emphasize the contribution of investors and private funding.

Investors are willing to invest when there is a prospect for return on investment made.(Cosgrave et al., 2013, p. 670).

The implication being that finding the common factors that influences to stakeholders i.e., business, or other possibilities that can support the future planning of smart cities and support them with accurate information systems the smart cities will attract more investment opportunities, investors and public funding that will encourage and increase to invest in future smart cities. Smart Cities are ecosystems, where smart buildings, built environment, traffic, and energy solutions are developed. (Ismagilova et al., 2019, p. 93)

Digitalization has an increasing impact beside the human consumption also on the built environment and it is seen to create new value integrating technology solutions, which have earlier been separate or even isolated. These solutions could help people to improve and help to live their life better, work more productively, travel safely, and explore further possibilities. (Nam and Pardo, 2014, p.2)

The prediction of digitalization is turning into a profitable business with positive environmental impact as well as support the whole society.

This thesis will limit to cover the questions that are related to the context of the information system strategies of the smart cities in Finland which consists of a wide platform of different initiatives with different aspects from management, technology, governance, political context, citizens and communities, economics, ambience, and infrastructure.

## 2.1 Smart city development in Finland

Smart city development in Finland have started alongside the technological societal development in the late 1990's when the rise of digitalization and internet started to change the processes of gather, share, and build information.

The construction of telecommunication infrastructure and the rapidly spreading use of the mobile phones emphasised stakeholders to a paradigmatic shift of speed and usage of information a democratisation of information, wide amount of information that haven't been reachable before came more easy to reach. (Jalava & Pohjola, 2007).

Smart city as a phenomenon in Finland had his born in the early 2000's as part of the digitalisation development, first projects were established by the Finnish labour ministry (TEKES) in 2012 in a project called INKA. (TEM, 2017.) also an EU funded project called 6AIKA was introduced in 2014. Both projects aimed to identify the development possibilities of Finnish smart cities.(Gaika.fi.)

According to Tekes the government funded Finnish innovation coalition which today is part of Business Finland and their report on smart city solutions (2017). Smart city is divided in following main areas, Smart transport, Smart energy and Smart building and planning.

The Finnish technological development has his ground in the tradition of industrial production which have been the economic back bone of the Finnish society from the early 19<sup>th</sup> century. Information technology have accelerated through the development of Nokia and telecommunication in the 80's and have had a boost from the fast adaptation of internet in the late 90's. At the same time as the more technological society have risen, more question that are related to the role of the citizens have risen as well. The question of involvement of the citizens in the technology society is related



to the capabilities that it brings and the skills to use it as contributively tools. (Eriksson & Vehviläinen, 1999, p. 5)

Reasons for choosing these focus areas rises on one side from the spars population in which Finnish people live cities vs. countryside evolution that create new possibilities in order to either serve services in a spars region or make the cities more attractive and vivid, at the same time the question of how information system strategy take in account their particular needs if there are particular needs (Eriksson & Vehviläinen, 1999, p. 29) The opportunities that structure the information systems in an more effective way in which both providers and citizens can achieve benefits from smarter cities in future, where ever they are situated.

Cities will be more populated in the future and have a need to structure and improve their functions to serve their citizens, to maintain desirability, vitality and attractiveness. (UN, 2022).

Finland as a country with stable economic and young urban infrastructure which started to evolve in the 1950`s , a good education level and stable national security have all the possibilities to develop or improve smarter cities in the years to come. (Hurme, 1998, p. 13)

Finland has a ratio of 18 inhabitant per square kilometre when in the most populated countries i.e., Macao the same ratio is 21 124. (Statistics Finland, 2018).

Another important factor which determines the Finnish conditions is the weather conditions where temperature could vary from -20 C to +20 C depending on the time of the year. These stringent conditions are setting variables and asking for innovation and unique approach.

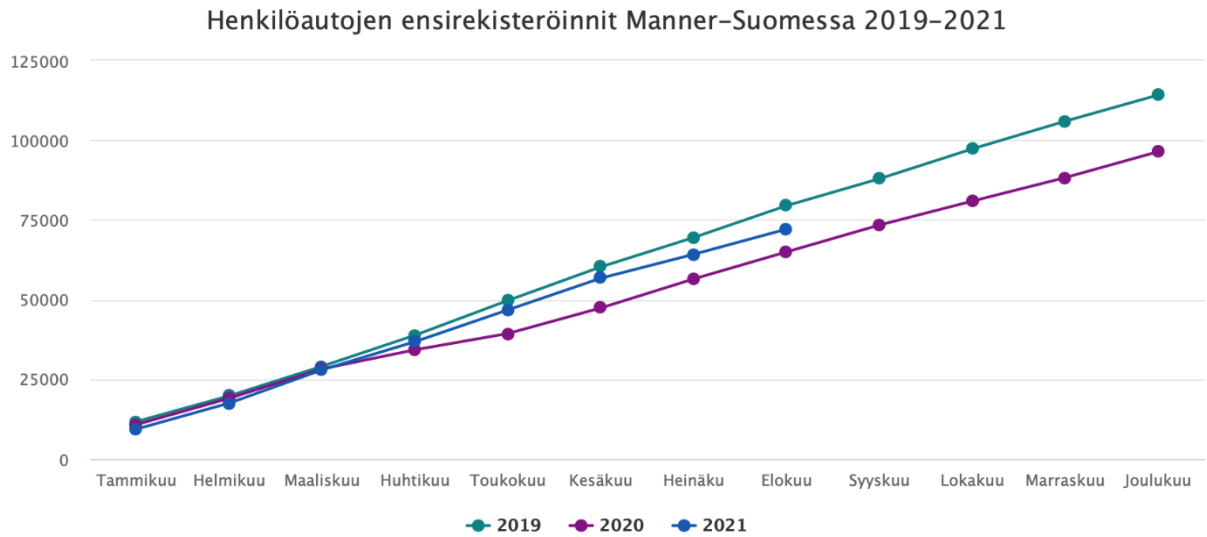
Due to the geographical dimensions 390 905 km<sup>2</sup> and 5 549 807 habitants living in the area which of 34 544 km<sup>2</sup> are lakes, habitation is spars around it and 67% of the habitants living outside the major cities 6AIKA cities means long distances and, in some parts, uninhabited areas, which still must be reached either for industrial, defensive or vitality factors. A remark is also the geopolitical location of Finland is at the border of the European union, position that have importance in the perspective of economy as the transportation of goods to and from the European union as well as in matters of national security to be surveyed.

Geography effects in transportation and create possibility to develop new transportation ecosystems as one area of information systems.

Transport and mobility are two main drivers affecting the existing mobility development in Finland, first one is related to the question to move from one point to other in a scar populated geographical area where public transportation don't necessarily cover all the population, secondly the target to decline the Co2 emissions that transport produces in private, public, and commercial traffic. In Finland emission rates are mostly coming from producing energy to heat 21 101 ton per year and from transportation 26 000 tons per year. (Environmental ministry report, 2019).

Out of 26 000 tons are related to transportation 11 998 tons are related to private transportation. Also, a reason for promoting the development from private ownership of a car is purely economic for single households, since today 17% of household consumption is spent in transport and mobility. (Tekes, report 2017).

Tekes have actively funded different solution created by enterprises and start-up companies around the mobility as a service (MaaS), parking infrastructure, autonomous driving, light vehicles and electric vehicles and traffic since 2013. Still the progress is had been slow and covers only a part of Finland. At the same time new registrations of private cars does not seem reducing and stays at the level of 120 000 new registered cars yearly (See Figure 1).

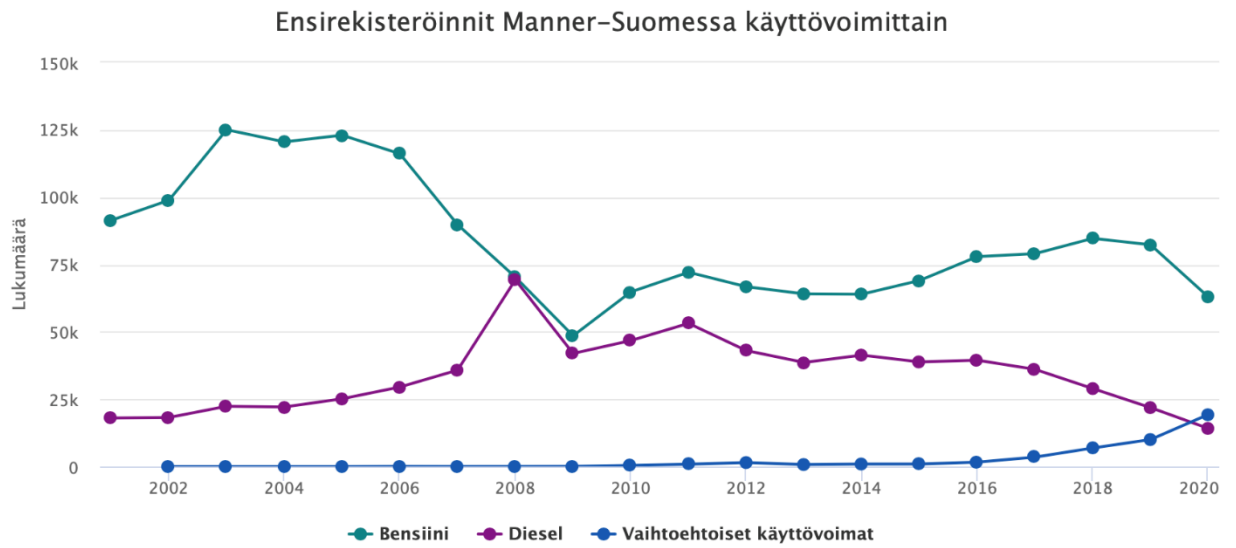


**Figure 1. Private car registrations in Finland (Traficom, 2021)**

A lent change in the power of the private cars have begun in favour of the electric and gas powers, still being at a moderate level. (See Figure 2).

The change from fossil power like benzene and diesel is today related to the availability of selection of cars which is constantly evolving. Also, the amount and location of the charging stations is still under construction especially on the eastern and northern part of Finland.

The conclusion regarding the development is that as soon as the variety of car models and prices with the vicinity of the charging is solved the transition from existing power types will shift to new more environmental power drains.



**Figure 2. Private car registration by power type (Traficom 2021)**

The Finnish state have made initiatives to lower the taxes to alternative power drains according to accelerate the development already from 2008. The tax is based on emissions of the motor and calculated with a WLTP (Worldwide Harmonized Light Vehicle Test Procedure) ratio of CO<sub>2</sub>. The tax can vary from 2,7% to 48,9% (Finland budget proposal, 2022) of the total price of the vehicle according to the CO<sub>2</sub> emissions. At the same time electric cars that produce low emissions of CO<sub>2</sub> are liberated from the taxation.

