Scaling Smart City Projects in Denmark: Challenges and Strategic Recommendations

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Synopsis:

The thesis: "Scaling Smart City Projects in Denmark: Challenges and Strategic Recommendations" investigates the challenges to why smart city projects fail to adopt, sustain and scale up in Denmark. The thesis employs a mixed methods approach with a literature review, document analysis, mapping, nationwide survey, stakeholder analysis, case study and stakeholder interviews. A survey was conducted to understand the municipalities challenges with addition from stakeholder interviews that gave insight into their expertise on smart city challenges that municipalities face. The mapping method was used shortly to map the municipalities that answered the survey. Additionally is a stakeholder analysis of the smart city stakeholders and a case study of Smart Aarhus. The thesis also explores theories, Diffusion of Innovation, Multi-Level Governance and Institutional theory. Diffusion of innovation theory gave insight into the stages of smart city implementation in municipalities in Denmark, while the multi-level governance theory helped to understand the governance structure of smart cities in Denmark. Lastly was the inclusion of the institutional theory which was used to understand the institutional dynamics within municipalities. Finally, the thesis proposed strategic recommendations to combat the challenges identified.

Preface

The individuals and departments listed below have our deepest gratitude and appreciation. Their helpful assistance and input were crucial to the completion of this report.

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Abstract

Cities around the world are pursuing smart city strategies to enhance urban resilience, sustainability and quality of life. This is due to the digital transformation, the increasing threat of climate change and urbanisation. Smart cities emerge as a complex concept and show difficulties in implementation, maintenance and scaling smart city projects among Danish municipalities. Even though Denmark is known for being one of the leaders in digital innovation, many projects remain in the pilot stage due to institutional, political, and organisational obstacles. Municipal capacities and governance frameworks affect whether smart city development in Danish municipalities is successful or stagnates.

This thesis examines how innovation diffusion, multi-level governance and institutional constraints shape the landscape of smart city implementation. Additionally, it uses a mixed-methods approach that includes a literature review, document analysis, mapping, stakeholder interviews, a survey and an Aarhus case study. The results point to several enduring issues, such as disjointed governance, pilot project fatigue, also known as "pilot sickness", etc. Concerns about data governance, public trust, and the unequal distribution of digital infrastructure exacerbate these problems.

The thesis identifies factors and approaches, such as effective stakeholder collaboration and adaptive governance models, that have allowed certain municipalities to achieve notable advancements despite these obstacles. The advantages of flexible innovation ecosystems and community-driven smart city planning are particularly demonstrated by the example of Aarhus. The thesis ends with strategic recommendations meant to improve inter-municipal cooperation, strengthen institutional frameworks and advance scalable, citizen-centred smart city solutions. The thesis advances the knowledge of how Danish municipalities can move forward from disjointed pilot projects to more integrated urban strategies by bridging theory and practice.

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Introduction 1

Cities are directly threatened by urbanisation and climate change, which puts greater pressure on them. To prevent this, cities create goals to become more resilient, efficient and sustainable. These issues led to the rise of the "smart city" idea. It represents a growing urban governing concept that improves the quality of urban living and more efficiently allocates resources through data-driven decision-making, digital technology and cross-sector collaboration. This thesis analyses the challenges and favourable conditions for implementing smart city initiatives into action, sustaining and scaling them in the Danish context. Many municipalities struggle to transition from isolated pilot initiatives to broad, long-term smart city strategies, even though Denmark is known as a digital pioneer.

1.1 Urban transitions

Cities have throughout history been through significant periods of transition, which consisted of adapting to new social, technological and economic challenges. In just the last 200 years, urban transformation has reshaped the built environment in two different ways. Western cities evolved in the 19th century from medieval structures into industrial hubs, which meant demolishing city walls to make way for railway networks, factories and housing for the increase and expansion in the workforce. With the increase and expansion comes a wave of new problems, such as public health crises, where a massive introduction to sanitary infrastructure was implemented. In the 20th century, new issues came with the rise of the automobile, which meant a large-scale urban redesign. Alongside the automobile was the introduction to high-rise buildings and the beginning of the suburbs, central business districts and ring roads [Hajer and Dassen, 2014, p.11]. In the late 20th and the 21st century, cities face a new transition which prioritises eco-efficiency. Cities require sustainable urban development, where cities must make use of renewable energy, waste recycling, environmentally friendly transportation and reduced CO_2-emissions [Hajer and Dassen, 2014, p.11]. With the focus on sustainability and with the technological evolution, 'smart cities' emerged as a solution to sustainability problems from urbanisation [Toli and Murtagh, 2020, p.1].

1.1.1 Smart cities

'Smart city' as a concept emerged as a direct response to the political, social and economic challenges that were faced by the post-industrial societies in the 21st century. Strategic use of digital technologies was introduced to develop innovative city solutions. The idea and main goal of the smart city is to address critical urban challenges faced by cities around the world. Challenges such as demographic shifts, healthcare demands, resource scarcity, financial instability and environmental pollution [Ghazal et al., 2025].

The concept of smart cities presents a future where urban living, digital solutions and data are used increasingly efficiently. The goal of smart cities is to improve infrastructure and the quality of life for the residents. The growth of the population emerges as a threat, which means there is an increasing need for efficient and sustainable urban environments. The Internet of Things (IoT) was developed as a central technology that transforms the way technology

is used in cities. The technology connects physical objects to the Internet. Parking spaces, drainage systems and trash bins are connected to the Internet, enabling real-time data collection and making room for real-time decision-making [Niras, 2024].

Defining 'Smartness'

Defining "smart cities" and "smartness" is complex due to their diverse implementations, process variations and the idealised "frictionless" vision of many smart city projects [Cureton and Hartley, 2025, p.24-27]. Over the past ten years, the idea of a "smart city" has gained popularity and the term "smart" has been used to describe a novel approach to issues [Fernando et al., 2025].

The Cambridge Dictionary defines "smart" as "having a clean, tidy and stylish appearance" and "intelligent, or able to think quickly or intelligently in difficult situations" [Cambridge Dictionary, 2025]. The term "smart" has been used to refer to a variety of concepts, including IT-led smart infrastructure, smart education, smart cities, smart energy, smart governance, smart transport, smart disaster resilience, and smart inclusivity. In contrast to its initial narrow focus on technology, the term was originally used broadly and holistically, as Fertner recalls. He states that the concept of smart cities was broad and holistic and not as focused on data integration and sensor-driven urban management, unlike what it is today [Christian Fertner, KU, 2025, p.2].

Gaarde Nielsen states that between 2014 and 2018, smart cities were primarily understood as using data and technology to improve decision-making. He states that after that period, the definition became more nuanced with more terms emerging, such as a "technological smart city" and an "economic smart city", with sustainability increasingly becoming a key element. In addition, he recounts an instance from his career in which he was recruited in India to lead a smart city unit focused on ensuring access to fresh water, a functional and context-specific interpretation of what a smart city could mean in addressing local urban challenges [Christian Gaarde Nielsen, Copenhagen Solutions Lab, 2025, p.2].

The concept appears as an umbrella term containing broader views [Fernando et al., 2025]. Figure 1.1 illustrates the broad concept of smart cities and some of its sub-concepts:

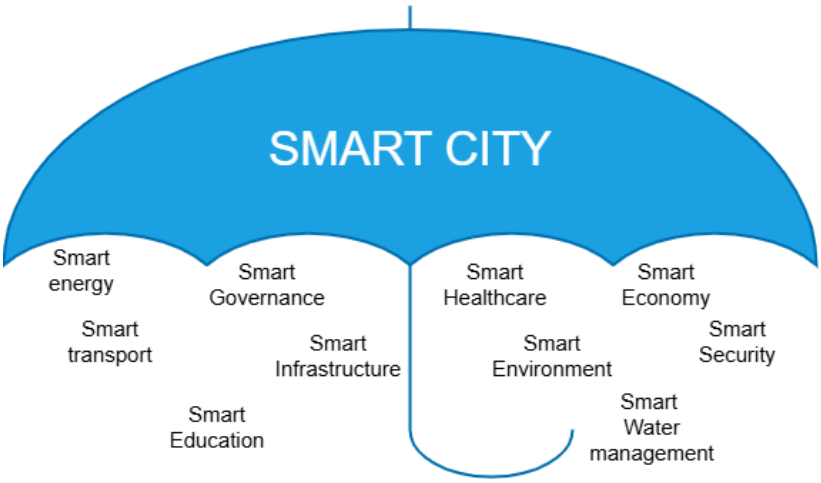


Figure 1.1. Own visualisation of the smart city umbrella based on [WSB, 2025]

1.1.2 The evolution of the concept

In the early days of the Smart City concept, the focus was associated with a futuristic city in which technology itself was the primary driver. Although digital tools have since become integrated into everyday life, initial efforts to deploy technology without a strategic purpose have given way to a problem-solving mindset. Today, smart city initiatives attract attention from tech firms, entrepreneurs, municipal governments and civil society alike. The research and interviews revealed three successive phases in how cities adopt and leverage smart city technologies, first driven by technology providers, then by city governments and finally by citizens. Some municipalities progress through all three stages, whereas others remain fixed in one phase. The three distinct phases are described below [Smart Cities Library, nd] [European Parliamentary Research Service, 2023].

Smart Cities 1.0: Technology driven

The first generation of smart cities, which was also known as smart city 1.0, adopted a strategy that was technology-driven while also being supported by big businesses that spearheaded this urban movement to sell technological solutions to cities so they could manage urban issues and activities more effectively. These technology providers would encourage the adoption of their solutions to cities that were not equipped to properly understand the implications of the technology or how it may impact citizen quality of life. Providers such as IBM(International Business Machines Corporation) or Cisco were among the leading promoters of this first generation [European Parliamentary Research Service, 2023, p.5].

Smart Cities 2.0: Technology enabled, city led

Smart cities 2.0, being the second generation, marked the emergence of municipalities having ambitions. This ambition was predominantly led by the municipal mayors and city administrators with a forward-thinking mentality, focusing on defining the future of their cities and what role smart technology will have. The view of the technology was as an enabler to improve the quality of life. A landmark example is Rio de Janeiro's partnership with IBM to deploy a sensor network across hillside favelas, which later expanded into a 21st-century central operations centre with streaming video for crime detection, integrated emergency services and other smart services. Most leading smart cities today fit this second-generation model. Barcelona, for instance, runs over 100 active projects, from public-space Wi-Fi and intelligent lighting to electric-vehicle charging infrastructure and hosts the Smart City Expo and City Protocol initiative to foster industry collaboration. Across these initiatives, city authorities set objectives, address social challenges and focus on citizen well-being and local needs, using technology to prevent it from dominating urban life [European Parliamentary Research Service, 2023, p.5].

Smart Cities 3.0 Citizen co-creation

The third generation, also called smart city 3.0, has appeared in recent years, where smart cities are beginning to embrace citizen co-creation models. It concentrates on the role of citizens in addressing their issues and assisting city managers in solving them. Smart city 3.0 highlights the ability of all individuals to share their opinions and help decision-makers find the most reliable and practical solutions for social, environmental and government challenges in cities. This focus is shifting towards more socially inclusive smart cities at this stage, where equality is emphasised. In addition, it also considers smart solutions that are not necessarily tech-driven ideas. This approves the power of the smart city concept in addressing urban topics without solely focusing on its technological dimensions. However,

more effort is still required to foster the inclusion of more groups within society, including people who either do not have the necessary skills to keep up with technological advancement or are resistant to it [European Parliamentary Research Service, 2023, p.6].

1.1.3 Components of a smart city

The definition of smart cities contains multiple dimensions that aim to improve urban life through technology, data-driven decision-making and policies. Among the many dimensions, it has been chosen to explain a few key aspects briefly, including Smart Economy, Smart People, Smart Governance, Smart Mobility, Smart Environment and Smart Living.

Smart Economy

This is an economic focus that is accomplished through innovation, entrepreneurship and digital transformation to boost economic growth. This kind of economy uses technological innovations, digital markets and start-up ecosystems that will drive competitiveness. The further adoption of artificial intelligence, automation and blockchain technologies enhances business operations, hence increasing efficiency [Hajer and Dassen, 2014, p.31].

Smart People

Smart people imply human and social capital that can be realised through education, digital literacy and civil participation. This shall be applicable when a smart city operates with an open attitude, integrates different cultures and involves the public more in governance. Education and knowledge-sharing platforms are also critical in empowering citizens to contribute to urban development [Hajer and Dassen, 2014, p.31].

Smart Governance

In a smart manner, governance would be transparent and data-driven, along with the active participation of citizens in policy-making. It is done through digital technologies, such as e-Governance platforms, blockchain for public records and AI-driven decision-making tools. Effective smart governance will be open public administration with an effortless style of service delivery and participatory democracy, where citizens are asked to suggest urban policies [Hajer and Dassen, 2014, p.31].

Smart Mobility

Smart mobility focuses on sustainable and efficient transportation modes, which means electric vehicles, bike-sharing programmes and intelligent traffic management systems. Urban planning strategies have to provide for pedestrian-focused infrastructure and multimodal access to let vehicles, especially those with reduced access, cut down on congestion levels and carbon emissions [Hajer and Dassen, 2014, p.32].

Smart Environment

Smart environments will enhance urban sustainability, where several resource-efficient practices can be combined, such as renewable energies and climate control, with minimised waste through the intelligent use of resources like energy. In this way, smart grids are essential, as well as other monitoring systems, green infrastructure or vertical gardens, to point out examples of maintaining an ecological balance. Otherwise, an urban metabolism's sustainability

ensures that cities effectively handle the inputs and outputs, where inputs are taken to be energy, water and food. Outputs are classified as waste and emissions [Hajer and Dassen, 2014, p.32].

Smart Living

Smart living improves the quality of life through attention to health care, security, cultural facilities and social inclusion in society. That may include digital health services, surveillance systems that perform intelligent functions, emergency response systems and cultural hubs. It should be a vision for a safe, inclusive and lively urban environment from which its citizens can age safely [Hajer and Dassen, 2014, p.32].

Smart city models

IBM - International Business Machines corporation model

The IBM "Smarter Cities" model proposes a dynamic approach to urban management that turns cities into proactive, adaptable systems rather than just reactive ones. These types of smart city models can identify trends and expect problems before they happen by analysing historical and real-time data from several sources, such as energy meters, traffic sensors and public safety systems. Authorities, therefore, have the possibility to put preventative measures into place which can raise the resilience of the city and raise the standard of living for its citizens. The integration of many data sources, including emergency response logs and traffic trends, into a single analytics platform is the fundamental idea behind this approach. This comprehensive approach enables decision-makers to base their decisions on verifiable facts, allowing them to modify operations and policies as circumstances necessitate. Aligning technological, financial and human resources with shared goals also results in significant efficiency benefits. Agencies may manage staff deployment, budget spending and service operations in real-time with integrated technologies. This collaboration reduces waste, expedites response times and saves the city money. Cities establish a self-reinforcing cycle by anticipating problems, making efficient use of service data and simplifying resources. The benefits that result from concerted efforts offer fresh perspectives that improve future planning and analysis. Over time, cities can become "smarter cities" thanks to this cycle of progress, as IBM predicts [IBM, 2018].

Asian model

The Asian smart city model is an interesting combination of rapid urbanisation, innovative technology and development policies customised to local conditions. Unlike many Western models that place a strong emphasis on sustainability and digital integration into post-industrial landscapes, Asian cities face problems from rapidly rising populations, diverse infrastructure and varying levels of institutional capacity. This means they frequently focus on realistic, problem-solving tactics to address critical concerns like traffic congestion, energy efficiency, environmental dangers and housing shortages. The Asian approach is distinguished by its ability to bring together a diverse range of stakeholders. Local governments frequently take the lead, driving programs and defining the vision for their communities while also relying on national financing and international partners for technological developments. Pilot projects are frequent, where cities test smart solutions at the neighbourhood or district level before rolling them out on a broader scale, allowing them to learn along the way and customise solutions that work best for their unique situations. Another essential consideration is technological advancement. Many Asian cities skip over outdated systems in favour of cutting-edge technologies such as 5G, IoT, AI traffic control and smart energy grids.

This adoption is supported by collaboration with the public and commercial sectors. These public and commercial sectors are with major tech companies from countries such as Korea, Japan, China and Singapore, who supply specific hardware and software solutions. There is no one-size-fits-all strategy used by the Asian smart city model. While other cities, like Manila in the Philippines and Jakarta in Indonesia, prioritise addressing urban informality and providing basic services, Singapore, for instance, places a higher priority on high-tech integration and citizen-focused services. Resilience and inclusivity are also given more attention here to guarantee that investments in smart cities benefit the most vulnerable areas. Furthermore, the focus is on addressing local issues such as flooding, pollution and resource scarcity. Finally, governing forms in Asia exhibit a broad spectrum of diversity. Some cities use centralised planning models, such as China's national smart city initiative, while others use more decentralised and experimental frameworks, reflecting the political and institutional diversity of the region [Asian Development Bank, 2020].

Nordic model

Instead of focusing solely on technology, the Nordic model approach prioritises human needs and values. It is based on shared Nordic principles of trust, equality, sustainability, collaboration and inclusion and views cities and regions as components of an interconnected ecosystem rather than separate units. It encourages "boundaryless" cooperation among local and regional governments, businesses, researchers and citizens, ensuring that solutions are co-designed, tested and changed in real communities [Nordic Innovation, 2021, p.3-4]. In this model, technology becomes a tool rather than the goal and citizens, whether in congested urban neighbourhoods or remote rural areas, are asked to describe problems and claim ownership of the outcomes [Nordic Innovation, 2021, p.6-7]. Work is divided into five distinct themes. First, leadership integrates defined missions and well-being indicators with true citizen empowerment. Second, inclusion bridges the urban-rural gap, ensures universal access and views mobility as a human experience. Third, living environment plans integrate nature-based design, circular economy thinking and cultural heritage protection into daily planning. Fourth, digital community practices ensure that people have control over their information, treat data as a shared resource and incorporate ethical and transparent data governance to uphold public trust. Fifth, life-centred planning, resilience strategies and public spaces that prioritise physical and mental health promote health and well-being [Nordic Innovation, 2021, p.14-15]. The Roadmap outlines guiding principles, such as bottom-up co-creation, regenerative design and data autonomy, that transform these primary barriers, such as fragmented institutions, data-ownership disputes, or short-term funding, into feasible paths for each of these themes. Lastly, the Nordic model specifically promotes exporting successful pilots so that innovations validated inside this values-based framework can be modified and used in other contexts [Nordic Innovation, 2021, p.10-17].

1.1.4 Key dimensions and developments in smart cities

Improved liveability and engagement

Other than efficiency, smart solutions make cities more liveable by addressing common issues such as waiting times for public transport, uncoordinated infrastructure projects and environmental hazards such as flooding. By connecting and ensuring smoother interactions between systems, smart city technologies create more interconnected urban environments with a focus on liveability [Niras, 2024]. A smart city generally seeks to enhance the well-being of its residents, businesses, visitors, organisations and administrators by delivering digital services that improve quality of life [EU, 2025b].

Data

Urban data, informatics and analytics are key in shaping cities to become a smart city. Urban informatics applies data to study urban developments. Urban analytics uses big data and methods in computing to understand the dynamics of the city. Both drive the evolution of the smart city. The integration of IoT, big data and GIS tools enhances the city's functionality [Cureton and Hartley, 2025, p.24-27].

The integration of physical objects with the Internet is known as the Internet of Things (IoT). These tangible objects can be anything from lighting for the home to smart devices used in hospitals or even entire cities. Objects are connected in a shared network, which makes them accessible to users to interact with. The key advantage of IoT is the ease of connecting new devices to the network, which can significantly drive its growth in significance [Domínguez-Morales et al., 2023, p.3].

The connection of devices has previously required overcoming complex multi-layered infrastructure, while today, open-access projects provide networks where users can connect their devices more easily. With interconnected devices spanning vast areas, the use of IoT presents a high potential for projects focusing on public well-being, particularly in smart cities. Although it sounds easily implementable and has many benefits, the expansion also brings challenges, especially concerning security and privacy. Data breaches or privacy from malicious actors remains a critical risk and concern [Domínguez-Morales et al., 2023, p.3].

Urban digital twin

The digital twin (UDT) is a representation of a physical entity in a digital form. With a maintaining level of accuracy and with the integration of data for improved efficiency, the digital entity can replicate the physical city on a digital level. The digital twin was originally developed by NASA, but later, Michael Grieves expanded the digital twin in 2003, and it has since then seen growth. The tool represents the next stage in smart cities by implementing the in-depth analysis of the intricate dynamics of urban environments [Cureton and Hartley, 2025, p.91].

Figure 1.2 illustrates the conceptual framework of a Digital Twin in an urban context. The figure illustrates the integration and interaction between various elements of a smart city ecosystem:

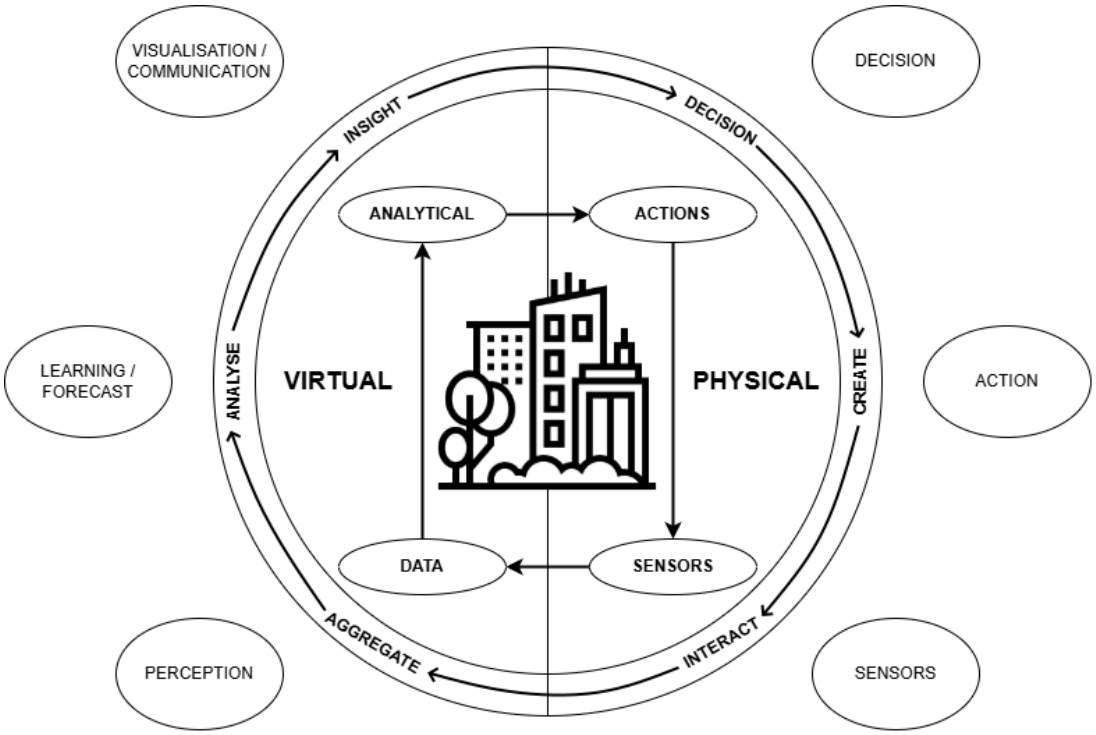


Figure 1.2. Own visualisation of a digital twin element with inspiration from Caprari et al. [2023]

1.2 Smart city challenges

Smart cities have been envisioned as a response to the growing complexity of urbanisation. Smart city programmes were initiated to utilise the power of digital technologies, data-driven decision-making and connected infrastructures to improve efficiency, sustainability and quality of life. Although this was a promising beginning, the widespread adoption of smart city solutions has been met with daunting challenges that have brought it to a halt in many cities. This chapter takes a critical look at the main factors holding back the implementation of smart city initiatives.

1.2.1 Challenges in scaling up smart cities

Expanding smart cities from pilot projects to scale implementation presents significant challenges. Implementation poses several governance-related barriers that affect the success of smart city projects. Most of the challenges identified in scaling smart cities emerged not only from research but also from interviews with people who worked and are still working at the frontline of urban innovation and smart cities. In the stakeholder interviews detailed in the methods section, urban planners, municipal representatives, and smart city experts shared their real-time struggles with smart city projects in interviews.

Cultural and organisational barriers

Driscoll points out that cities have been caught between two competing imperatives. On the one hand, they need the stability of strong regulatory and legal frameworks. On the other hand, they must embrace innovative, risk-taking

approaches to implement new technologies. The conservative nature of municipal decision-making, where failure is heavily penalised, means that even promising pilot projects may not be scaled up because of fear of failure and the associated political risks [Patrick Driscoll, DTU, 2025, p.3-4].

In an interview with Hirsbak, he explains that over time, planning laws have been fragmented and utilities have been separated. An example he mentioned is that energy and water are now in different departments. This fragmentation slows the development of integrated strategies for smart city initiatives. Alongside this is that municipalities are legally constrained. They can only allocate resources for projects with a clear legal basis which limits the flexibility when innovative cross-departmental approaches are needed [Stig Hirsbak, Aalborg University, 2025, p.2-4].

Economic vs social priorities and decline in smart city momentum

In the interview with Nielsen, he points out that there is a strong political rhetoric regarding smart cities. This is especially true for larger cities like Copenhagen, while smaller municipalities often lack the budget and political backing to invest in smart city projects [Christian Gaarde Nielsen, Copenhagen Solutions Lab, 2025, p.4].

In an interview with Driscoll, he reflects on the peak of the smart city interest being around 2010–2011 and notes the stagnation in the initiatives since then. There was an initial promise of technology to resolve the urban challenges, but there was a realisation of political caution, limited human capital and infrastructural shortcomings which prevented further progress [Patrick Driscoll, DTU, 2025, p.4].

Municipal capacity constraints

The municipality's ability to manage and sustain the projects emerges as a critical challenge that smart cities bring. The selected private sector partners are typically selected based on their technical expertise and background, but municipal governments often lack the necessary skills to effectively engage with these partners. This creates an imbalance that can lead to weak negotiation positions and inability to demand the necessary technical adjustments or improvements in the project [Bundgaard and Borrás, 2021, p.4].

Driscoll emphasises that municipalities often lack the in-house technical expertise and organisational capacity to manage large-scale smart city projects. He notes that while cities want to innovate (for instance, by adopting data-driven solutions like IoT and AI), their internal IT departments typically cannot match the scale and sophistication seen in the private sector. As a result, there is a significant dependence on external experts, which hinders the development of municipal capacity for long-term project sustainability [Patrick Driscoll, DTU, 2025, p.2].

Additionally, municipalities may experience difficulties in departmental coordination when it comes to smart city initiatives. These initiatives often require collaboration across multiple municipal departments, but implementation can be challenging due to administrative silos and a lack of leadership. Frequently at the forefront are management issues, such as a shortage of technical staff and expertise, which can hinder a city's capacity to expand smart projects. Nielsen echoes this sentiment by discussing how smaller municipalities, in particular, struggle due to a lack of clear strategic planning and limited personnel. Even with available EU funding, these cities often cannot allocate

the necessary human resources or budget to scale and sustain pilot projects [Christian Gaarde Nielsen, Copenhagen Solutions Lab, 2025, p.4].

