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SINGAPORE'S SMART CITY MODEL AND ITS APPLICABILITY TO A EUROPEAN
CITY: AN EXPLORATION OF SUCCESS FACTORS

A Comparative Analysis of Amsterdam and Singapore's Smart Environment and Smart
Mobility Strategies

Lara Marie Joy Anne van Daalen (52578)

Work project carried out under the supervision of:

Professor Andrew Harrison

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Table of Contents

Abstract	1
1 Introduction	2
1.1 Problem Statement.....	2
1.2 The Objective of the Field Lab	3
2 Singapore as a Smart City.....	4
2.1 The Ambiguity of the Term “Smart City”	4
2.2 Smart City Definitions	6
2.3 Singapore.....	8
3 Methodology.....	17
3.1 Qualitative Research	17
3.2 Quantitative Analysis.....	19
4 Findings of the Empirical Research.....	19
4.1 Singapore’s Country Specifics.....	20
4.2 Smart Governance	21
4.3 Smart Mobility	23
4.4 Smart Environment.....	24
4.5 Smart Economy.....	26
4.6 Smart People.....	28
4.7 Smart Living	29
4.8 Critical Aspects.....	31
5 Selection of a European City.....	33
5.1 Funnel Process	33
5.2 Results.....	40
6 Building a Smart City: A Case Study of Singapore and Amsterdam	42
6.1 A Comparative Analysis of Amsterdam and Singapore’s Smart Environment and Smart Mobility Strategies.....	43
7 Discussion & Conclusion	56
7.1 Main Findings.....	56
7.2 Significance and Implications.....	57
7.3 Limitations	59
8 Bibliography.....	61
9 Appendix.....	74

Table of Figures

<i>Figure 1 Urban population (% of total population)</i>	<i>2</i>
<i>Figure 2: Smart City Definitions.....</i>	<i>6</i>
<i>Figure 3: Smart City Ranking Overview</i>	<i>11</i>
<i>Figure 4: Funnel Process Criteria.....</i>	<i>33</i>
<i>Figure 5: Population Density in Singapore and Europe</i>	<i>34</i>
<i>Figure 6: Hofstede insights for Singapore, The Netherlands, United Kingdom, Switzerland .</i>	<i>39</i>
<i>Figure 7: The Amsterdam Arena - Johan Cruijff - and its sustainable solutions</i>	<i>47</i>
<i>Figure 8: NTU School of Arts, Media & Design - Singapore.....</i>	<i>49</i>
<i>Figure 9: The Royal Park Hotel - Singapore.....</i>	<i>49</i>
<i>Figure 10: Funnel Process Excel.....</i>	<i>78</i>
<i>Figure 11: Cultural distance to Singapore</i>	<i>78</i>
<i>Figure 12: Funnel Process City Selection</i>	<i>79</i>
<i>Figure 13: Comparison of Indicators</i>	<i>80</i>

Abstract

This paper explores Singapore's renowned Smart City model and its potential applicability to a European city. Through a comprehensive analysis of six dimensions, including interviews with industry experts, the study researches the key success factors driving Singapore's Smart City Model. Next, using a data-driven funnel process, Amsterdam was selected as the most suitable European city for comparison. The comparative analysis reveals distinct approaches to Smart City development and identifies mutual learning opportunities.

Keywords

Smart City, Singapore, Amsterdam, Case Study, Funnel Process, Smart Governance, Smart Mobility, Smart Environment, Smart Economy, Smart Living, Smart People

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1 Introduction

1.1 Problem Statement

Over the past two decades, there has been a steady global trend of population migration from rural to urban areas, leading to increasing urbanization. (United Nations 2023) This migration is driven by various factors, including the search for better opportunities in areas such as jobs, education, and medical care. Additionally, conflicts such as wars and political unrest have forced people to leave their homes and move to more industrialized countries in search of safety and stability. (Eremia, Toma and Sanduleac 2017) According to data from the World Bank in Figure 1, urbanization has been steadily increasing since 1960. (Worldbank 2023) By 2050, the global level of urbanization is projected to peak at 70%, with most of this increase occurring in Asia and Africa. This growth will take place in both "megacities" and smaller urban areas, (United Nations Development Programme 2023)

Figure 1 Urban population (% of total population)

1960	34%
2007	50%
2023	55%
By 2050	70%

The high pace of urbanization leads to both positive and negative consequences. First, one needs to point out the economic opportunities. Cities produce more than 80 percent of the global gross domestic product (GDP) and are therefore a crucial driver for sustainable growth. Furthermore, urbanization can improve

the overall quality of life, due to better infrastructure and systems. However, even though cities account for only two percent of the world's total land and currently are home to a bit more than half of the world's population, they are responsible for 80 percent of the greenhouse effect. Besides that, rapid urbanization can result in conflicts and poor living conditions, if not managed appropriately. (UN Environment Programme 2021) This connection shows that rapid urbanization requires strategic management and new approaches to urban planning. Overpopulation, resource scarcity and environmental issues lead to the increasing complexity

of urban life. The more “urban” our planet becomes, the “smarter” cities need to be. (Eremia, Toma and Sanduleac 2017) The conceptual work behind Smart Cities, needs to prioritize the development of inclusive, livable, and sustainable urban areas, to benefit from the positive aspects of urbanization. (United Nations Development Programme 2023) To achieve this, the usage of technology takes a crucial part. The technology spending for Smart City initiatives worldwide is forecasted to increase from \$81 billion USD in 2018 to \$189,5 billion USD in 2023 and therefore more than double. (International Data Corporation, 2020)

1.2 The Objective of the Field Lab

In recent years, Singapore has emerged as one of the world's leading Smart Cities, renowned for its cutting-edge technologies and innovative urban policies. The 2023 Smart City Index has ranked Singapore as the smartest Asian city, making it a prime case study for researchers seeking to understand how Smart Cities operate and how their success can be replicated elsewhere. The primary objective of this Field Lab is to establish a bridge between Asia and Europe by examining the potential value of Singapore's Smart City model for a selected European city through a quantitative funnel process. This study aims to identify the key drivers of Singapore's success as a Smart City and showcase best practices that can be utilized to advance urban development. The research question guiding this project is the following:

"What are the key success factors of Singapore's Smart City and how can these add value to a European city?"

To answer the research question, this Field Lab will utilize a mixed-methods approach. Firstly, empirical research in the form of expert interviews will be conducted to identify the key success factors of Singapore's Smart City model. Through this qualitative research, the thesis aims to gain a deep understanding of the factors that have made Singapore's Smart City model successful.

Secondly, a quantitative process will be used to identify the European city that meets the prerequisites and can leverage the most from Singapore's learnings. This process will involve developing a set of criteria based on the success factors identified through the expert interviews and then applying these criteria to a range of European cities. The city that meets the criteria and has the highest potential for success will be chosen as the case study for this Field Lab.

Ultimately, this research aims to make a valuable contribution to how Smart Cities can be developed and compared globally, with a focus on enhancing urban sustainability, livability, and economic growth.

2 Singapore as a Smart City

In this chapter, we aim to provide a theoretical foundation for our Field Lab by conducting a comprehensive literature review. We begin by discussing the term "Smart City" and its various interpretations and offer a clear definition. Next, we delve into the journey of Singapore, which has established itself as a global leader in Smart City development. Finally, we provide a detailed explanation of the six dimensions that comprise a Smart City. This theoretical framework will guide our analysis and evaluation of Singapore's Smart City model and its potential applicability to a European city.

2.1 The Ambiguity of the Term “Smart City”

Both in research and in practice, Smart Cities have grown in popularity over the past years. Cities across the world come up with interlinked solutions for transportation, innovative urban services, and general infrastructure with long-term positive effects on citizens and the economy. Many of the new approaches are based on harnessing technologies like information and communications technologies (ICT) and the internet of things (IoT). However, there is no shared definition of what makes a Smart City “smart”. Some of the definitions are grounded in

sustainability or technology, while others use a more holistic view. (Albino, Berardi and Dangelico 2015)

The term “Smart City” was first used in the 1990s by the California Institute for Smart Communities. They picked up the topic of how to build “smart” communities and apply ICT to a city. Back then the focus was on technologies and modern infrastructure within a city. (Alawadhi, et al. 2012) The variety of Smart City initiatives that nowadays exist across the world and their individual differences and attributes, make it challenging to narrow them down to a common definition. In fact, there is currently no consent about the meaning of the term “Smart City”. (Neirotti, et al. 2013)

What is missing is a common understanding of the relevant elements of a Smart City, its boundaries or limitation. That is why the term “Smart City” can be labelled as “fuzzy” or “ambiguous”. (Dameri, et al. 2019) Based on Cocchia (2014) this is due to two aspects:

1. The adjective “smart” has a broad set of meanings and can be interpreted in various ways; terms like “intelligent”, “wired” or “digital” are used as alternatives to describe Smart Cities.
2. As there is no shared definition for the concept of a Smart City and the term is still relatively vague, cities can label themselves, their initiatives, or their policies as “smart” and use the term for marketing purposes. (Cocchia 2014)

To create a more comprehensive definition, the following chapter seeks to give an overview of the most prominent definitions to then agree on the describing attributes for this Field Lab.

2.2 Smart City Definitions

Definition	Source
“A ‘Smart City’ continues to be defined as an urban setting that applies technology to enhance the benefits and diminish the shortcomings of urbanization for its citizens .“	(Bris, Lanvin and Haen 2021, 3)
“A city is smart when investments in human and social capital and traditional (transport) and modern (ICT) communication infrastructure fuel sustainable economic growth and a high quality of life , with a wise management of natural resources , through participatory governance.“	(Caragliu, Chiara and Nijkamp 2009, 50)
“A Smart City is a city well performing in a forward-looking way in these six characteristics: Smart Economy, Smart People, Smart Governance, Smart Mobility, Smart Environment and Smart Living .”	(Giffinger, et al. 2007)
A Smart City “infuses information into its physical infrastructure to improve conveniences, facilitate mobility, add efficiencies, conserve energy, improve the quality of air and water, identify problems and fix them quickly, recover rapidly from disasters, collect data to make better decisions, deploy resources effectively, and share data to enable collaboration across entities and domains .”	(Nam and Pardo 2011, 284)
“A Smart City is defined not by the technology it uses but by the outcomes it achieves. Lived Experience : A Smart City should provide an excellent quality of life for its people. Resilience : A Smart City should be able to respond nimbly to new challenges and unanticipated problems, enabling it to adapt and thrive. Sustainability : A Smart City should deploy and manage its resources in a way that manages its environmental footprint. Productivity : A Smart City should harness data and technology to improve productivity, efficiency, and effectiveness.”	(Smart Nation and Digital Government Office 2022, 6)

Figure 2: Smart City Definitions

In Figure 2 the most noteworthy approaches to defining the concept of a Smart City are listed. It emerges that some of them either focus on the human or technological component, while others merge the two concepts. However, the figure clearly points out that the maximization of

the quality of life are of high priority in the scientific discourse. (Bris, Lanvin and Haen 2021) (Caragliu, Chiara and Nijkamp 2009) (Giffinger, et al. 2007)

For instance, Bris et al. (2021, 3) emphasise in their definition that the objective of a Smart City is to “enhance the benefits and diminish the shortcomings of urbanization” while Hall and Bowermann (2000, 1) point out the monitoring and integration of “all of its critical infrastructure” to “maximize services to its citizens” as the uppermost target of a Smart City.

Caragliu et al. (2009, 50) highlight not only how technology needs to “fuel a high quality of life” but also “sustainable economic growth”. Furthermore, the authors bring up an institutional factor, namely the concept of “participatory governance”. Linked to this approach, is also the understanding of Nam and Pardo (2011). The authors stress the importance of combining not also technological and human aspects but also institutional factors to succeed in smart urban development.

The Smart Nation and Digital Government Office in Singapore defines a Smart City based on the outcomes to be achieved rather than the technologies or systems used. They identify four key areas of focus, including Lived Experience, Resilience, Sustainability, and Productivity. (Smart Nation and Digital Government Office 2022) Giffinger et al. (2007) point out six dimensions as the key characteristics of a Smart City, which include economy, people, governance, environment, mobility, and living. The six dimensions cover a wide range of areas and provide a holistic approach to understanding and analyzing the concept of a Smart City.

After analyzing various approaches to defining a Smart City, this paper has selected Giffinger et al.'s (2007) approach due to its comprehensive and concise structure. Additionally, the wide use and applicability of this framework ensure the relevance and usefulness of the following analysis.

2.3 Singapore

The term Smart City has become almost synonymous with the City-State of Singapore, with the government's decade-long dedication to building the city up to be a leading and exemplary model of a Smart City, achieving the number one spot in multiple rankings. (Ang-Tan and Ang 2022) The following chapters will provide a background to Singapore and an assessment to its position as a leading Smart City.

With a small land area and continuous population growth, Singapore always faced an urban density challenge to reconcile livability, environmental sustainability, and economic competitiveness. Besides the increasing urban density, Singapore must deal with a shift in demographics, as the population is ageing, and the birth rates are declining. This forces the City-State to create long-term measures and goals to maintain a liveable environment in the future, including adequate green areas, housing provision and well-integrated infrastructure systems. (Lee, Kwon, et al. 2016)

Despite the challenging starting point, Singapore manages to excel in various areas of everyday life. It is one of the strongest financial systems in the world and has built a world-class set of the most advanced infrastructures worldwide, with its public sector considered one of the most efficient, having very low levels of corruption. Also, its exceptional healthcare services have been digitalized to better serve the population's needs for better quality and accessibility, demonstrating great results, such as reaching a population life expectancy of 84 years. (Population 2023) The ability to use technology to improve the quality of life of its population and to prioritize efficient and sustainable governance was very important for the success of Singapore as a Smart City. (Smart Nation Singapore 2023)

Mobility is one of the most developed sectors, with the use of sensor technology and real-time traffic data to manage traffic congestion, as well as reduce over-crowded public transportation.