To emphasis autonomous driving as one solution to security and optimization of private and public transport, Finland have started different projects and funded different platforms for developers to develop the infrastructure and solutions to it, at the same time Finland is providing technological solutions e.g., software and open data solutions of geospatial locations to industry, still the development from software to infrastructure to usage is at his earlystages.

(TEM,2017)

The development of the 5G mobile networks is seen to be as well a factor that speeds up the development of transport, share and parking and it is seen that the in the future development creates possibilities for reshaping and create new services around transportation, maintenance and sharing economies. (Peng et al. 2017, p. 846)

In the Smart city development, the role of the stakeholders is eminent and today can be found several stakeholders, citizens, technology companies, public sector, building industry, automotive industry, service industry. (Van Zoonen, 2016, p.472)

Several subsegments are related to these main stakeholders, implication is that connecting different stakeholders in a commonly manageable information system, economic, productivity, sustainability, security, and service more benefits could be found and developed.

To be able to build a more commonly usable information system a common strategy that tie stakeholders together must be formulated. Since the stakeholders represent or approach different parts of the same question and have different opportunities and resources in the first step is meaningful find the most important factors that could influence the strategical planning.

The smart cities as cities are built and managed not only by one organisation but by several. Cities are governed by several stakeholders (Tesi Simone Carpi.Pdf, 2018, p. 28) which are not necessarily interconnected with each other. Another factor which describe the differences of the stakeholders are motives of their actions. (Eriksson & Vehviläinen, 1999, pp. 171, 172) Implication been that the lack of common agreed governance will affect negatively on the city governance. Commonly recognized stakeholders that should act together are the citizens and their communities, the government, the investors (Anttiroiko, 2016, p. 4). Beside recognizing the stakeholders also a common open repository and platforms are needed to be assigned for collecting, evaluate and govern the initiatives. (Anttiroiko, 2016, p. 9).

## **2.2 Smart City strategies in Finland**

The initiatives of development of smart cities in Finland were based on the same global phenome and prospect of urbanization. Do to the fact that Finland is sparsely populated the development is not seen as fast as in biggest cities around the world, instead the size of Finnish cities Helsinki area been the most crowded area with his 1,8 million habitants (33% of the nation's population) have different demands for smarten the urban areas. More collaborative between cities and more collaborative among their habitants. (6aika.fi.)

Municipal data reserve (Kuntatietovaranto) consists of Construction supervision, Environmental control, city planning and zoning, Land, and infrastructure, all four dimensions have a role in the planning of the city and have a role in the construction of

the cities. To be able to improve the management of these dimensions and to simplify data collection a digital twin of the dimensions has an important and justified role as one information layer for improve smartness of the cities. Implication being how it will be considered in the strategy phase and how or which parts of it would be designed in the information system strategy, another implication is how it would become an incremental part of the information system.

The Municipal data reserve is center of the information e.g., base data or first data layer in which other data bases can be added as additional data layers, together these layers supplement information, depending on the wanted information several layers can be attached via API to provide the needed analyses which can improve the planning and decision making.

(Riikka Lehti and Antti Mansikka CGI, 2021) (Kaupunkiympäristö kasvun kiihdyttäjänä.pdf)

INKA the innovation program for Finnish cities (Innovatiiviset kaupungit) was launched in 2012 by the labor ministry of Finland to accelerate local innovation initiatives and establish local innovation centers across the country. The program and campaign have a straight connection to an earlier programs TIKAS and OSKE which was programs that aimed to found centers of excellence

“Osaamiskeskus” in the 90’s. OSKE projects objective was to establish center of excellence across the country and emphasize the collaboration between each other’s the outcome was clusters that are linked to each other.

(Alueet+globaaleissa+ekosysteemeissä, 2013.).

OSKE laid the foundation to the INKA program presented in Figure 3, purpose was to establish the innovation and collaboration between cities, universities and business life with a demand driven pragmatic approach, investing in in developing different development environments and innovation platforms. The objectives of the program were to unify top down and bottom-up approaches to be more approachable and useful

for local communities and operators. Before starting the program, a tendering was arranged between the Finnish cities in 2013 as result of those five cities were selected to participate on the program in selected fields, sustainable energy (Vaasa), future health (Oulu), bio economy (Joensuu), cybersecurity (Jyväskylä) and intelligent city and renewable industry (Tampere). Later in 2013 seven collaborative cities were selected to join the programs, capital area (Pääkaupunkiseutu), Pori, Lappeenranta, Turku, Kuopio, Seinäjoki and Lahti. (TEM, 2017.)

Kuva 1. INKA-kaupungit.



Figure 3. INKA Cities (Valtioneuvosto 2014)



After the INKA program, the 6AIKA program, involved the six largest cities in Finland (Helsinki, Espoo, Tampere, Vantaa, Oulu, and Turku) which had common strategies that aim to develop more smarter and create more open services, e.g., open data.

The objective of the strategy was to create beneficial factors such as knowledge, business, and more workplaces in Finland. The program was funded by both the Finnish government and the EU, thumb rule being that every development project have to be operated by at least two different stakeholders one being public and the other being second or third party operator. (6aika.fi.).

The strategy was based on three major projects, open platforms, open data and interfaces, and open inclusion and customer relationship, these projects have promoted important elements of the Finnish smart city models, customer-oriented co-development, data opening and utilization and development of services in real urban environment.

Forum Virium is a limited liability company belonging to the city of Helsinki which develops new digital services together with business life, companies, the city of Helsinki, other public operators, and citizens. The objective was to develop better urban services, create and generate new business and emphasize internationalization potential.

Forum Virium sees that key tool to achieve smartness in urban environment are new technology and opening information resources. They see themselves as enablers for the development of the urban community.(Forum Virium Helsinki.fi)

Similar enablers have been established in all six cities of the 6AIKA projects to conduct smart city related projects.

In the INKA report (Valovirta, V., Tuominen, A. 2015) stated that the visionary aim of the INKA project was to establish high knowledge innovation centers in Finland to attract international attention, center of excellence that concentrate and coordinate the state and city level innovations on the fields of bio economy, sustainable energy solutions,

future health, smart city, and cybersecurity. These fields can be considered the ground of the Finnish smart cities or digitalization of the cities.

The scope of the INKA project was to create a unified evaluation model for the innovation process including stakeholder responsibilities which could be used as a ground process model for future similar projects. The outcome was a metalevel framework which is presented in figure 4, in which output input consequential creates the bases of the logic, this framework is intended to be adapted to the innovation and used as a suitable tool for next conceptual more determinate and detailed phases. The report concluded three phases of development, one the input – output phase to determine the following and evaluation of the development, second the phase of conceptualization where the single development is conceptualized and third studying the output among the users i.e., citizens.

#### Seuranta- ja arviointimalli v4

Panokset	Toiminta	Tuotokset	Vaikutukset
INKA-panokset	Konseptikehitys • Hankkeet	Uudet konseptit (tuote, palvelu, ratkaisu, liiketoimintamalli, kehitysalusta)	Vaikutukset innovaatiokykyyn • Osaaminen ja aineeton pääoma • Yritysten tuotekehitysintensiiviteetti • Yhteistyö ja kumppanuudet
INKA-tavoitteiden toteutumiseen mobilisoidut muut t&k-panokset • Julkiset • Yksityiset	Pilotit ja demonstraatiot • Pilotit kehitysalustoilla • Kaupunkien yhteiset pilotit • Pk-yritysten osuus piloteissa	Käyttäjien validoimat ratkaisut Kehitysalustat	Vaikutukset innovaatiokykyyn • Uudet arvoketjut/-verkostot • Uusien ratkaisujen huomiointi hankintojen määrittelyssä, investointien suunnittelussa, kaavoituksessa, standardeissa jne. • Kaupunkiseudun houkuttelevuus innovaatioympäristönä yrityksille, sijoittajille ja osaajille
Investoinnit • Julkiset investoinnit • Yksityiset investoinnit	Käyttöönotto • Innovatiivisten ratkaisujen hankinta • Toimintamallien käyttöönotto	Ratkaisu tai toimintamalli on otettu käyttöön Yrityksen ensimmäinen referenssitoimitus	Yritysvaikutukset • Uuden liiketoiminnan ja viennin käynnistyminen Edelläkävijämarkkinat • Vaativa kysyntä Paikalliset vaikutukset • Kuntapalveluiden laatu, tuottavuus ja vaikuttavuus
	Leviäminen • Innovatiivisten ratkaisujen hankinta • Markkinoinnin tuki • Viennin edistäminen	Laajempi käyttöönotto • INKA-kaupungit • Suomi • Vientimarkkinat	Taloudelliset vaikutukset • Alan yritysten liiketoiminnan volyyymi, vienti, uudet työpaikat • Toimitusketjun kotimaisuusaste Yhteiskunnalliset vaikutukset • Energiätehokkuus, uusiutuviin osuus, materiaalien kierrätysaste • Hyvinvointi vaikutukset: • Kuntapalveluiden tuottavuus • Kyberturvallisuus

Figure 4. INKA Evaluation matrix influence indicators 1

(Valovirta, V., Tuominen, A. 2015)

In the 6AIKA project the aim was independent from the INKA project to focus on the development of the smart cities, to innovate and develop solutions and knowledges to cities and develop services and solutions that improve their smartness i.e., open information, intelligent services, economic possibilities (see figure 11).

<b>Projects of 6AIKA cities</b>	
<b>Project Category</b>	
	<b>Flagship projects (Open collaboration, open data, open innovation platforms)</b>
	<b>Circular economy and energy</b>
	<b>Mobility</b>
	<b>Education</b>
	<b>Health and wellbeing</b>
	<b>Smart city solutions</b>
	<b>Business solution for Small and medium enterprices</b>
	<b>Employment and education</b>

**Figure 5. Project categories created in the Finnish 6AIKA project (6aika.fi)**

In the 6AIKA report (Valovirta, V. 2017) implicates that in most cases new solutions need different solution from the existing ones e.g., behavioral, professional, business models, laws, and regulations in the infrastructure and in the organizations. In public organizations they also need reorganization or changes, in which case they as well need time.

Distinction between scheme and a development project varies according to the innovativeness of the matter. It can be argued that the more innovative the project is the more time it need to be implemented at scale.

To approach projects related to smart cities evaluation of influence plays a crucial role, since Valovirta, V. argued the need of different solutions, we can imply that from this that different solution need different evaluation of influence.

### **2.3 Smart city literature review**

In this literature review we approach the questions related to information system that influences the smart city development, the reasons that influence the strategy planning of the smart cities. What have been studied and published before in international and Finnish literature.