Uneven development

The development of smart cities is also uneven, which is reflected in the Global Power City Index (GPCI), which ranks cities based on accessibility, economy, research and development, culture, liveability and environment [Cureton and Hartley, 2025, p.24-27]. This unevenness extends beyond just rankings, as smart city initiatives often focus on specific urban districts rather than entire cities. The report "Technology and the Future of Cities" discusses that targeted districts risk deepening socio-spatial inequalities by creating high-tech enclaves that are well-connected internally but disconnected from surrounding areas [Shelton and Clar, 2025, p.106].

The smart city is shaped by a techno-scientific perspective, which prioritises data science and engineering over social sciences. This emphasis on technology over equity raises concern that the smart city initiatives will boost existing disparities rather than bridge them. While rankings like the GPCI highlight global competitiveness, they may obscure the localised inequalities within cities where smart infrastructure is often concentrated in privileged areas [Shelton and Clar, 2025, p.107-108].

Defining and addressing public needs

Smart city projects must also address challenges at a city-wide level rather than being restricted to specific neighbourhoods. The process of public needs requires municipalities to engage with citizens, civil society organisations and end-users. For smart city projects to succeed, it depends on the extent to which cities proactively assess these needs and incorporate public participation. A lack of engagement can lead to an imbalance in priorities, where projects serve the interests of private stakeholders rather than the broader urban population [Bundgaard and Borrás, 2021, p.4-5].

Social legitimacy and public trust

Social legitimacy, which is based on how well-liked a project is by the general public, also has an impact on smart cities. Concerns regarding data ownership, privacy, and surveillance are frequently voiced when technologies become more digitally advanced [Bundgaard and Borrás, 2021, p.5].

- **Public opinion and contestation**: Strong opposition to the smart city project from citizens, its scalability will likely be compromised.
- **Data ownership**: When private companies retain control over data generated by smart city solutions, public trust decreases.
- **Citizen participation**: The more residents are actively involved in the pilot and development phases, the higher the legitimacy of the project.

Although his focus is on digitalisation, Fertner touches on a broader issue that early smart city projects often did not fully engage with citizens. The limited public participation sometimes led to projects that catered more to the interests of private partners rather than addressing the urban population's real needs [Christian Fertner, KU, 2025, p.2].

The interview with Fertner reveals that issues of social legitimacy, stemming from concerns about surveillance, data privacy and control, continue to erode public trust. The value of a smart city can be undermined by this scepticism, which can make it harder to scale projects justifiably, which lack transparency and public involvement [Christian Fertner, KU, 2025, p.3]

Perceived technological uncertainty

The perception of technological uncertainty is another major roadblock to scaling smart city projects. Reliability, long-term maintenance and potential security risks are of concern and are often the reason cities hesitate to adopt new technologies [Bundgaard and Borrás, 2021, p.5].

- **Bureaucratic Tailoring**: Capable municipalities take a path where the governance leads while adjusting projects over time.
- **Low-Uncertainty Partnering**: A model where public-private collaborations work best when the technology involved is perceived as stable.

However, projects involving technologies such as LED lighting systems tend to scale more easily because their benefits are well understood. In comparison, more experimental technologies, like underground infrastructure sensing, face greater obstacles due to uncertainty about their long-term feasibility [Peter Bjørn Larsen, Smart city insights, 2025, p.3]

In an interview with Driscoll, he mentions that scaling up of smart city projects is not a simple matter of technological advancement and implementation, it requires strong municipal governance, public trust, clear articulation of needs and a well-managed perception of technological risk. These issues are necessary to address to make sure smart cities escape the pilot stage and can transition into fully operational urban solutions [Patrick Driscoll, DTU, 2025, p.2-3].

Driscoll also noted how municipalities are hesitant to commit to new technologies due to uncertainties. These uncertainties include long-term maintenance, cybersecurity risks and rapid technological evolution. This uncertainty creates the reluctance to scale up smart city pilot projects and hinders it into fully integrated systems [Patrick Driscoll, DTU, 2025, p.2].

In the discussion of digitalisation of planning documents with Fertner, he highlights how legacy systems (Legally binding PDFs versus dynamic GIS data) and outdated legal requirements can create complications. These regulatory and infrastructural challenges slow down the transformation into more digital tools and act as a barrier to the scale-up of smart city solutions [Christian Fertner, KU, 2025, p.2].

1.3 Global perspectives on smart city challenges

Initiatives for developing smart cities have become more popular worldwide as cities look to incorporate digital technologies to enhance infrastructure, governance, sustainability, and quality of life. However, despite increasing interest and significant investment, cities in many nations continue to face barriers that hinder these programs successful implementation and scalability. Data management, institutional capacity, governance, finance, and citizen participation are usually the topics of these concerns.

To invest in a sustainable and equitable future and tackle challenges such as climate change, ageing infrastructure, and population growth, **New York City (NYC)** considers smart city technologies essential. The city's main objective, guided by the OneNYC plan, is to improve people's quality of life through smart infrastructure, e-governance, and energy efficiency. In addition to promoting diversity, equity, growth, resilience, and sustainability, this plan is dedicated to lowering greenhouse gas emissions to attain a net-zero economy [Munksgaard, 2020, p.3-7].

NYC's strategies are based on supporting a diverse population, addressing urgent needs, delivering reliable services, making use of community resources and fostering collaboration. These approaches emphasise accessibility, clear communication, resident engagement, user-focused service design, capacity building, digital integration within neighbourhoods and accountability. Nevertheless, the city still faces challenges from governmental rigour, resource constraints, a shortage of skilled experts and the complexities of retrofitting existing infrastructure [Munksgaard, 2020, p.9-10].

Despite the major setbacks, New York City is still ranked at the top of the smart city solution purchases. This reflects its major role and presence in the market. With a decentralised approach which engages various agencies, it fosters collaboration and makes use of specialised expertise. Initiatives such as the Open Data Program, LinkNYC, New York City Bike and the Brownsville Innovation Lab enhance the transparency, encourage public participation and boost access to essential services [Munksgaard, 2020, p.11].

The plan put forth by **Newcastle** City Council (NCC) to turn the city into an innovation hub is known as the Smart City Strategy (2017–2021). Creating a sustainable, intelligent and livable environment is the aim. The strategy's primary objective is to attract talent and investment by using technology and data to enhance sustainability, economic diversity, and quality of life. It also highlights the importance of stakeholder collaboration [NCC, 2017, p.6-10].

The strategy focusses on several important areas, including smart mobility through improved transport networks, smart governance through increased transparency and citizen participation, smart living through the use of technology to improve community services and quality of life, the smart environment through data-driven sustainability efforts, smart people through the development of skills, education and innovation and the smart economy through the use of technology to stimulate economic growth [NCC, 2017, p.26-36].

Newcastle wants to be known globally for its technological innovation to draw in talent, employment and investment. Improvements in sustainability, economic growth, quality of life, citizen engagement and international reputation are among the expected advantages. Despite its advantages, the strategy has several disadvantages, such as the lack of defined budgetary allocations, precise targets, thorough risk management plans and thorough community

participation techniques. Lastly, future difficulties could arise from the absence of conversation on data privacy [NCC, 2017, p.5].

1.4 The state of smart city development in Denmark

Denmark is emerging as one of the front-runners in smart city projects, leveraging digital technology to improve urban living and initiate economic expansion. The idea of smart cities has become popular all around the world, with a market worth almost $1.3 trillion and a 17% annual growth [Arup and CEDI, 2016, p.6]. The documents Danish Smart Cities: Sustainable Living in an Urban World and Growing Smart Cities in Denmark: Digital Technology for Urban Improvement and National Prosperity are used in this part to analyse smart city initiatives in Denmark. It outlines the key conclusions, challenges and overall impacts of these initiatives on urban growth. Danish smart city strategies are supported by a dual ambition, which is to utilise digital innovation for economic growth and to drive sustainable urban living. As cities become central to economic activities, there is an increasing focus on transforming urban surpluses into renewable resources, thereby ensuring that urban growth remains both productive and possibly viable [Copenhagen Cleantech Cluster, 2012, p.4].

1.4.1 Smart city activities in Denmark

Denmark takes a broad approach to smart city growth, as seen in the actions of cities like Copenhagen, Aarhus, Vejle and Albertslund. Copenhagen's projects, such as 'Copenhagen Connecting', lead this vision. They aim to boost urban infrastructure by combining various data sources. With initiative, it shows a pledge from the city to blend technology with sustainability. Community involvement and working together are a focus in Aarhus with their Smart Aarhus plan. With programs like Open Data Aarhus and the Dokk1 innovation center, it shows a commitment to openness and digital skills. With these efforts, it help connect the public and private sectors, which fosters creativity and collaboration among community members. Meanwhile, Vejle has set itself apart as a tough, smart city despite its compact size. In response to environmental threats and flood risks from rising sea levels, Vejle has made digital solutions a top priority. Real-time tracking and future predictions are available with these solutions, along with access to digital programs that make sure all citizens can benefit from the tech progress [Arup and CEDI, 2016, p.22]. In another part of Denmark, Albertslund has become an innovation hub. This is due to their groundbreaking work in smart lighting. DOLL, the Danish Outdoor Lighting Lab, has played a key role in digital tech, which can boost public services. This lab serves as a European testing ground for state-of-the-art lighting ideas [Arup and CEDI, 2016, p.23]. In addition to these initiatives, Danish cities are embedding sustainability into their urban systems by integrating digital technologies with existing infrastructure. Cities like Copenhagen and Aarhus not only enhance service delivery but also promote sustainable living through effective resource management and the conversion of waste streams into valuable energy sources [Copenhagen Cleantech Cluster, 2012, p.7].

1.4.2 Main findings and setbacks

This section of the thesis offers important insights regarding Danish municipalities progress in developing smart cities. There is a willing participation which is shown by several municipalities having smart city projects [Arup and CEDI, 2016, p.4-7]. However, there is a tendency that projects stay in the pilot stage, which is a common setback. Many of the projects have setbacks in scaling up and end up in a "pilot sickness". This difficulty is associated with uncertainty in municipal procurement procedures and the lack of unified long-term investment policies [Arup and CEDI, 2016, p.24]. Challenges with collaboration and investment are also evident. Despite Denmark's thriving smart city innovation ecosystem, limited cross-city collaboration and unclear municipal demand make it difficult to attract long-term corporate investment [Arup and CEDI, 2016, p.27]. Additionally, although Denmark has a high ranking on the EU Digital Scoreboard, there are public concerns around cybersecurity and data privacy, with about one-third of the population expressing worries about the security of digital public services [Arup and CEDI, 2016, p.29]. Moreover, although many municipalities have established open data portals, problems with data integration and interchange still exist. The full benefits of smart cities cannot be fully achieved due to technical and legal obstacles that limit the potential for extensive urban integration [Arup and CEDI, 2016, p.30]. Finally, the fragmented communication between digital and physical infrastructures continues to hinder digital transformation, despite its great potential. These interface issues restrict the application of smart solutions for sustainable urban development, underscoring the need for more integrated systems and shared platforms [Copenhagen Cleantech Cluster, 2012, p.10].

Conclusion

This introduction explores the complex landscape of smart city projects in Denmark. Smart city projects show a lot of promise in fields like technical innovation, environmental sustainability and public involvement. However, issues do arise like data interoperability, public trust, investment certainty and scalability, which are important areas for development. These challenges will be explored further in this thesis.

Research Question and Structure of the report 2

This chapter seeks to outline the objectives and target groups while also introducing the research question and sub-questions that the thesis aims to answer. The research design and structure of the thesis will also be explained.

2.1 Objectives and Target Groups

The primary objective of this research is to critically examine smart city development in Denmark. The research investigates municipalities that have had or still have successful initiatives, such as Copenhagen's pursuit of carbon neutrality, Aarhus's community-driven Smart Aarhus plan and other municipalities, as well as the challenges with these initiatives that prevent pilot projects from scaling up. In doing so, the research seeks to identify the factors that lead to the phenomenon known as "pilot sickness" and explore other barriers. The goal of this thesis is to research why some municipalities have been successful and why others haven't. In addition to this, recommendations were formulated for policymakers, urban planners, private sector partners, etc. The recommendations are to improve the scalability and integration of smart city initiatives across Danish municipalities. This thesis target group is for the previously stated stakeholders who directly experience the benefits and challenges of smart city projects.

Main Research Question:

Why do Danish municipalities face challenges in adopting, sustaining and scaling up smart city projects, and how do governance structures and municipal capacity influence these barriers?

Sub-questions:

1. *What are the key challenges that prevent Danish municipalities from successfully adopting, sustaining and scaling up smart city projects?*
2. *How do governance structures and municipal capacity impact the adoption of smart city projects in Denmark?*
3. *What strategic steps can Danish municipalities take to effectively implement smart city projects?*

The concept of a smart city promises to make urban life more efficient, sustainable and citizen-friendly. Although promising, many Danish cities are making these goals, their reality even though smart city implementation has proven challenging. While some of the projects fail because there are insufficient resources or management skills, others stall after the pilot stage. To guarantee that smart city solutions are not only novel ideas but also provide Danish municipalities with long-term advantages, it is imperative to comprehend these difficulties. The research is broken down into three sub-questions to comprehend these issues and offer suggestions for municipalities to address them.

The first sub-question explores the practical challenges that municipalities face. To get to the bottom of this, the thesis will use the answers from a survey conducted with the 98 municipalities, stakeholder interviews, mapping,

document analysis and a literature review. To frame this, institutional theory is used to examine administrative routines, regulatory complexity and interdepartmental silos. This will conclude in an analysis of the main challenges that municipalities face in adopting, implementing and scaling smart city projects.

The second sub-question in this thesis will seek to understand how the smart city governance structure is structured. To do this, multi-level governance theory will be used to map the distribution of authority and decision-making across the EU, national, regional and municipal levels. Alongside, a stakeholder analysis was conducted. This analysis seeks to understand the key stakeholders and bodies that influence the structure, implementation, scaling and adoption of smart city projects. Methodologically, there is a combination of document analysis, literature review, stakeholder interviews, and a survey. Together, these theories and methods allow for a pinpoint on not only who holds decision-making power and how formal structures are designed but also what practical capacity constraints enable or stall smart city projects at the local level.

The third sub-question aims to explore how municipalities can overcome the challenges identified by the other two sub-questions. The thesis will explore the diffusion of innovation theory, smart city indices, a case study of Aarhus and policy recommendations. The diffusion of innovation theory will analyse the Danish municipalities in their stage of smart city implementation and give recommendations based on their stage. Furthermore is researching the smart city indices and uses the metrics to identify key areas of improvement to become a smart city. Alongside this is the Smart Aarhus overview that will explore the key elements that made Smart Aarhus successful in recommending other Danish municipalities. The thesis will also look into policies that could make smart city adoption easier, such as accelerating procurement processes, improving ways to finance and strengthening knowledge-sharing networks.

2.2 Research design and Structure of the report

The research design, presented in Figure 2.1, is based on the theoretical and analytical framework for this thesis. This thesis takes a mixed-methods approach, combining data analysis from a plethora of methods. The goal is to build a comprehensive picture of the smart city landscape in Denmark and not just what's working and what's not, but also why certain challenges persist and what can be done about them. The report is structured into eight chapters. The first chapter introduces the concept of smart cities, and it also explains why this research is relevant at this moment in time. The second chapter outlines the research objectives and key themes that set the stage for the analysis phase that follows. This chapter also presents the research question and sub-questions, explaining how the thesis plans to answer these questions. The third chapter goes in depth into the research methods, how data is gathered, why the cases were chosen and how the analysis is approached. The fourth chapter analyses the biggest challenges that municipalities face in adopting, scaling and implementing smart cities. The fifth chapter analyses the governance structures and the impact of municipal capacity in the adaptation of smart city projects. The sixth chapter analyses the strategic steps forward for Danish municipalities in implementing smart city projects. The seventh chapter discusses the findings, interpretation of the findings, and limitations of the thesis, while the eighth chapter concludes with the findings of the thesis. Figure 2.1 visualises the research design of the thesis.

Figure 2.1. Visualisation of the research design of the report

Theoretical and Methodological framework 3

3.1 Theories

For the theoretical framework, Diffusion of Innovation, Multi-Level Governance and Institutional Theory were selected since these directly address the main issues identified in the introduction. Diffusion of Innovation explains what stage the municipalities are at in smart city implementation, while Multi-Level Governance highlights how divided decision-making and inter-departmental segregation delay coordinated action. Institutional Theory, meanwhile, sheds light on the influence of established organisational structures and political norms on the sustainability of these initiatives. The delimitation of other theories was due to them not fully addressing the key challenges of the research on how technological uncertainty, governance challenges and institutional dynamics interact in the scaling of smart city initiatives in Danish municipalities.

3.1.1 Diffusion of innovation theory

The diffusion of innovation theory integrates concepts from communication, management and sociology studies to predict how innovations spread. The theory focuses on explaining adoption decisions, especially about defined innovations within relatively homogeneous populations. According to Rogers (2003), diffusion is "the process by which an innovation is communicated through certain channels among the members of a social system over time." To reach a shared understanding, people use a specific kind of communication called diffusion. Due to innovations involving new ideas, there will always be an element of uncertainty. Rogers describes it as follows: “the degree to which several alternatives are perceived concerning the occurrence of an event and the relative probabilities of these alternatives”. Essentially, he characterises diffusion theory as an uncertainty reduction process, where the diffusion of information helps individuals make informed adoption decisions [García-Avilés, 2020].

He also defines innovation as “an idea, practice, or object perceived as new by an individual or other unit of adoption”. In a lot of cases, innovation involves a form of technology, which is described by him as “a design for instrumental action that reduces uncertainty in cause-effect relationships to achieve a desired outcome”. However, technological innovations also create new uncertainties, prompting individuals to seek further information before adopting them [García-Avilés, 2020].

In this thesis and research, the diffusion of innovation theory is particularly applicable to understanding the Danish municipalities scalability challenges faced in adopting smart city initiatives. Smart cities, as defined in Section 1, involve integrating advanced digital technologies such as IoT, AI and real-time data systems to improve urban efficiency and sustainability. These technological systems represent complex innovations that are not only new in function but also in how they redefine interdepartmental collaboration and citizen engagement within urban systems.

Innovation of diffusion theory allows us to analyse how these smart city solutions are introduced and communicated within local governments and how their adoption is shaped by the social systems in which municipalities operate. In particular, this framework helps us to assess how innovation characteristics such as complexity, observability, trialability and relative advantage affect adoption rates in different municipal contexts. This is especially important when thinking about "pilot sickness," which occurs when cities try out smart projects but are unable to scale them up. The theory also offers a means of comprehending how stakeholder decision-making is impacted by perceived risks and uncertainties, which are frequent obstacles to the deployment of smart city initiatives. By applying Roger's diffusion stages of knowledge, decision, implementation and confirmation, this research will identify at which stage Danish municipalities typically encounter resistance or delays and explore strategies that have helped to move projects beyond the pilot phase in more successful cases [Rogers, 2003,p. 170-183].

Overall, diffusion theory provides a structured framework for understanding how new ideas and technologies spread, emphasising communication, uncertainty reduction and the characteristics of both innovations and adopters. Figure 3.1 shows the diffusion theory model with its categories of who adopt at different rates over time.

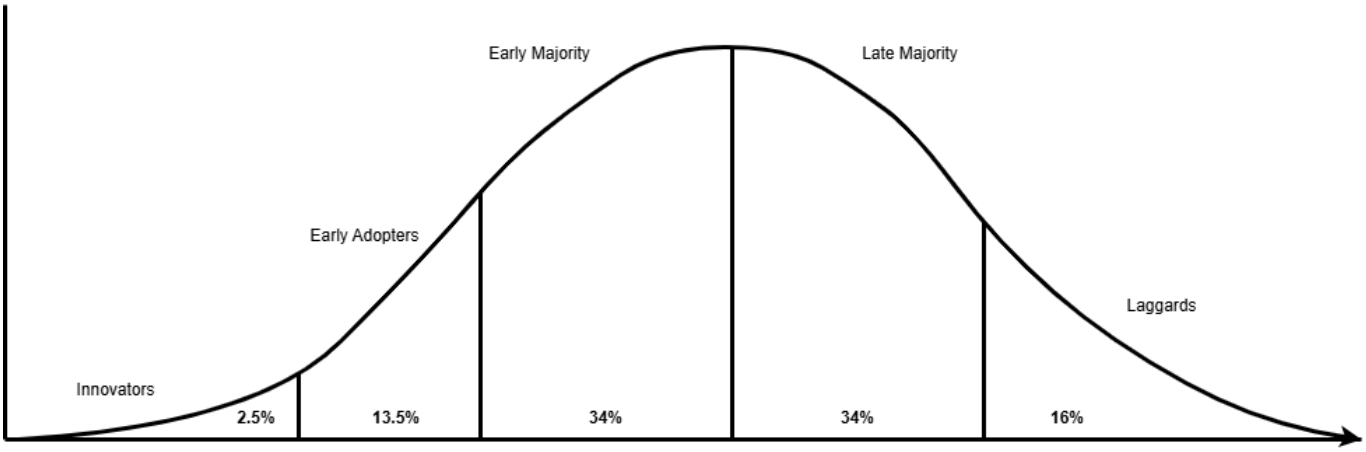


Figure 3.1. Own visualisation based on [Intrinsic safety training, 2024]

3.1.2 Multi-Level Governance (MLG)

The theory of multi-level governance (MLG) offers a framework for examining the allocation of power and responsibility among governmental levels. Municipal governments, international organisations, and non-state actors are examples of these levels. The responsibilities are divided due to complex management, diverse policy problems and challenges in a political environment that is increasingly intertwined. The MLG framework ensures that coordinated oversight preserves policy coherence across multiple authorities while promoting the delegation of decision-making to levels more sensitive to local requirements [Hooghe and Marks, 2001,p. 22-24].

The revolutionary political initiatives that defined the European integration process in the mid-1980s are closely associated with the development of MLG. It also demonstrates how important events, such as the planning that led to the 1985 Delors White Paper, contributed to the restructuring of the government's power. The later Single European Act (1986), which established the redistribution of responsibilities, allowed for a more responsive and

flexible approach to governance. Three interconnected dimensions are at the heart of the MLG model: the delegation of power to local levels, the division of duties among various actors (both state and non-state) and the creation of vertical coordination mechanisms intended to lessen the potential fragmentation brought on by dispersed policymaking [Hooghe and Marks, 2001,p. 23].

Denmark's smart city initiatives are exceptional illustrations of the application of the MLG concepts. Cities like Vejle, Aarhus and Copenhagen have started internal digital transformation projects that are prime examples of the principle of giving local governments more power. These initiatives give municipalities the tools they need to create urban solutions that address regional issues, like better public service delivery and environmental sustainability. However, there are also difficulties in putting innovative local projects into action, most notably what is known as the "pilot sickness" challenge. This phrase refers to the challenges that arise when promising pilot projects are unable to obtain the continuous funding, legal assistance, or coordinated efforts required for full-scale incorporation into urban policy frameworks [AND. and Sinani, 2023,p. 4].

Accountability is an important subject related to MLG. While increasing responsiveness, the distribution of authority can also lead to uncertainty in assigning responsibilities to the various stakeholders. Local authorities in Denmark typically have a thorough awareness of the requirements of the community. However, their dependence on centralised financial and regulatory systems may limit their operational independence. They aren't always clear, so legally binding accountability systems are in place to support the long-term adoption of innovative ideas. This dependence can also make it more difficult to scale up smart city initiatives [Caramani, 2020,p. 5].

Given these challenges, the MLG framework's ability to support inclusive and context-sensitive governance demonstrates its strengths. A robust and flexible policy framework is produced by effectively integrating centralised oversight and granting local actors authority. Strategic coordination combined with local expertise can produce more effective and durable governance results [Hooghe and Marks, 2001,p. 24].

3.1.3 Institutional theory

The Institutional theory's goal is to explain why governments/countries adopt specific scientific institutions and explain the forms these institutional entities take. Policymakers often see organisational structures as indicators of progress, and structures signal modern institutional development, which in their eyes justifies financial support. A key indicator is the presence of specific frameworks in higher education and government, which reflects a nation's commitment to scientific advancement. The theory of institutional theory, therefore, helps to explain the expansion and organisation of research sectors such as smart cities [Pinto, 2017].

For smart cities, institutional theory provides a valuable framework for understanding the organisational structures and governance models that shape their development of smart cities. The fast transformation of urban environments through ICT (Information and Communication Technologies) has shown the need for organisational theories to address these challenges. Although smart city initiatives often emphasise technological advancements, they frequently lack structured frameworks that integrate governance, collaboration and institutional dynamics. Therefore, a key issue in smart city development is the lack of adequate focus on the relationships between organisational

conditions and technology implementation in government projects [Radchenko, 2024].

The institutional theory will be used to understand and critically analyse how current organisational structures, norms and institutional pressures affect the adoption, scalability, and implementation of smart cities, focusing on Danish municipalities. With the help of the theory, it will be simpler to comprehend Danish municipal organisation and how municipal actors respond to institutional expectations. Institutional expectations such as modern governance models with a focus on progress through digitalisation, by adopting smart city frameworks. By including institutional theory in the research, the thesis can reveal the extent to which smart city development is driven by organisational conformity versus actual need, capacity or strategic alignment.

Institutional theory will help facilitate a close examination of how Danish municipalities, through their established norms, rules and routines, enable or impede smart city innovation [Radchenko, 2024]. Municipal departments are subject to institutional pressures that give precedence to established administrative procedures over experimental approaches [Patalon and Wyczisk, 2024,p. 612]. Institutional theory directs attention to the role of regulatory frameworks, professional norms and funding criteria in creating path dependencies that either support or constrain smart city scaling [Radchenko, 2024]. This thesis will identify specific institutional barriers to the embedding of pilot projects in routine urban governance by analysing case studies and stakeholder interviews. It will also examine how institutional entrepreneurs within municipalities utilise informal networks and reinterpret institutional rules to overcome these barriers and achieve sustainable integration of smart city initiatives.

3.2 Methods

This chapter outlines the methodology that supports the research in this thesis. The research adopts a mixed-methods approach that brings both rigour and human insight into the challenges of scaling smart city initiatives. It began with a systematic literature review to build a theoretical foundation, followed by a document analysis that grounds the work in real-world policies and practices. Stakeholder analysis and surveys capture the different perspectives and experiences of those involved, while in-depth interviews provide personal insights into the barriers and opportunities. Finally, the case study showcases these dynamics, humanising the complex. The strengths and limitations of each method are also described.

3.2.1 Literature review

During this project, a literature review was implemented to research the relevant literature. To successfully implement a literature review, analysing prior research not only sheds light on integrative areas but also helps pinpoint areas of research gaps. This is crucial to mapping and evaluating the research landscape. The process of a literature review involves several steps, which are essential to ensure suitability [Snyder, 2019]. The literature review examines published materials from a wide range to examine recent and ongoing research on the topic of smart cities. This also covers a plethora of other topics with different complexity levels. In this thesis, the main focus was on the challenges and problems of smart city implementation in Denmark. The strategy was therefore to research the relevant topics of

smart cities, Denmark, municipalities, etc. Keywords used during the literature review were as follows: "Smart city", "Smart Governance", "IoT", "Smart Sensors", "Smart City Challenges", "Smart City Projects", "Smart City Denmark", "Municipal Capacity Challenges", etc. This strategy included selecting relevant documents and exploring new terms that came from the research [Grant and Booth, 2009,p. 94].