Contactless payment is used in every transportation service. Besides making payments faster and easier for users, it's also another way for the government to track people's movements and to be able to reduce congestion, by placing more means of transportation in those areas.

For these innovations and developments to be possible, smartphones play a huge role in Singapore's society (with more than 92% of its population owning one or more (Statista 2023), compared with 77% in Europe (O'Dea 2022). Several Apps have been developed throughout the years, to provide many incentivizing the population to reduce kg of waste per person and pollution to have better air quality and water management. Moreover, the government has invested, and worked alongside many professionals and companies, to develop in the areas of AI and IoT.

2.3.1 Singapore as a Leading Smart City

A City-State with few natural resources and historically lacking any significant financial power had to prove its relevance through different means after gaining independence in the 1960s. (Mahizhnan 1999) Singapore, therefore, focused on becoming an intelligent city, where the government heavily subsidized the economy and directed the country to turn Singapore into the leading Smart City it is today. (Lee, Kwon, et al. 2016) The International Institute for Management Development in collaboration with Singapore University of Technology and Design (IMD-SUTD) developed a Smart City Index, which looks at variety of indicators such as Gross National Income (GNI)¹ per capita, Human Development Index (HDI)² and compares it to the perception of randomly chosen residents in over 118 cities. Singapore has consistently ranked first and is the only city to receive an AAA Smart City Ranking. (IMD & SUTD 2021)

¹ Gross National Income is conceptually similar to Gross Domestic Product, but is calculated to include money flowing to and from foreign countries

² Human Development Index measure the average human development of a country based on health, knowledge and standard of living

While acknowledging the potential bias of the index, there is further concrete evidence supporting Singapore's status as a leader in Smart Cities: First, the city state is in the top 5 GDP per capita and secondly, from the leading technological countries have the most Unicorns per capita with 3.5 Unicorns per million citizens.³ (Crunchbase 2022) Additionally to economic aspects, Singapore invests significantly in improving the lives of its citizens through education and its preservation of the environment through various carbon-reducing initiatives, marching well ahead of other Smart Cities. (Ahm Shamsuzzoha 2021)

Despite the aforementioned factors exhibiting why Singapore is the primary Smart City, the analysis would be incomplete without including results from different institutions that lead to a slight disparity in ranking, as seen in Figure 3: Smart City Ranking Overview. Though the rankings do not specifically look at how developed Singapore is as a 'Smart City', the indicators measured vary slightly from the IMD-SUTD index but are important in measuring the progress and development of a city and therefore it would be wrong to give Singapore the undisputed title of number one Smart City. While not always reserving the first position from every institution, the City-State's dedication and investments in its digital ecosystem, innovation, mobility, strong government support and citizen engagement have nevertheless enabled it to be consistently towards the front of all rankings, thus emphasizing that Singapore is a representative model for a leading Smart City. (Ang-Tan and Ang 2022)

³ A Unicorn is a company that has reached a valuation of \$1 billion USD without being listed on the stock market. Singapore has 19 Unicorns at 5.45 million population, the US with over 700 Unicorns only has ratio of 2.1 Unicorns per million citizens.

Ranking	Institution	Criteria / Indicators ⁴
1	IMD-SUTD Smart City Index	GNI, HDI, Citizen perception
2	McKinsey Global Institute	Technology comprehensiveness, Quantity of Smart City apps and the corresponding usage & satisfaction
1	Roland Berger's Digital Inclusion Index	Digital accessibility, affordability, ability, and attitude.
1	KPMG's Global Ranking of Leading Technology Hubs	Combination of Socio, Macro- & microeconomic trends, demographics, Academia, Digital Infrastructure
7	Global Innovation Index	Infrastructure, Market, Academia, Intelligent Outputs, Human Capital
7	IESE Cities in Motion	Human Capital, Social, Environment, Governance, Urban planning, Mobility, Technology, Economy, Mobility
7	IMD Smart City Index	GNI, HDI, Citizen perception

Figure 3: Smart City Ranking Overview⁵

2.3.2 The History of Singapore

The City-State of Singapore with a population of nearly six million and with the highest GDP per capita in the Asia-Pacific region (World Bank 2022) was not always a significant player in the global economy, but the strategically important location allowed Singapore to define its relevance despite the lack of other resources. (Findlay 2019)

Starting from its origins as a seaport settlement belonging to various Asian empires, the arrival of the British in 1819 marked the beginning of modern Singapore, as it became an important trading post. (Lepoer 1989) After the end of British colonisation in 1959, Singapore initially

⁴ The displayed criteria only provide a summary of the indicators, as an extensive list of every indicator would exceed 100 various measurements.

⁵ Figure references multiple reports from different institutions (IMD & SUTD 2021), (Woetzel, et al. 2018), (Low, Dujacquier and Kaur 2021), (Holt and Gibson 2021), (Dutta, Lanvin and Lorena León 2023), (Berrone 2022) & (IMD 2023)

remained part of Malaya (later Malaysia), but due to socio-political conflicts with the Malayan government Singapore split and gained full independence in 1965. (Khoo 2007)

The newly independent State of Singapore faced various challenges, including unemployment, education, housing, and a lack of natural energy resources. The People's Action Party (PAP), which has been the governing party since 1959, focused on economic development to improve the standard of living. Rapid economic growth was fuelled by substantial investments made in education, infrastructure, and public housing, but the PAP's one-party government with strict regulations and limited political freedom drew criticism. (Ortmann 2011)

Despite the challenges, Singapore built a prosperous industrial economy but in the 1980s began to diversify and shift towards an information-based economy. (Lee, Kwon, et al. 2016) This shift, crucial for Singapore to retain its competitive advantage, was supported by substantial government investments and paved the way for Singapore to become the Smart City-Nation it is today. (Mahizhnan 1999)

2.3.3 Singapore Smart City Dimensions

As the analysis in part 2.2 has shown, the definitions of a "Smart City" cover various aspects, depending on the research focus. However, this Field Lab will use the six-dimensions structure, covering Smart People, Smart Living, Smart Environment, Smart Mobility, Smart Economy, and Smart Governance. (Giffinger, et al. 2007) The covered initiatives and examples are provided to explain the characteristics of the six dimensions without profound critical analysis.

2.3.3.1 Smart Living

The topic of smart living seeks to **improve the quality of life of citizens by providing safe and healthy living conditions** by following an inclusive strategic approach, across all age groups and demographics. Examples of initiatives can be support for elderly or disabled people, a WiFi connected City or digital payment. (Bee Smart City 2020)

Technology plays a crucial role in Smart Living, but the development of a city relies equally on social solidarity. This aspect refers to the need of diverse classes of individuals, considering variations in income, culture, age, and occupation. Achieving Smart Living requires a healthy environment, personal and social security, and sufficient income. (Attaran, Kheibari et Bahrepour 2021) The initiatives implemented in Singapore have the goal to create “homes and estates cleaner, greener, safer and more sustainable”. These include making water usage data available for residents to be more efficient by saving water and money, and sensors to keep safety for all residents, such as smart lamp posts, personal alert buttons and monitoring systems for the elderly to request for emergencies anytime.

Smart initiatives were also created to improve healthcare in Singapore’s society. Investments were made to have the most recent assistive technologies and robotics in healthcare. TeleHealth and HealthHub Portals were created to ease Singaporean's access to their medical records and to provide them with health advice and services. Also, with climate change and the increase of Dengue disease in Singapore, the government has established drones that can detect the disease within the city. Additionally, the government created Apps that alert the residents on the latest news and for them to report possible issues (myENV and OneService). (SmartNationSingapore 2023)

2.3.3.2 Smart Government

Smart Government focuses on **strengthening connections and interactions between government and various stakeholders**, including citizens, businesses, and other organizations of civil society within a municipality. It involves reassessing the quality, extent, and range of services offered to citizens and businesses, incorporating innovative methods such as co-creation, crowdsourcing, and emerging technologies. This aims at enhancing the efficiency, effectiveness, transparency, and trustworthiness of governance processes. (Bee Smart City 2020)

The government of Singapore has been very active in trying to facilitate every aspect of society for its residents, making it easier for them to register as citizens, by providing digital birth and death certificates. Also, creating a multilingual digital service and translation program to facilitate business and understanding between different cultures. Along with many programs created, LifeSG is one of the most used: a mobile application that allows people to access more than forty government services, as well as to keep up with the latest news. It allows its users to access information related to their healthcare, work, employment, family, housing, and property. (Baharudin 2020) CrowdTaskSG is another initiative to get feedback and engagement from its residents (users get rewarded for answering surveys and by sharing their opinion and choices about matters of relevance to the government). Also, the creation of the HDB Resale Portal was an innovative way of making it easier for investors and residents to buy and sell real estate. (Smart Nation Singapore 2023)

2.3.3.3 Smart Economy

Smart Economy **helps transform and strengthen a municipality's economy by improving the overall business climate**, making a city more attractive for start-ups, investors, businesses, and talents. It grows the economy in an innovative and sustainable way to increase competitiveness, using mainly digital technology. The goal is to provide opportunities and conditions that support the creation and growth of businesses as well as new jobs. (Bee Smart City 2018) In Singapore, the government has organized the process of business grants and licenses on two websites (Business Grants Portal and GoBusiness Licensing Portal) to facilitate it to investors and businesses. A Smart Financial Centre is being created to keep up with the development of FinTech worldwide. With Singapore being one of the world's biggest financial hubs, this will allow financial institutions to adapt better to modern technologies, to be more efficient and to better manage risk. Other initiatives include a smarter way to trade and allowing

people to have access to government, banking, investment, and insurance data. The goal is to allow individuals and institutions to make better financial decisions. (GovTech Singapore 2019)

2.3.3.4 Smart Environment

Smart Environment refers to the **strategies employed by a municipal government to enhance the quality of life for both residents and visitors by effectively managing the built and natural surroundings**. The integration of cutting-edge technology plays a crucial role in implementing regulatory and cultural shifts that promote sustainable standards and practices. Key objectives of these initiatives include minimizing waste generation, monitoring and addressing pollution, reducing emissions, managing water resources, improving energy efficiency, and expediting the transition to local renewable energy sources. Smart Environment is connected to the concept of Smart Energy, which includes renewables, pollution control and monitoring, renovation of buildings and amenities, green buildings, and urban planning. (Attaran, Kheibari and Bahrepour 2021) An example of sustainable efforts can be illustrated by SolarNova Program, which was created for citizens to save energy and reduce electricity bills. This measure was first tested in areas such as Punggol Town and Northshore Residences I & II. (Cheong 2022) Urban planning has played an important role in Singapore, with goals such as bringing jobs closer to homes, reducing commute time, and improving public healthcare accessibility. This can only be achieved if urban planners possess rich data. “ePlanner” is a platform created to allow planners to access and analyze a big range of land-use planning information. (Urban Redevelopment Authority 2023)

The implementation of HDB Town Framework was key for a Smart Environment with measures to smart planning, environment, estate, living, and community. Also, the HBD Smart Hub helped with managing all estate operations.

2.3.3.5 Smart Mobility

Smart Mobility is centered around **enhancing the efficiency and quality of urban transportation, aiming to encourage the adoption and utilization of innovative mobility solutions**. By implementing effective mobility management strategies and making targeted infrastructure investments, Smart Mobility attempts to improve people's mobility options and experiences. (Bee Smart City 2018) Smart Mobility prioritizes clean and often non-motorized options. Relevant and real-time information can be accessed by the public to save time and improve commuting efficiency, save costs, and reduce CO² emissions. Mobility system users might also provide their own real-time data or contribute to long-term planning. ((Attaran, Kheibari et Bahrepour 2021)

The government of Singapore has established that 12% of Singapore total land would use for roads and infrastructure, which considering its small size and increasing population is a big challenge to face. As a result, sensors have been established to gather information regarding the activity of all bus public transport, leading to a decrease in terms of crowding issues and in the waiting time of its users. This allowed the government to gather real-time data and solve issues for the users, such as knowing the traffic conditions, taxi or car park availability and real-time data on bus arrival timings. Autonomous vehicles are another initiative on the rise, which currently has been having a great development and is already working in the Gardens by the Bay (Kelleher 2017) and inside the Nanyang Technological University. (2getthere 2023) The goal is to establish these vehicles in all Singapore to provide more comfort to the general population.

2.3.3.6 Smart People

The concept of Smart People evolves around **having access to education and training within a society that improves creativity and fosters innovation**. (Attaran, Kheibari et Bahrepour 2021) It aims at transforming the way citizens interact with the public and private sectors as

individuals or businesses. Talent development being an important factor for economic development, Smart People also helps facilitate career choices, labor market opportunities, vocational training as well as lifelong learning for all age groups and demographics; all of this by creating an accessible and inclusive environment. (Bee Smart City 2018) The government has been investing in its residents in initiatives such as the CentEx, where specialist engineers are being created to support the government. Data Science, AI, IoT and other innovative technologies have been studied and developed in this area, so that later they can be applied in the city. This initiative aims to allow the government of Singapore to “*think big, start small and act fast*” when it comes to adapting to technological innovations. (Smart Nation Singapore 2023)

3 Methodology

This chapter outlines the research approach taken in the Field Lab and the framework used for empirical research to select a suitable European city. A qualitative research method was used to understand how Singapore became a successful Smart City and if its success factors can be applied to a European city. The chapter also explains the quantitative aspect of the research, including how quantifiable indicators were used to select a European city.