The search and subsequent review resulted in outputs from primary sources scientific publications both national and international, conference publications, secondary sources as newsletters and unique reports, and attending at contemporary conferences in the specific field in Finland during spring 2022.

This formed the base data of literature review for this study. The literature review will create the theoretical framework of this thesis. Essential was to collect and study the writings and sources that have been written about information systems, digitalization, IoT and economics in relation of smart city development and their strategies.

The acceleration of urbanization e.g., cities have created needs to develop or at least improve further the information systems as well. According to the European Union the smart cities (SCIS) is a knowledge platform to exchange data, experience, and know-how and to collaborate on the creation of smart cities, providing a high quality of life for its citizens in a clean, energy efficient and climate friendly urban environment. A SCIS (See Figure 5) aim to connect project developers, cities, research institutions, industries, experts, and citizens. (EU Smart Cities, information system).



**Figure 6. European Union, Smart City information system (Eurocities.eu)**

At the same time articles enlighten that information systems from an empirical point of view are not a stand-alone science but instead a science that have multidisciplinary aspects and assembles also other management fields (Schuurman et al. 2012, p. 51).

Based on this it seen to be beneficial building a multidisciplinary foundation to deepen the reliability of the academic work. Two factors predominate in the strategic planning of information systems, the degree to which the process is conscious, formal, and documented and what is the situational viability e.g., the degree to which the information system and its management is compatible with the organization and its members. (Ein-Dor, P. & Segev, E. 1978).

Cities play an important role in the future of the world since the acceleration of urbanization ( UN | UN DESA | United Nations Department of Economic and Social Affairs, 2018).

Cities are centres of living and action providing prosper to its stakeholders and the environment. The variety of the parties and stakeholders effecting to city development

are many and they need common structures to manage their deliverables. Urban development is the base of create, manage and develop the cities which on the era of digitalization have started to be called "Smart Cities".(Smart city dive, MaClean, 2022)

Smart city needs to deliver smartness to its stakeholders to be able to deliver the wanted deliverables or resources to its users i.e., improved data. City smartness is closely linked to different forms and development of digitalisation, data, information, automatization, monitoring, surveillance and optimisation of space, energy, construction, habitation, education, transport, and management e.g., waste. (Scuotto, 2016, p. 358).

To provide better function ability and to enrich the smartness of the cities, information systems have an important role in creating, manage and develop the urban areas, areas that include several stakeholders that are both living and operate in these.

It would be too easy to just state that one information system will serve every situation or organization, since we already implicate that the strategy is related to the information system. Instead in this study we concentrate studying the factors that influences the strategies and how they can benefit the major stakeholders as a possible methodology or design model for the smart cities in the future.

Smart cities are a rather new term, first used in 1999 at the same time the phenomena are stated in several different ways and could lead to different interpretation of the same concept or create confusion and affect just partly in the same field without taking a holistic or strategical approach to the holiness that is needed to manage the information of a city.

The challenge is as well the fragmentation of the city governance which have his relations to political decision making, economy, industries, and citizens.

Therefore, this research wants to point out the importance of a common strategy that is commonly accepted between the stakeholders that participate in creating the smart cities of the future. (Ahvenniemi, H. et Al., p. 238)

As Webster, J. 2002 states in the article information systems being management oriented and rather young field the existing development is in many cases ad-hoc development. This brings at least the thought that studying the possibilities of a consistent and projectable information system strategy or strategy framework it will impact in the future the development of the Smart Cities. (Webster & Watson, 2002, p.142)

Information systems are seen as a formal sociotechnical, organizational system designed to collect, process, store and distribute information. (Piccoli et Al., 2018).

Information systems have been studied earlier in fields of management, health management and higher public higher education (Ahmad et al., 2021) in building management (Teicholz, 2013) all fields that are related to urban environment.

In this study I approach the factors that influences and are related to information systems of the smart cities.

What are the smart cities can be asked? to be able to understand the context of them is beneficial to introduce the most common contexts of the smart cities since the context varies largely in different definitions. (Ismagilova et al., 2019, p. 94). Smart cities employ information and communication technologies to improve, the quality of life of the citizens and its stakeholders.

European commission have described



*“Smart cities as a place where traditional networks are made more efficient with the use of digital solutions for the benefit of its habitants and business”*(European commission Smart Cities, 2018)

also that *“A smart city goes beyond the use of technologies for better resource use and less emissions”* (European commission, Smart Cities, 2018).

In the Smart city dive newsletter fifteen US described their impression of the state of the issue.

*“Over the years, the "smart city" concept has spurred local governments to consider the newest technologies that companies promised would help eliminate the hassles of urban life and make cities safer, greener, and more efficient. Local leaders wanted to harness the potential of app-based solutions and internet of things connectivity, where sensors provide masses of data they could use for better decision-making and greater adaptability.”* (Smart city dive, MaClean, 2022)

Already on the first definition of the European community can be found leading keywords which can be considered common to all the following definition the conclusion is that leading keywords like digital, network, beneficence, business, and habitats create a base of the research, also the target to reduce emissions have a guiding aspect.

To avoid confusion is well in place to understand what the relative Smart City concepts are and create a common framework for this study in that way we can later focus on what are the factors that are beneficial to be included in the strategy work of the information systems that benefits the creation of the Smart Cities, Digital cities, Intelligent cities, ubiquitous cities. (Albino et al., 2015, p.5).

The base or foundation of “Smart Cities” is seen in all concepts to emerge from digitalization and from the need of sharing information more accurately still in the way that the habitants can understand, influence, participate and involve in the processes without losing their privacy.

Already at this phase can be seen that in the context of “Smart City” can be found many stakeholders that can be added under the umbrella.(Zubizarreta, 2016)

The European community have created a Smart cities marketplace project to consolidate all the projects in one marketplace (see figure 7) to emphasis the change of information which is related to the developing of Smart cities. (European commission, Creating Smart Cities Together | Smart Cities Marketplace, 2018.).

### Projects facts and figures

<b>82</b> Total projects	<b>18</b> Lighthouse Projects	<b>345</b> Total Cities
<b>48</b> Lighthouse Cities	<b>72</b> Fellow Cities	<b>3</b> Observer cities
<b>€ 1.285.868.759</b> Total combined budget of projects	<b>€ 808.136.541</b> Total EU contribution	

**Figure 7. European Union, projects facts and figures related to Smart City initiatives**

The European community marketplace (EIP-SCC Marketplace) aim to bring cities, industries, SMEs, investors, banks, and other actors together target being to improve the quality of life and competitiveness of European cities and industries as well as to reach the energy and climate targets.

In this study the working definition was

“Factors influence the development of information system strategies in Finnish smart cities”

*“A city, connecting the physical infrastructure, the IT infrastructure, the social infrastructure, and the business infrastructure to leverage the collective intelligence of the city”. (Nam & Nam, 2011)*

A variety of definitions have been made about what are the smart cities or what makes a city smart, since the context of the smart cities have become actual partly because of the development of urbanization in the 20<sup>th</sup> century. Today 55% of population of the world are living in the urban areas and the prediction is that moving to urban areas continues to growth and reach 68% of population of the world leaving in urban areas by 2050 (UN 2018) the projection of growth is seen to concentrate in Asia and Africa (UN2018). Today most urbanized regions are North America 82% of people living in urban areas, Latin America and the Caribbean 81%, Europe 74%, and Oceania 68%. At the same time the level of urbanization in Asia is 50% and Africa 43%. (UN2018)

This raises the question of the development in Scandinavia and especially in Finland as well as how are we prepared for the urbanization development from information system strategy perspectives.

*“As the world continues to urbanize, sustainable development depends increasingly on the successful management of urban growth, especially in low-income and lower-middle-income countries where the pace of urbanization is projected to be the fastest. Many countries will face challenges in meeting the needs of their growing urban populations, including for housing, transportation, energy systems and other*

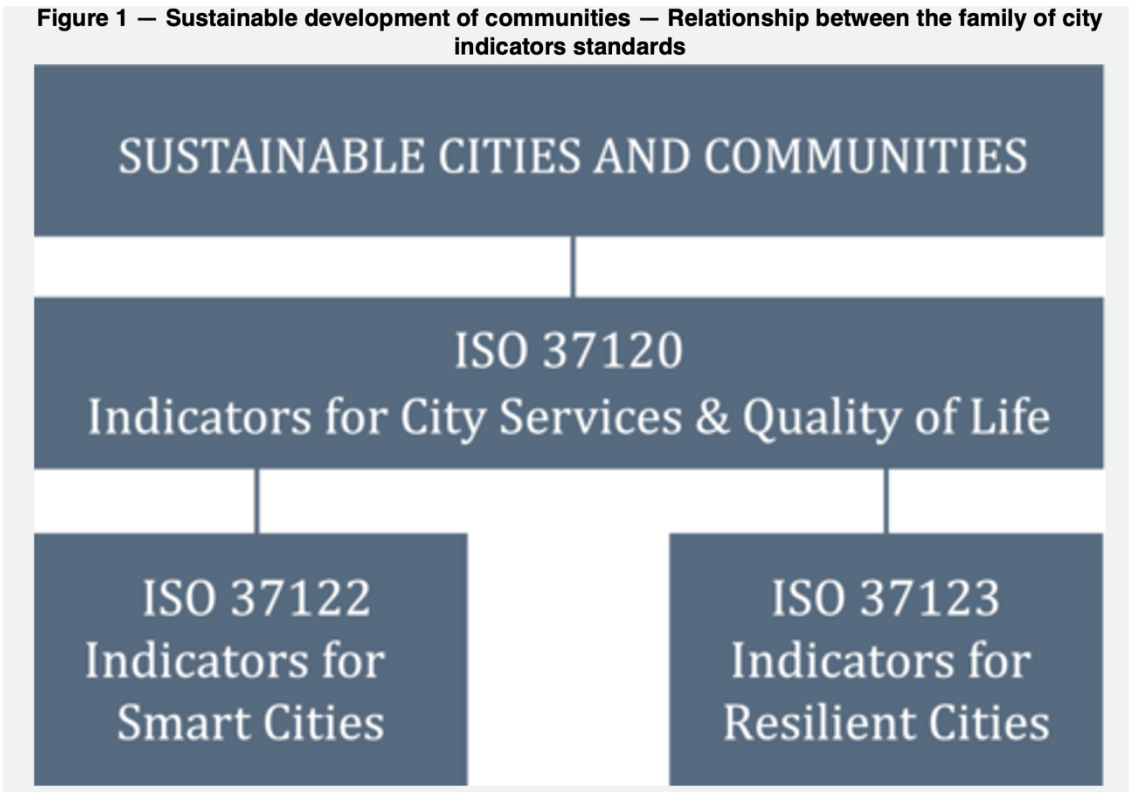
*infrastructure, as well as for employment and basic services such as education and health care. Integrated policies to improve the lives of both urban and rural dwellers are needed, while strengthening the linkages between urban and rural areas, building on their existing economic, social, and environmental ties.” (UN2018).*

As People have moved from a variety of communities to urban environments as a part of the industrialization, urban areas have grown to metropolitan areas, cities, and urban centres at the same time communities outside these have emptied as the persons have moved from them. Smart cities which can also be called intelligent city, digital city, creative city, knowledge city ubiquitous city or smart communities aim to provide an amount of intelligence in its governance to be able to function and provide the needs of the persons who live in these environments and nurse the productivity of them.