The literature review used an organised methodology in which pertinent literature was gathered and analysed methodically. Instead of merely summarising the earlier research, the interpretative process was applied, in which patterns, inconsistencies and knowledge gaps were critically examined to produce deeper understandings and guide the creation of fresh viewpoints. This process was essential for methodically comprehending the field's development, revealing contradictions in the body of existing literature, and offering insights into prevailing trends. This review allows for a deeper contextual understanding, ensuring that theoretical foundations are critically assessed rather than simply accepted [Brinkmann and Tanggaard, 2020,p. 94].

There are a few drawbacks to literature reviews despite their many benefits, which include depth, applicability, rigour, and insightful information that increases impact and relevance. These drawbacks include the potential for bias, which could lead to biased or inadequate results, and the time commitment is also a drawback. Selection, searching and careful evaluation are required to ensure that the literature's quality is maintained. Another disadvantage is that sources are frequently created for various reasons and in various situations, which might affect how results are interpreted. Thus, it is essential to retain objectivity and relevancy in the review by striking a balance between breadth and depth [Snyder, 2019] [Grant and Booth, 2009].

Throughout the period of this project, data were gathered from various databases. Some of these sources are: *Aalborg University Library (AUB)*, *Google Scholar*, *Scopus*, and also *ResearchGate* and *Science Direct*.

3.2.2 Document analysis

The main aim of choosing document analysis as one of the methods is to explore the evolution of smart city initiatives in Denmark. Document analysis is employed as a rigorous means of reviewing, interpreting and synthesising a wide range of texts from reports, sustainability strategies and policy documents to uncover both explicit data and the subtle narratives behind them. This strategy primarily relies on ideas that characterise document analysis as a process that goes beyond simple data collection to include critical and interpretive elements. Every document is read for the context and intentions that are woven throughout its text in addition to its factual information. This turned a collection of written records into a logical narrative about urban transformation and gave the thesis a deeper insight into the opportunities and challenges related to smart city development [Bowen, 2009,p. 27-40] [Brinkmann and Tanggaard, 2020,p. 185-201].

By defining document analysis as a methodical process that blends aspects of content and thematic analysis, this strategy is further improved. The approach encompasses a continual method of skimming, reading, and interpreting texts while coding for themes and categories that show up in the data. This technique supports triangulation by validating findings through convergence across different data sources and such triangulation "breeds credibility", ensuring that the analysis remains both methodologically rigorous and richly contextualised [Bowen, 2009,p. 29].

In practice, this method involved systematically categorising documents according to themes such as smart cities, digital twins, digital governance, sustainability practices and urban policy reforms. The process was both methodical and reflective, while the analysis was grounded in concrete evidence from official records. It also acknowledged the human elements within the texts by engaging empathetically with the documents, we could appreciate the voices and perspectives of municipal decision-makers and urban planners, thus capturing a narrative that reflects both technical details and lived experiences [Brinkmann and Tanggaard, 2020,p. 185-201].

While document analysis benefits from the accessibility and stability of published records, there are certain pros and cons. One of the key pros of this approach is its efficiency. Since the documents are publicly available, there is no need to request new data or wait for field responses. However, it is important to acknowledge the cons also. Documents are typically produced for specific purposes and might not always align perfectly with research objectives, which can lead to gaps in interpretation. Nonetheless, by cross-referencing multiple sources and critically evaluating their content, this study mitigates such limitations and provides a holistic view of the urban challenges and innovations inherent in Danish smart cities [Bowen, 2009,p. 34-35].

In summary, the document analysis not only provides a rigorous, evidence-based foundation for understanding smart city development but also humanises the data by acknowledging the voices and experiences of the urban stakeholders behind these documents.

3.2.3 Mapping

QGIS is the mapping tool used in this thesis. It has many features, including tools for geoprocessing. One of the advantages of QGIS is its adaptability, which enables users to personalise what they do. Its open-source feature also removes licensing restrictions, enabling both individuals and organisations to use it. A disadvantage, though would be that QGIS could operate slowly when dealing with large data [GQIG, 2025]. Dataforsyningen is where the geospatial data used in QGIS was obtained. Topographic maps, elevation models, and aerial photos are just a few of the many datasets that may be accessed through Denmark's official geodata platform. Since the data is accessible through downloads and in GIS formats, importing it into QGIS is made simpler. One benefit is the data's quality, which guarantees reliability. However, the fact that its documentation and interface are mostly in Danish could be a limitation, making it less usable for non-Danish speakers [Dataforsyningen, 2025].

3.2.4 Case study

The present thesis uses a case study which is used to look at Denmark's smart city initiatives and challenges. Robert Yin defines a case study as "an empirical inquiry that investigates a phenomenon within its real-life context." Notably, a case study is an approach to research and not a method or technique for data collection [Yin, 2014,p. 13]. This thesis adopts a qualitative research approach, which includes in-depth data collection related to a specific program, event, activity, process or a set of people over an extended period, which is done via various data collection methods. Also, an in-depth look at the unit of analysis in the natural setting is done via surveys, questionnaires, in-depth

interviews, observation and document analysis [Murthy, 2020].
Case studies can be categorised into four categories, which are mentioned below:

- *Descriptive Case Studies* This form of case study is commonly utilised in fields such as anthropology and sociology, to provide a detailed description of a phenomenon in its natural context.
- *Explanatory Case Studies* This kind of case study aims at explaining the 'why' and 'how' concerning specific events in an attempt to shed light on the causal forces that shape a phenomenon.
- *Exploratory Case Studies* This type of case study examines a phenomenon to create new research questions.
- *Longitudinal Case Studies* This case study attempts to examine the same phenomenon multiple times to identify changes over time.
  [Murthy, 2020].

The strengths of case studies are adaptability and flexibility, which allow the researcher to adapt their approach to a specific research context and area. Additionally, it gives a thorough investigation that might yield in-depth knowledge and insights about the topic. Finally, it's versatility across several fields. Subjectivity is a problem, though, as the design may add bias that compromises validity and reliability. Moreover, the a lack of clear-cut boundaries since case studies and other types of studies are often blurry [GERRING, 2004].

This project employs an approach of the *Explanatory Case Studies* to explain 'why' and 'how' smart city initiatives have been successful in Aarhus Municipality. Aarhus municipality was chosen for the case study since it has been one of Denmark's front-running innovators in smart city evolution, having already designed scalable digital and sustainability initiatives ahead of most of its counterparts. The document analysis and literature review repeatedly highlighted Aarhus's outstanding governance structures and capacity-building activities. Furthermore, semi-structured interviews were available with two key Aarhus stakeholders directly involved in the city's smart initiative, providing first-hand insight into how dedicated municipal teams, agile procurement approaches, and strong multi-level collaboration have helped make Aarhus a successful smart city.

3.2.5 Survey

The survey is chosen as a method for this thesis as it is widely used by researchers to collect data from a large number of respondents. An online survey is used as a qualitative tool due to it being cost-effective, and it has the ability to reach a variety and large part of the population. This method allows respondents to answer in a flexible way and this reduces the pressure of in-person interviews [Braun et al., 2020].

It was also used as it allows for open-ended questions, which enables the possibility to gather in-depth qualitative data. This method further facilitates a deeper understanding of respondents behaviours, experiences and personal opinions. Nonetheless, there can be limitations with this, and some of them are response bias, technical barriers and challenges with respondent authenticity [Braun et al., 2020].

Despite the limitations listed, online surveys remain an effective tool for qualitative and quantitative research, particularly when designed with clear questions and distributed strategically to target the right audience. By using

online survey platforms, researchers can efficiently collect valuable qualitative insights while minimising logistical constraints [Braun et al., 2020].

A survey was carried out to get opinions from each municipality about the state and difficulties of smart cities in their respected municipality. The survey's clear and targeted structure made sure that it reached the appropriate staff members in each municipality who would be most qualified to offer pertinent information on the topic. The goal of the survey was to obtain a comprehensive understanding of the situation of each municipality's position on smart cities [Braun et al., 2020].

The main goal of the survey conducted in this thesis was to explore the challenges with smart city projects in a Danish municipal context. The questions in the survey were brainstormed from the research question and its sub-questions, such as: "What do you experience as the biggest challenges in implementing smart city projects? (Select all that apply)". The survey consisted of a set of questions aimed at both gaining qualitative and quantitative data on the municipalities involvement in smart city initiatives and the key challenges they face or faced. The questions were designed to be clear and easy to understand while also being short, taking approximately 5 minutes for each respondent.

The survey included different ways of answering, including multiple choices, check boxes, short answers and long answers. The survey also included a pathway based on their answers. This was based on "Yes", "No", or "I don't know" on the questions: "Does your municipality currently have any smart city projects?" and "Has the municipality previously worked with smart cities?".

To ensure the survey reached the appropriate individuals, the survey was included in a mail which carefully explained the purpose of the survey and was sent to each of the municipal department's emails. The mail was the municipality's main mail, but the email stated that the email should be forwarded to the right person in the municipality. The survey also included a textbox where they could include their job and position in the municipality.

The survey was distributed to all 98 municipalities in Denmark, and there were 50 responders from 46 different municipalities. Each respondent gained their perspective on their respective municipality.

3.2.6 Stakeholder analysis

During this thesis, a stakeholder analysis was implemented to understand the key stakeholders in the smart city landscape in Denmark. This form of analysis is an approach that is based on identifying stakeholder groups and prioritising the key stakeholders for a given case and their respective roles they have [Marcus and Smith, 2011,p. 1564-1565].

Additionally, a selection of stakeholders and the criteria for becoming a stakeholder, as stakeholders originate at different levels and on different grounds according to influence and interests. A selection of stakeholders are described as follows by Varvasovszky and Brugha [2000]: *"Stakeholders can be defined as actors who have an interest in the issue under consideration, who are affected by the issue, or who - because of their position - have or could have an active or passive influence on the decision making and implementation process."* [Varvasovszky and

Brugha, 2000].

One method of identifying the stakeholders is interviewing a key stakeholder in the process. This is especially relevant for the key stakeholder identification through desk research. Throughout the interviews, questions about who else is currently in the field [Varvasovszky and Brugha, 2000]. The obstacle of stakeholder analysis is that stakeholders may have changed their opinions before the research is completed. There can also be mixed opinions, mixing individual and organisational opinions, which can result in reducing the validity [Varvasovszky and Brugha, 2000].

Stakeholders interests and levels of influence can be mapped to organise the stakeholders and get a clear view of the structure. This can be mapped in a **stakeholder mapping**, which is mapped by the indicators of: levels of interest and levels of influence. The map is structured around a four-quadrant influence-interest matrix, which puts different stakeholders in different categories. A visualisation can be seen in Figure 3.2.

Within this figure, the y-axis shows the level of influence while the x-axis represents the level of interest. At the top is the highest of influence, and the bottom is the lowest of influence, while at the left-most part is the lowest of interest, and the right-most part is the highest of interest. In this figure, the stakeholders are placed based on these criteria [Tristancho, 2023].

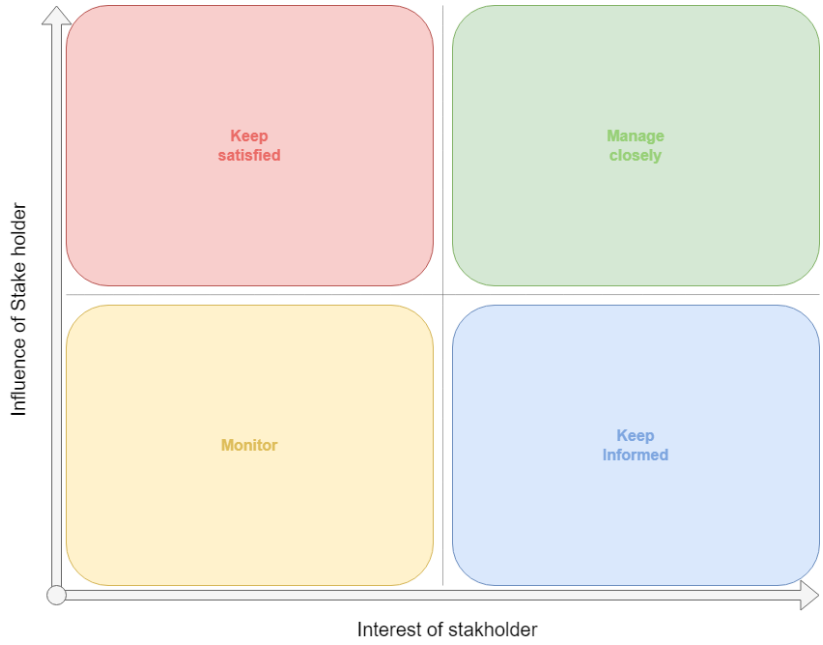


Figure 3.2. Own illustration of stakeholder mapping based on Tristancho [2023]

Strengths of stakeholder analysis include the inclusion of perspectives from a diverse set of sectors and stakeholders, while also the ability to identify the opposition to the project. Additionally, the approach in the ability to encourage and engage with the stakeholders in the project alongside strengthening connections among the involved stakeholders [Schneider, 2014]. The challenge, on the other hand, includes time-intensive and costly processes for the broad inclusion of stakeholders. Additionally, diverse and complex sets of individuals and stakeholder groups can make it difficult to produce a picture that fully represents the situation. Furthermore is the bias and the subjectivity of the stakeholders [Schneider, 2014].

In this thesis, the stakeholder analysis was heavily influenced by previous stakeholder analysis'. Previous analysis of the smart city stakeholders had a great influence on the conducted analysis of the stakeholders in this thesis. Although very influential, the analysis in this thesis is on a Danish context and with its visualisation of the stakeholders in the stakeholder mapping.

3.2.7 Stakeholder interviews

During this project, nine semi-structured interviews were conducted. The semi-structured interview approach was conducted to enable the exploration of the complexities of smart cities. Due to the complexity of smart cities, stakeholder interviews with key participants are key to understanding the complexity of this topic. The method of semi-structured interview allows the interview to be flexible while also being a comprehensive investigation of relevant topics to the theme. The flexibility of the method allows and ensures that nuanced insights can be discussed and understood to examine the theme of smart cities [Bryman et al., 2021,p. 212].

The main goal of each interview was to gain insight into their respective knowledge of smart cities in Denmark. The interviews were conducted with a plethora of people with different positions and knowledge around the field of smart cities. The interviews were a process throughout the research, meaning that the first interviews were of little knowledge of smart cities challenges, where the interviews were to explore the initial questions of smart city challenges. This reflects in the interview questions that were more exploratory and mostly on the challenges of smart cities in the initial research. Later on, with more knowledge in the field of smart city challenges, more comprehensive and specific challenges in smart cities were asked in the interviews. Questions of the stakeholders of smart cities, governance structures of smart cities, etc.

Even though semi-structured interviews provide an exploratory dialogue with the interviewee, they also pose limitations. These limitations come from the probability of overlooking critical issues if the conversation diverges too far from the interview themes. Additionally are the biases of interview participants, which can influence certain answers and data collected. To lessen these significant challenges, audio recordings were implemented to transcribe the interview to ensure a complete analysis. The data for the interviews can be seen in the Appendices [Delve, 2022].

For this thesis research, nine interviews were conducted. These experts were chosen for the interviews as they all have relevant expertise within the field, and a few of them suggested each other. Some were found also during our research in finding people within the field who could give valuable insights for our thesis. The interviews were with the following people:

- **Anders Esager Hansen (Vejle Kommune)** - An interview was conducted with Anders Esager Hansen. He is a digital consultant for Vejle Municipality. During this interview, insightful information was gathered on the opportunities and challenges of smart city initiatives in Vejle. The interview is included in the appendices [Anders Esager Hansen, Vejle Municipality, 2025].
- **Christian Fertner (IGN - Institut for Geovidenskab og Naturforvaltning - University of Copenhagen** - An interview was conducted with Christian Fertner. He is an Associate Professor of Urban and Regional Planning

at IGN, at Copenhagen University. A lot of information was provided on structural and governance challenges related to the implementation of smart city initiatives. The interview is included in the appendices [Christian Fertner, KU, 2025].

- **Christian Gaarde Nielsen (Copenhagen Solutions Lab)** - An interview was conducted with Christian Gaarde Nielsen. He is the Team Leader of Copenhagen Solutions Lab. From this interview, a lot was learned about Copenhagen's approach to smart city initiatives. The interview is included in the appendices [Christian Gaarde Nielsen, Copenhagen Solutions Lab, 2025].
- **Patrick Driscoll (DTU Wind, Technical University of Denmark)** - An interview was conducted with Patrick Driscoll. He is a Senior Executive Officer at DTU Wind. The interview with him focused on the scalability of smart city initiatives, challenges, and the complex nature of smart city development. The interview is included in the appendices [Patrick Driscoll, DTU, 2025].
- **Stig Hirsbak (Aalborg University)** - An interview was conducted with Stig Hirsbak. He is a special advisor from Aalborg University's Institute for Sustainability and Planning. A historical perspective on the development of smart cities was gathered from this interview. The interview is included in the appendices [Stig Hirsbak, Aalborg University, 2025].
- **Peter Bjørn Larsen (Smart City Insights)** - An interview was conducted with Peter Bjørn Larsen. He is the director and founder of the consultancy Smart City Insights. The interview provided valuable global and strategic perspectives on the growth of smart cities. Drawing from his experience advising over 40 cities globally and his background in both the public and private sectors. The interview is included in the appendices [Peter Bjørn Larsen, Smart city insights, 2025].
- **Morten Falbe-Hansen(Team leader Aarhus Smart City Lab)** - An interview was conducted with Morten Falbe-Hansen. He is the team leader of Aarhus City Lab. This interview provided an inside view on how the municipality leverages European-funded innovation to tackle real urban challenges. As head of a small multidisciplinary unit within the Innovation, Technology & Creativity (ITK) department, he oversees two flagship initiatives: TechCircle, Aarhus's digital innovation hub and CITCOM, a living-lab platform for testing AI and robotics in the city environment. The interview can be found in Appendices [Morten Falbe-Hansen, 2025].
- **Kim Stannov Søvsø (Innovation, Teknologi og Kreativitet)** - An interview was conducted with Kim Stannov Søvsø. He is the team coordinator for the ITK department at Aarhus City Lab. The interview shed light on how municipal innovation drives urban development. He has worked with ITK for around six years and has prior experience working with smart cities for Copenhagen and Aarhus. The interview can be found in Appendices [Kim Stannov Søvsø, ITK, 2025].
- **Camilla Føns Mortensen and Morten Koed Rasmussen (Head of Department – Buildings, Data and Climate Adaptation and Senior Project Leader – Mobility, Buildings and Data)** - An interview was conducted with Camilla who holds a master's in computer science (e-business) from the IT University and brings over a decade of experience implementing smart city strategies in both public and private sectors. The interview was also conducted alongside Morten, who opened a window into how a municipal master's graduate leverages academic research and hands-on experience to drive smart city solutions in the green transition. Drawing on his thesis work at the IT University on smart cities, Morten has spent years developing and implementing digital innovations at Høje Taastrup Municipality. The interview can be found in Appendices [Mortensen and Rasmussen, 2025].

Analysis 1 - Challenges in adopting, sustaining and scaling smart city projects 4

The implementation of smart cities in Danish municipalities was initially researched in Section 1, these will be expanded upon in this analysis. The majority of smart city projects remain limited in scope and encounter difficulties after their pilot phase despite widespread enthusiasm. This analysis is based on insights from literature review, document analysis, a nationwide survey and stakeholder analysis to analyse the challenges that prevent Danish municipalities from successfully adopting, sustaining and scaling up smart city projects.

The sub-question this section seeks to answer is as follows:

"***What are the key challenges that prevent Danish municipalities from successfully adopting, sustaining and scaling up smart city projects?***"

To successfully answer this question, a survey was created and sent to all the Danish municipalities in Denmark. Of all of them, 50 answers were gathered from 46 different municipalities. Alongside this, expert interviews were conducted with different experts to gain insights into the key challenges that prevent Danish municipalities from successfully adopting, sustaining and scaling up smart city projects. Information was also gathered from a literature review and document analysis to further dive into the key challenges. Finally, institutional theory was applied as a theoretical framework to better understand how and why these challenges persist.

4.1 Key challenges in Danish municipalities

The implementation and scaling of smart city initiatives in Danish municipalities was first identified in section 1, where a plethora of challenges were identified. Section 1 sought to introduce the problems that Danish municipalities face when implementing and scaling smart city initiatives. The analysis of the literature review, document analysis, survey and interview results will be presented in this section. The international community recognises Denmark as a leader in digitalisation and technology, yet numerous municipalities encounter major obstacles when deploying smart city solutions. The identified challenges span across organisational, technical, financial and cultural dimensions. These challenges are complicated and interact with each other, which reflects a complex environment and implementation. Although complex, these barriers are essential to understand and develop strategies that will be analysed in Section 6.

4.1.1 Background for the analysis and the key barriers

To understand the key challenges that prevent Danish municipalities from successfully adopting, sustaining and scaling smart city projects, a survey was conducted. The respondents are from 46 different municipalities of the total of 98 municipalities. The map and figures below illustrate the different aspects explored in the survey that are valuable for this part of the analysis:

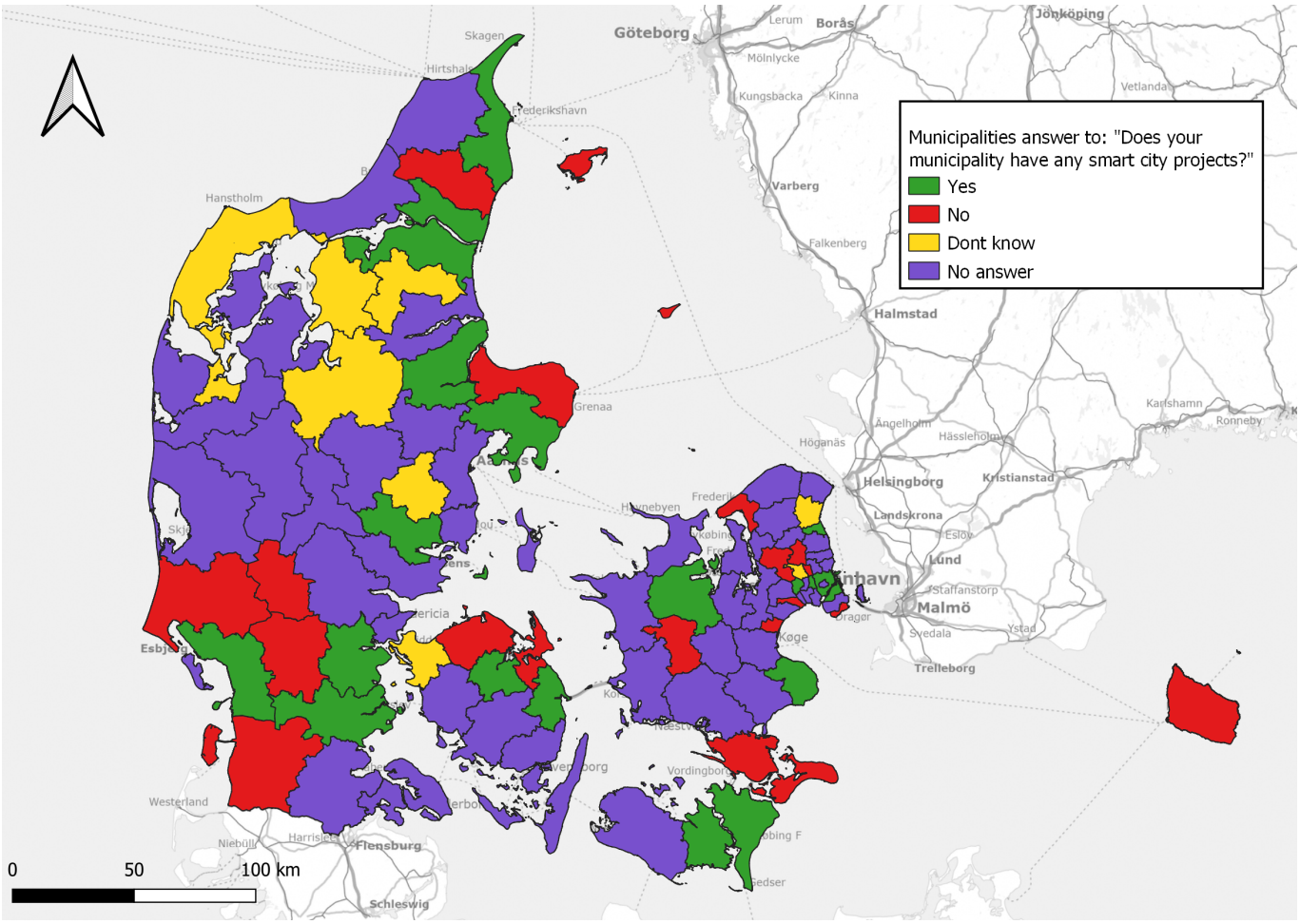


Figure 4.1. Own map of the responding municipalities in the survey [Thesis group, 2025]

The following two graphs show the percentage of 'Yes', 'No' and 'Don't know' of the municipalities that currently have smart city projects and the percentage of 'Yes', 'No' and 'Don't know' of the municipalities who answered 'No' to having smart city projects, if they have previously worked with smart cities.

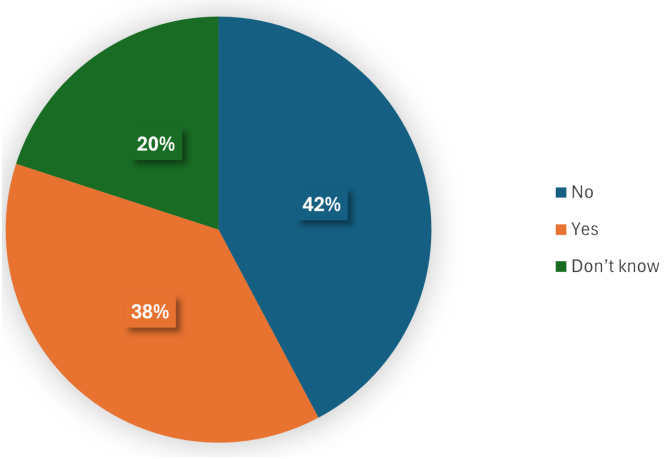


Figure 4.2. Does your municipality currently have any smart city projects?

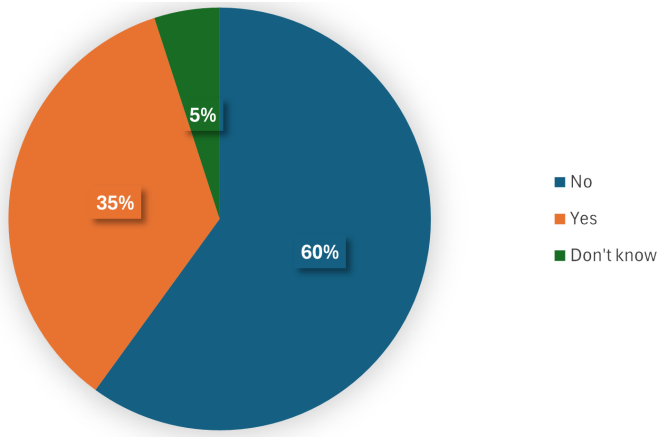


Figure 4.3. Has the municipality previously worked with smart cities?