3.1 Qualitative Research

3.1.1 Expert Interviews

Interviewing is considered the most common form of qualitative research, in which the researcher, i.e. interviewer uses a flexible process to gather information from the interviewees’ perspective. (Jamshed 2014) Interviews can be categorized between structured, semi-structured and unstructured. (DiCicco-Bloom and Crabtree 2006)

The method used for expert interviews in this field lab is semi-structured, where the respondents were asked a series of predefined open-ended questions, generally lasting from 30 to 90 minutes. The interviews were structured with an introductory open question concerning Singapore as a Smart City, leading into the core component of the interview which were questions focusing on the six dimensions of Smart Cities defined in chapter 2.3.3. The questions specifically touched on the success factors of each dimension and initiatives that exemplify Singapore's performance (find the full interview guide in Appendix 1). Towards the end of the interview, if the time allowed it, the general applicability of success factors to a European city was discussed. Additionally, the interviewer also asked follow-up questions that emerged from the topic to give the interviewee the freedom to voice criticism or speak about aspects that weren't specifically asked about. The interviews were generally conducted with one individual, but some of them were also in a small group, which allows the researcher to gain a wider range of insights, while the individual interview allowed a more in-depth exchange. (Bryman and Bell 2015)

The approach for finding an interviewee was that they primarily had to fulfil two criteria: be an expert in Smart Cities plus have experience in Singapore or specific knowledge about the City-State. A total of 70 experts were contacted, which resulted in 13 interviews with 16 experts. A detailed list of the experts with their experience can be found in Appendix 2. To achieve a truly comprehensive overview of the topic and differing opinions and perspectives, experts were selected from a variety of different fields, including academia, research, the private sector and government institutions. Depending on their experience, each interviewee focused more specifically on certain topics and dimensions and was more or less critical of Singapore's success.

Additionally, the ethical aspect of qualitative research was respected in this study by informing the participants about the reason for the interview, asking them for their consent to be recorded and offering them anonymity.

3.1.2 Data Analysis

The study used grounded theory as a method to systematically collect and analyze qualitative data. (Kawulich 2005, 2) A verbatim transcript of all interviews is available in Appendix 3, and central themes were detected and summarized in an Excel sheet. The data was continuously analyzed, compared, and reanalyzed to ensure connections were being made and differences detected. The findings reviewed in Chapter 4 provide the basis for the individual sections of the field lab, focusing on applying the success factors.

3.2 Quantitative Analysis

Although the research approach used in this project was primarily qualitative, a quantitative approach was employed to determine the most suitable European city for implementing the success factors observed in Singapore. Quantitative research is a valuable method for measuring and quantifying variables and their relationships through statistical analysis. (Bryman and Bell 2015) By utilizing existing data from various sources and datasets, the approach allows for cross-examination and comparison to arrive at a well-supported conclusion. (Thattamparambil 2020) The goal was to select a city that not only meets the necessary criteria for implementing the success factors but also seems to benefit the most from their implementation. The full process is described in detail in Chapter 5, including the reasoning behind each step and how thresholds were chosen for specific criteria to eliminate cities and move to the following stage.

4 Findings of the Empirical Research

This chapter presents an overview of the key findings from the empirical research conducted through interviews with 16 experts. The analysis was conducted across six Smart City

dimensions and three additional categories such as Singapore's country specifics and Critical Aspects, which are of special interest to this Field Lab. While the primary objective was to identify the success factors of Singapore as a Smart City, it is acknowledged that there are also critical aspects that need to be considered. However, due to the focus on success factors, this chapter only briefly touches on controversial aspects without delving into an in-depth discussion.

4.1 Singapore's Country Specifics

Despite its initial disadvantage of limited natural resources, since gaining independence Singapore has been extremely competitive in becoming the "*top dog of south-east Asia*". (Expert Interview 9, p. 3) By focusing on developing cutting-edge technology, Singapore has turned itself into an agile laboratory to test the latest and newest development with top-tier partnerships in academia. (Expert Interview 7 & 8) Singapore's strong partnerships are not confined to academia, as the country also has strong ties with the private sector, allowing for collaboration and co-creation. (Expert Interview 4) Many of these partnerships draw on successful initiatives from Europe, which Singapore has adapted and scaled to achieve success in the City-State. (Expert Interview 7)

The Central Role of Singapore's Government

The government is the central driving force behind Singapore's achievements, amidst all the partnerships. (Expert Interview 7) Singapore has achieved administrative success and consistently ranks highly due to the government's consistency. (Expert Interview 13) Their consistency in policies mainly focused on using technology to make the city more efficient, but also providing the citizens with public housing and economic stability and safety. (Expert Interview 2) For the Singaporean government a key advantage is their significant control over multiple levels and sectors of the City-State which allows quick and efficient policy

implementation, as demonstrated by successful initiatives in areas such as congestion avoidance, water management, and infrastructure. (Expert Interview 3 & 2) While in most of Europe the same governmental style would be considered undemocratic, would be highly criticized and unlikely to succeed; it is generally supported by Singaporeans through their compliance and homogeneity, as highlighted in Expert Interview 9. Although in Singapore a contributing reason for their high compliance amongst citizens can be attributed to the trust Singaporeans have in their government to act in their best interests and secondly, the significant economic growth. (Expert Interview 8)

Economic Growth through Immigration

Singapore's economic growth is significantly influenced by the influx of highly skilled immigrants from diverse countries, including a considerable number of Chinese migrants. (Expert Interview 2) The government's focus on racial harmony and a stable economy, along with attractive opportunities in the well-paid public sector, has played a significant role in attracting talented individuals to the country. (Expert Interview 3 & 11) These factors have contributed to Singapore becoming a densely populated and urbanized nation with favourable economic indicators, as noted in Expert Interview 11.

4.2 Smart Governance

Singapore is a City-State that has achieved success in digitalization and technology adoption. The government has been leading the way in digitalization, creating numerous apps, and collecting data to build the foundation for the industry to follow. Initiatives have been launched to help small and medium-sized enterprises to digitalize, increasing productivity. (Expert Interview 1) The country places a huge emphasis on tracing data, which makes a big difference in the technology used for Smart Cities.

The government follows the triple-A concept, which stands for Authority, Acceptance, and Ability. (Expert Interview 5) Singapore is a test environment for the best technology and has a clear understanding of how its systems need to work offline, which makes it easy to transfer them to online platforms. Singapore's government is efficient, effective, capable, stable, and has high continuity, which makes long-term planning easy, however, there is a lack of democratic accountability. (Expert Interview 10)

Singapore's Digital Transformation

Singapore has a roadmap envisioning the country's future, and the government looks far ahead to see opportunities with a digital mindset. There is a mix of looking at big data and hearing the voices of citizens, which helps in making the initiatives more responsive and inclusive. (Expert Interview 1 & 6) The Covid-19 pandemic acted as a spur to innovation and citizen engagement, establishing digital payments for hawkers. Government activities that were previously outsourced to private sector vendors were actively insourced again to avoid lock-in or vendor contracts. The success of Singapore's digital transformation is due to the compliant community, close relationship/collaboration with the private sector, and availability of IT engineers. The government has set up the GovTech program, an implementing arm that provides the digital and technological backbone to enable the implementation of systems. (Expert Interview 12) Another technology related department is the Smart Nation and Digital Government Office (SNDGO), which is a digital office that works closely with multiple departments and ministries to provide consultation on IT projects and accelerate their development. It is strategically positioned under the Prime Minister's purview, enabling it to effectively drive digital transformation efforts across the government. (Expert Interview 10, 12 & 13)

In summary, Singapore has achieved success in digitalization and technology adoption due to the government's leadership and long-term planning, the availability of IT engineers, and its

engaged community. The government has a roadmap envisioning the country's future and is constantly looking for opportunities with a digital mindset, reaching out to citizens and collaborating with the private sector to achieve its digital transformation goals.

4.3 Smart Mobility

Mobility plays a crucial role in any city's functioning and Singapore is no exception. The state-run and non-profit mobility system in Singapore has proven to be very efficient for citizens. It is the heart of the city, fundamental for the development of the Smart City and for the economy of Singapore to work. (Expert Interview 12) The small size of the island makes it easy to have an interconnected public transport system. Moreover, public mobility is encouraged by the government through costly car ownership (expensive Certificate of Entitlement), high tolls, high gas prices, and by having a well-connected and cheap public transport system (below a dollar per travel). However, it is a money-losing industry that is subsidized by the government. (Expert Interview 3, 5 & 9)

Land Transport Authority (LTA)

An example of a successful initiative created by the government in terms of implementing technology and improving transportation in Singapore would be the Land Transport Authority (LTA). For example, LTA has developed a fleet management system that allows them to track, control and regulate data related to transportation. Additionally, it collects different types of data and makes it available to the public, such as information about bus routes, timings, and traffic conditions. For instance, if there is an area with more elderly people or school kids, LTA can use this information to influence infrastructure decisions and improve the overall transportation experience for those specific citizens. (Expert Interview 12)

Mass Rapid Transportation System (MRT)

Another successful initiative in the field of mobility is the Mass Rapid Transportation System (MRT). This system has “an elastic limit when it comes to the Mobility City” (Expert Interview 8, p. 4), which means it can either go underground or above ground as needed. When there are no more possibilities of extending the mobility system of Singapore on surface land, the solution comes to build it underground or overground. The city has also been exploring the use of air mobility, such as electric drone taxis, which can seamlessly transition passengers from one mode of transport to another. (Expert Interview 8)

Autonomous Vehicles (AVs) & Electric Vehicles (EVs)

Additionally, Singapore is also a leader in autonomous vehicles (AVs), even though the small population means its market is not very significant. AVs and EVs have high importance in Singapore because of a reduction in policies for owning private vehicles. Moreover, private mobility policies in Singapore encourage innovation, which also includes the development of electrical vehicles and their charging stations. (Expert Interviews 5 & 7)

Overall, Singapore's mobility system is unique and aims at making life easier for its citizens while also contributing to the city's economic growth.

4.4 Smart Environment

Singapore has taken various initiatives to address the existential crisis it is facing due to issues such as floods, heat, and water scarcity. While the recycling rate is high in the industry sector, it is very low in private households; there is a need to create awareness and educate people on the importance of a more sustainable lifestyle. (Expert Interview 1) The country has introduced Smart Waste Management systems in housings that “sucks in waste into a system of collection instead of being picked by a truck” (Expert Interview 2, p. 6), using underground tubes and

after is forward to appropriate places. In addition to high-tech, AI, and big data approaches, frugal, low-cost innovation and nature-based solutions are also needed. (Expert Interview 3)

The Role of the Government: Marina Barrage & Punggol District

The government has introduced several initiatives to promote a circular economy, manage water resources effectively, and maintain its corporate social responsibility. The country focuses on air, water, waste, and greenery, particularly recycling water through rainwater collection. Marina Barrage is an excellent example of how infrastructure can be smart and benefit people while also addressing environmental concerns, such as water conservation. The Punggol district is another example, which has implemented innovative solutions such as sensors to monitor energy use and solar energy. (Expert Interview 6) The country emphasizes urban greenery, as plants in buildings can significantly reduce pollution particles. Singapore is working towards measuring the green quantity and the value of trees in comparison to other plants. It uses big data to measure and monitor environmental changes. (Expert Interview 9)

However, Singapore is not the most environmentally friendly, as the convenience and tourism it offers come at the cost of nature. Singapore primarily focuses on big-picture, high-profile, top-down solutions that make the right kind of noise. There is little emphasis on citizens and behavioural shifts at the ground level, such as reducing the use of single-use plastics. One possible reason for this is generational; it takes a generation of children to go through school and be socialized in a particular way. (Expert Interview 10 & 12)

Despite this, Singapore has strict enforcement laws, such as banning littering and chewing gum, which make people conscious of their environmental impact. (Expert Interview 9) The country also aims to manage greenery as an infrastructure, such as by digitalizing trees as assets and creating a greenery database. Greenery technologies, such as remote sensing, can detect structural defects in trees and environments, and identify risk factors. Moreover, with the

development of new technologies, it has jumped on the bandwagon of digitalization and the Internet of Things (IoT) to improve the design of environmentally friendly infrastructures. Technology can do a lot of things, but it needs to be aligned with legislation, regulations, and business models. (Expert Interview 8 & 12)

Overall, Singapore is making efforts to create a sustainable future through innovation and technology while balancing the convenience and tourism it offers.