The urbanization development that has been evolving since the 19<sup>th</sup> century stress the need of developing new approaches to the smartness of the cities from the standpoint that since the 19<sup>th</sup> century the amount of people living in the urban environment have been grown by 68% and will continue to growth by 2050 (UN 2018).

*“A smart sustainable city is an innovative city that uses ICTs and other means to improve quality of life, efficiency of urban operation and services, and competitiveness, while ensuring that it meets the needs of present and future generations with respect to economic, social, environmental as well as cultural aspects.” (UNECE2018)*

in the collection of standards ISO 37120 (See Figure 6) a collection of standards for the cities have been created as guidance. Which is a recommendation and not a mandatory collection, still the ISO 37120 collection can be considered as basic collection from which the planning of a strategy for information systems can be built. In the ten interviews conducted in the spring 2022 none of the interviewees mentioned the knowledge or the use of the ISO 37120 (see figure 8) which assume that either it is not known or not considered as commonly used standard in the Finnish smart city development.



**Figure 8. ISO 37120 sustainable development of communities, relationship between the family of city indicators standards**

Cities are built around conditions and possibilities of functions and prosperity. Natural resources like water, industrial resources like space, good housing possibilities like clean space and fresh air are appealing and attract both people and businesses, together they create a liveable and prospective area where is easy to attract people as workers, industries as work providers, business as providers of economic prosperity, the more these actors are in balance whit each other, more evident is that the community prospers and attract more of each other. In the situation Vice versa where the stakeholders start to move, downsize or natural resources are a scarcity the community most evidently start to collapse, and future development will stop. Cities grow when the benefits of proximity between people and firms are higher than the cost.

There is a debate about whether technology and instantaneous communications are making cities obsolete or reinforcing the importance of big cities as centres of the knowledge economy. Knowledge-based development of cities, globalization of innovation networks, and broadband services are driving forces of a new city planning paradigm towards smart cities that use technology and communication to create more efficient agglomerations in terms of competitiveness, innovation, environment, energy, utilities, governance, and delivery of services to the citizen. Some companies are building brand new master planned cities from scratch on greenfield sites.

Thus, this the development of smart cities has not reached major break outs and instead of the evolving urbanization which estimates that 68% of the world population lives in a city environment by 2050 is decreasing and losing his interest because of the heavy governance, heavy bureaucracy and missing the common understanding between the stakeholders. The purpose of this study is to critically outpoint the possibilities of the future smart cities. The implication of this study aims to point the need of information system development and implementation on as one of the artefacts of the smart cities.

Smart cities examples according to the European union "Smart City marketplace" there are 345 different related projects in the EU of which 12 are in Finland.(EU, 2018.) In this study we concentrate in projects made in Finland and study the differences and the similarities of their information system strategies. Aiming to find the gaps and the possibilities to implicate new models that could become a more unified model for the information system strategies in Finland and elsewhere.

An example of smart city project, In Vilnius (Šiurytė & Davidavičienė, 2016, p. 1) was studied the relation and suitability of five identified Smart city operators, broadband networks, smart devices like sensors, smart urban spaces, web base applications and open government data to create ICT smartness to the city and its habitants. Providing the ICT smartness to the city was founded to be the first step or enabler to smartness the accelerator of smartness being the citizens of the city in a way the users who use the created ICT infrastructure. To succeed the smart city need not only a functionable ICT but also an interrelationship between the authorities and the citizens, which is not always present. The case of Vilnius was studied with an empirical data analysis of citizens and municipality's attitude towards the development of smart cities also a survey among citizens were conducted using a predeterminate focus group of different age groups. Questions where related to the ICT infrastructure build by the government. Main conclusions were that smart city did not have a common definition still the ICT was recognized to have a role in building the future cities. The acceptance and use of technology vary in different age groups mainly because of different interests and acceptance. The government must emphasise the active dialog between the users i.e., habitants in every phase of the process of Smartening cities and create strategies and tools like for common creation and evaluation and maintain the Smart city infrastructure secure, available, and reachable to all his habitants and support the use of it. (Šiurytė & Davidavičienė, 2016, p. 5)

To understand the development in Finland the focus of research is restricted to the densest cities e.g., 6AIKA cities of Finland the cities of Espoo, Helsinki, Vantaa, Tampere, Turku, and Oulu of Finland an area in which proximately 33% of the Finnish population lives. These cities have been participating in the latest major smart city project 6AIKA, which we approach in this study qualitatively.

## 2.4 Information system strategies

When we talk about information systems, we usually talk about digitally organized information that is systemized in a way that it can be used faster, qualitatively and targeted to serve specific functions, i.e., personal information business or production information. Still the field of information systems is seen very fragmented (Alter, 1999,p.6). Information systems have been discussed through the computer age and several theoretical frameworks have been proposed, still a fully common unified grounded theory that satisfies all stakeholders have not been presented.(Alter, 1999, p. 5). The implication is that a theory either common or partly common needs an understandable expression that the stakeholders that are related in the development of an information system could all understand it. This is one of the starting implications also in the development of the smart cities. (Ismagilova, E et Al., p. 2, 2019).

The backbone of an information system must be most of all understandable and help the stakeholders and IT professionals to observe and interpret the need of implementation and operations and it must generate following outputs. Identify the objects or things that are wanted to be observed, conceptualization of these objects, determine the function levels and the quality of system operations, identify possible improvements and what effect possible changes will bring and understanding the future phenomena. At this point is also important the differences between information systems and computer systems. Computer systems been the technical and programs that are needed to run the operations and information also these days often expressed data being the object that is wanted to use to synthesize the actions. (Alter, 1999, p. 7).

In relation to smart cities, we have to bear in mind that smart cities employ most of all information and communication technologies that aim to have positive effects on its citizens, the local economy, transport, traffic management, environment and interactions with the government. (Ismagilova, E et Al., 2019., p. 2).



Digitalization have accelerated the total speed of computing and exchange of data at the same time it has created a sense of urgency among the users that are more capable and have access to faster tools i.e., mobile phones, internet, and open information databases. A solution to the constantly emerging trend could be an improved management of information and communication technology with an accessible integrated infrastructure and adaptable information system or architecture. (Ismagilova, E et Al. 2019, p. 7)

Information systems produce and support and automate the work performed by the work systems. IS may serve several work systems and produce information to single work system, also it can provide information to the stakeholders for decision making, structure and control an also systemize the work.

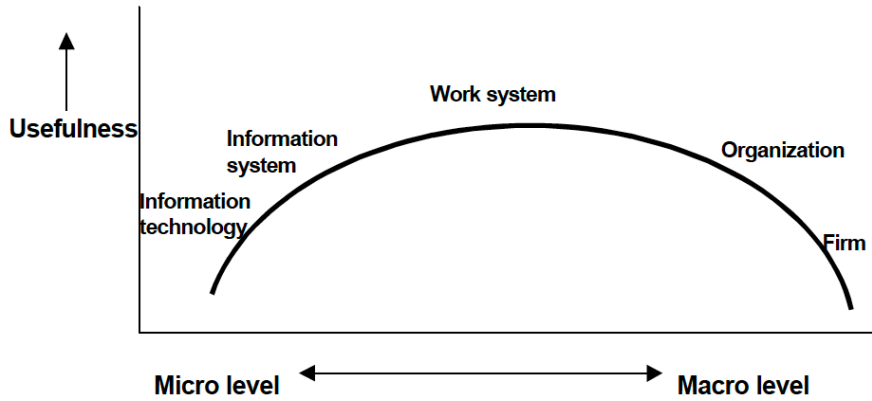
Between working systems and information systems lies sometimes contradictions if the general understanding of their roles lacks. A work system performs a function with a single goal i.e., gather data and it is evaluated based on this goal an information system uses the output of one or more work process i.e., gather the data and print it out to.

To be able to understand the work systems and the relation to this paper it is important to align the six elements of it, business processes, participants, information, technology, products, and customers. The first four are inside the work system producing the needed work that will be delivered to the two customer who is using the products. By customer we mean the user of the product thus that user must be kept separate from the participant who participate in the work. To relate the paper to smart cities an example of work process is the traffic lights which control who have the priority to advance in the traffic and who must stop at the junction. Giving turns is the only work if we add information about the number of cars and the direction passing the junction in a specified time, we could project the information to users of the junction and suggest when the junction is less crowded and vice versa. Example of this is the preferred times of a place in Google maps ([google.fi/maps/](https://www.google.fi/maps/)) that uses location information gathered

from the user's smart phones and combined with spatial data. The users who are the customers of this information can plan their movements according to this. Another more advanced example is the Waze service which collaborate with Google map and crowd produced content. (waze.com).

Cities are full of several challenges already today and the amount will rise in the future due to the urbanization development, most of the population will live in urban areas in the future. At the same time the development of existing cities has a need to manage the growth of the citizens, living areas, transportation, and sustainability. At the same time, it has been considered important that the connection between different operators, work systems, information systems, costumers and users must be built.

The information system has and usually is an ecosystem that bring together organizations, technology, and users in the figure 8 is presented the usefulness and the level of usefulness, which implies that from an information system point of view information technology and information systems are more useful at the micro level, still working systems being most useful.



**Figure 9. Degree of usefulness of different focal points for understanding the operation and significance of specific information systems.**

## **2.5 Information system strategies of Smart Cities**

The role of information systems in the smart city development is predicted to rise in the future. We can guess that since smartness of the cities is seen laying on open information sharing, new technology and multistakeholder collaboration. There might been a need to systematize and manage all these operations in a common way, a sort of common architecture. However, a city cannot become smart just via the use of technology (Nam & Pardo, 2014). Cities use a variety of ICT technologies, hardware, middleware, software, and application as well as non-technical interfaces such as physical paper.

*“The design of the architecture should make it possible to remedy the shortcomings of the current platforms. Data flows, data exchange and network components in the IoT are subject to effective risk management, and assessing and responding to threats to smart cities is challenging due to technical sophistication and standard immaturity”(Justas, 2021).*

The cities are faced with increasing digitalization in every function and from every operator, the prospect situation create a need to connect stakeholders in every phase of the value chain as well of deploy the needed systems to gather, exchange, process and analyze the data that born in the city and affect not only in value chain but also in decisions that need to be made. (Anthony Jnr, 2021, p. 4).