After these figures are following figures(Seen on next page) show the answers by respondents on the main challenges faced by the municipalities with smart city initiatives, either ongoing or past. According to Figure 4.4, the largest implementation challenge among those actively working on smart city projects is budget constraints at (37%), which are followed by a lack of technical expertise at (18%), concerns of data security at (15%) and political support (7%). Smaller percentages of respondents also mentioned difficulty moving from trial initiatives to full-scale operations, a lack of structural support and a lack of understanding regarding data security.

Municipalities that have started smart city projects in the past but stopped them are the focus of Figure 4.5. This lack of technical expertise was the primary cause for ending a project at 50%, with funding and political attention coming in at 16% and 17%, respectively. Notably, 17% of respondents indicated their projects were still in progress.

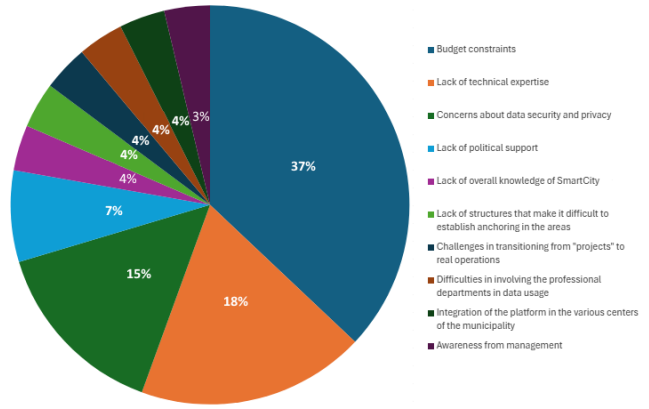


Figure 4.4. What do you experience as the biggest challenges in implementing smart city projects?

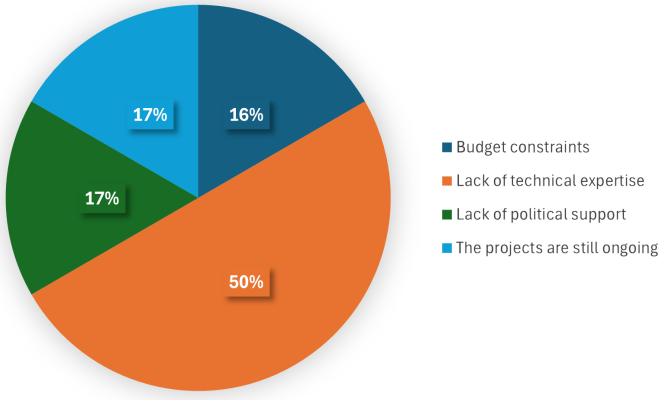
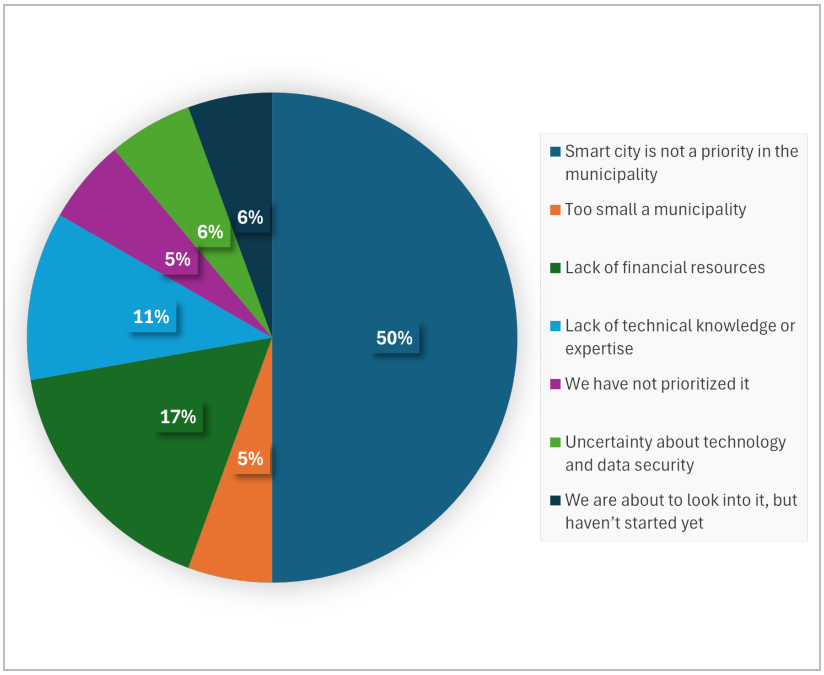


Figure 4.5. Why did the project stop?

Lastly is the graph of those municipalities that have never worked with any smart city projects. They were asked: "What is the reason the municipality has not worked with smart city projects yet?". The reasons why certain municipalities have not undertaken smart city projects can be seen in Figure 4.6. The primary explanation, given by 50% of respondents, is that local governments do not prioritise smart cities. Financial limitations are cited by 17% and a lack of technical skills by 11%. Concerns about data security (6%), municipal size (5%), or just not prioritising the issue (5%) are all mentioned in smaller percentages. (6%) also intend to begin shortly. In general, rather than being ideological, the challenges are mostly strategic and resource-related.

Figure 4.6. What is the reason the municipality has not worked with smart city projects yet?



Insights from the survey and interviews will be used to examine these key challenges in adopting, sustaining and scaling smart city projects, as elaborated upon below:

Digitalisation and legal constraints

The challenge in digitalisation and legal constraints is a complex field, which includes the transformation from traditional methods to digital methods and the difficulties in navigating legal frameworks.

Digitalisation of municipal documents - The duality of digital planning creation and legally binding PDF finalisation introduces inefficiencies. Fertner emphasises how legal limitations for low-resolution PDF maps impede full digitisation and points out the challenges of moving away from traditional methods, particularly with older designs that were initially paper-based or scanned. According to Hirsbak, the initial goal of the planning law has not been fulfilled because of its fragmentation over the years, and municipalities are only permitted to invest funds on matters that have a legal foundation [Christian Fertner, KU, 2025, p.3] [Stig Hirsbak, Aalborg University, 2025, p.4-7].

GDPR

Current data protection regulations, particularly the General Data Protection Regulation (GDPR), adds further complexity to the legal challenges facing smart city initiatives. Since coming into effect on May 25, 2018, the GDPR has established a foundational standard for safeguarding personal data and privacy across the European Union [GDPR.eu, 2025]. Smart city platforms rely on the continuous, real-time exchange of data between departments such as traffic management, energy utilities, and social services to operate efficiently and respond to citizens needs. Municipalities continue to face major challenges in complying with these regulations. The GDPR requires that any transfer of personal data, such as vehicle tracking feeds, utility usage metrics, or service request records, be supported by a specific lawful basis (Article 6), logged in a Record of Processing Activities, and often justified by a Data Protection Impact Assessment (DPIA) if processing poses a high risk to the individual [GDPR-Info.eu, 2016]. Moreover, transfers between autonomous controllers (e.g. the city's transport authority vs its health and social-services branch) trigger strict purpose-limitation and storage-limitation, which checks under Articles 5 and 25, meaning data must often be anonymised or aggregated before sharing, interrupting the millisecond-level exchange that smart-city applications require. These legal constraints routinely slow down pilot deployments [GDPR-Info.eu, 2016].

Narrow conceptual focus and buzzword fatigue

Early smart city projects emphasised technological efficiency, but this narrow focus can be limiting without integration into broader urban strategies. Fertner warns that this narrow focus can be limiting if it isn't supported by broader strategies and cautions against treating "smart city" as a mere buzzword rather than a driver of genuine urban improvement. Similarly, Gaarde Nielsen observes that, without clear definitions, "sometimes a city just ends up being dumb" [Christian Gaarde Nielsen, Copenhagen Solutions Lab, 2025, p.3] [Christian Fertner, KU, 2025, p.4]. Falbe-Hansen explained that although Aarhus was one of the frontrunners in adopting the smart city concept, the term itself is now used less frequently because smart technologies have become universal and are embedded across municipal departments. This reflects a broader shift away from narrow conceptual focus and buzzword reliance toward more practical and integrated approaches [Morten Falbe-Hansen, 2025, p.2]. The knowledge of smart cities also appears as a challenge for the municipalities. 3% of the municipalities in the survey responded that a lack of overall knowledge of Smart cities is a challenge for the municipality [Thesis group, 2025].

Data, privacy and security concerns

The use of data, securing of privacy among residents and the security concerns of collecting and storing data emerge as an increasing challenge with the use of digital tools. Based on the survey, of the 17 municipalities that responded "Yes" to having smart city projects, the third biggest challenge in the implementation of their smart city projects was data security and privacy concerns. 4 of the 17 municipalities answered that this is a barrier for the municipality. Furthermore, there was also a municipality that stated that this challenge is why the municipality hasn't had any smart city projects. There were also 1 of the municipalities that had not worked with smart city projects yet, which stated that privacy concerns were a challenge [Thesis group, 2025]. As cities increasingly rely

on sensor networks, concerns about surveillance and data governance become more prominent. Fertner points out that the large-scale collection of data prompts important questions about how surveillance is conducted and how this information is governed [Christian Fertner, KU, 2025, p.3]. Gaarde Nielsen adds that while digital systems play a role in reducing energy consumption, they also introduce cybersecurity risks, as the IT systems involved can be vulnerable to hacking [Christian Gaarde Nielsen, Copenhagen Solutions Lab, 2025, p.3].

GDPR - The GDPR's "privacy by design and by default" mandate (Article 25) forces project teams to build in encryption, consent-management interfaces and access-control gates from day one, rather than retrofitting them after a proof-of-concept is working. While this approach ultimately strengthens citizen trust, it often delays trials of new services, such as adaptive traffic-signal timing or demand-response energy schemes, by weeks or months, creating friction between innovation roadmaps and compliance timelines [GDPR-Info.eu, 2016].

Organisational and governance barriers

Municipal governance often resists transformative change. Driscoll describes a culture clash where a small group can face a system resistant to any kind of change, asserting that organisational change receives the least attention [Patrick Driscoll, DTU, 2025, p.2]. One significant obstacle to change is siloed departmental budgets, which Larsen identifies as one of the most critical challenges in municipal governance. He notes that municipal budgets remain fragmented across departments, preventing cross-departmental budgeting and coordinated efforts. This fragmentation makes it difficult to launch integrated or large-scale projects that span multiple sectors. Without breaking these financial silos, many smart city ambitions remain trapped within narrowly defined department budgets, limiting their reach and effectiveness. Larsen further highlights the organisational issue of isolated technical departments. When technical experts are confined within narrow units, they lack the authority to influence or make higher-level decisions. This structural separation undermines the ability of cities to leverage technical insights in shaping broad urban strategies [Peter Bjørn Larsen, Smart city insights, 2025, p.3-4]. Hirsbak reinforces this by pointing out that municipalities once had integrated utilities, but they are now split into separate units like energy and water. This division prevents the development of unified, strategic approaches and limits the ability to address cross-cutting urban challenges [Stig Hirsbak, Aalborg University, 2025, p.4]. Additionally, Driscoll touches on the difficulty of scaling projects, noting that they are often not anchored at the top or integrated into daily operations. This reflects another aspect of organisational fragmentation, meaning that without top-level buy-in, many promising projects remain isolated pilots and fail to expand city-wide [Patrick Driscoll, DTU, 2025, p.2]. Falbe-Hansen emphasises how Aarhus functions as a decentralised organisation with numerous municipal departments having their digitisation managers and making most of their own technological decisions. Departments carry out the implementation of the broad initiatives established by the Mayor's Office, such as the citywide AI responsibility framework. This decentralised method makes coordination difficult. Difficult in particularly for cross-departmental initiatives that need stakeholder alignment and several clearances. The ongoing difficulty of breaking down departmental silos is reflected in this complexity, which could slow down smart city initiatives [Morten Falbe-Hansen, 2025, p.2-4]. Lastly, they survey also shows that most of the respondents to: "who is responsible smart city-initiatives in your municipality?", was either: " Several departments in collaboration" or "No specific department or person is responsible", which shows the lack of

centrelised department for smart cities [Thesis group, 2025].

Cultural resistance and fear of failure

The fear of failure in the public sector is a central challenge with initiatives and projects in general. Driscoll explains that most municipalities lack mechanisms to reward failure, and without such incentives, innovation is unlikely to occur. Moreover, individuals who lead pilot initiatives may risk being blamed if the project fails to deliver expected results, which can discourage others from pursuing innovative efforts [Patrick Driscoll, DTU, 2025, p.4]. Nielsen explains that such projects are often discontinued not because of technical or operational shortcomings, but due to increasing political pressure, changing priorities, or heightened public scrutiny. This premature termination of innovative efforts reinforces institutional caution and deepens the fear of taking risks [Christian Gaarde Nielsen, Copenhagen Solutions Lab, 2025, p.4]. Additionally, Hirsbak emphasises that civil servants are frequently overburdened with existing responsibilities, and when no additional time or resources are allocated, they are understandably reluctant to engage in unfunded or exploratory innovations. The combined impact of political vulnerability, organisational pressure, and limited time creates a challenging environment in which even well-designed innovation efforts are often avoided. This ultimately restricts the transformative potential of smart city initiatives [Stig Hirsbak, Aalborg University, 2025, p.5-6]. This reluctance to embrace innovation is not just a matter of local culture within individual municipalities but points to a broader structural issue in the way public governance systems engage with innovation. Although the private sector frequently adopts a "fail fast, learn fast" approach, the public sector functions under a blame culture where errors can harm reputations and careers. Due to the inherent uncertainty and complexity involved in integrating data systems, artificial intelligence, and cross-sector relationships, this dynamic is particularly difficult in the context of smart cities [Mergel, 2019].

Capacity and skill shortages

Capacity and skill shortages emerge as one of the biggest barriers for municipalities when it comes to sustaining smart city projects. Lack of technical expertise and manpower is necessary in sustaining smart city projects due to their complexity and the work needed to maintain them. Based on the survey, of the 17 municipalities that responded 'Yes' to having smart city projects, the second biggest challenge in the implementation of their smart city projects was the lack of technical expertise. There were also 2 respondents that were lacked technical knowledge or expertise when it comes to why the municipality has not worked with smart city projects yet [Thesis group, 2025].

Even the ones were funding is available, the respondents worry that their teams do not have the skills needed to integrate and scale IoT solutions. One respondent points out that not all divisions are familiar with or have adopted the smart city infrastructure, making cross-sector data use and governance difficult. Only one mentions operations and maintenance as a stand-alone issue, although several others follow the same pattern when discussing the transition from projects to real, sustainable operations [Thesis group, 2025].

In the municipalities that have previously implemented smart city projects, the most common reason for project termination was a lack of technical expertise, indicating that while the municipalities had the desire or initial motivation

to start projects, they struggled with the practical capabilities required to maintain or scale the projects. These reasons could include a lack of IT staff, difficulties with IoT infrastructure, or a lack of familiarity with data platforms. In the municipalities that have not previously implemented smart city projects or currently do not, the most common reason for project termination was a lack of technical knowledge or expertise, indicating that some municipalities may lack the ability or confidence to start and oversee smart city projects, which frequently involve complex technologies and cross-departmental coordination [Thesis group, 2025]. Even when municipalities have the ambition or early tendency to begin digital projects, they often lack the practical skills required to maintain or develop them. Challenges such as insufficient IT staff, difficulties with IoT infrastructure and unfamiliarity with data platforms frequently slow down progress. Municipal IT units typically lack the specialised skills required for advanced digital initiatives. Driscoll warns against underestimating the gap between the competencies of hyper-scalers and the talent available within municipal IT departments, further noting that municipalities cannot compete with private-sector salaries for AI experts [Patrick Driscoll, DTU, 2025, p.3]. Fertner highlights that digital tools demand experienced users, cautioning that less experienced staff might uncritically accept outputs at face value [Christian Fertner, KU, 2025, p.4]. Nielsen also points to chronic constraints such as limited personnel and low turnover, which further hamper municipalities ability to sustain and expand digital projects [Christian Gaarde Nielsen, Copenhagen Solutions Lab, 2025, p.4].

Financial and budgetary constraints

Financial and budgetary constraints emerge as the largest barrier for the Danish municipalities. Based on the survey, of the 17 municipalities that responded "Yes" to having smart city projects, the biggest challenges in the implementation of their smart city projects were budget constraints. 10 of the 17 municipalities answered that this barrier emerged as the largest. There were also 3 of the 18 respondents who lacked financial resources when it comes to why the municipality has not worked with smart city projects yet. This is a broad category that can include difficulties in investment costs and the ongoing expenses of operating and maintaining smart technologies in the municipalities. The municipalities repeatedly noted that while they can purchase smart solutions, they lack the staff and budget to keep them running optimally over time [Thesis group, 2025].

Among the 7 municipalities that have had smart city projects in the past and don't have any now, only 1 responded that the challenge was financial budget. For the municipalities that have not had smart city projects in the past nor have now, the second most answered reason mentioned is financial limitations, which was mentioned by three municipalities. This highlights a lack of financial resources to implement smart city projects [Thesis group, 2025]. Even if there may be an interest in innovation and smart city projects, the tight municipal budget may make it difficult to invest in such projects with high costs in new technologies. This is particularly true when the benefits are long-term or diffuse, which can discourage municipalities from implementing the projects due to uncertainty about the immediate impact or return on investment. Smaller municipalities particularly struggle with resource allocation. Nielsen also observes that they often can't dedicate the necessary human resources to secure grants, while Larsen identifies fragmented budgeting with no dedicated smart city funds [Christian Gaarde Nielsen, Copenhagen Solutions Lab, 2025, p.2]. In Denmark's mild problem context, there is less political urgency to allocate large funds to such projects, making modest allocations laughable relative to ambitions. Hirsbak adds that demographic shifts intensify competition

for limited welfare resources [Stig Hirsbak, Aalborg University, 2025, p.2].

Scaling challenges and market dynamics

A lack of anchoring inside the day-to-day operations of municipal departments is the reason why several pilot initiatives fail to scale. Although external funds and passion are frequently used to launch such projects, they run the risk of remaining isolated experiments if they are not integrated into long-term budgets, staffing structures, or workflows. A survey participant pointed out that there are evident challenges in transitioning from projects to real operation [Thesis group, 2025]. Larsen cautions that viewing the municipality as the sole client overlooks private and third-sector stakeholders essential for viable solutions. Driscoll further notes that early smart city markets were driven by technology vendors seeking to lock in cities for long-term spending, rather than by municipal needs [Peter Bjørn Larsen, Smart city insights, 2025, p.5] [Patrick Driscoll, DTU, 2025, p.5]. Falbe-Hansen explains that cities are complex customers, and failures make headlines, and many stakeholders must agree, which hereby slows processes. However, if companies learn to navigate city requirements such as data, security and regulations, then there's a large European market. The experiments at the Aarhus City Lab help bridge that gap. Building on this insight, the CITCOM project brings together 32 partners across 11 countries to establish a pan-European testing infrastructure for AI and robotics. By providing standardised data sets and legal frameworks, CITCOM enables companies to trial mobile robots, ranging from sidewalk weed removers to grocery-delivery bots for the elderly in real urban settings. Harmonising regulations across borders is challenging but essential for achieving scalable deployments. Driven by the EU's mandate for cross-border collaboration, CITCOM aims to create a durable testbed that helps European cities remain competitive with China and the US while upholding stringent data-protection standards. Falbe-Hansen also emphasises that open sharing and the avoidance of vendor lock-in are key. He states that small cities lack the resources to build from scratch and adopt and adapt others work [Morten Falbe-Hansen, 2025, p.3-4]. Multiple municipalities mentioned in the survey that their ambitions often outpace reality. There is an initial enthusiasm for Smart City pilots, but it also gives way to hard choices when budgets tighten and staff time is limited [Thesis group, 2025].

Lack of political backing

Among the municipalities that have smart city projects, only 2 respond that the lack of political backing is a key barrier to their smart city projects. Even though this number is of not large significance, the political backing ties with the budget of the projects. The projects are typically complex, long-term and resource-intensive since the municipality acts as both the implementer and the primary funder. Without strong political will, it becomes difficult to secure the scalability and sustainability over time [Thesis group, 2025]. Søvsø highlighted this political dimension when he noted that smart city work used to be split between ITK, handling practical projects and the mayor's office, driving political ambition and high-level partnerships under the Smarter Aarhus umbrella, which officially closed last year [Kim Stannov Søvsø, ITK, 2025,p.2]. He further noted that as the smart city term matured, they reframed and reorganised around a digital strategy and said that ambitions were high, but funding was hard to secure [Kim Stannov Søvsø, ITK, 2025, p.3].

Although not large in significance among the municipalities that have smart city projects, among the municipalities that have had smart city projects in the past, it is a different story. Among these municipalities, lack of political backing is the second most frequent reason for the discontinuation of smart city projects. This reflects the importance of political support for smart city projects. Without a strong political leadership or prioritisation, smart city projects can lose momentum, especially when budgets are tight [Thesis group, 2025]. Driscoll echoed this institutional friction by stating that cities, particularly the governing side, have competing goals. They strive for stability with strong regulatory environments and legal requirements, yet they also desire innovation [Patrick Driscoll, DTU, 2025,p.2]. Larsen similarly observed that when a technical person sits in an isolated department, they lack the authority to make higher-level decisions, and this is a significant issue [Peter Bjørn Larsen, Smart city insights, 2025, p.3].

Among the municipalities that have not had smart city projects in the past nor have now, the primary reason and response municipalities have not yet worked with smart city projects is that smart city is not a priority. This was mentioned by eight municipalities, and it suggests that smart city projects often do not feature on the political or strategic agenda. This could be due to limited awareness of their benefits or a perception that such projects are not relevant for the municipalities [Thesis group, 2025]. Falbe-Hansen, speaking from Aarhus, noted that the Mayor's Department oversees the Smarter Aarhus initiative, but each major department has its digitalisation manager. They coordinate monthly, but most technology decisions happen within departments [Morten Falbe-Hansen, 2025, p.3].

Local realities

Lastly, a few municipalities mentioned that the term Smart city can be seen as counterproductive for the smaller or rural contexts, but instead they will rebrand initiatives under "IoT" or "digitalisation" to secure both the political and organisational support. These responses show Danish municipalities excited to use technology to improve services, save money, also be more sustainable when considered collectively. However, they are constantly stopped because of a lack of funding and a lack of expertise, along with unclear ownership, plus the difficulty of transitioning from one-time pilots into long-term, cross-departmental operations. One respondent responded with "Overtaken by reality" as a challenge in response, which is a somewhat vague response that likely implies a mix of practical challenges, which may include budget cuts, staffing shortages, or unexpected implementation barriers [Thesis group, 2025]. Also, re-prioritising set back smart city projects greatly. More than half of all of the respondents stated that smart city projects are not a priority within the municipality. They also said the municipality has not yet worked with smart city projects [Thesis group, 2025].

4.1.2 Summary of key barriers

The key barriers identified in this analysis range from **technical capacity** and **financial constraints** to **cultural resistance** and **governance fragmentation**. The ***institutional theory*** helps to explain how these challenges persist despite Denmark having a high level of digital integration. The organisational structure of municipalities often operates within a rigid framework that prioritises stability, legal compliance, and conventional administrative procedures over risk-taking and experimentation. This does not mean that municipalities avoid innovation altogether. It rather highlights how institutional norms and expectations can restrict the extent to which new approaches are

pursued or sustained. These norms and institutional pressures impede disruptive innovation and the expansion of smart city projects. Municipal actors are heavily influenced by institutional expectations that favour modernisation and digitalisation while also manoeuvring demands from legal, financial and political systems. As a result, many smart city projects struggle to move beyond the pilot stage and are not fully integrated into everyday governance practices. The findings from this thesis indicate that unless institutional constraints are addressed, technical improvements or financial investments alone will not be enough to achieve sustainable and scalable smart city transformation in Denmark.

4.1.3 List of key barriers from interviews and survey

- **Silos & fragmentation** - between municipal departments, hindering cross-functional coordination.
- **Weak structural support** -for digital projects (no clear mandates or dedicated teams).
- **Complex regulatory frameworks** - (e.g. GDPR, procurement rules) that slow down pilot projects.
- **Financial Limitations** – insufficient dedicated budgets for piloting and scaling.
- **Technical expertise shortages** - lack of in-house skills to design, procure and maintain smart city initiatives.
- **Insufficient political backing** – initiatives stall when leadership priorities shift.
- **Pilot sickness** – projects remain in trial mode without a clear path to fully scaling.
- **Data protection & privacy concerns** - raising legal and citizen-trust hurdles.
- **Low citizen participation** - weakening social legitimacy and community buy-in.

4.2 Summary of the findings

To summarise, the results of analysis 1 show that Danish municipalities encounter a wide range of complex challenges that hinder the broad adoption, sustainability and development of smart city efforts. Key challenges include **organisational silos, conceptual uncertainty, data protection issues, legal and digital constraints, resistance to change and a lack of technological capability**. **Lack of funds and poor political backing** hinder progress, especially in smaller towns and cities with limited resources. Even though pilot projects are common, a lot of them stagnate because of **pilot sickness**, which happens when initiatives don't move into long-term strategy. Furthermore, the **low levels of citizen participation with public mistrust**, and **social legitimacy** are there in smart city initiatives are weakened by concerns of technical risks. The **uneven distribution of smart city infrastructure** combines with a preference for top-down technological solutions over inclusive community-led approaches. This risks reinforcing or even worsening existing urban inequalities instead of addressing them because this distribution, along with preference exists.

Analysis 2 - Governance Structures and Municipal Capacity 5

This section analyses the fundamental conditions that promote municipal innovation, with a particular emphasis on the structural position of Danish municipalities to organise, coordinate and oversee smart city initiatives. To evaluate how power relations, institutional regulations and administrative practices affect municipalities capacity to transform ambitions into long-term results, the analytical framework must be established. This section examines how the frameworks and resources of Danish municipalities enable or hinder them from moving smart city projects beyond pilots into fully integrated urban solutions.

The sub-question this section seeks to answer is as follows:

"***How do governance structures and municipal capacity impact the adoption of smart city projects in Denmark?***"

The analysis begins by situating Danish smart city initiatives within a multi-level governance framework, from EU directives and funding programs down through the regional level to the municipal departments responsible for implementation. This analysis will uncover how coordination or fragmentation among these levels shapes project continuity and compliance. It also delves into municipal organisational structures, exploring how siloed departments, informal coordination via mayoral offices and frequent changes in political leadership can affect strategic vision, limit technical expertise and the ability to sustain innovation. It draws on both document analysis and in-depth interviews with different experts who have been involved or are still involved with the smart city initiative. It highlights common institutional norms and capacity gaps that often result in pilots stalling before full implementation. Finally, a stakeholder analysis maps the key actors ranging from local utilities and city planners to national policy makers and private investors whose interests and influence determine which projects gain traction and which don't. By understanding these governance and capacity dynamics, it lays the groundwork for the solution-oriented strategies to follow in Section 6.