4.5 Smart Economy

The economic landscape in Singapore is full of contrast: on the one hand one can find the regional headquarters of big tech firms, on the other hand, there are a lot of small and medium-sized enterprises, far away from digitalization. (Expert Interview 1) Also one can see that income is unevenly distributed across Singapore's population due to the contrast between highly educated and low-skilled workers. (Expert Interview 11)

One of the key factors why Singapore was very focused from its beginning to improve its overall business climate and strengthen its economy is due to the history of being a port city, with few natural resources. This disadvantaged starting point forced the City-State to focus on becoming Southeast Asia's hub for technology and innovation – the strategy is *“focusing on things where they can win the battles they are fighting”*. The mindset to constantly innovate comes out of the necessity, to be able to compete with their neighbour countries, despite the geographical context the island is located in. (Expert Interview 9, p. 3-4)

The Role of Government in Fostering Entrepreneurship and Innovation

As already discussed before, Singapore as a City-State has control over various layers (e.g. taxation policy, immigration policy, ...), which they can use to drive the economy in a way that follows the long-term vision. (Expert Interview 3) Policies, that support cutting-edge technology have the priority to be implemented rapidly. (Expert Interview 7) This means, that

in Singapore the government itself is a main driver of innovation and entrepreneurship, in contrast to the presumption that often exists in Western countries, that innovation comes from the private sector and the public sector is lagging. (Expert Interview 10) For instance, it is the mission of the Economic Development Board (EDB) to strengthen the industry, by both bringing in international companies and connecting them with local opportunities and business partners. (Expert Interview 12) Besides that, the government does not only drive the local ecosystem by providing productivity grants for digitalization efforts and tax incentives (Expert Interview 1), but also by supporting entrepreneurs with funds for Start-Up incubators, Mentorship and Networking (Expert Interview 3) and subsidizing companies and entrepreneurs to build long-term connections. (Expert Interview 7)

Singapore's Stable and Regulated Business Environment

Singapore is dependent to bring in foreign companies, as the City-State has a very small economy, and international investors provide both funding and expertise. (Expert Interview 6) Singapore has emerged as a key business hub for Southeast Asia; there are several factors that contribute to Singapore's attractiveness as a business location. Firstly, the government provides regulations and tax incentives that neighboring countries cannot match. (Expert Interview 9) Secondly, Singapore's political stability is a major advantage, providing a reliable business environment. (Expert Interview 10) Finally, the City-State provides a diverse and highly skilled workforce, offering businesses a competitive edge in the region. These factors have combined to make Singapore a leading destination for businesses seeking to establish a foothold in Southeast Asia. (Expert Interview 9)

Building a Skilled and Talented Workforce

Another critical component of Singapore's Smart Economy is its ongoing commitment to workforce training and development. Given Singapore's relatively small workforce and its aim

to keep unemployment rates low, the government seeks to ensure that all citizens remain active and productive members of the local economy. In addition, attracting foreign companies requires a workforce that can meet the specific skill demands of those companies. (Expert Interview 1) Thus, the government invests heavily in education and training programs to equip workers with the necessary skills and knowledge to succeed in the modern economy and attract the best talent on an international level. (Expert Interview 5)

4.6 Smart People

A Smart City is one that mobilizes the intelligence of everybody, “*from the seven-year-old child to the 70-year-old grandparent*” (Expert Interview 8, p. 2), a Smart City is led by smart citizens. (Expert Interview 4) It is all about supporting citizens to engage in society, fostering their creativity and driving innovation and entrepreneurship.

Singapore's Solutions to Digital Inequality

With most government services now available online, there is a growing concern that certain segments of the population may be left behind and unable to access these services. To address this issue, the Singaporean government has implemented several initiatives aimed at creating a more inclusive and supportive environment for those who may struggle with the use of technology. (Expert Interview 10) For instance, the Smart Nations Engagement program specifically targets vulnerable populations such as the elderly and those with limited access to digital devices, offering them training and support to build both acceptance and technical skills. (Expert Interview 5)

Building a Culture of Continuous Education for All Ages

In addition to adult training programs, the education system in Singapore also plays a critical role in preparing future generations to become “smart”. From a very early age, children are exposed to technology and learn to work with tablets as part of their schooling. The system is

known for being highly competitive and elitist, with a focus on identifying which industries are likely to be most relevant for Singapore's economy and then working backwards to prepare young people accordingly. (Expert Interview 10) Despite this, the government is committed to bridging the gap between social classes and providing resources to underprivileged families to ensure that everyone has access to the technology needed to succeed. (Expert Interview 12)

Furthermore, Singapore offers scholarships to its top-performing students to study at the world's best-ranked universities and successfully retains some of its brightest graduates to work in civil services, which contrasts with other countries where top-performing students often opt to work in the private sector. (Expert Interview 6) The government's ability to offer competitive salaries and career opportunities has resulted in a talented and motivated public service sector that is seen as best practice for governments internationally. This, in turn, has contributed to the success of Singapore's Smart City by ensuring that highly skilled individuals are involved in decision-making processes and implementing innovative ideas. (Expert Interview 3)

4.7 Smart Living

For this Smart City dimension, there are two main areas covered by experts: Health and Housing. While health innovations focus on improving quality of life, the Public Housing system in Singapore has been praised for driving upward mobility, promoting community building, and providing stability for the City-State.

Gathering Information to Improve Digital Health Services

Over the years, Singapore has made significant progress in its healthcare system, with the recent COVID-19 pandemic acting as a catalyst for change, particularly in the adoption of remote consultations. (Expert Interview 10) The HealthHub, an all-in-one online platform, has been a major step towards providing citizens with easy access to their medical records and health-related information. This system also allows authorized users to access the health data of their

loved ones, such as children or partners. Even though each healthcare provider has their own app, they still draw data from the same overarching system. (Expert Interview 3) Moreover, the HealthHub system provides the government with a better overview of the general health trends, enabling them to make informed decisions about healthcare policies and offer timely pre-diabetic consultations or encourage healthier eating habits. (Expert Interview 12) Another noteworthy initiative aimed at promoting healthy habits among Singaporeans is the national 10,000-step challenge, where the government provides its citizens with smart trackers to monitor their daily activity levels. By achieving the daily step target, individuals can earn points which can be redeemed for rewards such as free coffee coupons. (Expert Interview 1)

Singapore's Public Housing System: A Long-Term Vision for the Future

In Singapore, most citizens (around 80%) reside in public housing units managed by the Housing & Development Board (HDB). (Expert Interview 5) This housing system is considered a foundational aspect of Singapore (Expert Interview 3) and is renowned for its effectiveness in driving upward mobility. (Expert Interview 5) It is not only deeply embedded in the local culture but also provides stability and obligation for the City-State. (Expert Interview 1) Due to the limited land availability, the government designs and manages the city's population density. (Expert Interview 2) Public housing units are designed to promote community building and integration, with local councils and communities working together to drive collective intelligence. (Expert Interview 3) However, not all groups have equal access to subsidized housing, with some minority groups facing challenges in purchasing housing at a subsidized rate. There is also a racial quota policy where a certain percentage of public housing is reserved for specific ethnicities to prevent segregation and ghettos: 70% of housing belongs to Chinese, 15% to Malays - the rest is for Indians and other minorities. (Expert Interview 6)

What makes the Singapore housing model unique is the standard of homeownership, with almost every young couple able to purchase their home through the well-developed mortgage system. Still, it is essential to note that Singapore is not a welfare state. (Expert Interview 6) The housing system follows a clear long-term vision to build a sense of ownership, identity, and citizenship among its residents. (Expert Interview 1) The government aims to prevent brain drain and promote community support, encouraging filial piety by incentivizing couples to purchase homes near their parents with increased subsidies. (Expert Interview 6)

Integrating Technology into Public Housing

Public housing in Singapore has come a long way and now integrates advanced technology to improve the living standards of its residents. (Expert Interview 1) In terms of sustainability, public housing is also designed with green features, such as rainwater collection and recycling systems. (Expert Interview 5) Furthermore, Singapore is making efforts to be more inclusive by integrating IoT sensors in homes. These sensors allow residents to get help for various issues, including medical assistance or translation problems, with just a press of a button. (Expert Interview 12)

4.8 Critical Aspects

Although the interview's primary objective was to uncover Singapore's success factors, the interviewees were granted the liberty to criticize the Smart City model and its policies.

One of the main issues highlighted was the government's data collection, which is required to create a digital twin⁶ of the City-State. Refusal to comply with data collection could result in being excluded from the city's system and benefits, demonstrating that the compliance and

⁶ As part of Singapore's Smart Nation project, a data-rich digital twin of the country has been made to improve urban planning and design. The digital twin is called "Virtual Singapore" and is the first of its kind.

acceptance of citizens are essential factors to gain from Smart Initiatives introduced by the government. (Expert Interview 1) Despite the availability of ministries for feedback on privacy concerns, the extent of feedback is questionable, and citizens experience considerable stress due to the authoritarian nature of the government. (Expert Interview 9 & 6)

Inequality was also critically mentioned, as with the example of mobility, public transport was praised, but car ownership's limitations and high costs were discussed, (Expert Interview 5) due to the status and exclusivity associated with owning a private vehicle, as they are only a viable option for the very wealthy. On the hand further alternatives aside from vehicles aren't as attractive and accessible for most citizens, for example cycling. (Expert Interview 3 & 9) Thus there is a noticeable economic divide between the average citizen and the wealthy, (Expert Interview 3) but also for other minority groups, such as the LGBTQ+ community, as they struggle to find public housing, due to them not conforming with traditional Singaporean family values. (Expert Interview 5 & 6)

Lastly, Singapore's status as a leading Smart City was disputed as the governmental policies prioritised technological advancement, which has overshadowed the fundamental aspect of including, especially engaging citizens to improve their lives. (Expert Interview 8 & 9) In recent years, Singapore's urban development policies have moved away from a high-tech focus and instead prioritized people-centric solutions that are tailored to the city's unique context. The priority now is to “*emphasize [...] citizen participation*” (Expert Interview 4, p.3) and create more responsive city that meets the needs of its citizens more effectively. (Expert Interview 7 & 8)

5 Selection of a European City

5.1 Funnel Process



Figure 4: Funnel Process Criteria

The quantitative aspect of this Field Lab aims to establish a Funnel Process that identifies the most suitable European city for comparing and analysing the success factors observed in Singapore. Singapore, as a Smart City and Smart Nation, serves as an exemplary model for our study, particularly in the context of Smart City development. However, it should be noted that the research of this Field Lab is specifically

focused on European cities and not nations, as we seek to apply the lessons learned from Singapore to urban centres within the European continent.

5.1.1 Choice of Cities

As a start of this funnel process, the cities were chosen based on the Smart City Ranking 2023 of the IMD Smart Cities Index Report of 2023, which rates the cities according to their performance and provides a comprehensive overview of the most relevant and significant cities for applying the Smart City model. This index was an ideal starting point as all ranked cities in the index offered abundant data for comparing different cities and efficiently evaluating them through our funnel process. (IMD 2023) This ranking contains 141 cities worldwide, Singapore being positioned the first Asian city in the ranking for the past three years. As a start of this data analysis, a total of 50 European cities was picked out to compare them to the data of Singapore. These 50 cities are all the European cities available from the International Ranking. The Excel

therefore amounts to 51 cities total including Singapore.⁷ It is important to note that the ranking of the cities in the Smart City Ranking will not influence the choice of the final city in the Funnel Process, it is just used to make a first city selection. In the following chapters, we will examine the various filters that have been selected for the Funnel Process (available in Appendix 4, Figure 10), and their implementation to determine the ultimate European city to compare with Singapore.⁸

5.1.2 Population Density

As urbanization continues to increase globally, the development of Smart Cities has emerged as a potential solution to address the associated challenges. Given this context, it is important to begin the Funnel Process by considering the population and density of the cities in question. Following the expert interviews, Singapore was identified as a successful model for Smart Cities due to its high population density. Therefore, it is essential to filter cities with low population densities, as high density is a necessary factor to face the challenges of rapid urbanization. Singapore shows a very high and extreme number compared to all European

	Singapore	European Average
Population Density	8,480 people/km ²	5,077,3 people/km ²

Figure 5: Population Density in Singapore and Europe

cities, therefore, the average population density of European cities will be used as a benchmark to make the first filter as accurate as possible. (see Figure 5) Cities falling below this threshold are excluded from the analysis. This filtering process has resulted in a final selection of 17 cities, Singapore not included. (The entire figure with all cities listed can be found in the

⁷ Luxembourg was taken out of the ranking since it was added in 2023 and therefore misses comparison data, as well as Ukraine due to the recent events from the past year.

⁸ The entire final Excel Process can be found in the Appendix 4, Figure 16

Appendix 4, Figure 12) This initial broad filter is a common practice, aiming for precision in subsequent stages of the funnel process.



Population Density

After filter - 17 European cities left: Amsterdam, Athens, Barcelona, Bilbao, Bordeaux, Brussels, Bucharest, Geneva, Lille, Lisbon, London, Lyon, Madrid, Milan, Paris, Stockholm and The Hague.

5.1.3 Technology

Ranking (from best to worst)
AAA
AA
A
BBB
BB
B
CCC
CC
C
DDD
DD
D

In Singapore, technology has been identified as the most significant success factor for its Smart City transformation, forming the core of its development. While there is a perception that the city is sometimes overly focused on technology at the expense of people, Singapore's impressive rankings in the technology sector cannot be overlooked. As we seek to recreate some of Singapore's success factors in a European city, it is imperative that the selected city possesses the necessary technological infrastructure. For this, the Technology sector from our IMD Smart City Ranking Index 2023 will be useful. Indeed, all cities have their Technology scale classified into 12 different categories, AAA being the highest score and D being the lowest.

This Technology pillar is solicited by the perception of residents, describing the technological provisions and services available to the inhabitants. Given that Singapore has a Technology sector ranking of A, it is desirable for our chosen European city to have a relatively high score. We therefore eliminate all cities falling within the second quartile of the technology ranking scale (Group 2), which includes cities with a ranking of C or below. This filter removes Athens, Lisbon, Lille, and Bordeaux from our list of possible cities. After applying this filter, we are left with a final selection of 13 European cities.