Do to the fast and continuous digitalization and democratization of information, factor that have created a waste number of single solutions, software's, platforms, and applications a bitterly unified or standardized IS model is seen to lack. This study approaches the possibilities that implicate the need of in deep the research of information system strategies which are related to the evolution of the smart cities.

If we see smart cities as we organizations which are meant to work in a multistakeholder model we can approach the information system of it as an enterprise architecture that in business content is seen as a tool for management and planning that have the potential to align the processes that manage information, information systems and technology to deliver the same objectives.( *Niemi, E., & Pekkola, S .2017, p.315*).

### 3 Case context and research methodology

The study has been carried out by creating the background from a traditional literature review, supplemented by a qualitative interpretative case study, interviewing six 6AIKA city representatives, two system suppliers and two technology experts in face-to-face interviews in Mars 2022 (see table 1). A comparison of INKA and 6AIKA projects which were previously project for Finnish cities, has been used as ground source of data. Literature research has been complemented by researching international smart city studies and information system strategies. Information systems being formal socio-technical organizational systems for collecting, processing, storing, and sharing information, have a role in organize the actions, from a socio-technical perspective, information systems consist of tasks, people, structure, and technology. Information system scanning is defined as the integration of components for the collection, storage and processing of data, the data of which is used to generate data, add data, and use digital products that facilitate decision-making.

Case Study	Phenomena	Theory	Result
Literature review	Smart City	Smart City framework	Factors that
Interviews	Urbanization	Smart city projects in	influence the
Media sources and webpages	Demographic-Changes	Finland	Finnish smart
Seminars	Digitalization	Information system	city information
Analysis		Strategies	system
Interpretation			strategies

**Table 1. Case context and research methodology of the thesis**

I choose these research methods because the phenomenon of Smart city is multidimensional and evolving constantly and was more appropriate to approach qualitatively to understand the relation between theory and human actioners. Smart city being also intangible and susceptible to subjective interpretations.

In this research qualitative method helps us to gain a deeper understanding of a phenomenon and especially the characteristics that influences.

Qualitative research is built on 1) earlier research and theories about the subject 2) empirical material, collecting data through interviewing ten stakeholders that works in city planning and 3) the researcher's own thinking and reasoning. (Saaranen-Kauppinen & Puusniekka, 2006.)

The data for this study was collected from the operators of the biggest Finnish cities e.g., 6AIKA cities and industry experts, the approach is hermeneutic. In simple terms, hermeneutics means the natural ability of humans to understand (Gadamer, 2004, p. 129–130).

The empirical material used in this study is focusing on the role of the stakeholders in the city information system strategies and what factors they note that is influence. A total of ten city operators and stakeholders were interviewed in the spring of 2022. The answers were collected and transcript, clustered and analyzed for building the ground theory for assumptions and implications a total of ten interviews were conducted.

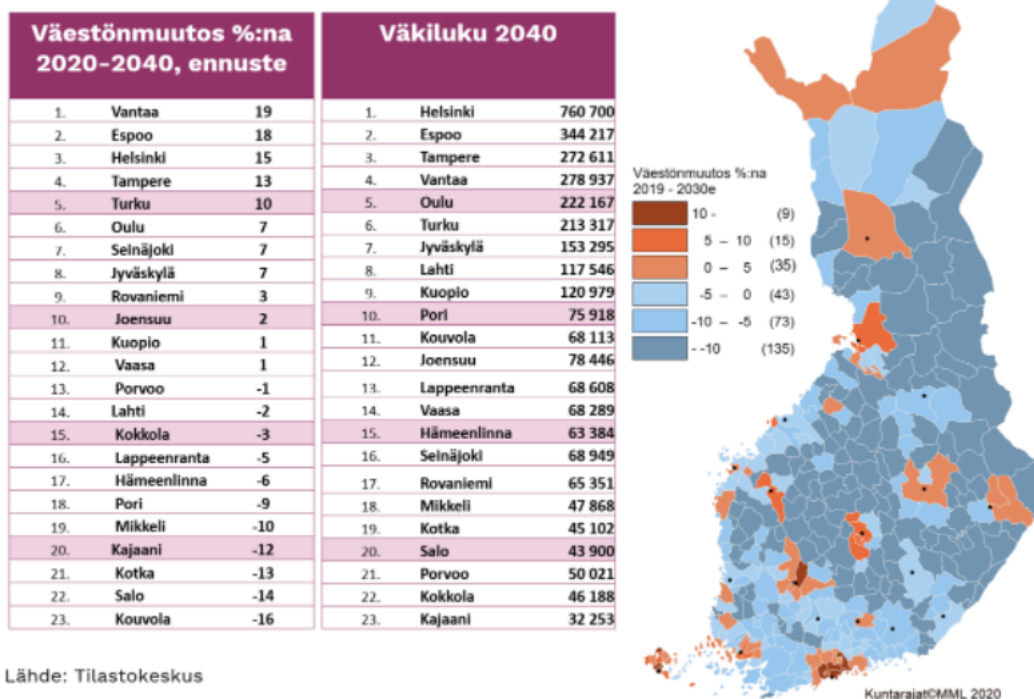
In the interview the participants answered to questions from their perception of the smart city, strategic process, procurement, governance, and information system.

Collection of empirical data was made based on the experiences and reasoning of the researcher. Perception is another commonly used empirical method in qualitative research. Perception is when the researcher is studying the phenomenon wither as part of the phenomenon as an outsider. (Tuomi & Sarajärvi, 2018, p. 95–96.)

During the spring I also attended in tree seminars in Finland, related to smart city development, and used notes from this seminar as a part of the empirical research.

### 3.1 Case context

In this research I studied the Finnish cities that have been participated in the INKA and 6AIKA projects. Cities of Espoo, Helsinki, Oulu, Tampere, Turku, and Vantaa which are the biggest cities in Finland and where 33% of the Finnish population is concentrated and are seen to be the cities that by 2040 (see Figure 10), will continue to grow by population. This eventually requires development of several sectors like infrastructure, information, housing, economy, sustainability, education possibilities, energy distribution and transportation. As well of the habitants moving to urban areas in Finland a change in the socio-economic and socio-cultural demographics is seen to evolve. The total increase of Finnish population is estimated to come mostly by immigration to Finland rather than Finnish population. Development that has influences in socio-cultural factors like language, culture and cultural heritages, other estimations are the ageing and the low birth rate of Finnish traditional population. How these estimations influence on information systems is to be seen but also have their role of influence in planning the future information systems e.g., needed spoken and written languages, perception of services, local service level and achievability of services.



*C23-kaupunkien väestönmuutos %:na 2020–2040 sekä väkiluku 2040.*

**Figure 10. Demographic change in Finnish cities 2020–2040**

The context of this research is the information system strategies that influences the smart city development, identify the use of information systems as enablers of the strategic goals, identify at a metalevel the information systems and concepts that are in use today and identify possible areas of development or opportunities for further development of information system strategies. (Justas, 2021, p. 6).

Qualitative research gives us the possibility to understand the people e.g., stakeholders and their social and cultural contexts that effects in their actions and allow us as researchers to understand their decisions. A city being at the same time a domain for private and public action is a domain where social context is as well an important factor which effects on the decision making.



In this research the reasoning is built from the interviewing addressed stakeholders of the Finnish cities that have participated in previous projects INKA and 6AIKA and already have conduct actions that serve the development of the smart cities in Finland.

The interpretive case study is chosen for this research to understand the phenomena in the Finnish cities from analyzing the collected data and to build recommendations based on the findings the theory will conclude this research and serve as a starting point for further research.

Chosen stakeholders are considered as experts in their fields. Open data from the interviews is transcript and coded, categorized and submitted to analysis. As earlier stated, the domain of smart cities is relatively wide and for that the first action is to fully understand the focus of this research which build the ground of this research.

### **3.2 Method**

Theoretical framework of this study is built by a literature review about the smart cities international development and presenting the Finnish development of INKA and 6AIKA projects and conducting ten interviews among the recognized stakeholders of smart city development who effect on building the strategies of information systems of Finnish smart cities. Based on the background an interpretive qualitative case study has been conducted. Interpretive research assumes that access to reality is constructed trough social constructions such as language, shared meaning, or instruments. (Myers, M.D, 2019).

In this research it manifests in research the question of influencing factors through interviewing participants from recognized stakeholders of the smart city domain and to find meanings in the factors that influences the strategical decisions.

The case study is a flexible research design which allows the researcher to retain the holistic characteristics of real-life events while investigating empirical events. A case study is an empirical inquiry which investigates a contemporary phenomenon within its real-life context when the boundaries between the phenomenon and the context are not clear and in which multiple sources are used. (Yin, R. 1984)

Interpretive research focuses on analytically disclosing those meaning-making practices, while showing how those practices configure to generate observable outcomes.

Qualitative methods help to gain a deeper understanding of a phenomenon and especially the characteristics of that.

Qualitative research is built on 1) earlier research and theories about the subject, 2) empirical material and 3) the researcher's own thinking and reasoning. (Saaranen-Kauppinen & Puusniekka, 2006.)

The point of view for this study is in stakeholders and the approach is hermeneutic. In simple terms, hermeneutics means the natural ability of humans to understand (Gadamer, 2004, p. 129–130).

The objective and research gap that this thesis is aiming to understand what factors influences the strategy of a smart city information system and the information system itself. A research gap is a topic that have not been approached or studied before.

The reasons for choosing these research methods are related to the phenomena that is at research a domain was technology, governance, human behavior and change in societies are creating the research field a socio-technological situation.

What is the process that take in consideration the needs and requirements form a viable information system to produce deliverables that are essential for the information system by information system in this research is meant the technical system and the

non-technical system that take in consideration the factors that are essential to achieve the maximum output to his users?

*“Using inductive reasoning, a researcher starts ‘bottom-up’ and begins by collecting data about the topic. After analyzing these, hopefully some patterns will begin to emerge, leading to one or more tentative hypotheses. These hypotheses are then developed into a more general theory.” (Myers, M.D.)*

In this research I start approaching the research question from a set of philosophical assumptions, first I assume that the technological development will increase in different factors of the city domain i.e., buildings, streets, maintenance, usage, ecology, and energy. Secondly, I assume that the governance of the cities will be more data based i.e., sensors, automation, collection, and perception, third assumption is that habitants of the cities have an increasing influence in the design and use of the cities. This induction led to the assumption that the earlier assumption will influence in how the information is collected stored, managed, and used in the future cities. The research will then focus on what is influencing the strategies that are related to information systems and why.