5.1 Multi-Level Governance structure

The development of smart cities in Denmark is governed at several levels. At these levels, important roles are played by private sector partners, national, regional, and local governments. The legal framework, sustainability objectives, digital transformation, and urban innovation are all in line with smart city initiatives due to this structure. Below is an overview of the different governance levels shaping smart city policies and implementation in Denmark.

5.1.1 European Union (EU Level) – Supranational governance

As a member of the EU, Denmark has the benefits of a global framework that guides the growth of smart cities through networks, funding, laws, and policies. The European Union has implemented two significant policy initiatives to guide urban innovation: the European Innovation Partnership on Smart Cities and Communities (EIP-SCC) and the Urban Agenda for the EU. Through the EIP-SCC, thousands of European stakeholders collaborated to support integrated solutions for sustainable urban living. This evolved into the Smart Cities Marketplace, an essential platform for information exchange, investment matching, and policy alignment [European Commission, nd]. Similarly, the Urban Agenda for the EU has institutionalised multi-level governance, involving national and local authorities in EU policy development, especially through partnerships with a focus on digital transition, mobility and climate adaptation. Together, these frameworks support Danish municipalities by incorporating their local ambitions in broader European agendas and facilitating access to EU expertise and networks [Morais, 2021].

Legal and technical instruments also shape smart city governance. The INSPIRE Directive (2007) standardised geospatial data infrastructures across member states, improving interoperability and allowing Danish municipalities to integrate spatial and environmental data into planning tools [European Parliament and Council, 2007]. At the same time, the General Data Protection Regulation (GDPR) enforces an aligned privacy regime across the EU. This requires cities and their digital partners to apply strict protections for citizen data, such as privacy-by-design, especially in projects using AI or sensors. While such frameworks build trust, they may slow innovation, particularly for smaller cities with limited compliance capacity [Wernick et al., 2023].

On the financial side, EU research programmes have been vital enablers for smart city projects. Horizon Europe is the EU's primary research framework (2021–2027). It supports large-scale experimentation through missions and partnerships. Its "100 Climate-Neutral and Smart Cities by 2030" mission includes cities like Aarhus and Sønderborg, offering funding and technical assistance to pilot smart city solutions and achieve carbon neutrality. Danish cities access these via national or regional programmes. The European Investment Bank (EIB) also plays a key role, supporting municipal investments through low-interest loans and advisory support, often in combination with EU grants [European Commission, 2022]. Søvsø remarked that Aarhus City lab also participate in Horizon projects and said that they're important because they allow you to collaborate across borders and bring home insights and frameworks that you wouldn't get otherwise [Kim Stannov Søvsø, ITK, 2025, p.3]. However, he added that there's always a co-funding requirement in EU projects, and that's a barrier for many smaller municipalities. He mentioned that even if the EU covers 70%, you still have to raise the other 30%" [Kim Stannov Søvsø, ITK, 2025, p.3].

The EU is not just about funding, it is also focused on sharing knowledge and encouraging cities to work together. Through the Smart Cities Marketplace, cities can build up their project ideas, connect with others and expand on their smart solutions. Initiatives like Horizon Europe's Cities Mission bring together more experienced cities with those looking to learn, creating a space for sharing and improving best practices. In Denmark, for instance, municipalities have been actively engaging with these opportunities, using the support of EU networks and programs to enhance their smart city projects [EIT Urban Mobility, 2024]. Larsen reflected on this through earlier European Commission (EC) engagements. He worked on an EC project on key enabling technologies and innovation strategies in various nations, including South Korea, Israel and others. They mentioned smart cities, so he conducted pre-research

on governments in Europe, the US, Japan, South Korea, Israel and other places to understand what it was all about [Peter Bjørn Larsen, Smart city insights, 2025, p.1].

To put it in simpler terms, the involvement of peers, financial backing, regulatory guidelines and a clear strategic vision all play important roles in enhancing the implementation of smart cities in Denmark through EU governance. While it can be a bit tricky to navigate all the rules and regulations, this process also helps cities in Denmark work towards broader European goals.

5.1.2 National Level (Government ministries and agencies)

At the national level, the smart city aspect is embedded in a broader national strategy of digitalisation and climate, instead of a stand-alone smart city policy. The government set the national digital and green transition agendas, which the local initiatives frame themself around. The digital strategy 2022-2025 is an agreement by the state, regions and the municipalities which sets the targets for public sector digitisation and climate action through technology and digital efforts. The government provides a top-down digital governance which provides municipalities with IT infrastructure like NemID, MitID and other data platforms and standards to build their smart services on [European Commission, 2023].

The Climate Act 2019 requires Denmark to achieve a 70% reduction in greenhouse gas emissions by 2030, a target that has motivated 95% of Danish municipalities to establish corresponding local 70% emissions objectives, ensuring that local smart energy, transport, and climate projects are following state policy [Government of Denmark, 2019]. The Danish Business Authority, which is under the Industry Ministry and plays a dual role by regulating data-driven services and by actively fostering innovation. They have a national smart city network that brings together state policymakers, municipalities, researchers and companies to exchange knowledge and best practices. This institution also facilitates the development of technical standards, in partnership with Danish Standards, for urban data sharing and IoT, to ensure the interoperability of local smart city initiatives on a national scale [Arup and CEDI, 2016, p.24-29]. Larsen noted, while Denmark claims to be a smart city leader, national funding remains minimal. Ambitious declarations such as becoming a world leader in smart cities are backed by budgets as small as 8 million DKK, compared to billions in other nations. National institutions, such as the Danish Business Authority or open data platforms, play peripheral roles, with limited impact due to underfunding and siloed initiatives [Peter Bjørn Larsen, Smart city insights, 2025, p.6].

Through these instruments, the national government seeks to create an optimal environment for municipalities by offering funding mechanisms, legal frameworks and institutional pathways that align local initiatives with national objectives. In the 2010s, for instance, state innovation funds distributed through regional growth forums provided support to city-level demonstrators on the condition of co-financing and public-private cooperation, resulting in initiatives such as the Alexandra Institute in Aarhus, which is a smart city research and development hub that was started with regional and national backing [Baraniewicz-Kotasińska, 2022, p.13]. Similarly, the Ministry of Foreign Affairs via Invest in Denmark collaborated with cities, regions and academic institutions to publish the Growing Smart Cities in Denmark national strategy report, which called for concerted efforts to give the country a head start in smart

solutions. These initiatives show how state governance not only provides funding and regulations for smart cities but also demonstrates political commitment and strategic direction [Ministry of Foreign Affairs of Denmark, 2023].

Despite Denmark's solid digital foundations, governance challenges still exist at the national-municipal level. The absence of a national smart city policy or authority has led to fragmentation. In reality, the majority of smart city initiatives are locally driven. Although over half of Danish municipalities have explored smart city projects, many are still isolated pilots rather than scaled solutions. According to an assessment by Arup and CEDI, projects are primarily small in scale and frequently experience pilot sickness. The government offers digital infrastructure and broad strategies, but there is minimal oversight or integration of the several smart city initiatives spread among 98 municipalities, which illustrates a lack of national coordination [Arup and CEDI, 2016, p.6-7]. Similarly, Søvsø from Aarhus Municipality emphasises that smart city efforts in Denmark have historically been driven bottom-up, often by municipal departments like Aarhus's ITK (Innovation, Technology and Creativity), not by national coordination. Early national smart city ambitions lacked the political commitment or structural support needed to scale innovations. As a result, Denmark has no comprehensive national smart city network, unlike its Scandinavian neighbours. Instead, cities collaborate in loosely organised clusters such as Gate 21, GovTech and Open Data Denmark, which are initiatives that emerged from local needs, not national mandates [Kim Stannov Søvsø, ITK, 2025, p.2]. Additionally, smaller towns are left dependent on state-sponsored research networks or consultancies as a result of the concentration of resources and expertise in larger cities and central institutions. These challenges have been recognised by the national government, and it has supported networks to combine municipal expertise and help Local Government Denmark (KL) share best practices [Arup and CEDI, 2016, p.25].

Therefore, smart city governance in Denmark illustrates a high degree of decentralisation, where innovation is pursued at the local level but lacks systemic support or integration at the national level. Even successful municipal pilots struggle to scale without a national strategy, budget or coordination mechanism. The future of smart cities in Denmark may depend less on branding and more on creating sustainable, politically supported and cross-sectoral governance structures that can connect national ambitions with municipal realities.

5.1.3 Regional collaborative level

Sjælland, Midtjylland, Syddanmark, Nordjylland and Hovedstaden are the five administrative regions that make up Denmark. These regions were created in 2007 to manage regional planning and healthcare. They increasingly leverage their developmental mandate to support and align local initiatives. This often takes the form of strategic planning and network facilitation rather than top-down control. Several regions have integrated smart city initiatives into their regional strategies based on research. One example is Midtjylland, which launched a policy framework called 'Smart Cities in Smart Regions'. This was done to enhance collaboration among its municipalities, companies and knowledge institutions [Arup and CEDI, 2016, p.14-25].

Having frameworks like this helps governments convene stakeholders across cities to share data, expertise and results, also recognising different challenges. An outcome of regional coordination is the creation of shared platforms. Midtjylland was also the initiator of the Open Data Dk network that links major cities on one common

platform [Baraniewicz-Kotasińska, 2022, p.10]. Open Data DK is a cross-governmental association that works to promote the use of open public data. The mission is to strengthen the publication and use of open public data that can be used across the public sector. The platform offers guidance, tools and advice to public authorities in Denmark in the area of publishing data openly in a shared data portal. The association is a collaboration between municipalities, regions and public bodies, which makes it a national organisation. The use of Open Data DK offers a framework that can help smart city projects prosper [Open Data DK, 2025].

Additionally, to ensure vertical coordination, the Danish Regions association, which represents all five regions, frequently collaborates with the national government and municipalities. One recent example of this was the DK2020 program, in which all regions supported each municipality in creating a climate action plan aligned with the Paris agreement, thereby transforming regional climate-smart initiatives into a national movement [C40 Cities, 2023]. In addition to established regional organisations, Denmark uses public-private partnerships and inter-municipal collaboration as adaptable governance tools for smart cities. One well-known partner is Gate 21, a Greater Copenhagen-based partnership that unites enterprises, universities, municipalities and the Capital Region to jointly develop and test green urban solutions. The partnership for green transition, as Gate 21 refers to itself, brings together stakeholders to develop and demonstrate sustainable solutions that can then be scaled and spread across the whole country [Gate 21, 2025].

A similar role is played in Jutland by Business Region Aarhus, an association of 12 municipalities in and around Aarhus. It focuses on the second-biggest city in Denmark. It bases its goal on smart regional growth, saying that smart communities are cities, towns and rural areas where digital technology helps to utilise resources better and challenge the traditional division of labour between public and private sectors [Business Region Aarhus, 2023]. Business Region Aarhus has transformed East Jutland into a living laboratory for digital innovation by supporting projects like an IT cluster for small businesses and a regional open data platform. As an alternative to solely corporate-driven smart city models, the Aarhus city administration's Smart Aarhus program openly adopts a collaborative governance philosophy known as the Scandinavian third way, which emphasises co-creation with citizens and local stakeholders [Baraniewicz-Kotasińska, 2022, p.13].

Another significant partnership is Green Hub Denmark in North Jutland, a public-private partnership with its headquarters in Aalborg. Green Hub Denmark brings together businesses, utilities, researchers and local governments to test technologies such as electrified transport systems or smart energy grids in actual urban areas before expanding them regionally and beyond. These inter-municipal hubs, which are frequently funded by both national grants and regional development funds, efficiently close the gap between isolated municipal pilots and expand market adoption by sharing risk and resources [Green Hub Denmark, 2025]. GovTech Midtjylland is another collaborative initiative between 13 municipalities in the region of Central Jutland (Region Midtjylland). Its purpose is to implement and develop new technologies to solve infrastructure and public sector challenges. Govtech Midtjylland act as a working community that helps local governments implement and use new technologies. Their focus areas are mainly on Bygningsdata (Building data), IoT infrastructure and AI. The challenges they seek to solve with the technologies are as such: climate issues, increasing welfare needs and improving efficiency in public services. They state that their vision is to create strong collaboration that allows public entities to innovate together, while ensuring

broader impact and better resource utilisation [Midtjylland, 2025].

With all of the aforementioned partnerships, an organisation that serves as a guide for all municipalities is required, and this is where KL (Kommunernes Landsforening) comes in. It is an organisation and negotiating body for all of the Danish municipalities. The organisation represents the municipality's collective interests in dialogue with the Danish government, the EU and other stakeholders. They make sure the local perspectives are integrated into the national and EU policy-making in areas such as climate, digitalisation and urban development. KL furthermore provides municipalities with guidance, research and administrative support. This is especially needed in implementing smart city projects. KL acts a a platform for initiatives which foster cooperation between municipalities. KL helps smart city solutions, data management and innovation across the country [KL, 2025].

These partners and public bodies were the primary mentions during the interviews during this thesis. This ecosystem of different public bodies and collaborative partnering illustrates a dynamic form of multilevel governance where coordination is shared across local, regional and national levels. Midtjylland, Gate 21, KL and OpenData DK have distinct but connected roles in the governance structure [Mortensen and Rasmussen, 2025, p.3] [Kim Stannov Søvsø, ITK, 2025, p.3].

These actors highlight how MLG in smart cities in Denmark blends vertical authority with horizontal cooperation, which helps municipalities to not only comply with high-level frameworks but also actively shape smart city policies. While these actors play significant roles in collaboration and shaping the smart city agenda, they don't hold any decision-making power over municipalities. Their influence is on facilitating collaboration, providing strategic guidance and sharing knowledge.

5.1.4 Municipal structure and its impact on smart city integration

Denmark is made up of 98 municipalities, and each one has a democratically elected council. The municipalities are responsible for public services such as schools, libraries, parks and local infrastructure. These functions give them a significant influence on the advancement of community projects. From a financial perspective, Danish municipalities enjoy a great level of autonomy in their management. The Danish municipalities receive government funding and, at the same time, they raise their own income and property taxes, meaning they control about half of the entire public spending in Denmark [Arup and CEDI, 2016, p.14-28]. Smart city development in Denmark is therefore largely driven from the municipal level. Local governments typically initiate projects in collaboration with private businesses and universities. In practice, many Danish towns and cities, whether large or small, have piloted smart solutions under municipal leadership, often making partnerships with tech firms, start-ups and research institutions. By prioritising certain technologies or standards, local authorities help shape the emerging market for smart city services and infrastructure [Arup and CEDI, 2016, p.14-26]. This localised innovation model has been reinforced by internal consultancy teams like Aarhus City Lab, which act as bridges between city departments and technology partners while remaining embedded within the municipal structure [Morten Falbe-Hansen, 2025, p.2]. As Falbe-Hansen explained, they operate as an internal consultancy, offering services to other departments, and the broader ITK department functions as a cross-cutting unit supporting digital development. Moreover, each

major department has its digitalisation manager and most technology decisions happen within departments, despite monthly coordination [Morten Falbe-Hansen, 2025, p.2-3].

However, there are also significant obstacles to smart city development at the local level. Fragmentation among the 98 municipalities is a major problem. Smart city initiatives may continue to be isolated within specific cities or departments in the absence of effective coordination mechanisms. There are comparatively few examples of smart projects being scaled up to other cities, and many municipalities have pursued them as one-off pilots. This phenomenon, which is sometimes referred to as 'pilot sickness', means that successful trials are often not translated into a wide scale. In the survey conducted for this project, one respondent noted a "lack of structures that make it difficult to establish anchoring in the areas" [Thesis group, 2025]. According to a study on Danish smart city initiatives, local project managers believe that bureaucratic silos and fragmented collaboration are ongoing implementation challenges that make it difficult to integrate efforts across municipal boundaries. In many instances, private-sector involvement has also been limited by a lack of inter-municipal cooperation and indecision. Vendors face a patchwork of modest initiatives rather than an integrated market when each municipality designs its smart city direction, which reduces incentives for larger investments [Bjørner, 2021, p.7] [Arup and CEDI, 2016, p.6-7]. These governance limitations are echoed by practitioners, who note that internal silos and departmental agendas often undermine long-term coordination efforts, especially when political ambitions shift or when co-financing mechanisms are weak [Kim Stannov Søvsø, ITK, 2025, p.3]. Søvsø stated that smart city work used to be split between ITK, handling practical projects and the mayor's office, driving political ambition and that while strategies evolved, "funding was hard to secure" [Kim Stannov Søvsø, ITK, 2025, p.4]. Furthermore, fragmented approaches have resulted in redundancies and inefficiencies, as smaller municipalities replicate isolated trials rather than pooling data, resources or infrastructure. As Larsen noted, when a technical person sits in an isolated department, they lack the authority to make higher-level decisions, and this is a significant issue [Peter Bjørn Larsen, Smart city insights, 2025, p.3].

The ability of cities to adapt and adopt is another issue. The main cities in Denmark and their numerous mid-sized and smaller municipalities differ greatly in terms of resources and level of experience. In addition to having more specialised smart city teams or innovation units, larger cities like Copenhagen or Aarhus also tend to have more robust technological and financial capabilities. According to findings, many local governments in Denmark still lack skills, knowledge and a cross-departmental organisation to effectively extend smart city projects, even though more than half of the municipalities have started some kind of smart city project. Common problems include a lack of digital expertise, trouble acquiring sophisticated technology and trouble coordinating across municipal administrative silos [Arup and CEDI, 2016, p.6-7]. This digital skills gap has been reinforced in practice, where municipalities often rely on external consultants, which, while helpful in the short term, fail to build internal capacity or ownership of innovation [Patrick Driscoll, DTU, 2025, p.2]. Driscoll observed that there's a massive gap between the competencies of hyper-scalers like Microsoft or Amazon and the talent available in a municipal IT department, noting that internal digital capacity often lags behind strategic ambition [Patrick Driscoll, DTU, 2025, p.3]. Moreover, staff already managing essential services rarely have the bandwidth to take on high-risk experimental technologies [Kim Stannov Søvsø, ITK, 2025, p.3].

Despite these challenges, Denmark's local governance approach offers significant opportunities for innovation. With

municipal autonomy, every city or town can customise smart city initiatives to fit its particular objectives and context, whether that means concentrating on digital health services in a rural community, intelligent transit in a commuting area, or climate adaptation measures in a coastal town [Baraniewicz-Kotasińska, 2022, p.9]. As Mortensen noted, municipalities are increasingly working in networked models, collaborating across regions and with support entities like Gate21 to pilot and distribute emerging solutions. At the same time, bottom-up innovation remains uneven and larger cities have the political mandate and risk appetite to experiment, while smaller ones remain late adopters due to limited capacity and budget sensitivity [Mortensen and Rasmussen, 2025, p.3-4]. Smaller towns can also benefit from platforms for municipal cooperation offered by several regional and national support bodies, such as Local Government Denmark (KL) and the five regional governments, which assist them in pooling resources and expertise for the development of smart cities [Local Government Denmark (KL), 2022]. Initiatives like Open Data DK and GovTech Midtjylland have also created frameworks for smaller municipalities to access shared tools and technical infrastructure, reducing the burden of solo innovation [Kim Stannov Søvsø, ITK, 2025, p.2].

This bottom-up strategy has encouraged innovation and enabled local governments to act as pilot projects for novel ideas. But it has also resulted in governance problems like capacity fluctuations, fragmentation, and the need for coordination across jurisdictions. These problems need to be fixed if Danish towns are to fully benefit from smart city innovations at scale. Among the strategies that can improve implementation capability are exchanging best practices, developing local digital capabilities and strengthening inter-municipal cooperation. Ultimately, Denmark's experience indicates that to effectively govern smart cities, municipal autonomy and cooperative frameworks must be balanced, allowing for the growth of local innovation.

5.2 Stakeholder analysis

Smart cities present a wide number of stakeholders with different powers, influence and interest in smart cities in Denmark. A stakeholder analysis was carried out to determine the main stakeholders, persons, and organisations influencing the development and upkeep of smart city projects in Denmark in order to give a thorough picture of the interest and influence structure in such projects. The various levels of influence and interest that were discovered through document analysis and interviews are displayed in the visual stakeholder analysis in Figure 5.1.

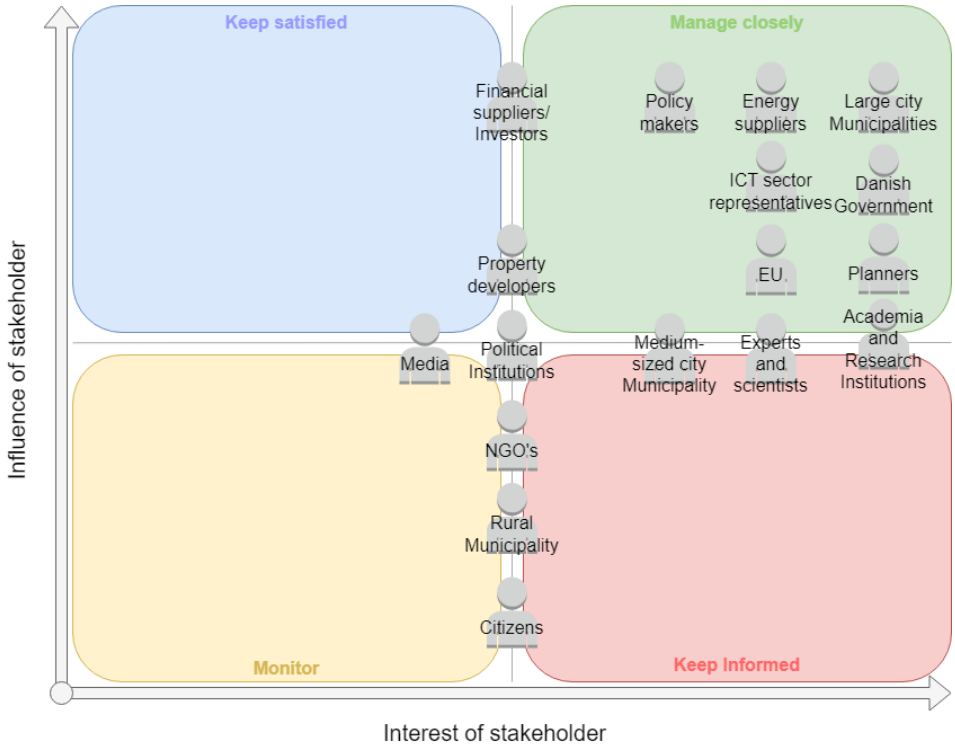


Figure 5.1. Own visualisation of the stakeholder analysis for smart city projects in Denmark.

Political Institutions

In order to improve the governance and transferability of smart city initiatives, political institutions are essential. Their participation offers supervision and promotes the exchange of institutional expertise, which can be used to enhance and inform present and upcoming projects. Their interest in smart city projects is medium since they are mainly governance-oriented, focusing on regulatory frameworks and policy alignment. Their influence is also medium since their political clout allows them to shape governance structures and influence the strategic direction of projects [Jayasena et al., 2019, p.4].

Energy suppliers

Sustainable energy is fundamental in smart cities since sustainability is a central concern in their development and operation of the smart city project. A reliable and sustainable energy supply is essential to ensure the effective functioning of smart city systems. Energy suppliers contribute significantly to this by supporting both infrastructure and policy development aimed at sustainable operations. Their interest in smart city projects is high since it's driven by sustainability goals and the opportunity to align with long-term environmental objectives. Their influence is high since they control critical energy infrastructure [Jayasena et al., 2019,p.3].

Large city municipalities

Large city municipalities are key stakeholders in smart city development due to their strategic capacity. Their role encompasses initiating, promoting and managing resources for complex urban infrastructure and public service systems. As primary implementers of smart city initiatives, their participation is critical in ensuring operational success and citizen engagement. Their interest is therefore high, which is driven by direct involvement in service

delivery, infrastructure coordination and urban innovation. Their influence is also high due to extensive governance authority, financial capacity and strategic positioning within national and regional networks [Jayasena et al., 2019,p.3].

Medium-sized city municipalities

Medium-sized city municipalities are just as important to smart city initiatives, even though they have fewer resources than their larger counterparts. They are have the opportunity managing infrastructure and delivering essential services at a lower scale can show the successful implementation of smart city concepts at smaller scale. Their role often includes adapting scalable solutions developed in larger cities to fit local needs. Therefore, their interest is high as they are actively involved in service delivery and can benefit from technological efficiencies. Their influence is also high due to their autonomy in planning and urban management, although sometimes constrained by funding or technical capacity [Thesis group, 2025] [Jayasena et al., 2019,p.3].

Rural Municipalities

It can be very challenging for rural municipalities to participate in smart city initiatives. According to survey responses, the term "smart city" is considered out of step with rural settings. A small population, a low priority for digitalisation, and a lack of funding are some of the factors that hinder the adoption of smart city initiatives. As such, while rural municipalities might benefit from smart solutions tailored to local needs for example smart agriculture or digital public services, these projects often receive little attention. Therefore, their interest is low to medium, which is due to them being constrained by perceived relevance and competing priorities. Their influence is also low due to limited financial and administrative capacity to initiate or scale smart projects [Thesis group, 2025] [Jayasena et al., 2019, p.3].

Financial suppliers/Investors

Smart city projects, depending on the project, need significant budgets to implement and operate. Financial suppliers such as Technology Companies are therefore essential to smart city projects. Investor participation is primarily guided by return on investment, with financial viability often determining their level of engagement. Their interest in smart cities is medium since their involvement is investment-focused rather than mission-driven. However, their influence is high due to their funding, which can directly shape the scope and trajectory of smart city projects [Jayasena et al., 2019, p.3].

ICT sector representatives

Information and communications technology (ICT) sector representatives are essential to both the initiation and operation of smart cities. This is due to the technological factors, which are critical requirements at every stage of smart city development. These stakeholders provide the technologies and digital infrastructure that enable smart city functions and services. This makes ICT making them central to the digital transformation process. Their interest in smart city projects is high since they have direct technical contributions and the strategic opportunities associated with technological innovation. Their influence is also high since their solutions and systems form the backbone of smart city infrastructure [Jayasena et al., 2019, p.3].

Danish Government

The Danish Government plays a central role in the development of smart cities by supporting policy formulation at the national level. As smart cities offer strategic solutions to address challenges arising from urbanisation, the

government is responsible for knowledge creation. Its interest in smart cities is high since the Government is tasked with setting national policy agendas that influence the implementation and overseeing urban development strategies. The government's influence is also high due to its authority over regulatory frameworks and its ability to allocate funding and resources [Jayasena et al., 2019, p.3].

Policy makers

Policy makers play a crucial role in shaping the legal and regulatory framework of smart cities. Through policy implementation, they can promote the development of smart cities, but also hinder their implementation. Their interest in smart cities is high due to smart city development being technology and sustainability-driven. Their influence is also high since they possess the authority to enforce laws that directly impact the governance and direction of smart city projects [Jayasena et al., 2019, p.4].

EU

The European Union provides critical financial and policy support to smart city projects across its member states. Through the EU's missions and programs like Horizon Europe, it drives innovation and sustainability goals at scale. Their interest is high due to international sustainability goals and funding frameworks, while their influence is also high as they shape standards and enable financing [EU, 2025a].

Planners

Urban planners are one of the primary stakeholders in the initiation and development of smart cities since they play a central role in the projects. This is due to smart city projects are primarily an urban development and planning objective. Planners guide land use, zoning and integrated design to ensure that smart city initiatives are in line with long-term urban strategies. Their interest in smart cities is high since smart city development and planning goals are an urban development. Their influence is also high since they hold high operational authority. Though high operational authority, often work within broader political and regulatory constraints [Jayasena et al., 2019, p.4].