Technology factor

13 European cities left: Amsterdam, Barcelona, Bilbao, Brussels, Bucharest, Geneva, London, Lyon, Madrid, Milan, Paris, Stockholm and The Hague.

5.1.4 Political Environment

In order to properly plan and develop a Smart City for the long-term, it is important to take into consideration the political environment of the country in which the city is located. The political environment is measured by the Global Innovation Index, composed of two indicators. First, it measures the political and operational stability, measuring how the government can foster growth. (Index, What is the future of innovation-driven growth? 2022) And second, the government effectiveness indicator, which evaluates the quality and prosperity of the government and its policies. Singapore is an exemplary model that has flourished due to its stable political environment and strong focus on its Smart City development, which has been able to attract multinational and private companies.

Therefore, for a European city to become a leading Smart City, it must meet Singapore's standard for a politically stable environment that fosters necessary growth and development. Singapore has the highest possible score of 100, and the elimination threshold for European cities is calculated by taking the combined average of their scores and removing all cities falling below that average. Spain, Italy, and Romania fall below this average and do not meet the necessary requirements. As a result, Bilbao, Madrid, Barcelona, Milan, and Bucharest are eliminated, leaving a shortlist of eight European cities.



Political stability

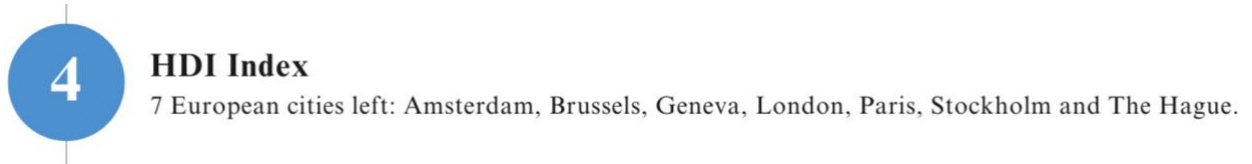
8 European cities left: Amsterdam, Brussels, Geneva, London, Lyon, Paris, Stockholm and The Hague.

5.1.5 HDI Value

To refine the selection process, we have chosen to focus on more specific metrics next, starting with the Human Development Index (HDI). This metric is a composite measure of a country's average achievements in three fundamental dimensions of human development:

1. **Life expectancy Index:** A long and healthy life, as measured by life expectancy at birth.
2. **Education Index:** Knowledge, as measured by mean years of schooling and expected years of schooling.
3. **GNI Index:** A decent standard of living, as measured by GNI per capita in PPP terms in US\$. (Human Development Reports 2021)

Using Singapore as a benchmark, with a value of 0.939, all cities that have a lower HDI Value than Singapore are eliminated, resulting in Lyon being eliminated.



5.1.6 Digital Readiness

Singapore is a city that prioritizes digitalization and phone usage for years. It is the fifth highest mobile internet user penetration rate in the world after Bahrain, United Arab Emirates, Kuwait, and New Zealand; with a rate of 98.74% in 2022. (Statista 2023) This demonstrates the city's emphasis on digitalization and mobile phone usage. To apply Singapore's success factors to a European city, it is crucial that the city is also technologically advanced and digitally ready. Therefore, for the next filter in the Funnel Process, Mobile Internet User Penetration rate is used as a measure of digital readiness. The average Mobile Internet User Penetration rate for

European cities is calculated and cities that fall below the average are eliminated. As a result, Paris and The Hague were eliminated from the list.



Digital readiness

5 European cities left: Amsterdam, Brussels, Geneva, London and Stockholm.

5.1.7 Unemployment Rate

Other than having a strong internet consumption, Singapore also has a very low unemployment rate (1,90% in January 2023). (CEIC 2023) It is important to find a European city that has a relatively low unemployment rate, as it guarantees a certain stability in the city and therefore involvement of the citizens in the country. The unemployment rate is given as a percentage number, for the country of each city. All countries with an unemployment rate under the European average are eliminated. Using the same average calculation, Brussels and Stockholm are excluded from the list of candidate cities.



Unemployment rate

3 European cities left: Amsterdam, Geneva and London.

5.1.8 Hofstede Analysis

After these six filters, the Top Three European Cities left are: Amsterdam in the Netherlands, London in the United Kingdom, and Geneva in Switzerland. The last filter of the Funnel Process will be a direct comparison to Singapore's cultural values to identify the European city that is culturally closest to Singapore since the aim of this Funnel Process is to find out to what extent Singaporean success factors can be applied to a European City. During expert interviews, it was also cited multiple times that for a Smart City to succeed, it needs to put the “we” before the “I” and have trust in its government system, especially when it comes to sharing data. This is a

topic Singapore is good at since they see data sharing rather as a protection and not a risk, which in Europe is more complicated to achieve. Therefore, based on the Hofstede analysis, a cultural acceptance and general mindset which is the closest to Singapore will be our final filter before the application of success factors from the Singaporean Smart City to a European city.

The Hofstede Analysis helps us to understand how societies differ in their values, behaviors, and beliefs based on a score of 0 to 100. One dimension is for instance “power distance,” which measures how people in a society accept and expect unequal distribution of power. A high score (between 50 and 100) indicates a society where people accept and respect authority, while a low score (0 to 50) suggests a more egalitarian society. By comparing Singapore to Switzerland, UK, and Amsterdam in cultural dimensions, the country's cultural acceptance and mindset can be determined to know which one aligns closely with Singapore's. This analysis guides us in identifying cultural compatibility and understanding how well certain success factors from Singapore can be applied to a European city.

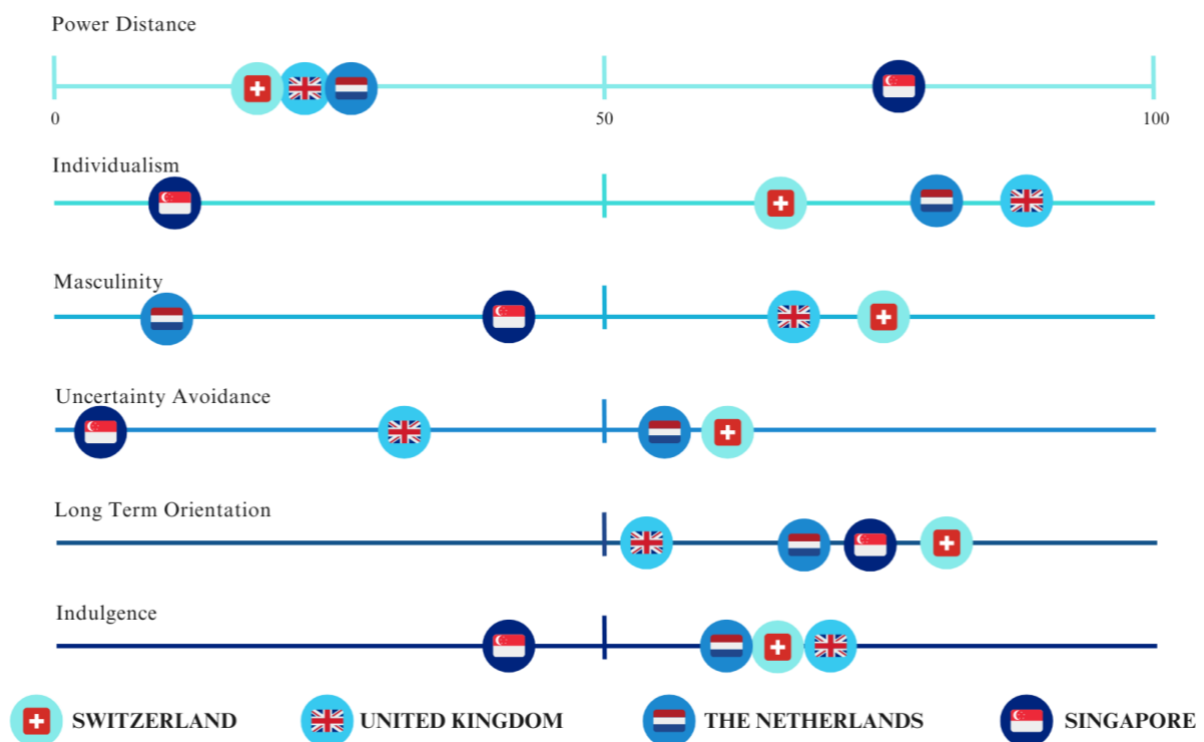


Figure 6: Hofstede insights for Singapore, The Netherlands, United Kingdom, Switzerland

After analyzing the results of the cultural distance in each dimension of the Hofstede Analysis, Switzerland shows only one dimension in common with Singapore - **long term orientation**. Since The Netherlands and United Kingdom both have two dimensions in common with Singapore, Switzerland is eliminated from the ranking, therefore the city of Geneva is eliminated, and London and Amsterdam are the two cities left.

For the United Kingdom, the common dimensions with Singapore are the **uncertainty avoidance** dimension, meaning the extent to which the members of a culture feel threatened by ambiguous or unknown situations; and the **long-term orientation** dimension, how every society must maintain some links with its own past while dealing with the challenges of the present and future. (Insights 2022) In these dimensions, Singapore and the United Kingdom collect a total difference of points of 48. For the Netherlands, the two dimensions that are in common with Singapore are the **long-term orientation** dimension and the **masculinity** dimension. Singapore and the Netherlands both have low masculinity, meaning that the dominant values in society are caring for others and having a good quality of life. By adding up the difference of points from the two dimensions, the total amounts to 39 points.

After analyzing the cultural difference between Singapore and the Netherlands and Singapore and the United Kingdom, we conclude that the Netherlands is culturally closer to Singapore than the United Kingdom or Switzerland.

5.2 Results

It is important to emphasize that while the Hofstede analysis influenced the final decision to decide between Amsterdam and London, it was not the sole determining factor. The selection process involved evaluating multiple criteria, including population density, technological advancement, political stability, the Human Development Index, digital readiness, and unemployment rate.

While London shares historical ties with Singapore, it is important to consider the current cultural proximity and relevance to the study. Amsterdam, with its vibrant and diverse cultural landscape, offers a closer cultural alignment with Singapore in terms of contemporary practices and challenges. This alignment enhances the potential for meaningful knowledge exchange and implementation of successful smart city strategies. These factors collectively led to the shortlist of Amsterdam and London. The reasoning for selecting Amsterdam over London as the final choice for comparison is influenced by several reasons. The first one is the **proximity to Mainland Europe**, as Amsterdam's geographical location provides a unique advantage as it serves as a gateway to mainland Europe. This proximity enables Amsterdam to be influenced by European policies and collaborate with other European cities, offering different perspectives and opportunities for cross-city learning and collaboration in the context of smart city development. The second one is the fact that Amsterdam is part of the **European Union Membership**. As a member of the European Union (EU), Amsterdam operates within the regulatory framework and benefits from EU policies and funding opportunities that support smart city initiatives. This EU membership can facilitate the exchange of best practices and create synergies with other EU cities, contributing to the advancement of smart city strategies. Furthermore, while both London and Amsterdam are major cities in their respective countries, Amsterdam's smaller size provides an advantage for **more focused research and analysis**. The manageable scale of Amsterdam allows for a more in-depth examination of its smart city initiatives and facilitates a comprehensive understanding of the factors contributing to its success. By considering these reasons, it becomes clear why Amsterdam was chosen as the final city for comparison with Singapore. The combination of its proximity to mainland Europe, EU membership, size and scale, policy innovation, and cultural proximity sets Amsterdam apart and makes it a suitable and compelling choice for this research project.

6 Building a Smart City: A Case Study of Singapore and Amsterdam

The capital of the Netherlands is part of the COROP region of Groot-Amsterdam and boasts an impressive profile as one of Europe's most bustling cities. Home to Schiphol Airport, one of the busiest airports in the continent, and the second-largest port in the Netherlands, Amsterdam has positioned itself as a hub for international trade and commerce. (Bowen 2020) Located in the western part of the Netherlands, Amsterdam is the largest and most populous city in the country, with a population of approximately 1.16 million people. While the population size of Amsterdam may be significantly smaller than that of Singapore, it is important to consider other factors such as population density. Amsterdam's relatively high density allows for concentrated urban development and the potential for efficient implementation of Smart City solutions.

Amsterdam is already a highly ranked Smart City, currently holding the 15th position in the Smart City Index 2023, which is based on a combination of hard data and survey responses. (IMD 2023) However, the objective of our process to choose a European city was not solely to identify a city that needs improvement, but to find one that has the potential to benefit from Smart City concepts based on specific indicators (see chapter 5, Funnel Process). Moreover, by comparing the two cities' approaches to Smart City development, we can identify similarities and differences in their strategies, policies, and practices, which can lead to valuable insights and recommendations for both cities. Therefore, the comparative analysis between Singapore and Amsterdam serves to build a bridge between Asia and Europe and promote knowledge exchange and collaboration in the field of Smart City development.

6.1 A Comparative Analysis of Amsterdam and Singapore's Smart Environment and Smart Mobility Strategies

Environment and Mobility are crucial dimensions in creating a sustainable and efficient infrastructure for a Smart City. This chapter is dedicated to exploring the Mobility and Environmental dimensions in a Smart City by focusing on Singapore's success factors in these areas and their potential applicability to Amsterdam. The chapter will explore the current state of smart initiatives in Amsterdam's environment and mobility sectors, highlighting several projects and their impact. Through analysing these examples and comparing them with Singapore's smart initiatives, the chapter will conclude on the potential for Amsterdam to learn from Singapore's success and improve its own Smart City efforts in these two dimensions.