The research starts from data collection from literature for identify the relevant research area and continues with data collection using an interpretative case study methodology in which the foundation is about the phenomena of smart cities and the interviewing the identified stakeholders of the Finnish cities that have been participating in the project INKA and 6AIKA which are the latest smart city projects that have been conducted in Finland about the phenomena.

Smart cities are a rather new term, first used in 1999 at the same time the phenomena are stated in several different ways and could lead to different interpretation of the same concept or create confusion and affect just partly in the same field without taking a holistic or strategical approach to the holiness that is needed to manage the

information of a city. The problem is as well the fragmentation of the city governance which have his relations to political decision making, economy, industries, and habitants. Therefore, the research wants to point out the importance of a common strategy that is commonly accepted between the stakeholders that participate in creating the smart cities of the future.

The problematics that effects on the creation of smart cities have different starting points, from one side they are related to space i.e., where the smart city will be created, what extensa of smartness make it smart, for whom the smartness is essential and what benefits, usability, economical, ecological, or else are aimed. Another side of the problem is that the decision-making process of the cities is fragmented and reflects the will of several stakeholders partly from different reasons. A unity either in decision making, processes or in building the information needed is mostly lacking and is not efficient enough. Analyzing the problem can lead us to confusion and to analyze to many segments of smart city creation such us urban development, sustainability, operational technology, public security, public transportation, public health, or education. In this research we strictly focus on what are the possibilities and benefits of creating a strategy tool, framework, methodology that contribute the information system design for the smart cities.

### **3.3 Data Collection**

The data collection is done by collecting and reviewing scientific literature about subjects of smart cities, information systems, IoT, public reports from EU and Finnish government, reports of Finnish INKA and 6AIKA projects. Conducting ten interviews among the recognized stakeholders of smart city development who effect on building the strategies of information systems of Finnish smart cities. Interviews was conducted face to face in one-hour long sessions, according to an advance prepared questionnaire which contained questions about smart city determination, governance, project

management, strategy, and recognized information systems in use. Interviews were recorded and transcript during mars of 2022 (see Appendix 1).

Secondary sources like newsletters, participation in Finnish conferences and following public conversation about smart city development, demographic change, and political development.

To strengthen the research results, I conducted additional interviews among industrial experts from ICT companies, Telecom companies, Operational technology companies and mobility service companies to obtain insights, views, and notations not only from the stakeholders of the cities but from industries that influence the information system strategy of the cities and for so having an important role in building it.

### **3.4 Data analysis from the interviews**

In the context of information systems, we do not exactly know how, or which form of information system could improve the smart city development and that is why we research it. Now the literature shows that information systems related to cities are divided in different areas and do not necessarily are connected, as well we see the decision making and the governance of information is still fragmented and partly unrelated and so partly nor as efficient as it might be to serve the strategic objectives. That is way we implicate that related to the strategy process could be found many objectives that need attention or improvement being today partly ambitions rather than deliverables. A well-known example is the autonomous vehicles which have a high priority in several city strategies but still lacks many foundations of policies, infrastructure, and implementations.

In this research the main questions of the interview represent the category level and the sub questions represents the properties related to the categories (see Table 2).

In table 3 have been collected the synthesis of the ten conducted interviews which can are recognizable and have influence in the factors (see Table 3).

Table of coding the interviews					
	Q1 About Smart Cities	Q2 Governance	Q3 Planning	Q4 Project management?	Q5 Technologies
	How you determine the term or concept of smart city?	How is the governance and the reporting build?	How is yours IS planning process arranged?	How are the decided projects managed?	What technologies have been used?
Sq1	What factors by your definition make a city smart?	How the process of collecting the needed information is implemented today?	Who are participating in the planning process?	What disciplines are used during the projects?	Can you name the existing information systems?
Sq2	What segments by your definition are part of a smart city?	What advantages and disadvantages the existing implementation have or not have?	What is the importance order of the parties that are participating in the planning process?	How are the projects documented and stored?	Which information system are critical, and which are not as critical?
Sq3	Who are the stakeholders of information in the smart city?	What are the advantages and the disadvantages of the existing governance?	Can you describe the decision-making process related to designing the information systems?	How are the projects outcomes evaluated and discussed?	What technology based i.e., databases or similar are used?
Sq4					How are different information systems are correlated with each other?

**Table 2. Coding the interview questions**

Table of analysing the data from the interviews					
	Q1 About Smart Cities	Q2 Governance	Q3 Planning	Q4 Project management?	Q5 Technologies
	How you determine the term or concept of smart city?	How is the governance and the reporting build?	How is yours IS planning process arranged?	How are the decided projects managed?	What technologies have been used?
Answer	A smart city is an environment where information is used to its benefit	Several governances, political, hierarichal, by department, by use case	By project, by process, by technology needs i.e., new technology is replacing old, by personal desire	In most of the cases according to established project management disciplines, but also without structure	ICT, Telecom, Cloud, Digital twins, planning and data warehousing
Sq1	What factors by your definition make a city smart?	How the process of collecting the needed information is implemented today?	Who are participating in the planning process?	What disciplines are used during the projects?	Can you name the existing information systems?
Answer	A city that enables all his stakeholders in the development of the city, as well as the state	In various ways and mostly not in real time from several data bases	By project, experts, member of governance and in some cases citizens	Wide range of disciplines are in use but not necessarily used in information system planning.	Wide range of technology and applications are in use and is noted that a city can manage also with less applications
Sq2	What segments by your definition are part of a smart city?	What advantages and disadvantages the existing implementations have or not have?	What is the importance order of the parties that are participating in the planning process?	How are the projects documented and stored?	Which information system are critical, and which are not as critical?
Answer	Health, education, security, energy, transport	Advantages are that they operate, disadvantages are the quantity of implementations	Use case is seen the most important, then the technology and then the strategy	In various different ways, common is that each department documents in chosen way their projects, as well common is that information between the projects need improvement	Security, energy, health, education, transport all the systems that operates individual data
Sq3	Who are the stakeholders of information in the smart city?	What are the advantages and the disadvantages of the existing governance?	Can you describe the decision-making process related to designing the information systems?	How are the projects outcomes evaluated and discussed?	What technology based i.e., databases or similar are used?
Answer	The city, the governance, the citizens and the industries	The governance is seen fragmented	In most cases it is use case and technologically driven.	The evaluation is done from functionality and budgetary point of aspects	Wide range of technology and applications are in use and is noted that a city can manage also with less applications
Sq4					How are different information systems are correlated with each other?
					In various different ways, common is that each department documents in chosen way their projects, as well common is that information between the projects need improvement

Table 3. Collection of data from the interviews

## 4 Research findings

Interviewing ten persons related to the Finnish smart city domain from city administrators, ICT industry, telecommunication industry and operational technology industry and comparing to the literature findings are related primary to how to manage all the things that influences to creating a strategy to be able later create an information system that delivers the sufficient deliverables to its users. All the studied cities have announced publicly a strategy statement which can be considered as their objective.

### 4.1 Examples of strategy statements of Finnish 6AIKA cities

*“Espoo is profiled as Finland’s safest and most vibrant international pioneer city in education, knowledge, innovation and entrepreneurship” (Espoo 2025)*

*“The use of the services must be made more customer orientated and as smooth as possible from the perspective of different Helsinki residents. Digitalisation must support this development” (Helsinki 2025).*

*“We combine a humane and good-natured atmosphere, state of the art technology and entrepreneurship, as well as a distinctive, innovative intelligent culture...Together, we are building international success stories and boldly taking advantages of the opportunities of digitalization” (Oulu 2030)*

*“We take advantage of the digitalization and enable efficient use of data to support the development of well-being and vitality” (Tampere strategy 2030)*

*“The services are available digitally and be tailored to everyone’s needs and made available proactively” (Turku strategy 2030)*

*“Vantaa is an innovative city that have been awarded for his work among rapid growth, carbon neutrality, social innovations and digital solutions” (Vantaa 2025)*



The challenges are more related to management decision paths than in technological capabilities. All the interviews brought in discussion the different decision-making practices even between a city or a department information system is seen in many cases as a tool instead of a strategic platform that could benefit multiple stakeholders. As well the basic planning is often driven by single use cases rather than common use cases which often leads to plan information system for one rather than for many.

As well the use of open data and the citizens participation is seen to be more moderate than it could be. Even than the cities have created several co-development possibilities and tools for citizens to influence. This brings as back to one of the determinations of a smart city, the city is as smart as its citizens.

All the interviewees stated that technology itself is not determine the future development instead technology will be more usable and sharable in the future as cloud computing, data lakes and IoT applications will be introduced.

*“We have all the technology that we need the shareability and use of the information is first and all related to people, governance, hierarchy and the knowledge of use”*

*(Interviewee 1, from industry)*

## **4.2 Factors from stakeholders**

About the stakeholders' roles in this research, we covered stakeholders from the Finnish smart cities that have participated in the INKA ad 6AIKA projects, participants from ICT industry, telecommunication, and operational technology. The reason to select these stakeholders was to understand the question from different approaches and to identify the similarities and the defiance's since all these stakeholders are working guided by the same strategy at the beginning. Key findings were primary found in how separately the

stakeholders work instead of working together this is not due to the unwillingness of cooperation instead often the governance of the projects is organized in a way that cooperation cannot be achieved e.g., use of different technologies in different cities.

In the perspective of this thesis object and the need the implication are that to be able to include the information attained from the OT the planning of the information system (IS) must be extended from IT departments to OT operators, at the same time standards and processes that are already in use in the IT planning processes must be presented at early stage in the planning phase of the planning. Recognized stakeholders that can influence in the development are the managers of the different operations and sharing the need of information at early stage.

The role of OT in the context of the smart cities is related both to the smart spaces and the smart usage and smart citizens. The user and manage layer where the usage act from the user needs point of view. The management concentrate in security, transportation, distribution, and infrastructure are related to user generated functions. Different operational technology collects different type of data from different collective points i.e., surveillance cameras for monitoring the use of it and to prevent and develop the existing state. The connection with the more general information system can be seen both beneficial and critical at the same time. Beneficial from point the surveillance point of view and critical if left unconsidered in the planning of the information system or even crucial if left unmanaged or unconsidered. (Daniela POPESCU & Laura Diana RADU, 2016)

Analyzing the seminars attended about the smart city development in Finland I discovered following aspects that were presented and as an assumption I assume that these discovers have a relation at least a willingness of contribution to the future development of the smart city of Finland.

The industry presented the smart city evolution need a clear digital road map to align the whole ecosystem which will be lead with knowledge, automatization of reporting, managing the economic factors and establish savings with application management.