Media

By covering the advantages and difficulties of smart city initiatives, the media has a significant impact on how the general public views them. The media can create scepticism by highlighting achievements and exposing problems, which can affect how the public and the politicians view and feel about smart city initiatives. This influence can be either positive or negative, which depends on the media. Their interest in smart cities is medium since their primary focus is only on providing coverage rather than direct involvement. Their influence is also medium due to their ability to sway both public opinion and political discourse [Jayasena et al., 2019, p.4].

Experts and scientists

Experts and scientists play a critical role in the development and implementation of a smart city. They provide technical insights with their specialised knowledge. Their input is essential in the planning and strategic development stages of smart city projects. Since they are professional contributors, their interest in smart city projects is high, which is driven by their engagement in advancing the technological and scientific aspects of smart cities. Their influence is medium since they typically hold advisory power by guiding decisions with their expertise, not directly making decisions [Jayasena et al., 2019, p.4].

Academia and research institutions

Academic and research institutions play a significant role in the development and initiation of smart cities with their research contributions. A significant number of pilot smart city projects have been led by the involvement of research institutes. These institutions are essential in the planning and strategic development of smart cities since they provide valuable insights and guidance on implementation and innovative solutions. Therefore, their interest in smart cities is high due to their strategic involvement in smart cities by providing guidance, knowledge sharing and initiation of pilot projects. Although high in interest, their influence is medium since they don't have direct decision-making power [Jayasena et al., 2019, p.3].

Property developers

Property developers are key stakeholders in the development of smart cities. They are often driven by the desire for innovation and profitability in urban development projects. Though they play a significant role in the smart city infrastructure, their goals can sometimes conflict with public interests since they prioritise projects that are business-driven, such as technological advancements in property development. Their interest in smart cities is medium since their focus is on the business opportunities presented by these projects. Additionally is their influence, which is also medium since they hold power over land use and building decisions, which can shape the landscape of smart cities [Jayasena et al., 2019, p.4].

NGO's

Non-Governmental Organisations (NGO's) are interested in the result that comes out of smart city projects. They are primarily motivated by the impact of smart cities, focusing on the outcomes of their implementation and the lessons that can be learned throughout the process. Their interest in smart cities is medium, due to their focus on learning from each stage of the implementation of smart cities. However, their influence is low due to the limited decision-making power. NGO's can still advocate for policy changes in smart city projects [Jayasena et al., 2019, p.4] [Harvard law school, 2025].

Citizens

Citizens provide lived experiences and feedback on urban space usability and service delivery, which are essential to effective urban planning and implementation of smart city projects. Ensuring engagement can provide valuable insights, such as inefficiencies and sharing their views on both the positive and negative aspects. Their interest is medium due to the broad aspect of smart cities, as smart cities do not always directly affect the citizens, which lowers their interest in some aspects of smart cities. Their influence is also not high, but rather low, as they hold limited formal power. Their input is vital in shaping the direction of smart city projects and making sure that the projects are in the interest of the community and meet the needs [Jayasena et al., 2019, p.3].

A summarised overview of the stakeholders can be seen on Table 5.1

Stakeholder	Role	Interest Level	Influence Level
Political Institutions	Influence governance and share lessons across contexts	Medium	Medium
Energy Suppliers	Ensure sustainable energy supply and policy alignment	High	High
Large City Municipalities	Lead smart city initiatives, implement large-scale infrastructure and serve as innovation hubs	High	High
Medium-sized City Municipalities	Implement smart solutions fit for local needs. Often with limited resources	High	Medium
Rural Municipalities	Focus on digital inclusion, local development and green transition projects	Medium	Low
Financial Suppliers / Investors	Provide funding based on return on investment (ROI)	Medium	High
ICT Sector Representatives	Deliver technology and digital infrastructure	High	High
Danish Government	Set national policies, regulations and provide funding	High	High
Policy Makers	Create legal frameworks and long-term strategies	High	High
EU	Provide funding, policy frameworks and support for smart city initiatives	High	High
Planners	Design sustainable urban environments incorporating smart solutions	High	High
Media	Shape public opinion and awareness of smart city projects	Medium	Medium
Experts and Scientists	Provide innovation expertise and technical knowledge	High	Medium
Academia and Research Institutions	Support planning and strategy development through research	High	Medium
Property Developers	Invest in smart infrastructure and real estate innovation	Medium	Medium
NGOs	Promote inclusive development and social goals	Medium	Low
Citizens	Participate, provide feedback and experience smart services	Medium	Low

Table 5.1. Overview of the stakeholders in the smart city landscape in Denmark [Jayasena et al., 2019, p.3-4].

5.2.1 Power structure among stakeholders

To fully understand the power structure in smart city projects, it is essential to identify and understand how decisions are made, resources are allocated, and which actors drive the strategic direction of development in smart city projects. Based on the stakeholder analysis, the power structure reveals a concentration of governmental bodies, sectoral

enablers and key urban municipalities. These stakeholders have the most influence, either directly or indirectly, when it comes to the implementation of a smart city project. The governance and corresponding power structures are further elaborated in Section 5.1, which discusses the multilevel governance (MLG) approach in detail.

Overall, the power structure in Danish smart city projects reflects a top-heavy model. The strategic decision-making is driven by government institutions, infrastructure providers (ICT and energy sectors)and urban municipalities. In addition to these are other stakeholders, including academia, NGO's and citizens, who contribute in more advisory contributions.

In conclusion, the stakeholder analysis identifies the key stakeholders when it comes to stakeholders in smart city projects in Denmark. It has to be noted, though, that the smart city concept is a comprehensive field of different types of smart city projects, which means that there are a plethora of stakeholders that have not been identified for this analysis. In the context of Danish smart city projects, the main stakeholders are the EU, policymakers, the Danish government, ICT sector representatives, planners, large and medium-sized city municipalities and energy suppliers.

5.3 Summary of the findings

To summarise, **analysis 2** investigated how the development and scalability of smart city initiatives are influenced by Denmark's **multi-level governance structure** and **municipal capabilities**. It shows that although Denmark has a national and supranational framework, including national agencies, inter-municipal networks and EU policy instruments, implementation is frequently dispersed because of **siloed municipal departments**, **inconsistent political backing** and a **lack of internal knowledge**. Disparities in capacities, notably between urban and rural areas, are created by the municipal system as a whole, especially the decentralised style of governance across 98 municipalities, which permits innovation according to local requirements. This centralisation may hinder broader stakeholder participation in smart city efforts, which are cross-sectoral and frequently need internal coordination through mayoral offices. The results of the **stakeholder analysis** show a complex ecosystem of actors with various levels of interest and influence that affect project outcomes, including national governments, EU institutions, ICT vendors, planners and citizens. The **findings** show that for smart city governance in Denmark to move from isolated pilots to sustainable and integrated urban transformation, **interdepartmental collaboration, political stability, and broad stakeholder participation** are crucial.

Analysis 3 - Strategies for Successful Implementation 6

After analysing the ongoing challenges that Danish municipalities face and the structural factors influencing the development of smart cities, this third and final analytical section looks at recommendations to be more suitable for smart city projects. These recommendations are to help cities overcome obstacles, including fragmented governance, abandoned pilot programs, and insufficient institutional capability.

This analysis seeks to answer this sub-question:

What strategic steps can Danish municipalities take to effectively implement smart city projects?

In order to promote smart city development in Denmark, this section provides a comprehensive framework for combining theoretical, comparative, and practice-based insights. The foundation for offering strategic recommendations appropriate for municipalities at different stages of digital maturity, from early innovators to laggards, is the Innovation Diffusion Theory. Some global smart city indices that provide comparative analysis by situating Danish cities, particularly Copenhagen and Aarhus, in the global context of urban digital innovation and citizen engagement include the Cities of the Future Index, IMD Smart City Index, and IESE Cities in Motion. The case study of Aarhus also shows how public involvement, data infrastructure, and cooperative governance help other municipalities operationalise their goals for a smart city. Lessons learnt and best practices based on expert interviews are also broken down in the section that follows. It ends by offering organisational and strategic policy recommendations, comparing with Nordic counterparts, and generating ideas at the national and local levels to enhance coordination, capacity building, and long-term smart city development across Denmark.

6.1 Innovation of diffusion

This section explores the innovation of diffusion in smart city development in Denmark. It classifies municipalities based on their adoption style and pace, and shows how various cities fit into the stages of the innovation diffusion theory. From early testing to late deployment, demonstrating the disparities in technology competence and strategic aspirations among the municipalities.

Innovators

These are the pioneers, which are usually big, successful cities. They are the cities of Aarhus and Copenhagen. This group aligns with Smart Cities 1.0(Technology-driven) in 1.1.2. These cities are the pioneers of innovative and experimental smart city projects. Their projects frequently involve ambitious CO_2-neutral infrastructure solutions, real-time data analytics for urban planning, and AI-driven traffic management [C40 Cities, 2016] [European Commision, 2025]. These cities are positioned as global leaders in urban innovation because of their active collaboration with

academic institutions, tech firms, and foreign partners. Aarhus has been particularly referenced and regarded by other cities internationally as a successful smart city. They are willing to take on higher risks and invest significantly in research and development to test transformative technologies [Rogers, 2001, p.4984].

Early adopters

The innovators of Copenhagen and Aarhus are being closely followed by early adopter cities such as Aalborg, Odense and Vejle. This group aligns with Smart Cities 2.0(Technology-enabled city-led) in 1.1.2. They embrace smart transport solutions, digitise municipal services and invest in green energy infrastructure like district heating from renewable sources, even though they aren't always the first to try new things. It is usually beneficial for these municipalities to observe the innovators experiences and responses to their local environment, which balance ambition and pragmatism [Invest in Aalborg, 2025] [Energy Cities, 2025] [Vejle Kommune, 2018] [Rogers, 2001, p.4984].

Early majority

This group adopts smart city technologies after clear evidence of success is demonstrated by the innovators or the early adopters. This group aligns with Smart Cities 3.0(Citizen co-creation) in 1.1.2. Their focus is often on scalable, cost-effective implementations such as smart waste collection systems, digitised citizen service platforms and integration of solar or wind energy into public facilities. These municipalities are typically cautious, ensuring that smart initiatives align with community needs and budget [Rogers, 2001, p.4984-4985].

Late majority

This group waits until smart city technologies are standardised, costs have decreased, and sufficient funding from the government or regulatory support is in place. This group typically adopts after the Smart Cities 3.0 phase in 1.1.2, once technology and processes have become fully standardised. Their efforts center on basic digital upgrades, such as LED-based smart street lighting, online portals for municipal services and standardised energy-efficiency programs in public buildings. Adoption is driven more by necessity and compliance than innovation, and local leadership may prioritise reliability over experimentation [Rogers, 2001, p.4985].

Laggards

This segment includes the smallest, most rural, or economically constrained municipalities. This group represents the post 3.0 adopters, engaging only in minimal digital upgrades in 1.1.2. These often lag due to limited financial resources, don't prioritise smart city adoption, lack technical expertise, or have a cultural resistance to change. Projects are minimal and often basic technological connectivity or compliance-driven digitalisation. Initiatives may be driven more by external factors than internal strategy, and they often rely on partnerships with regional or national entities for implementation support [Rogers, 2001, p.4985].

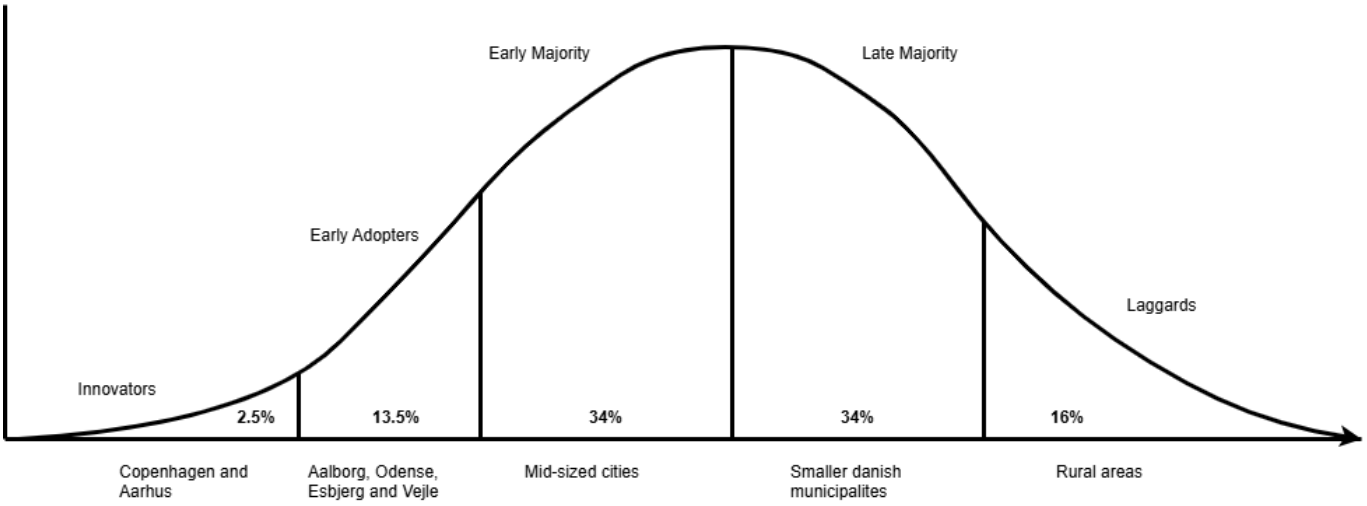


Figure 6.1. Visualisation of the diffusion danish municipalities

Strategic steps of the groups

Innovators

The innovators in Denmark are municipalities such as Copenhagen and Aarhus. These municipalities should remain on their track as they lead in Denmark when it comes to smart cities. They have already established themself as the leaders in Denmark, therefore they should continue to invest in research and development and collaborate with universities, technology companies and international partners. Additionally is the collaboration and knowledge sharing with other municipalities. They can do this by sharing insights, frameworks and lessons learned from their pilot projects. This not only reinforces their leadership but also helps the broader national progress in smart urban development [Arup and CEDI, 2016, p.19-25]. In Aarhus, Falbe-Hansen described how each major department has its digitalisation manager. They coordinate monthly, and Aarhus City Lab operates as an internal consultancy, offering services to other departments [Morten Falbe-Hansen, 2025, p.2-3]. Furthermore, Søvsø highlighted Aarhus's international collaboration through Open Data Denmark and Horizon projects, reinforcing its role as a frontrunner in cross-border smart city ecosystems [Kim Stannov Søvsø, ITK, 2025, p.3].

Early adopters

The early adopters in Denmark are municipalities such as Aalborg, Odense and Vejle. These municipalities have the ability to scale tested innovations and adapt them to their local needs. These municipalities can benefit from observing the innovators and are at a reduced risk by implementing already proven solutions. Their next steps could include more pilot projects and implementing more already proven beneficial projects. These municipalities also have the opportunity to invest in the development of internal competencies through staff training and digital capability building. By doing this, the municipality can ensure that the smart city solutions can be implemented effectively [OECD, 2021, p.19]. For example, Larsen noted that smaller municipalities such as Skanderborg are quite innovative and effective at integrating technologies, suggesting that some early adopters, though modest in scale, have already demonstrated strong technical and organisational adaptability [Peter Bjørn Larsen, Smart city insights, 2025, p.3].

Early majority

These are mid-sized municipalities are the ones that tend to adopt technology once they are demonstrated to be cost-effective and deliver visible value to residents. The projects they should prioritise are the ones that are scalable and cost-effective, which deliver visible value to residents to ensure public understanding of why they need this technology. These projects could be digital citizen platforms or automated waste collection systems. These municipalities strategic steps would secure national or EU-level funding that can support their initiatives. The municipalities would also need to ensure engagement with citizens to ensure that projects align with the municipality's needs. These municipalities have the benefit of learning from the challenges faced by innovators and early adopters and selecting the projects that suit the municipality's needs [OECD, 2021, p.19]. Mortensen noted that municipalities are increasingly working in networked models, collaborating across regions and with support entities like Gate21, indicating a growing trend of peer support systems that early majority municipalities can plug into for technical knowledge and experience sharing [Mortensen and Rasmussen, 2025, p.3].

Late majority

These municipalities are typically smaller in size and more cautious when it comes to resources. These municipalities should focus on adopting projects that are proven beneficial while also focusing on the local needs. These municipalities wait until the technologies are more affordable and are supported by funding frameworks. These municipalities begin with basic digital upgrades such as online service portals and smart street lighting. The emphasis is on functionality and compliance rather than innovation [United Nations Economic Commission for Europe, 2020, p.44]. Driscoll cautioned that if a project fails, you won't get the next one funded, and that means there's a fear of risk, which is an approach typical of late majority municipalities [Patrick Driscoll, DTU, 2025, p.4].

Laggards

These municipalities are frequently tiny in population, rural or have limited resources. These localities frequently have no interest in or rationale for funding smart city initiatives. This is typically brought on by a lack of internal drive for digital transformation, technical know-how and financial resources. Their strategic stops should be on building the fundamental infrastructure, such as the use of digital administrative tools. Furthermore, the engagement and partnership with regional or private actors can provide the necessary technical and financial support if the municipality is interested in smart city projects [Kim Stannov Søvsø, ITK, 2025, p.3]. This can create a collaborative environment for future projects, which can provide awareness of their situation and needs. Lastly, also engage citizens in understanding the benefits of smart technologies. Small progress can lay the fundamental groundwork for a more ambitious development in the future [United Nations Economic Commission for Europe, 2020, p.44]. Søvsø described how smaller municipalities often rely on broader networks like Open Data Denmark or GovTech Midtjylland, to access tools and frameworks that they would struggle to develop independently [Kim Stannov Søvsø, ITK, 2025, p.2]. These networks help reduce the burden of solo innovation and foster low-risk entry points for laggards.

General steps forward

The innovation diffusion analysis of smart city development in Denmark indicates that the approach, capacity, and ambition of municipalities vary greatly. However, any municipality, regardless of its position as a leader or a pioneer, can take important and well-thought-out steps towards smart city transformation that are appropriate for its resources

and environment. All groups can speed up Denmark's collective progress in smart city development by exchanging knowledge and working together, especially leaders and followers.

To move forward, municipalities can focus on improving their digital capabilities, implementing scalable citizen-focused initiatives and utilising national and regional networks like GovTech Midtjylland and Open Data DK. The strain on resources is reduced, especially for smaller towns, through technical partnerships and shared platforms. Citizen engagement, even in its early phases, ensures that projects reflect local values and build trust. By putting small, context-specific solutions into place, each municipality can help create a smart city environment that is more inclusive and connected.

6.2 Smart City indices

This section gives an overview of different smart city indices that are used all over the world. They compare different rankings, criteria, and highlight how cities are ranked across different aspects such as digital infrastructure, sustainability, citizen engagement and mobility. The analysis shows a comparative viewpoint on global smart city performance and where Danish cities stand.

6.2.1 The Cities of the Future Index

The cities of the future index is developed by EasyPark Group. Their index evaluates global cities based on how they effectively use technology to improve the quality of life for their citizens. This index evaluates thousands of cities globally, and is identified based on their digital transformation and sustainable development. In measuring a city's performance, this index uses a comprehensive framework based on four key factor [EasyPark, 2025]:

- Digital life: The integration of technology in education, healthcare and everyday services.
- Mobility innovation: The adoption of smart transport solutions, which includes green transit and traffic management.
- Business tech infrastructure: The usage of digital business tools, e-payments and connectivity.
- Environmental sustainability: A city's climate response, energy use and green infrastructure.

Based on their performance across these dimensions, cities are categorised by population size and ranked accordingly. The following table shows the top-ranked cities in three population columns: those with over 3 million residents, those with populations between 600.000 and 3 million and smaller cities with populations ranging from 50.000 to 600.000. This method ensures that both city regions and smaller urban centres are recognised for their efforts and achievements [EasyPark, 2025].

As seen on Table 6.1, Danish cities like Copenhagen, Aarhus, and Aalborg are present. The rankings in the table show that these cities show their commitment to creating more resilient, habitable and inclusive cities. The cities of the future index acknowledges cities of all sizes, and promotes a more balanced and globally representative view [EasyPark, 2025].

	Over 3 million		600.000 - 3 million		50.000 to 600.000	
#	City	Country	City	Country	City	Country
1	London	UK	Copenhagen	Denmark	Lund	Sweden
2	New York	USA	Stockholm	Sweden	Stavanger	Norway
3	San Francisco	USA	Oslo	Norway	Espoo	Finland
4	Singapore	Singapore	Amsterdam	Netherlands	Malmo	Sweden
5	Berlin	Germany	Zurich	Switzerland	Aalborg	Denmark
6	Rotterdam	Netherlands	Gothenburg	Sweden	Aarhus	Denmark

Table 6.1. Top ranking cities in the Cities of the Future Index

6.2.2 Smartecocity

The Smartecocity Index ranks global cities based on their implementation of smart technologies and digital innovation. This index examines how cities effectively apply technology across infrastructure, governance, environment and citizen services. It highlights leading instances of urban digital transformation and puts them within a global framework of technological advancement [SmartEcoCity, 2025].

The index uses a framework composed of the following ten pillars:

- **Vision** – A clear and well-defined strategy to develop a smart city.
- **Leadership** – Dedicated city leadership that steers smart city projects.
- **Spending plan** – Enough money has been allocated to assist smart city projects.
- **Incentives in money** – Strategies to promote private sector involvement, such as grants, refunds, aid, or competitions.
- **Support programmes** – Events and networks to engage private actors.
- **Talent-readiness** – Programmes designed to equip the city's workforce with relevant smart city skills.
- **A focus on people** – Human-centred approach to the development and application of smart city initiatives.
- **Ecosystems** – A wide-ranging network of active participants to encourage and maintain innovation.
- **Policies** – A supportive policy environment that includes areas such as data governance, intellectual property protection and urban planning.
- **Track record** – Demonstrated government experience in launching and managing successful smart city projects.
  [SmartEcoCity, 2025]

Based on their performance across these dimensions, the cities are ranked. The following table presents a selection of leading cities recognised for their smart city achievements and an inclusion of the Danish city of Copenhagen for a Danish context [SmartEcoCity, 2025].

As seen on Table 6.2, the only Danish city present is Copenhagen. These rankings not only include technological innovation but also rank cities on a broader readiness to evolve into a more inclusive, efficient and resilient urban space. The Smartecocity Index offers to understand and track smart city development on a global scale [SmartEcoCity, 2025].

#	City	Country
1	London	UK
2	Singapore	Singapore
3	Seoul	South Korea
4	New York	USA
5	Helsinki	Finland
24	Copenhagen	Denmark

Table 6.2. Top ranking cities in the Smartecocity Index and Copenhagen for a danish context.

6.2.3 IMD

The IMD Smart City Index (SCI) is globally recognised and examines how cities make use of technology to enhance urban life. It is developed by the IMD World Competitiveness Center in collaboration with the Singapore University of Technology and Design (SUTD). This index offers a more data-driven perspective on what makes cities smart. In comparison to other indices, the SCI combines statistical indicators with subjective perceptions that are collected from residents. This offers a different view of a city's strengths and weaknesses [IMD, 2024a, p.4].

The index evaluates 142 cities worldwide across five key aspects that reflect both the quality of life and infrastructure capability. They are as follows:

- Health and Safety: Resident's opinions about public health infrastructure and personal safety, as well as the accessibility and quality of healthcare services.
- Mobility: Traffic flow, the efficiency of urban transport systems, and the accessibility of mobility choices like bicycle infrastructure and public transport.
- Activities: Opportunities for leisure, entertainment, culture, and recreation that promote an active neighbourhood.
- Opportunities: Locals economic and educational opportunities, including work prospects, income levels, and access to superior education.
- Governance: The availability of digital services, venues for public engagement, and responsiveness of the government are all examples of how open and accessible local management is.
  [IMD, 2024a, p.71]

Based on performance across these five aspects, the top six cities in the 2024 edition of the Smart City Index are as follows [IMD, 2024a, p.5]:

#	City	Country
1	Zurich	Switzerland
2	Oslo	Norway
3	Canberra	Australia
4	Geneva	Switzerland
5	Singapore	Singapore
6	Copenhagen	Denmark

Table 6.3. Top ranking cities in the IMD Index.

As seen on Table 6.3, Copenhagen is the only Danish city to be included in the ranking, with a ranking of sixth overall. The city is still at a high point, even though it is two spots lower than it was in 2023. The city nevertheless maintains its high performance, receiving an “A” in technologies and an “AA” in smart city rating and structures. A city’s strength and digital maturity are reflected in these grades, which range from AAA (highest) to D (lowest) [IMD, 2024a, p.71].

Citizen priorities and perceptions

The IMD smart city index focuses on citizen inclusion and is one of its advantages. Locals were asked to list the top five issues that their local administration should focus on. The results helped shape a deeper understanding of community needs and expectations. Figure6.2 shows the priority areas of residents of Copenhagen:

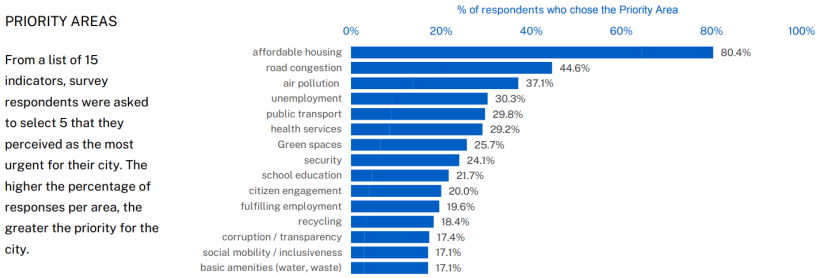


Figure 6.2. Priority areas identified in the Copenhagen survey [IMD, 2024a, p.71]

In addition to prioritisation, residents were surveyed on a range of statements related to digital governance, urban infrastructure and the responsiveness of public services [IMD, 2024a, p.71]. Figure 6.3 illustrate the percentage of respondents who agree or strongly agree with these statements in Copenhagen:

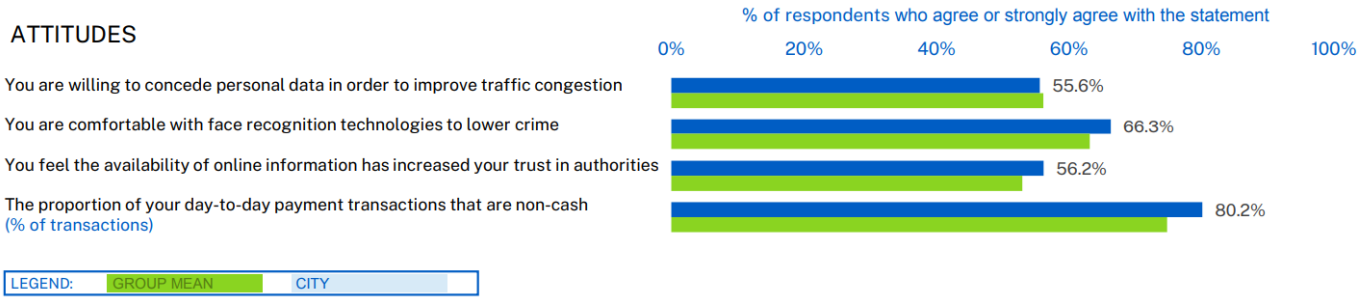


Figure 6.3. Attitudes identified in the Copenhagen survey [IMD, 2024a, p.71]

Alongside the attitudes are the structures and technologies scored show on figure 6.4:

Figure 6.4. [IMD, 2024a, p.71]

The data used in these figures is from a survey methodology used by the IMD Smart City Index, which combines subjective citizen feedback with objective performance indicators. The residents are directly included through structured surveys that prioritise pressing urban issues and their opinions on technological use in the urban environment. With a citizen-centric focus, the index ensures that it includes local priorities rather than solely top-down metrics.