6.1.1 Smart Environment: Exploring Sustainable Initiatives

The global environment is facing unprecedented challenges due to climate change, resource reduction, and pollution. These issues pose significant risks to human health, economic stability, and the natural systems on which we rely. To address these challenges and create a more sustainable future, there has been growing interest in the concept of a Smart Environment. Environment refers to the natural world around us, including living and non-living things such as air, water, plants, and animals, as well as human-made elements such as buildings and infrastructure. (Dictionary 2022) Smart Environment, as seen in 2.3.3.4, refers to enhancing the quality of life for both residents and visitors by effectively managing the built and natural surroundings.

6.1.1.1 Amsterdam's Environmental Situation

Amsterdam has been actively working towards becoming a more sustainable and environmentally friendly city. The city has set ambitious goals to reduce its carbon footprint, and by 2025, the city of Amsterdam plans on reducing its CO² emission by 40%; and 75% by

2040. (Jason Pomeroy 2017) The city has already demonstrated its aptitude for promoting sustainable transport options, such as cycling and public transport, and implementing measures to improve air quality. (City of Amsterdam 2021) Additionally, Amsterdam has been investing in renewable energy sources, such as wind and solar power. Indeed, Amsterdam's train network has been running on wind energy since 2017. (CNET 2017) While the city still faces challenges such as high levels of air pollution and congestion, it has taken significant steps towards a more sustainable future. Expert interviews showed that it is not sufficient for the government alone to drive initiatives, and that the citizens themselves must be involved. Amsterdam stood out as a city that prioritizes the well-being of its citizens over urban development. (Expert Interview 8) This reflects Amsterdam's commitment to educating its citizens on sustainable living and actively involving them in shaping the future of the city. This approach positions Amsterdam favourably to learn from other Smart Cities such as Singapore.

6.1.1.2 Common Smart Environment Initiatives in Singapore and Amsterdam

Making use of the natural resources

By transforming its environmental challenges into sustainable solutions, Singapore has been able to tackle problems such as flooding by utilizing water as a renewable energy source. The Marina Barrage is a prime example of how Singapore has developed smart infrastructure that not only benefits its citizens but also addresses environmental concerns. (Expert Interview 6) Amsterdam, which also experiences flooding due to heavy rainfall, has followed Singapore's lead by implementing similar smart initiatives on a smaller scale. This approach leverages the natural advantage of water resources to prevent flooding and reduce water waste. Amsterdam has multiple ongoing projects that aim to achieve these objectives.

The **Amsterdam Rainproof Program** is a significant initiative aimed at making Amsterdam more resilient to heavy rainfall and flooding and transforming the city into a more “spongelike”

environment by considering water management. The program is a collaboration between the municipality of Amsterdam, the water authorities Waternet, and various stakeholders with the goal of making Amsterdam completely rainproof by 2050. To achieve this goal, the program is working to implement a range of measures, including green roofs, rain gardens, and the creation of water storage spaces in public places. As an example, green roofs can be installed at the top of buildings or rooftop restaurants, promoting vegetable growth while holding back a significant amount of water for plants and cooling the roof. The program is also working to educate citizens about the importance of rainwater management and to encourage them to act in their homes and businesses. Since the creation of the Amsterdam Rainproof in 2014, the program has installed 2,600 green roofs; 7,300 m² of permeable pavement and 1,000 rainwater harvesting systems; and created 90 water squares. (Amsterdam Smart City 2016)

Another natural resource used as an environmental energy in both cities is **solar panels**. By harnessing the energy of the sun, solar panels generate electricity that can be used to power homes, businesses, and public infrastructure, such as streetlights and transportation systems. (The Economic Times 2023) Solar panels have an important role for Smart Environment, as they promote sustainability, efficiency, and energy independence. Singapore has been using solar panels since 2008, with a particular focus on installing them on public housing blocks. Over the years, Singapore's use of solar panels has expanded to include other public buildings and infrastructure, public transportation, and even floating solar farms on reservoirs. (Housing and Development Board 2021) Similarly, Amsterdam has implemented a solar panel program throughout the city, with a primary focus on residential buildings. The **Sun Coalition** program is a solar technology initiative aimed at ensuring every citizen has access to a solar panel on the roof of their home. By the end of 2022, this program aims to install 850,000 solar panels in the city. The success of this program is dependent on collaboration with the citizens of Amsterdam,

who must be willing to embrace this renewable technology to allow for widespread implementation throughout the city. (ZonCoalitie 2022)

Amsterdam's Existing Best Practices

Amsterdam shares many Smart initiatives with Singapore and can learn from its best practices. Singapore's Punggol District, which uses sensors to monitor energy use and promotes an ecosystem of innovators, represents a Smart Environment best practice. Similarly, Amsterdam has undertaken best practice Smart Environment projects.

The Amsterdam Arena – Johan Cruijff Stadium

A successful initiative carried in Amsterdam is the **Amsterdam Arena**, the largest stadium of the Netherlands located in the capital. Its big achievement is that it has been carbon neutral since 2015 thanks to its 4200 solar panels on the rooftop generating 930,000kWh, representing 10% of the stadium's annual electricity consumption. Other than using sun for its energy, the stadium also uses wind from the Oudendijk wind farm nearby. The Amsterdam Arena also uses the power from the district nearby for heating and the lake nearby for cooling. The seats of the stadium are made of sugarcane; and 280 recycled car batteries are stored as a backup power source for the stadium. This local storage is possible thanks to the in and out energy coming from and for the stadium and its surroundings. The energy collected from the stadium can also provide power to the surrounded neighbourhood when it is unused or when the districts are in need. (see Figure 7) This is a perfect example of a Smart Initiative, as it recollects every sustainable energy aspect, as well as assuring wellbeing for the customers and its outside neighbours.

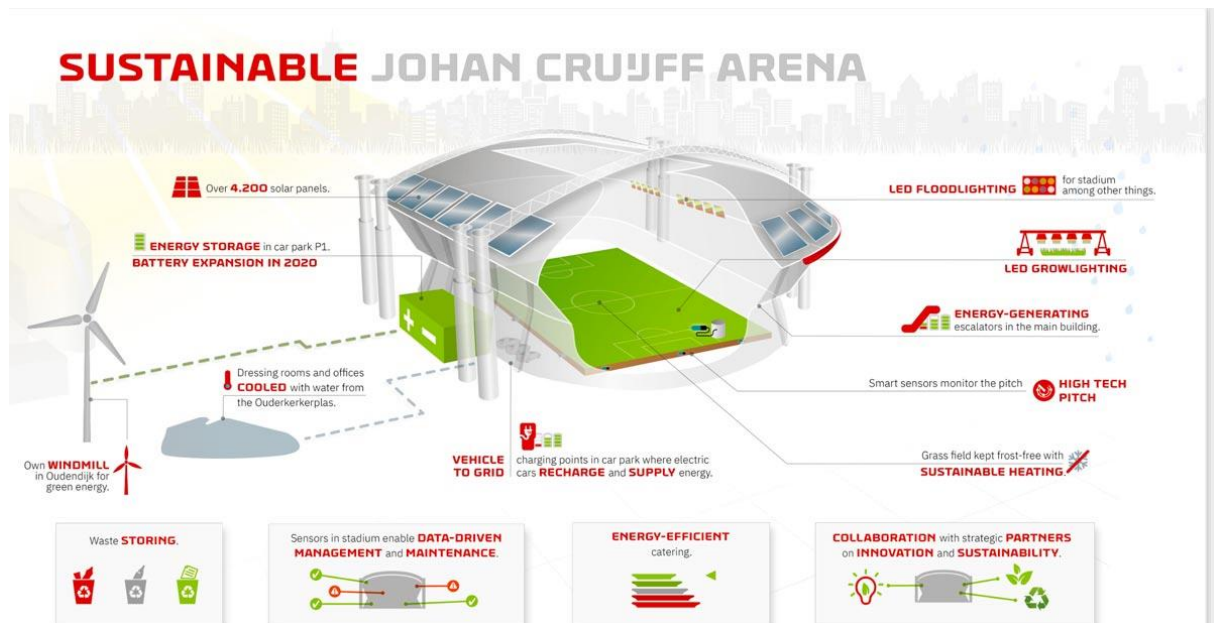


Figure 7: The Amsterdam Arena - Johan Crujff - and its sustainable solutions

The **Ijburg district** is a district where floating houses are at the centre of the project, reducing under-flood risk and rising sea levels. They have concrete basements to add a story to the house and protect from damage, and the amount of water underneath the house gives how much weight can be on top. One of the key features of the Ijburg district is its focus on sustainability and innovation. The district was designed to be energy-efficient, with a heating and cooling system that uses waste heat from a nearby power plant. The district also uses renewable energy sources, such as solar panels and wind turbines to generate electricity. In addition to its focus on energy efficiency, the Ijburg district has implemented several other initiatives to promote sustainability and livability. For example, the district has a comprehensive cycling network, with dedicated bike lanes and bike-sharing facilities, to encourage cycling as a mode of transportation. The district also has several parks and green spaces, which help to improve air quality, and provide habitats for wildlife. (Smart Cities Dive 2023) The Ijburg district is an example of how sustainable urban development can create liveable and resilient communities. The district's focus on energy efficiency, cycling, green spaces, and innovative housing projects has made it a model for sustainable urban development.

6.1.1.3 Smart Environment Initiatives: From Singapore's Success Factors to Amsterdam

Amsterdam has several Smart Environment initiatives in place, however, there are some success factors that Amsterdam could potentially adopt from Singapore.

Green buildings

One major consumption challenge for Amsterdam to conquer as a Smart City is buildings. Indeed, 70% of the energy consumed in the city is used for heating and electricity in buildings. (Jason Pomeroy 2020) Even though Amsterdam is working on including more natural resources for its energy consumption, an initiative that could be implemented from Singapore's approach is adding more green buildings to the city. **Green buildings** are structures that are designed and constructed to have positive impacts on the environment, while also prioritizing the well-being of occupants. These buildings must meet a set of criteria that includes for example the efficient use of renewable energy, good indoor air quality, the use of non-toxic and sustainable materials and the consideration of the environment in design. (KWEcoSolutions 2021) The implementation of green buildings in Singapore were inspired thanks to the Green Plan 2030, which targets to help tackle climate change, strengthening Singapore's commitments under the UN's 2030 Sustainable Development Agenda and Paris Agreement, and positioning itself to achieve long-term net zero emissions aspiration by 2050. (Green Plan 2023) This plan includes different key targets, such as having planted 1 million trees by 2030 and for every household to be within 10 minutes of a green space; for citizens and businesses to adopt a more sustainable practice; for at least 30% of schools to be carbon neutral by 2030 and to reduce household water consumption by 130 litres per day, to target having 60,000 EV charging points by 2030 and to create a new sustainable program to help local enterprises to adopt sustainable practices. (Dwilde Consulting 2021) To illustrate one of these key targets, as of 2022, there were 6,531 electric vehicles registered in Singapore, equivalent to 0,65% of all vehicles in the country.

Singapore has already constructed green buildings all around the city such as the NTU School of Arts, Media & Design, the Park Royal Hotel, or the Oasia Hotel.



Figure 9: The Royal Park Hotel - Singapore



Figure 8: NTU School of Arts, Media & Design - Singapore

The implementation of these buildings could be a new target for Amsterdam in districts that do not touch the old city center, such as Zuidas, known as the “FinancialMile”, where office buildings could be constructed as greener, or Amstel III, which is currently undergoing significant redevelopment. (A map of the city of Amsterdam can be found in Appendix 12) As Amsterdam has already started to implement green rooftops such as the RainProof program, green buildings is a viable solution for the city to reduce energy consumption.

Smart Waste Management

Another success factor to promote ecological sustainability already implemented in Singapore is **Smart Waste Management**, a modern and advanced method of managing and collecting waste. It utilizes IoT (Internet of Things) technology to gather information on waste generation patterns and behaviours. This enables municipalities, cities, and waste collectors to enhance their waste operations, promote sustainability, and make informed decisions regarding their businesses. (Nord Sense 2022) The use of sensors to measure the fill level of containers, providing real-time updates and optimizing waste collection routes would minimize the need for staff and enable alerts for undesirable incidents through GPS features. (Evreka 2023) Singapore has been using the **Centralized Monitoring System** for recycling bins since 2019

and the **Smart Bin Pilot Programme** since 2018 to monitor the level of bins and send alerts when collection needs to be done, as well as **Automated Waste Collection System (AWCS)** in some of its high-rise buildings, which helps transport waste directly from individual households to a central collection point. (Housing and Development Board 2023) The citizens are also involved as they can follow a mobile application that makes it possible to locate nearby bins and report if there is any issue with them. Here again, **citizen engagement** comes out as important to a Smart City. (Eco Business 2019)

Overall, Smart Waste Management reduces the need of waste collection staff and reduces the carbon footprint. This system could be implemented in Amsterdam to improve waste management efficiency and reduce the environmental impact of waste disposal, instead of just using underground garbage containers. This initiative goes hand in hand with the **Zero Waste Masterplan**, which aims to reduce the amount of waste sent to landfills through recycling and waste reduction. (Towards Zero Waste 2023) Amsterdam could adopt this initiative by implementing waste reduction, recycling, and waste-to-energy initiatives to reduce the amount of waste sent to landfills and improve the city's environmental sustainability. Finally, an initiative that could be implemented from Singapore to Amsterdam is to **ban littering**. This initiative of banning littering and chewing gum took place in Singapore in 1992 and made people more aware of their environmental impact for the next generations, making the city clean and sustainable on the long term. Even though banning is a complicated approach from country to country, Amsterdam has started to ban littering since 2016 with a fine of €150EUR. This is nothing compared to the \$2,000SGD on the first conviction in Singapore (approx. €1,360EUR), but it shows that Amsterdam could strengthen its law to get better results. However, the prohibition of chewing gum may be extreme for Amsterdam and might not be a good strategy to adopt.