Discussing question about open data usage two examples have been Enlighted the Finnish example of avoindata.fi a government managed platform where everyone can upload his data packages for public development and use. Avoindata.fi have 2073 data collection provided by 758 providers and 76 usability applications in April 2022 still considered a moderate level and for that seen not as efficient as it could be to improve the smartness of a city.

Factors that can accelerate the progress are changes in the operating environment and the priority of the changes as well as the strategy that is wanted to achieve. Considering the relation to IS and how to plan a suitable IS that operates and improves two factors are seen to be developed. First the IS planning process must have a connection to the stated strategy, today IS planning is seen as a separately operated function without direct connection to the strategy. As well is seen that increased number of academical level studies must be included in the IS planning processes also is stated that cities itself not necessarily have the resources to study the needed factors. Models like triple helix model are recommended. Triple helix model consisting of university, government, and industry stakeholders. Today information system projects are seen to be too separate to be as efficient as they could be.

Another assumption is the improvement of geospatial recognizing from roads to buildings to improve last mile management in transport and deliveries.

Another assumption is related to architectural planning how buildings are digitally planned and what benefits new building ecosystems could create.

*“From industry point of view development of information systems and the digitalisation is always seen a budgetary issue, the one who sales the services for less will get the contract which mean that only the basic functions will be delivered”*

*(Interviewee 2, from industry)*

*“Realtime and data lakes are the future technologies or applications i.e., real time tracking and management of work machines to understand where they are and to manage them according to need and to maybe prevent the purloin of them”*

*(Interviewee 3, from industry)*

### **4.3 Factors from Finnish city planning representees**

About the status of the Finnish smart cities according to the researched issues the overall status of Finnish Smart cities that have been participating in the INKA and 6AIKA projects the cities have progressed and have established several projects that aim to develop further the smartness of the cities still cooperation and common strategies regarding information systems could be achieved for achieving efficiencies and improvements.

Open data is a topic that collect discussion and cities have created different databases were different data sets are available (avoindata.fi) still the usage is at a moderate level as well as the participation of the citizens.

One of the important things is to cross link different systems to improve the management of master data layer and to avoid that same data is not kept separately in another system, which creates challenges and multiple work and sometimes confusion or bad data.

*“The information systems of the cities should be compatible and in the best case consist of the same design principles to create synergies, transparency, and usability of the same data in different sectors. Even further thinking the same compatibleness could be in use*



#### 4.4 Factors the participation of the citizens

About the lack the participation of the citizens it was lower than expected and there is a need to be further addressed and developed, since the prediction is that more people will live in the cities in the future, which mean that services, habitation, traffic, energy, and sustainability questions will increase and must be managed even more effectively. Interviewees stressed this question in several ways, how to involve citizen participation? How to create constant participation methods or platforms for citizens? Also, the cities were critically claimed for creating ego systems instead of ecosystems, meaning that personal objectives guide the processes.

*“We have distributed and opened several city data and created several platforms for citizens to participate in the development of the city and we have achieved some good results, still we would like to see more citizen participating in the creation of the future smart or smarter city”*

*(Interviewee 5, from city represent)*

Even that the 6AIKA cities have opened different data sets two factors have influenced on the progress. One the moderate level of knowhow of the cities of how and what data is essential to be open and for whom. Second the moderate level of analyses made upon the collected data.

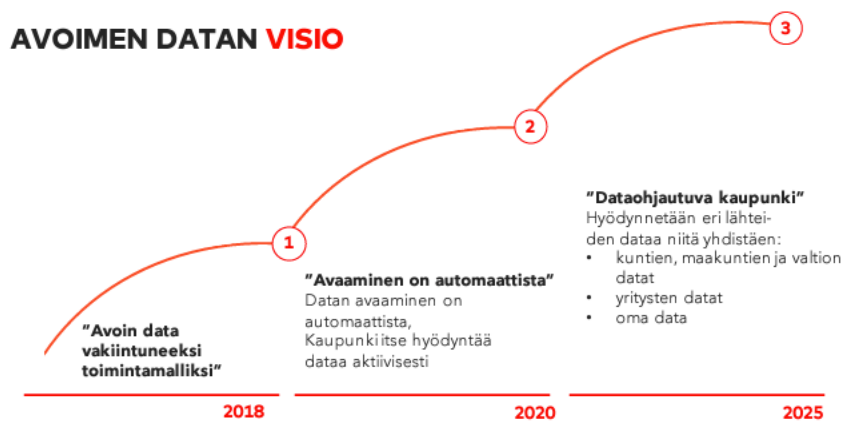
*“The loop wholes to avoid are the un unified data or differentiation in the knowledge bases or the lack of a unified model. Which make more difficult the managing the information’s i.e., health and social benefits data or in the data between a city and the state. This is also due to the critical information like person data and the protection of it matter that need is regulated by the law.”*

*(Interviewee 6, from city represent)*

It is also implicated that at organizational level of the Finnish cities a common framework which commonly guides the evolution of the smart cities does not exist instead the development work is mainly done separately by each city to avoid creating contractionary and multiple solutions to same questions a framework that serve public sector, private sector, and citizens.

*“Several projects with universities have been conducted in research, service design and data management as well as with urban economy programs. All projects have been documented mainly in MS platforms. Regarding results it must be aware that evaluation of the digitalization projects needs a longer time, and this is something where the city is paying attention in the future. Until then all the strategic projects are regularly audited by the city management.”*

*(Interviewee 7, from city represent)*



Kuva 4. Kärkihankkeen toimijoiden määrittämä avoimen datan visio.

## Figure 12. Open data vision 6AIKA report

The figure of the vision for open data has been created as one of the selected top projects of the 6AIKA project. It indicates that starting from opening the data to collaborators for further development a public repository avoindata.fi have been discussed and operationally achievable from 2018.

In May 2022, 2061, data sets by 758 producers have been published on this site. The vision is that by 2025 the open data of avondata.fi is one of the most used data repositories that connects enables the data driven city by connect and use data from the public and private sector stakeholders.



## 5 Summary of research findings

Literature	Researcher finding
<p>A smart city is defined with the meaning of smartness penetrating the urban context, the role of technologies in making a city smarter, and focal domain (infrastructures and services) that need to be smarter. (Nam and Pardo (2014, p.2)</p>	<p>The determination of a smart city in this research shows that by a Finnish city, have similarities to Nam and Pardo, as well the utilization of technology for the benefits of resident's daily lives, in services, security, and mobility services can be identified in INKA and 6AIKA projects, still can be argued that information systems have had minor attention from a multistakeholder aspect which we understand as a factor that can penetrate the urban context and systemize single work systems.</p>
<p>Smart cities aim to provide more efficient, sustainable, competitive, productive, open, and transparent place to live. (Li et al. (2016, p. 1249)</p>	<p>In the Finnish context a smart city uses technology wisely and considers residents and businesses and their needs to maintain well-being and vitality, without forgetting sustainability. Which is not always the situation in all the European countries can be implemented that Finland have as being a stable society all the possibilities to lead the smartification of the cities.</p>
<p>A city is smart when there are actions taken towards innovation in management, technology, and policy, all</p>	<p>Solutions that use cross functional real time data are not used as well as they could be e.g., avoindata.fi for the time</p>

<p>of which entail risks and opportunities. Gil-Garcia et al. (2016, p. 524)</p> <p>“When participatory innovation platforms become the norm in local development, they gradually reshape the entire city.” (Anttiroikko, A: 2016, cities as a platform, p.4)</p>	<p>being, even that is stated a need in this segment i.e., real time tracking or monitoring of building equipment or air purity situations in specific areas or map point. Information that can be used either for surveillance, productivity or for security issues.</p>
<p>Smart cities are all about networks of sensors, smart devices, real-time data, and ICT integration in every aspect of human life. El-Haddadeh et al. (2018, p. 1)</p>	<p>Collected data is seen to improve the management of city spaces as well as the planning of them, the creation of digital ecosystems e.g., platforms and information models, as well as possible API connectivity with different actors. (IoT, SaaS, Cloud, Data models). Still the vision needs an implementable strategy that connect stakeholders instead of separating them.</p>
<p>It is important to define societal impacts by target groups, regionally and nationwide as well as outside the 6AIKA cities to obtain an objective view of what factors influences in the development (Valovirta, V. Tuominen A. p 22)</p>	<p>Questions that relate to people as citizens of smart cities can be seen as a question of participation that needs to be developed and made achievable in the way that citizens can influence in the development of their smart city.</p>

## 6 Discussion

To discussion, the evolution in Finland follows the global evolution and is estimated that urbanization will increase based on several reports from both Finnish and the European commission (lvm.fi and ec.europa) In Finland 75% of the population is estimated to live in urban areas by the year 2040, globally 68% of the population is estimated to live in the cities by the year 2050. (Tilastokeskus 2021, UN 2021). At the same time demographic changes of Finnish population are aging and lowering birth rate and is assumed that the population growth of Finland will depend as well on immigration to Finland. To attract immigrants to Finland cities and their possibilities is seen to have an increasing role as well. It can be discussed that at simultaneously aging of Finland, urbanization, and immigration correlate. Still the phenomena will need to develop existing information system. Limitation of this research are to exclude the single segment and include the common factors of the information system design.

In consequence of the evolution urban areas have an increased need to be developed to manage the change. Changes that are based on digitalization, urbanization, and demographic changes. Estimations in Finland by the national statistic center (Tilastokeskus) implicate that while the population growths it is ageing as well by the year 2040 the number of people that have passed 65 years will rise by 200 000 people from today. At the same time the birth rate of Finland is decreasing especially among the Finnish people. This could mean that parts on Finland will either be settled only by older people or that in Finland rises abandon areas, from the perspective of information systems can be argued a need for adjust existing systems according to the change and to discuss with what workforces the changes will be produced. Already Finland high employment rate in 2022 is 75% among age group 15-64 years, which have led to shortage of skilled work force in the ICT sector and service sector. (Tilastokeskus 2022).

At the same time the evolution of the digital possibilities i.e., 5G, IoT, e-transport, Smart grid energy, rises new possibilities to manage the evolution in new functions and ways to enable the scalability of information, to analyse, to conceptualize, and serve in a

different way to stakeholders. Information systems being sociotechnical domains emphasis on behavioural aspects could be beneficiary to include in the technical development processes to emphasis the usability of the new services as well as well as the understanding of the points that could create new economic. (Batty et. Al, 2012).

City should be seen as a platform as Anttiroiko, A. implicates in his article about Finnish cities in 2016. Concluding *“When participatory innovation platforms become the norm in local development, they gradually reshape the entire city.”* (Anttiroikko, A: 2016, cities as a platform)

In this research we have pointed that participation of citizens is still moderate even that is recognized, and efforts have been made. Are made efforts i.e., open participation or open data achievable or meaningful to citizens can be discussed further.