Key components of the IMD index

To support cities in improving their performance and aligning with global best practices, the IMD Index places strong emphasis on three core factors: citizen inclusion, data usage and the application of insights to enhance urban life [IMD, 2024a,p.6-8].

- **Citizen Inclusion:** The index is based on a dedication to community inclusion. Through planned surveys, the SCI actively includes citizen feedback instead of depending just on top-down assessments. When evaluating a city's smart capabilities and directing future development, this method guarantees that local requirements, preferences and perceptions are included [IMD, 2024a,p.6-8].
- **Data-driven Evaluation:** The SCI integrates objective data such as public service performance, mobility efficiency, and infrastructure quality, with subjective input. This dual strategy balances data with first-hand knowledge to provide a more thorough picture of a city's advantages and disadvantages [IMD, 2024a,p.29].
- **Actionable Insights:** In addition to assigning scores to cities, the IMD index offers municipalities a diagnostic tool to pinpoint areas in need of improvement and development. The thesis identified points for enhancing the overall infrastructure of smart cities. Cities are provided with useful insights that promote focused interventions, policy improvements, and resource allocation by coordinating survey results with measurable indicators [IMD, 2024a,p.29].

These factors work together to establish the IMD Smart City Index key components to ensure performance and align with global best practices for smart cities.

6.2.4 Key strategies for Danish municipalities from smart city indices

Drawing on the frameworks and findings of the IMD Smart City Index, the Cities of the Future Index and the Smartecocity Index, several strategic themes emerge that can guide Danish municipalities in designing and implementing effective smart city initiatives. Each index brings unique evaluative dimensions, ranging from citizen inclusion to technological infrastructure and governance, which together provide a holistic roadmap for advancing urban innovation in a Danish context:

- **Prioritise Citizen-Centric Design (IMD, The Cities of the Future Index and Smartecocity):** All three indices emphasise the importance of engaging citizens in the planning and execution of smart city initiatives. The IMD index, in particular, utilises citizen perceptions, which demonstrates how resident feedback can inform policy and investment. Danish municipalities should institutionalise mechanisms for regular citizen input through surveys, participatory platforms and co-creation workshops. This can ensure urban technologies serve actual community needs.
- **Strengthen strategic governance and vision (Smartecocity):** Leadership with vision and a coherent governance structure is highlighted by the Smartecocity Index. Danish municipalities are encouraged to create long-term smart city strategies to support clear objectives, cross-sectoral coordination and leadership. Establishing this will provide strong governance frameworks and consistency across projects.
- **Enable inclusive digital infrastructure (Cities of the Future, IMD):** Inclusion of digital tools, connected and accessible to e-services are core dimensions in both the Cities of the Future and IMD indices. Danish municipalities should ensure that the digital infrastructure is not only high in performance but also equitably distributed.
- **Foster environmental and mobility innovation (Cities of the Future and IMD):** Sustainability and mobility are central to the Cities of the Future Index and IMD. Danish cities can leverage this by advancing green transport, for example, electric buses and cycling infrastructure. Additionally are smart mobility platforms and sustainable energy initiatives. These measures not only align with EU climate goals but also contribute to public health and urban resilience.
- **Invest in talent and skills (Smartecocity and IMD):** Developing a digitally skilled workforce is essential to the success of smart city projects. The Smartecocity Index and IMD recommends targeted talent readiness programmes. Danish municipalities should collaborate with research institutions, universities and the private sector to offer training in data science, urban tech and civic innovation, which can ensure local capacity to manage and sustain smart systems.
- **Adopt a data-driven approach (IMD and Smartecocity):** Both the IMD and Smartecocity indices mention the importance of integrating objective data with citizen feedback. Danish municipalities should invest in data platforms that gather, analyse and visualise real-time information from traffic patterns to energy use while also protecting data privacy. These platforms can guide resource allocation, monitor project performance and identify areas for intervention.

- **Leverage public-private ecosystems (Smartecocity):** The Smartecocity Index highlights the role of supportive ecosystems and financial encouragement.Danish cities should open up for collaborations through innovation hubs to attract investment and test new ideas.

Danish municipalities will be better off with smart cities if they develop comprehensive, flexible, and citizen-aligned smart city strategies with help from these cross-index insights. By finding a balance between efficiency and equity, as well as between innovation and inclusion, technology-driven innovation will be a significant enabler for sustainability and urban well-being.

6.3 Case Study: Analysis of a Danish municipality (Aarhus)

6.3.1 Introduction to Aarhus

Aarhus is one of Denmark's leading smart cities since 2012, and Smart Aarhus has been working to develop the digital Aarhus in partnership with Aarhus University, VIA University College, the Alexandra Institute, IT Forum, the Danish Technological Institute and various private companies [Aarhus Kommune, 2021]. Aarhus is the second-largest city in Denmark, with a population of 373.335 as of 2025 and is located on the eastern coast of Jutland [Aarhus i tal, 2025] [The city of Aarhus, 2025] [Bolius, 2024]. The city of Aarhus is among the top 75 destinations in the world based on the ICCA ranking of international meeting destinations. The city is also a popular meeting point for international scientific congresses and conferences [The city of Aarhus, 2025].

Innovation plays a central role in shaping Aarhus. Center for Innovation in Aarhus (CFIA) is the dedicated innovation hub in the municipality. The center's mission is to strengthen innovation capacity across the municipality. Alongside CFIA is the Aarhus City Lab (AACL), which focuses on innovation through emerging technologies. AACL connects the municipality with external partners such as research institutions, private companies and citizens to develop and test digital solutions in a real-world context. ACCL is a testbed for smart technologies and contributes to sustainable and cost-effective innovation in the services the municipality uses [ITK, 2024].

Furthermore, in a city context, it is the Smart City Aarhus. The city was chosen as the case study due to its position and active role in the smart city movement. Being the second largest city in Denmark, Aarhus emerges as a city with great ambition and innovative infrastructure, closer to other municipalities compared to, for example, Copenhagen. The city demonstrates its ambition through its Smart City Aarhus Strategy.

6.3.2 Smart Aarhus overview

Smart Aarhus is an innovative initiative that aims to promote sustainable urban growth and drive Aarhus municipality's digital transformation. Smart Aarhus serves as the link between the municipality and the urban community. They link citizens, corporations and knowledge institutions during the digital transformation. They also help to create a more cohesive municipality that prioritises the well-being of its citizens. Simultaneously, Smart Aarhus promotes a digital solutions market in Denmark and around the world through engagement with entrepreneurs and companies. Smart

Aarhus intends to produce smart solutions to important societal, environmental and economic concerns by building governance frameworks that encourage collaboration among the public and private sectors, citizens, businesses and knowledge institutions. Operational efficiency. The plan focuses on addressing the municipality's most pressing business concerns, such as infrastructure upgrades, welfare programs and public participation. One significant driver of this transition is the strategic use of data to enable more democratic decision-making and improve operational efficiency [Aarhus Kommune, 2021, p.3-5].

Key initiatives The strategic goals Smart Aarhus seeks to complete are through a series of interconnected activities that together promote Aarhus Municipality's digital and sustainable growth. Integration of data and digitalisation is the key enabler for initiating IoT sensors, AI support tools and data sharing platforms to facilitate municipal operations and improve service delivery. Sustainability is a priority in the strategy, aiming for carbon neutrality by 2030. Digital energy management, electrification of transport networks and the institutionalisation of circular economy activities are some of the major methods used. Citizen wellbeing is improved by self-service digital platforms and by automating operations in health, social care and employment services. In the educational sector, the implementation of digital learning technologies is accompanied by systematic professional development for instructors, which strengthens pedagogical digital competencies. The employment industry is also being changed by improved job matching algorithms and automated administrative procedures. A strong digital infrastructure and governance framework underpins these initiatives, including secure IT infrastructures, comprehensive data governance policies and targeted competence-building programs that provide scalability, resilience and trust. International collaborations, such as membership in the Nordic Smart City Network, collaboration on European Union-funded projects and interaction with GovTech initiatives, help to expand the strategy's reach and effectiveness [Aarhus Kommune, 2021, p.4-13].

Advantages and disadvantages The Smart Aarhus initiative includes various advantages and disadvantages, which will be discussed. Efficiency improvements are expected from digital technologies that streamline municipal services, decrease bureaucratic inefficiencies and optimise energy use. The environmental benefits are significant, in line with Aarhus's goal of CO_2 neutrality. Since digital platforms facilitate better access to municipal services and promote active participation in decision-making, another positive outcome is greater citizen empowerment. The plan is to boost economic growth and position Aarhus as a centre for innovation by attracting investors and tech firms. The increasing dependence on digital technologies is a factor to take into account, which raises cybersecurity risks and issues. Other than that is the digital divide, where certain demographics may be less fortunate. Lastly, the process of digital transformation may be slowed by administrative challenges and current technological gaps [Aarhus Kommune, 2021, p.4-17].

Existing platforms The Smart Aarhus strategy is built on established platforms such as Internet Week Denmark (IWDK), which since 2014 has celebrated and discussed the internet and digital development. Another is the work with Open Data in 2013. Aarhus became the first city in Denmark to open an open data portal. There are some others, such as Aarhus City Lab and the Nordic Smart City Network, reinforcing its foundation with prior projects [Aarhus Kommune, 2021, p.17].

Findings

Governance and organisational capacity - In the Smart Aarhus strategy, governance and organisational capacity are established as foundational elements to ensure coordinated planning, implementation and scaling of initiatives across the municipality. The strategy defines a multi-level governance structure in which the municipal director group serves as the ultimate steering committee, approving strategic adjustments and annual action plan projects. A steering group for digitalisation is in charge of day-to-day management, and it is assisted by a special Smart Aarhus secretariat located in the Business Development and Sustainability division. Staff from Strategy and Control and Business and Sustainable Development make up this secretariat, which collaborates continuously with representatives from all municipal departments to coordinate projects, exchange best practices, and lessen the effects of silos [Aarhus Kommune, 2021, p.14-15]. A higher-level Executive Board and a large Smart Aarhus Network are the two external forums that Smart Aarhus hosts. This unites academic partners, private sector innovators, public sector leaders, and public stakeholders. The strategy focuses on three "enabler" areas to increase organisational capacity:

- IT infrastructure & architecture: Improving secure, scalable frameworks that form the basis of all digital solutions [Aarhus Kommune, 2021, p.13]
- Common data definitions: Governance principles, and quality-assurance protocols must be established in order to ensure dependable, functional data flows [Aarhus Kommune, 2021, p.13].
- Digital culture & competencies: Investing money into competency-building programs and teaching municipal staff new methods, data literacy, and technology adoption will help the organisation adopt a digital mindset [Aarhus Kommune, 2021, p.13].

Citizen engagement - Denmark's smart-city approach involves citizens as co-creators of urban solutions, rather than just service recipients. In Aarhus, this has taken on three complementary forms as follows.

Co-design Workshops and Living Labs:

The Aarhus City Lab hosts data camps and hackathons regularly, during which residents, students and local businesses collaborate to prototype apps and services using Open Data Aarhus datasets. In 2018, a hackathon brought together local kids and healthcare professionals to create a prototype air-quality dashboard, which is now being tested on three municipal school roofs. The City Lab collaborates with local organisations to handle small-scale field trials of citizen-designed pilots, such as parking-space sharing and public-space lighting control, rather than just one-time events [Baraniewicz-Kotasińska, 2022, p.17].

Digital participation platforms:

Smart Aarhus allows residents to suggest community challenges as eliminating single-use plastic and enhancing bike lane safety. The Smart Aarhus secretariat triages challenges with 500 signatures and convenes a cross-sector working group to develop solutions. A real-time participatory budgeting tool allows citizens to allocate 0,5% of the city's capital projects budget. Over 8.000 residents voted on 12 micro-projects, ranging from solar-powered bus shelters to pocket-park retrofits, to receive funding in 2023 [Baraniewicz-Kotasińska, 2022, p.11].

Embedded civic sensors:

Citizen-driven environmental monitoring has been facilitated in Aarhus by a number of smart projects that place an emphasis on open data and participatory government. Projects have deployed scattered sensors using the city's LoRaWAN infrastructure to gather environmental data, including air quality and traffic flow [Aarhus Kommune, 2021,p. 16]. The *Digital Neighbourhoods* project complemented these initiatives by using interactive installations to allow locals to vote and suggest ideas for urban improvement [Baraniewicz-Kotasińska, 2022,p. 11]. These programs helped increase public awareness and literacy regarding digital tools and urban data, in addition to encouraging public participation.

Scaling and sustainability

Scaling in Aarhus employs what Snow et al refer to as a "link and leverage" method, which involves drawing on existing civic events, institutional frameworks and collaborations to expand pilots into full municipal services. For example, Internet Week Denmark, which began in 2014, has become a regular venue for crowdsourcing, testing and showcasing digital ideas. Sustainability is ensured through these three pillars [Snow et al., 2017].

- Modular open-source infrastructure, such as Aarhus Open Data platform (www.opendata.dk), enables various players to utilise datasets across several initiatives [Snow et al., 2017].
- Energy-efficiency partnerships such as Go Green with Aarhus use blended funding models that combine EU grants (for example, Horizon Europe), municipal funds and private-sector co-financing [Snow et al., 2017].
- Collaborative governance, which is a model in which coalitions of governmental, corporate and civil-society players own the scaling process from concept to implementation [Snow et al., 2017].

Discussion of Aarhus lessons

Several success factors are revealed by the Aarhus case. Reaching acceptance and encouraging inclusivity were highly valued by concept supporters from academic and public institutions, according to Snow et al. To encourage local ownership and distributed innovation, Aarhus established a non-hierarchical administration structure where secretariats act as facilitators rather than controllers. More exploratory initiatives were intentionally piloted, tested, and improved, and failures were seen as teaching opportunities. Nonetheless, there are a lot of gaps. For example, despite Aarhus's strong emphasis on inclusivity, the document Scandinavian Third Way highlights the difficulties in ensuring that marginalised groups have access to digital services. Leaders understand that as initiatives expand and require formal governance, it can be difficult to maintain the enthusiasm for collaboration. Keeping innovation and regulation in check is also one where Aarhus's collaborative governance approach prioritises openness, but securing citizen data, privacy, and cybersecurity requires more legislation [Snow et al., 2017].

General lessons for other municipalities from the Smart Aarhus Initiative

The Smart Aarhus program provides insightful data for municipalities looking to adopt smart city initiatives. Its methodology prioritises sustainability, citizen participation, technology integration and collaborative governance.

Collaborative governance:

Smart Aarhus has a multi-level governance structure that includes a special administration inside the Business

Development and Sustainability department and a municipal director group serving as the steering committee. This framework ensures coordinated planning and execution across municipal departments, minimises silo effects, and fosters cross-sector cooperation [Snow et al., 2017] [Aarhus Kommune, 2021].

Leveraging current platforms:
The project expands on venues like Internet Week Denmark (IWDK), which was launched in 2014 and offers an opportunity for ideas to be tested, collected, and presented online. Furthermore, innovation and data-driven decision-making are encouraged by the Open Data Aarhus portal, which was launched in 2013 and advocates for transparency and data accessibility [Snow et al., 2017] [Aarhus Kommune, 2021].

Engaging citizens:
Engagement with citizens is prioritised in Smart Aarhus in its attempts to adapt digitally. Self-service digital platforms are growing and automating processes in employment, social care, and health services, increasing engagement, which boosts productivity in the city [Aarhus Kommune, 2021] [Baraniewicz-Kotasińska, 2022].

International collaboration:
Encouragement to participate in networks like the Nordic Smart City Network and collaborate on EU-funded projects. These expand the strategy's reach and efficacy while also promoting the adoption of best practices and knowledge exchange [Aarhus Kommune, 2021] [Andersen et al., 2016].

6.4 Policy recommendations

6.4.1 Recommendations for Denmark

A national strategy can help Denmark improve its standing in the implementation of smart cities. Although a number of municipalities have started local projects, Denmark can benefit from a national plan. The following suggestions list important steps Denmark can take to enhance in the implementation of smart cities in Denmark.

National vision and strategic coordination - The Danish government can take the initiative in creating a unified national smart city agenda by creating a framework for strategy that encourages innovation, sustainability, and digital transformation in every municipality. Denmark does not yet have a national smart city framework that offers a common vision, shared objectives, or thorough information sharing, in contrast to Sweden and Norway [Smart byer Norge, 2025] [Smart city Sweden, 2025]. The main objectives of a national plan should be to integrate data governance principles, promote municipal-level implementation with consistent direction and coordinate smart city initiatives with national climate targets [European Parliamentary Research Service, 2023, p.47].

Establishment of a national smart city network - Denmark, unlike its Nordic neighbours, lacks a national platform to support smart city initiatives. Norway and Sweden have national networks that link businesses, citizens, researchers and local government to cooperate and have knowledge exchange. A similar strategy may enhance Denmark's efforts in smart cities on a national level by establishing a centralised smart city network that encourages collaboration across sectors [Smart byer Norge, 2025] [Smart city Sweden, 2025].

Technical and financial support for municipalities - Implementing digital projects can be complicated, and to help with this, the national government should improve its financial and technical support systems. The creation of regional advisory centres on digital acquisition and data governance. Additionally are nationwide training programs for local government employees, such as AI ethics and the use of digital tools. Developing project-funded programs that offer professional advice and supporting the raising capacity initiatives. This will particularly help smaller municipalities to maintain their ambitions for smart cities [Arup and CEDI, 2016, p.6] [European Parliamentary Research Service, 2023, p.50].

Standards, ethics and legal frameworks - To encourage the development of smart cities, standardised legal and ethical frameworks are desperately needed. Best practices for cybersecurity, interoperability and data protection should be outlined in national guidelines to maintain public confidence and regulatory compliance. Digital infrastructure certification could improve quality control and avoid over-reliance on certain suppliers [European Parliamentary Research Service, 2023, p.45].

Public-private partnerships and investment facilitation - To mobilise resources and promote innovation, Denmark can strengthen its backing for public-private partnerships (PPPs). To help municipalities create fair and open partnerships with private companies, a national PPP facilitation unit or handbook should be established. Additionally, public funds could be used to reduce the risk of large-scale projects, increasing their appeal to domestic and foreign investors [European Parliamentary Research Service, 2023, p.47].

Knowledge sharing and scalability - The government can support systems that let cities exchange data, tools and experiences to encourage a culture of learning and replication. Scalability plans should be a requirement of national funding for smart city experiments to prevent isolated or temporary programs. To assist towns in duplicating successful ideas and modifying them for local settings, a national digital portal for case studies, assessments, and implementation guides could potentially be established [European Parliamentary Research Service, 2023, p.53].

6.4.2 Recommendations for municipalities

Municipalities are crucial actors in the implementation of smart city initiatives. The following recommendations seek to ensure that smart city projects can strive at the municipalities.

Cross-sector governance and organisational structure - Governmental structures that encourage departmental and external cooperation are a recommendation for municipalities. In Aarhus, this is done through a steering group that consists of representatives from municipal organisations, local businesses, universities and various city departments. This steering group ensures that decisions on smart city projects are made cooperatively by taking advantage of a range of expertise and stakeholders, and by promoting ownership over the projects. Aarhus illustrates a shared governance framework that incorporates academic institutions, civil society, businesses and government agencies. All these to coordinate strategy, operations and stakeholder interaction. Similar participatory structures can be made in other municipalities but at a lower scale [Arup and CEDI, 2016, p.24].

Public-private and regional collaboration - Collaboration is needed to ensure smart city initiatives can succeed.

Establishing shared network and infrastructure projects, costs may decrease, and efficiency may increase. Ensuring being part of regional partnerships can assist municipalities by giving them access to more comprehensive funding sources and expertise [Arup and CEDI, 2016, p.20].

Open Data and interoperability - Local governments must use open data more to promote innovation and boost transparency. Municipalities will be less dependent on private databases and encourage data interchange if open data platforms that adhere to national and international standards are established. Tools like Open Data and shared technical specifications will further improve system interoperability [Arup and CEDI, 2016, p.24].

Capacity building and digital skills - For smart cities to succeed, local staff members digital skills must be strengthened. Municipalities have to fund continuing education initiatives that cover topics like technological integration, digital ethics and data management. Additional assistance for developing staff members, including recruiting digital talent, can be obtained through partnerships with academic institutions and involvement in knowledge-sharing networks [Arup and CEDI, 2016, p.38] [European Parliamentary Research Service, 2023, p.50].

Ethics, privacy and data governance Smart cities projects should be grounded in ethical principles due to the fact that they often entail the collection and processing of personal data, the use of surveillance technology and the automation of public services. Transparency, accountability, and equity are ensured in urban innovation by integrating ethics into the implementation of smart concepts. Municipalities must have clear data governance processes, including impact analyses for digital services and open data usage guidelines. Working groups or ethics committees can be established to oversee emerging technologies and boost public confidence [Arup and CEDI, 2016, p.24] [European Parliamentary Research Service, 2023, p.19-20].

Citizen perception and public engagement - To ensure that smart city initiatives reflect the needs of the general public, municipalities should actively engage citizens through planned discussions and surveys. Public sentiment data can be obtained through tools like the IMD Smart City Index that combine technical indicators and citizen input. Building trust and a sense of shared ownership is facilitated by disclosing the outcomes and openly addressing community issues [IMD, 2024b].

Pilot projects and long-term strategy - To overcome isolated pilots, municipalities should plan projects with built-in scaling pathways. These pathways could include early stakeholder engagement strategies, dedicated budgeting for future phases and the use of adaptable technologies that can be expanded or modified across departments or city areas. Clearly defining success criteria and developing strategies for wider implementation will improve the sustainability of the project. To guarantee accountability and coordinated progress, cities should also create strategic roadmaps that specify long-term objectives, performance metrics and schedules. To keep these plans current and responsive, regular evaluations and community input channels are necessary [European Parliamentary Research Service, 2023, p.53] [Arup and CEDI, 2016, p.31].

6.5 Summary of the findings

In conclusion, analysis 3 presented a **multi-level strategy** to improve the deployment of smart cities in Denmark. Using the **Innovation Diffusion Theory**, it classifies cities based on the rate of adoption and offers each group customised advice from pioneers like Copenhagen and Aarhus. Using a **case study** of Aarhus and international smart city indices, this section highlights **important facilitators** such as **robust digital infrastructure, open data platforms, inclusive public interaction and cooperative governance frameworks**. Through **co-design labs, participatory budgeting and resident-empowering digital platforms**, Aarhus is an example of success. The **policy recommendations** emphasise the necessity of a national framework for smart cities, regional collaboration, digital skills investment, ethical data governance and scalable development of projects. These results collectively offer a strategic road map for converting fragmented pilots into sustainable, citizen-centred smart city ecosystems.

Discussion 7

7.1 Summary

This project explores the challenges and opportunities that smart city projects have in implementing, sustaining and scaling across Danish municipalities. Despite Denmark's reputation as a digital frontrunner and its commitment to technological innovation and sustainability goals, the efforts of smart city efforts remain unevenly distributed across the 98 municipalities in Denmark. The thesis highlights a complex mix of institutional and structural capacity-related barriers that obstruct the sustainability and scalability of smart city projects. **Challenges** often seen include technical capacity limitations, legal and data protection concerns (such as GDPR), organisational silos, inconsistent political support and resource shortages. These factors affect smaller municipalities that face issues related to funding, staffing and access to expertise. This all adds up to frequent results of **'pilot sickness'**, which is used in this project to describe the failure of smart city projects to transition from their initial phase to long-term integrated strategies.

The project uses a **mixed-methods approach**, which includes a literature review, document analysis, stakeholder interviews, stakeholder analysis, mapping, a survey and a case study of the city of Aarhus. Alongside these methods, the thesis integrates **theoretical perspectives** from **diffusion of innovation, multi-level governance (MLG) and institutional theory**. This **thesis's goal** was to uncover why smart city projects in Denmark fail to go beyond the pilot phase, and to identify the strategic steps required for their long-term integration.

Furthermore, an extensive knowledge of smart city difficulties was made possible by the research's **methodology** of **literature review** and **document analysis**. These methods, alongside interviews, ensured the triangulation of findings across data sources and permitted both breadth and depth of investigation. The **stakeholder analysis** provided valuable insight into the key actors influencing smart city agendas, their interdependencies, and the power dynamics that shape the implementation at the municipal level. It helped identify who drives or delays innovation and how relationships between political, technical, and civic stakeholders can influence outcomes. The **survey** provided insight into the perspective of the municipal respondents. These responses greatly added to the insights into the prior knowledge that was identified. To further deep-dive into additional questions gathered from the initial research, **stakeholder interviews** were implemented. The interviews provided valuable insights into the perspectives of experts in their respective fields and significantly contributed to the research. Additionally, a brief use of **mapping** was employed to map the survey respondents.

The thesis also employs Aarhus as a **case study** to show how a Danish municipality has used strategic governance, outside collaborations and an innovative culture to overcome some of the institutional and structural obstacles found with this research. Aarhus's Smart City Strategy, which includes an executive board, a wide range of stakeholders and a cross-departmental administration, incorporates digital transformation into its organisational structure. Investments in co-design techniques, such as open data infrastructure and digital competences, are also areas that are fundamental to their strategy. Their dedication to community engagement and collaborative innovation is demonstrated by initiatives like Internet Week Denmark and the Aarhus City Lab.

The **theoretical framework** that combined Institutional Theory, Multi-Level Governance and Diffusion of Innovation offered a structured perspective for analysing the empirical data. The **institutional theory** gave insight into the resistance to change and path-dependent practices that were found to be incorporated in municipal systems. A deeper comprehension of why certain cities progress while others lag was made possible by the use of this theory. It also shed light on the influence of established organisational structures and political norms on the sustainability of these initiatives. **Multi-Level Governance theory** helped to understand the governance structures of smart cities in Denmark. It also highlighted how divided decision-making and inter-departmental segregation delay coordinated action. **Diffusion of innovation theory** gave an understanding of what stage the municipalities are at with smart city initiatives.

To summarise the **findings** of this thesis, there is potential for improvement in Denmark's smart city landscape. In Analysis One, it was seen that key challenges are hindering the Danish municipalities from adopting, sustaining and scaling smart city projects. **Analysis part one** concluded that the challenges are numerous, including legal constraints, narrow conceptual focus, security concerns, organisational and governance barriers, cultural resistance, fear of failure, capacity shortages, budget constraints, scaling, lack of political backing, etc. All of these challenges hinder the progress of smart city initiatives. **Analysis part two** concluded that the governance structure and municipal capacity have an impact on the adoption of smart city projects in Denmark. The minimal national funding and aid make it hard for municipalities to scale projects, causing them to halt in the pilot phase. Even though Denmark has a strong national framework, including national agencies, inter-municipal networks, implementation is often fragmented by departmental silos, uneven support and lack of internal expertise. The results in this analysis show that for municipalities to move from pilots into long-term efforts, there must be collaboration between departments and broad stakeholder participation. **Analysis part three** concluded with strategic steps that municipalities can deploy for smart city initiatives. The diffusion theory helped to understand the rate of adoption and offers recommendations for the municipalities based on their situation. Additionally are the recommendations from the case study of Aarhus and the Smart city indices.