6.1.1.4 Conclusion on Amsterdam's Smart Environment

Overall, Amsterdam has a prospering Smart Environment. The city has projects in common with Singapore such as making use of natural resources, especially water, to construct more renewable buildings. Some projects that Amsterdam has undergone are perfect Smart Initiatives for the environment, such as the Amsterdam Arena and the IJburg district. Amsterdam can still learn from Singapore's success factors, by adding green buildings or implementing Smart Waste Management. Citizen engagement is also a recurring factor in the successful implementation of Smart Initiatives, which is something that Amsterdam has understood and is implementing through applications or rewards. A good example of this is the **Tree wifi**, which gives you free wifi when the quality of the air improves. (Arquinetpolis 2021) There are still some initiatives that can be learnt from Amsterdam to Singapore as well. Indeed, a recurring issue that came back from expert interviews for Singapore is the use of single-use plastic bags in the city. (Expert Interview 3) This is an issue Amsterdam does not have since the use of free plastic bags has been banned since 2016. (Government of The Netherlands 2016) Another issue in Singapore is the use of non-eco-friendly resources such as air conditioning which is used immensely in high-rise buildings all over the city. (Expert Interview 9) This gives Amsterdam an advantage towards becoming a better Smart City as its weather conditions are not that extreme as in Singapore.

6.1.2 Smart Mobility: Promoting Sustainable and Efficient Transportation through Innovative Initiatives

Transportation is an essential component of modern society, providing people with access to jobs, education, healthcare, and other important services. However, traditional transportation systems have also contributed to a range of problems, including traffic congestion, air pollution, and greenhouse gas emissions. To address these challenges and create a more sustainable and efficient transportation system, there has been a growing interest in Smart Mobility. Mobility,

the ability to move freely or be easily moved, becomes smart with the use of advanced technology and innovative solutions to create more efficient, sustainable, and convenient transportation systems. (Cambridge Dictionary 2023)

6.1.2.1 Amsterdam's Mobility Situation

The city of Amsterdam has a high-quality public transport system, including buses, trams, and ferries, as well as an extensive network of bicycle lanes and walking paths. This makes it easy for residents and visitors alike to navigate the city without a car. Amsterdam is also part of sustainable mobility initiatives, with a goal to become carbon neutral by 2050, like most countries in Europe following the European Climate Law. (City of Amsterdam 2023) The city has implemented several policies and programs to promote sustainable transport options and reduce the use of fossil fuels. For example, the city encourages cycling by providing ample bicycle parking, improving infrastructure, and offering bicycle rental services. In addition to promoting sustainable mobility options, Amsterdam has also taken steps to reduce congestion and improve air quality, and has implemented a low-emission zone, which restricts access to the city centre for vehicles that do not meet certain emissions standards. The city also encourages the use of electric vehicles and has installed charging points throughout the city.

6.1.2.2 Common Smart Mobility Initiatives in Singapore and Amsterdam

As we have seen in expert interviews, Singapore is a leader of autonomous and electric vehicles, even though the market is not yet significant. Amsterdam has also made changes to their city to implement more Electric Vehicles. Indeed, Amsterdam has encouraged the use of electric vehicles (EVs) by providing EV charging infrastructure and financial incentives for EV purchases. The city also introduced the **Amsterdam Electric** program to promote electric transportation and eliminate all gas and diesel vehicles by 2030. (Global Resilience Institute 2022) Amsterdam and Singapore have both implemented **Smart Parking Systems** to reduce traffic congestion and improve the overall mobility of the city. They have also invested in

cycling infrastructure to promote cycling as a mode of transportation and reduce carbon emissions. Amsterdam has also made use of their canals, as it is an extensive network to the city's transportation infrastructure, and has implemented **Roboat**, autonomous self-driving boats for people or goods, which promotes sustainable water management and air quality. This project was implemented with the help of students from universities, in collaboration between MIT and AMS (Institute for Advanced Metropolitan Solutions), which makes the new generation more aware of sustainable and efficient transportation processes.

6.1.2.3 Smart Mobility Initiatives: From Singapore's Success Factors to Amsterdam

In the case of mobility, it is important to note that public transportation is encouraged by the Singaporean government. This helps Singapore to maintain an efficient and sustainable transportation system. One initiative that is already well established in Singapore is **Smart Traffic Management**, which is controlled by the **Land Transport Authority (LTA)**, a fleet management system that allows to track, control, and regulate real-time data to manage traffic flow and optimize transportation routes, and making it available to the public through an online application. Indeed, small interventions can make the biggest difference and it is therefore very efficient to have accurate transport timings for everyone. (Expert Interview 1) Amsterdam could make use of a mobile application, such as SingPass in Singapore, to know when to use public transportation, reduce traffic congestion and improve transportation efficiency. This could help promote activity mobility and implement road pricing schemes to manage traffic congestion. The only condition to this for Amsterdam would be to share and make available their location. Singapore encourages citizens to use public transportation by offering a low transportation price, and by having a large tax on car buying and very high gas price. (Expert Interview 9) An easy initiative to take from Singapore to Amsterdam would be to lower the prices of transportation. Singapore provides very cheap public transportation, having a ticket cost below

a dollar per travel. (Expert Interview 3) In Amsterdam, the GVB (metro, bus, tram) ticket amounts to €3,40EUR for one hour only. Amsterdam should therefore lower their public transportation ticket prices to attract more people in taking them.

Overall, these Smart City initiatives from Singapore could potentially be adapted and implemented in Amsterdam to promote ecological sustainability and efficient mobility. However, it is important to consider the unique characteristics and needs of each city when implementing these initiatives to ensure that they are effective and beneficial for the local community. Amsterdam has the advantage of already having a large amount of bikes used every day (847,000 for 442,693 households) compared to Singapore who is still struggling to make it work. (Expert Interview 8) This shows that even though Singapore has efficient transportation, it stays quite slow on implementing compact and user-friendly vehicles such as bicycles.

6.1.2.4 Conclusion on Amsterdam's Smart Mobility

Amsterdam's current mobility situation is characterized by a commitment to sustainability and an emphasis on public transport, cycling, and walking. These efforts have made the city a leader in sustainable mobility and have contributed to a high quality of life for residents and visitors. Amsterdam has also made use of its canal network to implement autonomous self-driving boats, promoting sustainable water management and air quality. Amsterdam and Singapore have both implemented Smart City initiatives to promote sustainable and efficient mobility options. Both cities have invested in cycling infrastructure, Smart Traffic Management, and electric vehicle incentives to reduce carbon emissions and improve the overall transportation system. By learning from each other's success factors and implementing unique initiatives that cater to their specific needs, these two cities can continue to make significant strides towards becoming more sustainable and environmentally friendly.

6.1.2.5 An Outlook for the Future: Smart Environment and Mobility's Future

Developments in Amsterdam

Overall, Amsterdam's initiatives in the environment and mobility sectors have made it a more sustainable and liveable city, setting an example for other cities around the world to follow. Amsterdam has made notable progress in creating a prospering Smart City, with a focus on using natural resources to construct more renewable buildings with the use of solar panels or rainproof roofs, while also emphasizing citizen engagement through initiatives like Tree Wi-Fi. Amsterdam has prioritized sustainable and efficient transportation options by investing in cycling infrastructure, Smart Management, and electric vehicle incentives, while also implementing autonomous self-driving boats to promote sustainable water management. Amsterdam can learn from Singapore's success factors by implementing green buildings, which would bring a positive impact on the environment and might help Amsterdam achieve their environmental goals quicker. Smart Waste Management in Amsterdam could also be improved by adding an Automated Waste Collection System or increasing its littering fine. Lastly, Amsterdam should consider lowering its prices of public transportation to encourage citizens to use them more and have it as a preferred transportation solution after cycling.

It is important to note that Singapore can also learn from some success factors of Amsterdam as a Smart City. Indeed, Singapore has room for improvement in certain areas, such as its challenge with reducing the use of single-use plastic bags, an issue where Amsterdam has made significant progress with the ban of free plastic bags since 2016 or making cycling an easier option for its citizens. By exchanging knowledge and best practices, both cities of Amsterdam and Singapore can continue to make progress towards becoming more sustainable and environmentally friendly Smart Cities.

7 Discussion & Conclusion

Singapore has emerged as one of the world's leading Smart Cities in recent years, renowned for its cutting-edge technologies and innovative urban policies. The objective of this Field Lab is to establish a bridge between Asia and Europe by examining the potential value of Singapore's Smart City model for a selected European city through a quantitative funnel process. By comparing the approaches of Singapore and Amsterdam to Smart City development, we can identify valuable insights and recommendations for both cities. This comparative analysis serves to promote knowledge exchange and collaboration in the field of Smart City development, bridging the gap between Asia and Europe. The research question guiding this project is: **"What are the key success factors of Singapore's Smart City and how can these add value to a European city?"**

7.1 Main Findings

After reviewing literature research on Singapore's Smart City, expert interviews were conducted to uncover success factors across its six dimensions, Smart Governance, Mobility, Economy, Environment, People and Living. Achievements, such as housing strategy, water and waste management, education system, and leading technology were discussed, as well as critical aspects, such as the authoritarian government and Singapore's status as the world's leading Smart City.

The aim was to compare Singapore with European Smart City sharing distinct features across the technological, political, economic, and socio-cultural environment. Amsterdam was chosen through an extensive funnel process of 50 European cities as the most suitable city for comparison.

The comparative analysis of Singapore and Amsterdam reveals two leading smart cities with distinct governmental systems and smart city strategies. Singapore's top-down-oriented

government allows for long-term planning and high investments in Smart Initiatives that stretch across all dimensions, such as advancing their citizens through tailored education and skills training to shape a competitive workforce. Furthermore, the centralized government enables their key strength in superior digitalization and technology, with different digital platforms such as LifeSG. In contrast, Amsterdam follows a more bottom-up strategy, prioritizing transparency, and empowering citizens to engage and co-create in Smart Initiatives, such as the Amsterdam Smart Citizen Lab.

Both cities have the potential to benefit from each other's strengths and weaknesses. Amsterdam has various areas for improvement, including green buildings, reducing public transport costs, and investing more in holistic education programs. On the other hand, Singapore can reap advantages by actively involving its citizens in shaping and advancing their Smart City. Nevertheless, there may be challenges in replicating specific aspects, such as Singapore's advanced technology or Amsterdam's citizen engagement approach, due to cultural and governmental disparities. Therefore, it is crucial for both cities to consider two fundamental aspects. Firstly, an exchange of smart initiatives offers an opportunity for both Smart Cities to thrive and enhance the quality of life for their citizens. Secondly, the research underscores the significance and necessity of prioritizing citizen engagement across all dimensions. Both cities should prioritize this aspect to address the evolving demands of Smart Cities and further strengthen their status as leading Smart Cities.

7.2 Significance and Implications

This research has significant implications for the field of Smart City development, as well as for future research. By identifying the key success factors of Singapore's Smart City model and conducting a comparative analysis with Amsterdam, valuable insights and recommendations have emerged, which can drive advancements in urban development globally.

Contribution to the Field

This Field Lab has made several contributions to the field of Smart City development:

- **Identification of Key Success Factors:** Through in-depth research and expert interviews, this research has identified the key success factors that have propelled Singapore to its position as a leading Smart City. These factors encompass various dimensions, including technology adoption, citizen engagement, sustainable infrastructure, and data-driven decision-making.
- **Comparative Analysis:** The comparative analysis between Singapore and Amsterdam has shed light on the similarities and differences in their approaches to Smart City development. This analysis provides a deeper understanding of the strategies, policies, and practices that have shaped these cities and offers valuable insights for other urban centers worldwide.
- **Integration of Asian and European Perspectives:** By comparing Singapore and Amsterdam, this research has bridged the gap between Asia and Europe in the field of Smart City development. The integration of these perspectives enriches the knowledge base and promotes cross-cultural collaboration in addressing urban challenges.

Future Research Directions

- **Cultural Factors:** Further research can explore the influence of cultural factors on Smart City development. Understanding the cultural nuances and their impact on technology adoption, citizen engagement, and policy implementation will enhance the effectiveness of Smart City initiatives in diverse cultural contexts.
- **Long-Term Sustainability and Scalability:** It is crucial to conduct research on the long-term sustainability and scalability of Smart City initiatives. Understanding the

challenges and opportunities associated with scaling up successful projects will guide future planning and ensure the continued growth and success of Smart Cities.

- **Impact of Governmental Structure:** Future research can investigate the relationship between a city's governmental structure and the success of its Smart City initiatives. Specifically, there is a need to examine how Singapore's authoritarian government impacts the development and implementation of Smart City policies.

In conclusion, this research contributes significantly to the field of Smart City development. The findings have practical implications for policymakers, urban planners, and practitioners. Furthermore, future research directions outlined herein will further enrich the understanding of Smart City development, cultural influences, and long-term sustainability.