Streimikis et al. 2021 implicates in their journal article that *“Civilization is a complex society characterized by urban development, social stratification, forms of government, and symbolic communication systems such as writing”* (Streimikis et al. 2021).

Which we found in this research interviewing the stakeholders of the cities and their notations about involvement of the citizens in decision making. Which even that is recognized is still at a low participation level.

The aim of this study was to study to identify the factors that influence the strategies of information systems as possible enablers of future smart city. In which the study founded more possibilities in the selection processes of a single information system than in a specific information system itself. (Gil-Garcia et al. 2016, p. 524)

There are limitations in the study and the research in this thesis is limit to information systems of the Finnish cities that have participated in the 6AIKA process earlier 2014-

2020. (6aika.fi) Initiatives that have a linkage between each other's but also are topics wide enough to have the possibility to be researched as separate topics in future studies.

The decision making is often related to single use cases and to bring solution in these and do not cover multiple use cases. Second aim was to identify at a meta level the information systems that are used today and the reasons that have led to the use of them. Again, the qualitative study shows that the studied Finnish cities have created each their own information system plans with the industries and a unified solution is not in use, to be able to steer the unification as well laws, standards like ISO 37201 or regulations must be considered. Suggestion of unified solution was still found as a viable suggestion if it don't narrow the independence of a city. Even that this study has limited and out scoped the effect of the political decision making to be able to entirely achieve its inputs to knowledge a level of political decision making have a role in information systems and smart cities as well i.e., urban area planning or health governance. The upcoming renovation of Finnish social and security governance model SOTE will start at the end of 2022 and will have major impact in the existing information infrastructures (soteuudistus.fi).

To indicate the future possibilities of information systems in the smart cities this study brings to discussion the role of the citizen-user and how to encourage his participation in producing the needed information and in the decision-making process since the city have a role of providing services to his citizens and the city is as smart as his citizens. An attention that has been also made in the end report of 6AIKA cities open data flagship project. Since citizens rarely participate in choosing the information systems of a city discussion with all the stakeholders that influences in decisions can be discussed. (Öberg et Al, 2017).

How the planning of information systems aiming a more common planning methodology across all the departments and sectors instead of use case based solutioning can be achieved. Need mores discussion as an area of improvement efficiency and use of

information. A vision could be a unified information system methodology for a group of cities or even for a geographical area such as Scandinavia or Europe to be added in the information Technology System Library (ITIL4) library or to ISO 37210 standard, which are the collection of guidelines widely used today. (ISO 37210).

Limitation of the study and suggestion for the future research. This study has his limitations as the phenomena of smart cities are approached, interpreted, and implemented in several ways. As well in study we have not covered the sustainability factors of a smart cities, we have approached the study from a socio-technological aspect.

As we have implicated from the findings smart cities are related to strategy, governance, project management, stakeholders, and citizen participation. We can as well implicate that the phenomena have created different interpretations and at the same time is identifiable the need of multidisciplinary research of digitalization meaning, tools, software, and applications. Economics meaning economic possibilities and creation of sustainable businesses, city planning to attract citizens and policies to govern not only the city but the whole society to improve the more digitalized urban society in which by 2040 most of the Finnish people lives.

## 7 Conclusions

The development of urbanization in Finland is estimated to concentrate in those Finnish cities where today live at least 100 000 inhabitants and will decrease in cities where today less than 5000 inhabitants by 2040, at the same time the birth rate is decreasing, and aging is increasing which can lead to polarization and create desertification in parts major parts of Finland. To have the ability to influence in the development information and information systems have an important role as building the informational foundation for the management of both citizens and services and for that reason must be designed from not only use case point of view but from a strategic point of view as the digitalization is evolving and can be appointed to serve the future situations. Participation of citizens has as well an important and even increasing role in determining which services are essential as well new economy has possibilities to use the information systems that are open, the city must be able to govern and coordinate the structures more adequately to be smarter as cities.

The stakeholders and issues that influence in building the strategies of information systems for smart cities are not elsewhere they are around us and every citizen has the possibility to influence on the development.

The insight and ground of this thesis is in the findings that information systems are considered often separately and from a narrow perspective often from only a use case perspective and not from a strategic perspective.

Creating a more unified processes and models lies a possibility to unify and improve the planning of information systems to improve synergies and efficiency as well to decrease costs related to information system and management.

Usage of open data and participation of citizens has a need to be accelerated as seen as an important factor of improvement. Regarding the already made efforts and

investments in openly shared data, platforms of creation and surveys collected from the citizens the magnitude and the speed of involvement in participation is still moderate, which leaves as to a conclusion that either citizens trust in the parties that design, produce and set in use services of smart city to them, or the need of develop smarter cities is already at an acceptable level in Finland. Still is to be argued that cities of 2022 are most evidently have a need to be even smarter according to the existing estimations about the evolution and cannot be achieved without the participation of the citizens who are the users of the smart cities.

There is a need to understand more precisely the social factor of information and technology which we have described as socio-technological domain not only from an information system point, but as well from human computer interaction standpoint since the low level of participation and the increase of urbanization and other effective phenomenon i.e., aging of the population is seen to increase. As well as the fragmentation between urban and countryside need attentions from several disciplines, engineering, energy distribution and food production and distribution to meet an equilibrium that serve at the same time society, economy, and sustainability.

These issues cannot be answered only with information systems, but they influence the strategy that is the base of actions and for so should be considered in how the needed information systems are planned and build.



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## **Appendix**

### **Appendix 1. Questionary**

The main research question is How the future information systems support smart city development? The research is a metalevel research on information system strategies and have an objective to deliver a methodology that lay the foundation for future developments. Simplifying the outcome of this research could be a grounded theory (i.e., theory of SC design) a canvas (i.e., Business canvas) or a guidebook (i.e., instruction collection) for future use.

This questionnaire is prepared for conducting the interview discussions about questions related to the phenomena of smart cities and the case study about how the information systems and its strategies are designed.

The scopes of the study are

- Identify the use of information systems as enablers of the smart city
- Identify at a meta level the information systems that are used and the reasons that have led to use them
- Identify the possible development possibilities of information systems of the smart cities

Introduction questions

*Smart Cities*

How you determine the term or concept of smart city?

What factors by your definition make a city smart?

What segments by your definition are part of a smart city?

Who are the stakeholders of information in the smart city?

How the process of collecting the needed information is implemented today?

What advantages and disadvantages the existing implementation have or not have?

Can you name the existing information systems?

Which information system are critical, and which are not as critical?

Please feel free and add issues and factors that from your standpoint effects on the existing information system of your city or community.

#### *Questions about planning and governance*

How is yours IS planning process arranged?

Who are participating in the planning process?

What is the importance order of the parties that are participating in the planning process?

Do you have a strategic process that is regarding information systems?

#### *Governance*

How is the governance and the reporting build?

Which parties governs the structure and decision-making process?

What are the advantages and the disadvantages of the existing governance?

Can you describe the decision-making process related to designing the information systems?

#### *Project management and technological bases*

How are the decided projects managed?

What disciplines are used during the projects?

How are the projects documented and stored?

How are the projects outcomes evaluated and discussed?

What technology based i.e., databases or similar are used?

How are different information systems are correlated with each other?

Which are the “loop wholes” in the existing information systems? (Describe either in words or drownings).

## **Appendix2. ISO 37120**

Accelerating improvements in city services and quality of life is fundamental to the definition of a smart city, ISO 37120, is intended to provide a complete set of indicators to measure progress towards a smart city.

The indicators detailed in ISO 37120 have quickly become the international reference point for sustainable cities. ISO/TC 268/WG2 experts have identified the need for additional indicators for smart cities.

The document complements ISO 37120 and establishes indicators with definitions and methodologies to measure and consider aspects and practices that dramatically increase the pace at which cities improve their social, economic, and environmental sustainability outcomes.

This document, when used in conjunction with ISO 37120, helps cities to identify indicators for applying city management systems such as ISO 37101 and to implement smart city policies, program, and projects to:

- respond to challenges such as climate change, rapid population growth, and political and economic instability by fundamentally improving how they engage society.
- apply collaborative leadership methods, work across disciplines and city systems.
- use data information and modern technologies to deliver better services and quality of life to those in the city (residents, businesses, visitors)
- provide a better life environment where smart policies, practices and technology are put to the service of citizens.
- achieve their sustainability and environmental goals in a more innovative way.
- identify the need for and benefits of smart infrastructure.
- facilitate innovation and growth.
- build a dynamic and innovative economy ready for the challenges of tomorrow.

(ISO 37120)

## 1 Scope

## 2 Normative references

## 3 Terms and definitions for cities

## 4 City indicators

## 4 City indicators

## 5 Economy

5.1 Percentage of service contracts providing city services which contain an open data policy

5.2 Survival rate of new businesses per 100 000 population

5.3 Percentage of the labour force employed in occupations in the information and communications technology (ICT) sector

5.4 Percentage of the labour force employed in occupations in the education and research and development sectors

## 6 Education

6.1 Percentage of city population with professional proficiency in more than one language

6.2 Number of computers, laptops, tablets, or other digital learning devices available per 1 000 students

6.3 Number of sciences, technology, engineering, and mathematics (STEM) higher education degrees per 100 000 population

## 7 Energy

7.1 Percentage of electrical and thermal energy produced from wastewater treatment, solid waste and other liquid waste treatment and other waste heat resources, as a share of the city's total energy mix for a given year

7.2 Electrical and thermal energy (GJ) produced from wastewater treatment per capita per year

7.3 Electrical and thermal energy (GJ) produced from solid waste or other liquid waste treatment per capita per year

7.4 Percentage of the city's electricity that is produced using decentralised electricity production systems

7.5 Storage capacity of the city's energy grid per total city energy consumption

7.6 Percentage of street lighting managed by a light performance management system

7.7 Percentage of street lighting that has been refurbished and newly installed

7.8 Percentage of public buildings requiring renovation/refurbishment

7.9 Percentage of buildings in the city with smart energy meters

7.10 Number of electric vehicles charging stations per registered electric vehicle

8 Environment and climate change

8.1 Percentage of buildings built or refurbished within the last 5 years in conformity with green building principles

8.2 Number of real-time remote air quality monitoring stations per square kilometre (km<sup>2</sup>)

8.3 Percentage of public buildings equipped for monitoring indoor air quality

9 Finance

9.1 Annual amount of revenues collected from the sharing economy as a percentage of own-source revenue

9.2 Percentage of payments to the city that are paid electronically based on electronic invoices

10 Governance

10.1 Annual number of online visits to the municipal open data portal per 100 000 population

10.2 Percentage of city services accessible and that can be requested online