7.3 Limitations

While Singapore and Amsterdam can be recognized as global leaders in the Smart City movement, there are several limitations to consider when analysing their approaches to urban development. First, while both cities have implemented a range of innovative technologies and policies to improve energy efficiency, reduce emissions, and enhance quality of life for their citizens, there may be cultural, social, or economic factors that limit the applicability of these strategies in other contexts. For instance, Singapore has a highly centralized, authoritarian government structure and a unique geographical location that may enable certain Smart City solutions that would not be possible in other cities with different political or geographic conditions. Similarly, Amsterdam has a long history of progressive politics and a strong tradition of urban planning that may make it more receptive to certain Smart City initiatives.

Secondly, the findings presented in this thesis are largely based on a review of secondary sources and may not reflect the perspectives or experiences of residents, business owners, or other stakeholders in Singapore or Amsterdam. While there is a wealth of information available

on these cities' Smart City initiatives, much of it comes from academic studies or expert interviews, which may not capture the full range of opinions or experiences of those who live and work in these cities. One potential approach to further research would be to conduct a survey to Dutch or Singaporean citizens to better understand their attitudes and experiences related to the Smart City initiatives put in place. For example, in Amsterdam, a survey could be conducted to gather data on residents' attitudes and behaviours related to energy use and to assess the plausibility and potential impact of some of the ideas presented in this thesis.

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9 Appendix

Appendix 1: Interview Guide

1. Short introduction; information about the research methodology
2. Opening questions:
 - Can you please tell me about your current job/research projects? When did you first come into contact with the concept of “Smart Cities” (general)?
3. Main Part: Smart City Dimensions:

Most definitions of a Smart City look at six dimensions (Smart People, Smart Living, Smart Environment, Smart Mobility, Smart Economy and Smart Governance). I would like to briefly discuss all of them with you. Therefore the main part of the interview would cover the following questions:

- What makes Smart Governance successful in Singapore? What specific initiatives would you define as best practice examples?
- What makes Smart Economy successful in Singapore? What specific initiatives would you define as best practice examples? Etc...
- Outlook on Europe:
 - What opportunities can you identify for European Cities to learn from Singapore’s success story?
 - What would be your recommendation if you want to make Europe “smarter”?
 - Can Singapore as a Smart City be replicated?
- Closing question: Is there anything else you would like to talk about concerning Singapore and Smart Cities?

Appendix 2: Overview Interviewees

INTERVIEW	NAME OF THE EXPERT(S)	EXPERTISE
EXPERT INTERVIEW 1	Samuel Chang	Samuel Chang is a Research Fellow and heads the Urban Psychology Lab in the Lee Kuan Yew Centre for Innovative Cities at the Singapore University of Technology and Design. He is an applied social psychologist, and his research focuses on human behavior and decisions in cities across a range of areas including mobility, sustainability and wellbeing (human adaptability and resilience).
EXPERT INTERVIEW 2	Sylvain Remy, Ph.D.	Sylvain Remy is a distinguished academic and expert in the field of Economic Geography, particularly in relation to urban centers, innovation, and entrepreneurship. He presently serves as the Director of the Institute for Sustainable Development and Smart Cities and has previously held a faculty position at ESSEC Singapore. His extensive research experience and scholarly contributions have earned him widespread recognition and esteem within his field.
EXPERT INTERVIEW 3	Anonymized	Due to company policies, the interviewee requested to keep this interview anonymous. This expert is an international organisation's thematic Lead on Digitalization and Smart Cities, Singapore. He has led innovation, digitalization and Smart Cities initiatives across the world.
EXPERT INTERVIEW 4	Dr. Sang Keon Lee	Dr. Sang-Keon Lee is currently the director of Technology Institute of KAIST in South Korea. He has worked on many Smart City projects and initiatives. Also has been a guest speaker at many events and conferences. Throughout his career, he has published many articles and case studies about smart and sustainable cities, including “International Case Study of Smart Cities, Singapore” in cooperation with Korea Research Institute of Human Settlements.
EXPERT INTERVIEW 5	Linh Le	Linh Le is principal project manager at Amazon Web Services for the Global Smart City Competency Program. He works & lives in Singapore and specializes in field of urban development and Smart Cities.
EXPERT INTERVIEW 6	Anonymized	The interview was conducted with three researchers, who requested to remain

		anonymous due to company policies. All of them work for a research institute in Singapore, that deals with the critical issues of urbanization and explore how to integrate technology. Their individual backgrounds are social psychology, Sociology and Computer Engineering.
EXPERT INTERVIEW 7	Genki Unno	Genki Unno is a visiting researcher at Singapore-ETH Centre, which is part of the CREATE campus, or the Campus for Research Excellence and Technological Enterprise, established by Singapore's National Research Foundation. Besides, he works for Takenaka, one of the biggest construction companies in Japan.
EXPERT INTERVIEW 8	Professor Jason Pomeroy	Jason Pomeroy is an accomplished architect and television personality, recognized as the presenter of the program "Smart Cities 2.0". With a focus on sustainability and innovation, he has earned a reputation as a designer of buildings, landscapes, and interiors that prioritize environmental conservation and efficiency. One of his most notable achievements includes the design of an energy-efficient house in Malaysia, which harnesses the power of solar panels and a rainwater harvesting system to provide electricity and water.
EXPERT INTERVIEW 9	Karim Perdana, Amelinda Pandu Kusumaningtyas	Both researchers work for the Center for Digital Society (CfDS) in Indonesia, who published a case study in 2020 on "Singapore: From Smart City to Smart Nation". The center aims to manage and understand the phenomenon of digital society. Perdana is specialized in technology development and cyber security, while Kusumaningtyas interests focus on digital economy and mobility.
EXPERT INTERVIEW 10	Dr. Tim Bunnell	Tim Bunnell is Professor in the Department of Geography at the National University of Singapore, where he works on urban development in Southeast Asia. Furthermore, he is editor of the Singapore Journal of Tropical Geography and chair of the Cities research cluster in the Faculty of Arts and Social Sciences at the National University of Singapore (NUS).
EXPERT INTERVIEW 11	Professor Mark Findlay	He was the director at the Center for AI and Data Governance Service and is now the Professorial Research Fellow at Singapore Management University (works in law). Lives

		in Singapore but is from Sydney originally.
EXPERT INTERVIEW 12	Shanny Tan	She is the Deputy Director at the Smart City Projects Office, which is part of the Smart Nation and Digital Government Office. A ministry within the Singaporean government which consult, control, advise IT projects of government.
EXPERT INTERVIEW 13	Kok Chin Tay	Kok Chin Tay is Chairman of the Smart Cities Network, a non-profit organization established in 2018. Under his leadership, the organization has grown to include a membership of consultants and solution providers, with a focus on fostering strategic partnerships with governments and industry bodies across ASEAN countries. In addition to his role with the Smart Cities Network, Kok Chin Tay serves as Director of the ASEAN Smart Cities Council, a key part of the world's largest network of Smart Cities ecosystem stakeholders.

Appendix 3: [Interview Transcripts](#)

Appendix 4: Funnel Process

		World Population Review 2023	IMD SCI 2023	Global Innovation Index 2022	IMD SCI 2023	By country, Statista 2022	By countries, Statista 2023
City	Country	Population Density	Technology 2023	Political Environment Score	City HDI Value	Digital Readiness - Internet Usage	Unemployment Rate
Singapore	Singapore	8480	A	100	0.939	93,74%	1,90%
Amsterdam	Netherlands	5333	A	86,6	0.962	87,32%	3,60%
London	United Kingdom	10936	AA	76,9	0.973	92,26%	3,70%
Geneva	Switzerland	12000	A	89,3	0.966	87,67%	4,80%
Brussels	Belgium	7528	A	77	0.953	87,30%	5,80%
Stockholm	Sweden	6388	A	86,1	0.972	89,86%	7,20%
The Hague	Netherlands	6650	A	86,6	0.941	79,55%	
Paris	France	20623	A	76,5	0.949	80,90%	
Lyon	France	9720	BB	76,5	0.914		
Bucharest	Romania	7184	B	57,9			
Milan	Italy	7551	BB	63,7			
Barcelona	Spain	15992	BB	71,8			
Bilbao	Spain	8353	BBB	71,8			
Madrid	Spain	5400	BBB	71,8			
Dusseldorf	Germany	2849	BB				
Ankara	Turkey	1874	CCC				
Sofia	Bulgaria	885,3	CC				
Istanbul	Turkey	2523	CC				
Lille	France	6600	CCC				
Glasgow	United Kingdom	3400	B				
Marseille	France	3619	CC				
Bordeaux	France	5300	CCC				
Lisbon	Portugal	5445	CC				
Newcastle	United Kingdom	2646	CC				
Leeds	United Kingdom	4626	CC				
Athens	Greece	17040	CCC				
Zaragoza	Spain	699	CC				
Birmingham	United Kingdom	3649	BB				
Manchester	United Kingdom	4773	BB				
Rome	Italy	2624	CCC				
Krakow	Poland	2359	CCC				
Kiel	Germany	2100	CCC				
Budapest	Hungary	3351	BB				
Bologna	Italy	2784	BB				
Warsaw	Poland	3601	BBB				
Hanover	Germany	2600	B				
Tallinn	Estonia	2747	BB				
Rotterdam	Netherlands	2995	A				
Vienna	Austria	4326	A				
Gothenburg	Sweden	1300	A				
Bratislava	Slovakia	1169	BBB				
Munich	Germany	4800	A				
Dublin	Ireland	4588	BBB				
Berlin	Germany	4126	BBB				
Helsinki	Finland	3034	A				
Prague	Czech Republic	2600	A				
Lausanne	Switzerland	3398	A				
Copenhagen	Denmark	4417	A				
Hamburg	Germany	2500	BBB				
Oslo	Norway	1400	A				
Zurich	Switzerland	4816	A				
Average of European Cities		5077,3		Average of European Cities		Average of European Cities	Average of European Cities
				76,34615385		86,26%	5,02%

Figure 10: Funnel Process Excel

	Hofstede Insight - Cultural Distance to Singapore						
Cities	Power distance	Individualism		Masculinity	Uncertainty Avoidance	Long term orientation	Indulgence
Singapore	74	20		48	8	72	46
Netherlands	38	80		14	53	67	68
United Kingdom	35	89		66	35	51	69
Netherlands			34			5	
United Kingdom					27	21	
Total difference to Singapore							
Netherlands							39
United Kingdom							48

Figure 11: Cultural distance to Singapore



Figure 12: Funnel Process City Selection

Appendix 5: Indicators relevant to success of Smart City (IMD 2023)

Criteria	Amsterdam	Singapore	Difference
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Living

% of citizens that agree that affordable housing has the highest priority for their city	68.7 %	76.2 %	7.50%
Cannot find housing for 30% or less than their salary	75.1 %	54.2 %	-20.90%
Health Services as Priority Area	14 – 40 %	9 - 40.5 %	

Education

Lifelong learning opportunities are provided by local institutions	61.9 %	81.1 %	19.20%
IT skills are taught well in school	54.1 %	70.9 %	16.80%

Technology

Online reporting of city maintenance problems provides a speedy solution	49.4 %	70.4 %	21.00%
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Online services provided by the city has made it easier to start a new business	52.6 %	71.1 %	18.50%
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Engagement

Information on local government decisions are easily accessible	61.2 %	78.3 %	17.10%
Residents contribute to decision making of local government	52.6 %	61 %	8.40%
Residents provide feedback on local government projects	59.2 %	68.8 %	9.60%
An online platform where residents can propose ideas has improved city life	55.3 %	61.4 %	6.10%

Figure 13: Comparison of Indicators

Appendix 6: Expert Interviews - Insights and Outlooks for Europe

The insights shared by the interviewees proved to be invaluable in identifying how Singapore's success as a Smart City could be compared to a European city context. Despite Singapore's unique characteristics such as a single-party governmental system and considerable wealth (Expert Interview 3 & 11), European governments can consider implementing policies that prioritize civil services to enhance citizen services and encourage community-driven initiatives, such as public housing (Expert Interview 3). Additionally, adopting all-inclusive apps, such as SingPass (Expert Interview 12), could also prove to be a useful tool in facilitating a more streamlined approach to government-citizen interactions.

Balancing Privacy & Innovation

The discussion also highlighted the importance of aligning policies with technology. While Europe has strict privacy laws and may be more sceptical of new technology, with stricter regulations concerning new introduction of technology that may harm citizens (Expert Interview 8), this scepticism could “[...] create an environment that is not very innovative”

(Expert Interview 5, p. 7). Experts emphasized that European policies need to be more open to embracing innovative solutions that can enhance citizens' lives without constantly fearing a loss of privacy (Expert Interview 4), as long as these technological advancements prioritize the well-being of people (Expert Interview 1). Trust between the government, technology, and citizens was underscored as a crucial factor, with multiple experts emphasizing that people's trust in the government and technology is paramount for the effective use of data (Expert Interview 8).

Successful Initiatives for Europe

Furthermore, a European example such as the Dijon Metropole (Expert Interview 2) showcased how centralizing government services can lead to improved service delivery. Drawing from Singapore's success, creating platforms that facilitate collaboration between citizens and ministries, prioritizing citizen-centric approaches, and focusing on engagement through volunteering, inclusive apps, and feedback mechanisms could be valuable strategies for progressive city development in Europe. (Expert Interview 4 & 6) Overall, the interviews shed light on potential areas for European cities to learn from Singapore's experiences and success as a Smart City, while tailoring solutions to their unique contexts. (Expert Interview 3) This can be achieved by implementing policies and technologies that prioritize citizens' needs, foster trust, and promote collaborative approaches between citizens and the government. (Expert Interview 6)

Appendix 7: Map of Amsterdam Center and possible districts for Green Buildings