To **summarise** the whole research, it was revealed that Denmark's smart city landscape has room for improvement. Even though several municipalities are pioneering innovative solutions, some systemic gaps in coordination, capacity and strategy limit the broader scaling of smart city projects in Denmark. Stronger national support, shared learning networks, and institutional reforms are needed for the transformative potential of smart city projects. The thesis also clarifies how organisational habits, governance frameworks and municipal-level practices interact to influence the results of smart city initiatives transformation. To create resilient and adaptable smart city initiatives, it emphasises the value of internal leadership, cross-sector cooperation and public involvement. The thesis offers a grasp of Denmark's developing smart city ecosystem and the circumstances that allow it to flourish by tracking both the structural obstacles and creative solutions across municipalities.

7.2 Interpretation

This part **interprets** the research's findings. The concluding findings of this project are that the challenges in smart city initiatives are numerous and are subject to be more than those mentioned in the thesis. The thesis doesn't account for the full picture of smart city challenges in Denmark due to the immense complexity of the term.

Although this study provides an examination of Denmark's smart city challenges, generalising the results requires taking into account the study's methodology and contextual limitations. A more thorough interpretation of the project's findings requires greater investigation, especially through comparative case studies, continuous analysis and participatory techniques that take into account the opinions of the public. In the end, this interpretation emphasises that the development of smart cities is a profoundly institutional problem rather than just a technical one.

The **Danish context** is the setting for the research's interpretive broadness. The empirical data is rooted locally, even when references to and alignment with global and European patterns are made. The results may therefore not be immediately applicable to nations with distinct administrative customs, governing structures, or resource limitations. However, other nations attempting to strike a balance between local innovation and national alignment can learn from Denmark's decentralised governance approach and emphasis on municipal independence. According to the interpretation, seemingly Danish-specific limitations such municipal silos and fragmentation are representative of larger governance issues in public smart city projects throughout the EU.

Furthermore is the rapid evolution of **smart city technologies**. It poses a challenge to the longevity of the technology. This challenge is not mentioned previously in this thesis, but is significantly relevant in the area of smart cities. Smart city projects are often of large budgets, and technology is seeing large improvements over time [Pring-Mill, 2023]. Also, the regulatory environment is always changing, which could affect procurement and compliance procedures. This includes data protection under the GDPR and changing infrastructure standards. This means that some of the institutional and governance-related barriers identified in this project may see a difference shortly. The constant change in the legislative and technical context highlights a crucial conflict. Cities have to find a balance between their desire to innovate and the slow-moving legal system and institutional limitations. This delays acceptance for many, particularly smaller municipalities, who are prone to wait for safe or extensively validated solutions. This view implies that for cities to operate with confidence in changing digital environments, national policy frameworks must provide more precise advice and dynamic adherence tools.

The political will, size, institutional capacity, and focus on innovation give the **case study of Aarhus** a comprehensive analysis, but it may not be easily replicable in smaller or more resource-constrained municipalities, but may be in municipalities of similar size and vision. In terms of interpretation, Aarhus is notable for both its governing ideology and its resources. To obtain long-term funding and policy impact, it organises multi-stakeholder working groups, involves citizens through participatory budgeting and places itself within EU programs. Its strategy is a prime example of "smart city 3.0" thinking, which substitutes experimental governance and citizen co-creation for top-down technological implementations. The main takeaway from this is that, to successfully change smart cities, organisational adaptability and cultural openness may be more important than scale or money alone. Therefore, even though Aarhus offers a valuable model, its ability to scale its strategies to other municipalities is uncertain since

municipalities vary in size, infrastructure and vision.

The thesis makes use of the **triangulated methodology** and **theoretical framework** of the research to explain the scalability, sustainability, and unequal implementation of smart projects in Danish cities. The only two **quantitative methods** used were the survey and the mapping, which gave insight into the municipal perspective on smart cities. The data of the **survey** proved to be useful for identifying trends and patterns. The responses varied widely based on the job roles of the respondents, which ranged from IT professionals and urban planners to administrative staff. There was a high percentage of 'don't know' responses, which revealed that there was low internal awareness and limited integration of smart city projects within departments. This showed that there was a broader problem of digital maturity among municipalities. Though the research provides insight that is valuable in the institutional and structural factors that influence the development of smart city initiatives, it's important to look at the methodological scope and contextual nuances when interpreting the findings.

7.3 Limitation

This research has **several limitations** that impact the interpretation, generalisability, and breadth of its conclusions, as is the case with all research. It is important to recognise certain methodological, contextual, and analytical limitations, even if the mixed-methods approach offered a deep understanding of smart city implementation in Denmark. These limitations point to areas for caution and future research opportunities rather than lessening the research's value.

The first point to consider is that the study is largely based on qualitative methods, which include stakeholder interviews, document analysis, literature review and a case study approach. Although these methods offer contextualised insights, they also present limitations in terms of external validity. The perspectives obtained through stakeholder interviews, while diverse, primarily reflect the views of selected individuals involved in or have knowledge about smart city initiatives. As such, the interpretations drawn may not be fully representative of the broader range of experiences and capacities across all 98 Danish municipalities. An additional theoretical and empirical gap is the lack of a financial analysis and an assessment of environmental performance. Neither the cost-benefit analysis of smart city investments nor the compatibility of digital initiatives with Denmark's sustainability objectives are examined in the present research. These limitations make it harder to evaluate the long-term sustainability and climatic impact of smart city initiatives. Even though the literature review and document analysis offered crucial background information on national frameworks, policy alignment, and strategic intent, they did not examine unofficial implementation mechanisms like political negotiating, network-based coordination, or the importance of interpersonal trust. Despite not being included in this research, these factors frequently have a significant impact on how smart city plans are implemented in practice. Additionally, the project mostly examined developed or successful cases rather than unsuccessful or stopped efforts, which would have offered important counterarguments to balance the analysis of what helps or hinders the success of smart cities. This selection bias could cause systemic resistance to be under-reported and progress to be overemphasised.

Another limitation is that the finding's durability is at risk from the quick development of smart city technology and the legal structures that go along with it. Legal environments that are always changing include digital infrastructure requirements, municipal procurement policies, and data protection under the GDPR. This suggests that several of the governance-related and institutional constraints found in the study might change significantly soon. Technical standards, new regulatory reforms or more funding available could all help alleviate what is now seen as a limitation, such as the restricted interoperability of digital systems or data sharing protocols. The cycles of planning and procurement are also impacted by the speed of technological advancement. Municipalities may find it difficult to plan investments for the future when faced with changing requirements and a lack of internal expertise. The research did not thoroughly evaluate the methods used by municipalities for long-term planning of digital infrastructure or technology life-cycle management, both of which are essential to maintaining smart city operations over time.

Moreover, while the survey data helped highlight patterns and trends, it did not achieve full national coverage. Not all municipalities participated, and there was variation in the roles of the respondents. This variability in job roles introduces a possible bias in the data, as some respondents may have had limited familiarity with smart city projects or may have interpreted the survey questions through very different operational lenses. This could affect the consistency and reliability of certain conclusions drawn from the survey results. Furthermore, the interpretation of the survey results was made more difficult by the absence of a defined framework for digital maturity among municipalities. It is challenging to determine whether the mentioned challenges are the result of institutional constraints or misunderstandings when there is no common baseline for digital skills or capability. Furthermore, the survey omitted questions about digital fairness, diversity, and citizen satisfaction, all of which are crucial for assessing the wider societal effects of smart city projects.

Another important limitation is that although the Aarhus case study deepens the research, its particular setting, which is marked by institutional capacity, strong political will, and a progressive innovation culture, might be difficult to duplicate in smaller or more resource-constrained areas. Therefore, even if Aarhus provides a useful model, it's unclear if its tactics can be applied to other municipal contexts. Aarhus has additional advantages that many other municipalities do not, such as regional cooperation and extensive experience with EU projects. The study didn't look at how municipalities without access to these networks might make up for it, or if similar support ecosystems exist elsewhere in Denmark. This restricts knowledge of the more comprehensive enabling circumstances required for the diffusion of innovation.

Finally, although the research touches on global and European trends and includes references to international frameworks (EU digital policy alignment and smart city indices), the empirical focus remains within the Danish context. This national focus, while appropriate for the scope of the study, limits the external validity of the findings. Future research could enhance transferability by comparing Danish smart city development with efforts in other Nordic or EU countries facing similar socio-political and technological conditions. It's also critical to remember that neither citizens nor civil society organisations were actively involved in the research. There was no primary data gathered from citizens or end users of smart city services, despite the conceptual discussion of participatory techniques and the Aarhus Convention. Because of this, the research is unable to comment on issues that are essential to the social sustainability of smart cities, such as user pleasure, digital inclusion, and public trust.

While the study offers a comprehensive and theoretically grounded exploration of smart city challenges in Denmark, its methodological and contextual constraints suggest caution in generalising findings without further comparative and longitudinal research.

Conclusion 8

In conclusion, even though Denmark is known throughout the world as a leader in digital technology, the country still faces many challenges in the development of smart cities. Due to complex interactions between institutional inertia, disjointed governance structures, limited municipal capacity and financial constraints, many municipalities find it difficult to progress beyond pilot projects. These challenges make it difficult for smart city initiatives to be implemented, scaled and adopted. Although Denmark has a strong capacity for innovation and high levels of digital proficiency, these advantages have not yet been fully implemented into local smart city implementations.

The thesis's main aim was to answer the research question "**Why do Danish municipalities face challenges in adopting, sustaining, and scaling up smart city projects, and how do governance structures and municipal capacity influence these barriers?**".

The reason why Danish municipalities face challenges in adopting, sustaining and scaling up smart city projects is a complex array of challenges. Many interconnected structural, institutional, political and organisational factors make it difficult for Danish municipalities to implement, maintain, and expand smart city initiatives. A mix of internal and external constraints prevents municipalities from turning isolated pilot projects into long-term, scalable solutions.

The challenges identified in this thesis are: **Legal constraints** such as digitalisation of municipal documents and GDPR. **Narrow conceptual** focus and buzzword fatigue in the use of the concept of smart city. **Security concerns** in data and privacy, which also include GDPR and surveillance. **Organisational and governance barriers** hindering cross-departmental budgeting and coordinated efforts. **Cultural resistance and fear of failure** is prominent in municipalities being reluctant to engage in exploratory innovations. **Capacity shortages** and technical expertise are not yet available to the full extent in the municipalities. **Budget constraints** with limited funding. **Scaling** is hindered by isolated strategies and pilot projects. **Lack of political backing** is lastly also a hindrance for municipalities, which hinders, for example budget for smart city projects. These challenges were revealed to be complex and intertwined.

The governance structures influenced these barriers by siloed municipal departments, inconsistent political backing and funding, and a lack of internal knowledge. It is shown that Denmark has a framework including national agencies, inter-municipal networks the implementation is mainly structured in the municipalities. It is mainly the municipalities that initiate and do the heavy lifting in smart city projects in their respective municipality. Additionally the municipalities are structured in a silo's which can make difficulties for cross-silo projects like smart city project. The governance proved to be complex, of having a plethora of stakeholders with a great amount of influence and interest over the smart city projects in Denmark, but the main driver in smart cities remains at the municipality. Even though decentralisation provides local municipalities with independence, the lack of strategic support and resource pooling inhibits larger transformation and has a big impact on the municipal capacity.

The strategic steps that municipalities can deploy for smart city initiatives in addition to a great number. Based on the diffusion theory, it helped to understand the rate of adoption and offers recommendations for the municipalities based on their situation. Innovators were analysed to be municipalities such as Aarhus and Copenhagen, which are the main

drivers and should remain on pace with their current initiatives while still considering this thesis' recommendations. Other municipalities may strive to become more like what Aarhus and Copenhagen are doing with their smart city initiatives. Recommendations such as strengthen strategic governance, enable inclusive digital infrastructure, foster environmental and mobility innovation, invest in talent and skills, adopt a data-driven approach and leverage public-private ecosystems. Additionally are the strategic steps for Denmark, which are national vision and strategic coordination, Establishment of a national smart city network, technical and financial support for municipalities, legal frameworks, investment facilitation and investment in facilitation.

Bibliography

Aarhus i tal (2025). Antal indbyggere. https://ledelsesinformation.aarhuskommune.dk/Embed#vfs://global/AARHUS-I-TAL/BEFOLKNING_I_TAL-Demografi-Antal-indbyggere.xview. Last visited: 06/05/2025.

Aarhus Kommune (2021). Smart aarhus strategi 2021-22n. https://aarhus.dk/media/dlxhclj3/smart-aarhus-strategi.pdf. Last visited: 23/05/2025.

AND., A. K. and Sinani, B. (2023). Multi level governance: Legal and institutional challenges. Online, https://tribunajuridica.eu/arhiva/An13v1/3.%20Kokaj,%20Sinani.pdf. Last visited: 10-04-2025.

Anders Esager Hansen, Vejle Municipality (2025). Transcription of interview, attached to the report. 14-03-2025.

Andersen, K. N., Medaglia, R., and Henriksen, H. Z. (2016). Smart cities and citizen engagement: The case of aarhus. *Journal of Theoretical and Applied Electronic Commerce Research*, 11(3):65–76. https://www.mdpi.com/journal/jtaer. Last visited: 23 May 2025.

Arup and CEDI (2016). Growing smart cities in denmark: Digital technology for urban improvement and national prosperity. , Ministry of Foreign Affairs of Denmark, Copenhagen. Last visited: 20/05/2025.

Asian Development Bank (2020). Smart city pathways for developing asia: An analytical framework and guidance. https://www.adb.org/publications/smart-city-pathways-developing-asia. Last visited: 05/05/2025.

Baraniewicz-Kotasińska, S. (2022). The scandinavian third way as a proposal for sustainable smart city development—a case study of aarhus city. *Sustainability*, 14(6):3495. https://www.mdpi.com/2071-1050/14/6/3495. Last visited: 18/05/2025.

Bjørner, T. B. (2021). The advantages of and barriers to being smart in a smart city: The perceptions of project managers within a smart city cluster project in greater copenhagen. *Cities*, 114:103187. https://www.sciencedirect.com/science/article/pii/S0264275121000858. Last visited: 15/05/2025.

Bolius (2024). Her er de største og mindste kommuner i danmark. https://www.bolius.dk/her-er-de-stoerste-og-mindste-kommuner-i-danmark-40500. Last visited: 06/05/2025.

Bowen, G. (2009). Document analysis as a qualitative research method. *Qualitative Research Journal*, 9:27–40.

Braun, V., Clarke, V., Boulton, E., Davey, L., and McEvoy, C. (2020). The online survey as a qualitative research tool. *International Journal of Social Research Methodology*, 24(6):641–654. Last visited: 02-04-2025.

Brinkmann, S. and Tanggaard, L. (2020). *Kvalitative metoder, tilgange og perspektiver: en introduktion*, chapter Document Analysis, pages 185–201. Hans Reitzels Forlag. Last visited: 27-02-2025.

Bryman, A., Clark, T., Foster, L., and Sloan, L. (2021). *"Bryman's Social Research Methods"*, chapter Structured interviewing, pages 209–230. Oxford University Press. Last visited: 24-02-2025.

Bundgaard, L. and Borrás, S. (2021). City-wide scale-up of smart city pilot projects: Governance conditions. https://www.sciencedirect.com/science/article/pii/S0040162521004467. Last visited: [23-05-2025].

Business Region Aarhus (2023). World leaders in smart city solutions. https://businessregionaarhus.com/why-business-region-aarhus/why-business-region-aarhus/world-leaders-in-smart-city-solutions. Last visited: 18/05/2025.

C40 Cities (2016). Cities100: Copenhagen - smart traffic signals boost cycling. https://www.c40.org/case-studies/cities100-copenhagen-smart-traffic-signals-boost-cycling/. Last visited: 20/05/2025.

C40 Cities (2023). From local action to global impact: Denmark's groundbreaking climate action planning. https://www.c40.org/news/local-action-global-impact-denmark-climate-action-planning-dk2020/. Last visited: 19/05/2025.

Cambridge Dictionary (2025). Meaning of smart in english. https://dictionary.cambridge.org/dictionary/english/smart. Last visited: [19-02-2025].

Caprari, G., Castelli, G., Montuori, M., Camardelli, M., and Malvezzi, R. (2023). Digital twin for urban planning in the green deal era: A state of the art and future perspectives. https://www.mdpi.com/2071-1050/14/10/6263. Last visited: 22/05/2025.

Caramani, D. (2020). A postfunctionalist theory of multi level governance. Online, https://hooghe.web.unc.edu/wp-content/uploads/sites/11492/2020/11/2020_hooghe-marks-schakel_multilevel-governance_reduced-size-Caramani.pdf. Last visited: 10-04-2025.

Christian Fertner, KU (2025). Transcription of interview, attached to the report. 05-03-2025.

Christian Gaarde Nielsen, Copenhagen Solutions Lab (2025). Transcription of interview, attached to the report. 14-03-2025.

Copenhagen Cleantech Cluster (2012). Danish smart cities: Sustainable living in an urban world. Report, https://cdn.copcap.com/hubfs/Downloads/Dokumenter/Danish_Smart_Citites_Sustainable_Living_In_An_Urban_World.pdf. Last visited: 02-04-2025.

Cureton, P. and Hartley, E. (2025). Geodesign, urban digital twins, and futures. https://www-taylorfrancis-com.zorac.aub.aau.dk/reader/download/8f39e912-873b-49b6-b06a-97688c442a66/book/pdf?context=ubx. Last visited: [11-02-2025].

Dataforsyningen (2025). Dataoversigt. https://dataforsyningen.dk/data. Last visited: 27/05/2025.

Delve (2022). Semi-structured interviews definition. https://delvetool.com/blog/semi-structured#:~:text=A%20semi%2Dstructured%20interview%20is,and%20the%20topic%20of%20interest. Last visited: 24-02-2025.

Domínguez-Morales, M., Ángel Varela-Vaca, and Miró-Amarante, L. (2023). Internet of things. https://mts.intechopen.com/storage/books/11197/authors_book/authors_book.pdf. Last visited: 22/05/2025.

EasyPark (2025). The cities of the future index. https://easyparkgroup.com/studies/cities-of-the-future/en/. Last visited: 21/05/2025.

EIT Urban Mobility (2024). Eit urban mobility and netzerocities invite cities to the twinning learning programme. https://eit.europa.eu/our-activities/opportunities/eit-urban-mobility-and-netzerocities-invite-cities-twinning-learning. Last visited: 14/05/2025.

Energy Cities (2025). City of odense. https://energy-cities.eu/members/city-of-odense/. Last visited: 20/05/2025.

EU (2025a). Eu mission: Climate-neutral and smart cities. Online, https://research-and-innovation.ec.europa.eu/funding/funding-opportunities/funding-programmes-and-open-calls/horizon-europe/eu-missions-horizon-europe/climate-neutral-and-smart-cities_en. Last visited: 30-04-2025.

EU (2025b). Smart cities and communities. https://digital-strategy.ec.europa.eu/en/policies/smart-cities-and-communities. Last visited: [18-02-2025].

European Commision (2025). Aarhus. https://www.intelligentcitieschallenge.eu/cities/aarhus. Last visited: 20/05/2025.

European Commission (2022). Sustainable urban development – urban dimension of cohesion policy 2021–2027. https://ec.europa.eu/regional_policy/policy/themes/urban-development_en. Last visited: 14/05/2025.

European Commission (2023). Digital connectivity and digital strategy in denmark. https://digital-strategy.ec.europa.eu/en/policies/digital-connectivity-denmark. Last visited: 19/05/2025.

European Commission (n.d.). Smart cities marketplace: Investing in a sustainable and green europe. https://commission.europa.eu/eu-regional-and-urban-development/topics/cities-and-urban-development/city-initiatives/smart-cities_en. Last visited: 14/05/2025.

European Parliament and Council (2007). Directive 2007/2/ec establishing an infrastructure for spatial information in the european community (inspire). https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32007L0002. Last visited: 14/05/2025.

European Parliamentary Research Service (2023). Social approach to the transition to smart cities. https://www.europarl.europa.eu/RegData/etudes/STUD/2023/737128/EPRS_STU(2023)737128_EN.pdf. Last Visited: 20/05/2025.

Fernando, L. S., Kumari, M. S. D., and Kulatunga, M. S. A. (2025). Enhancing the smartness of the “smart city” concept: A critical review for a better conceptualization. https://link.springer.com/referenceworkentry/10.1007/978-981-16-8800-3_73-1. Last visited: [19-02-2025].

García-Avilés, J. (2020). *Diffusion of Innovation*, pages 1–8. ResearchGate. Last visited: 23-04-2025.

Gate 21 (2025). Fokusområder. https://gate21.dk/saadan-arbejder-vi/fokusomraader/. Last visited: 13/05/2025.

GDPR-Info.eu (2016). The gdpr text. https://gdpr-info.eu/. Last visited: 09/05/2025.

GDPR.eu (2025). What is gdpr? https://gdpr.eu/what-is-gdpr/. Last visited: 09/05/2025.

GERRING, J. (2004). What is a case study and what is it good for? *American Political Science Review*, 98(2):341–354. Last visited: 31-03-2025.

Ghazal, T. M., Hasan, M. K., Alshurideh, M. T., Alzoubi, H. M., Ahmad, M., Akbar, S. S., Kurdi, B. A., and Akour, I. A. (2025). Iot for smart cities: Machine learning approaches in smart healthcare—a review. https://www.mdpi.com/1999-5903/13/8/218. Last visited: [18-02-2025].

Government of Denmark (2019). Climate act (act no. 965 of 26 june 2020). https://www.c40.org/news/local-action-global-impact-denmark-climate-action-planning-dk2020/. Last visited: 19/05/2025.

GQIG (2025). Qgis. https://www.qgis.org/. Last visited: 27/05/2025.

Grant, M. J. and Booth, A. (2009). A typology of reviews: an analysis of 14 review types and associated methodologies. *Health Information & Libraries Journal*, 26(2):91–108. https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1471-1842.2009.00848.x. Last visited: 25-02-2025.

Green Hub Denmark (2025). Green hub denmark – public-private partnership for sustainable innovation. https://stateofgreen.com/en/solution-providers/greenhubdenmark/. Last visited: 18/05/2025.

Hajer, M. and Dassen, T. (2014). Smart about cities. https://www.researchgate.net/publication/326539234_Smart_about_Cities_-_Visualising_the_Challenge_for_21st_Century_Urbanism. Last visited: [12-03-2025].

Harvard law school (2025). Nongovernmental organisations (ngos). https://hls.harvard.edu/bernard-koteen-office-of-public-interest-advising/about-opia/what-is-public-interest-law/public-service-practice-settings/international-public-interest-law-practice-setting/nongovernmental-organizations-ngos/. Last visited: 15/05/2025.

Hooghe, L. and Marks, G. (2001). *Multi Level Governance and European Integration: Policy and Politics in the European Union*. Oxford University Press, https://www.researchgate.net/publication/246883870_Multi-Level_Governance_and_European_Integration. Last visited: 10-04-2025.

IBM (2018). Ibm smarter cities. https://www.ibm.com/smarterplanet. Last visited: 05/052025.

IMD (2024a). Imd smart city index. https://www.coit.es/sites/default/files/imd_-smartcityindex-2024-full-report.pdf. Last visited: 21/05/2025.

IMD (2024b). Smart city index. https://www.imd.org/smart-city-observatory/home/. Last visited: 20/05/2025.

Intrinsic safety training (2024). Leveraging the diffusion of innovation theory to reinforce safety practices. https://www.intrinsicsafety.com.au/2023/10/leveraging-diffusion-innovation-enhance-safety/. Last visited: 05/05/2025.

Invest in Aalborg (2025). Smart energy in aalborg. https://investinaalborg.dk/key-sectors/energy-and-sustainability/smart-energy/. Last visited: 20/05/2025.

ITK (2024). Innovation. https://itk.aarhus.dk/om-itk/afdelinger/innovation. Last visited: 06/05/2025.

Jayasena, N., Mallawarachchi, H., and Waidyasekara, A. (2019). Stakeholder analysis for smart city development project: An extensive literature review. *MATEC Web of Conferences*, 266:06012. Last visited: 29-04-2025.

Kim Stannov Søvsø, ITK (2025). Transcription of interview, attached to the report. 12-03-2025.

KL (2025). Kl's organisation. https://www.kl.dk/om-kl/kl-s-organisation#kl-internationalt-a5. Last visited: 13/05/2025.

Local Government Denmark (KL) (2022). Danish local government: A quick overview. https://www.kl.dk/om-kl/english/kl-local-government-denmark. Last visited: 15/05/2025.

Marcus, A. A. and Smith, D. (2011). Environmental encyclopedia. https://kbdk-aub.primo.exlibrisgroup.com/permalink/45KBDK_AUB/159qapk/cdi_proquest_journals_2533996870. Last visited: 02-04-2025.

Mergel, I. (2019). Digital service teams in government. *Government Information Quarterly*, 36(4). https://d-nb.info/1202713505/34. Last visited: 09-05-2025.

Midtjylland, G. (2025). GovTech Midtjylland. https://govtechmidtjylland.dk/om-gtm/baggrund. Last visited: 13/05/2025.

Ministry of Foreign Affairs of Denmark (2023). Turning denmark into a leading smart city nation. https://investindk.com/insights/turning-denmark-into-a-leading-smart-city-nation. Last visited: 19/05/2025.

Morais, P. (2021). Urban agenda for the eu – multi-level governance in action (updated 5-year brochure). https://futurium.ec.europa.eu/en/urban-agenda/library/online-brochure-urban-agenda-eu-multi-level-governance-action-has-new-revised-version. Last visited: 14/05/2025.

Morten Falbe-Hansen, A. C. L. (2025). Transcription of interview, attached to the report. Last visited: 09-05-2025.

Mortensen, C. F. and Rasmussen, M. K. (2025). Transcription of interview, attached to the report. Last visited: 15-05-2025.

Munksgaard, M. (2020). A roadmap to new york for smart city solution providers. https://industriensfond.dk/wp-content/uploads/2022/02/Access-Cities-Smart-City-Roadmap.pdf. Last visited: [21-02-2025].

Murthy, S. S. (2020). Ethics and the practice of forensic science in india. *Sociology*, 54(6):1079–1094. https://journals.sagepub.com/doi/epub/10.1177/0038022920970318. Last visited: 28-03-2025.

NCC (2017). Smart city strategy. https://www.newcastle.nsw.gov.au/getmedia/392DB4BE-D418-48D8-A593-7A17A4B482BB/2752_Smart-City-Strategy-FINAL-WEB.pdf. Last visited: [21-02-2025].

Niras (2024). Hvad er smart city? https://www.niras.dk/sektorer/data-digitalisering/fremtidens-byer-er-smart-cities-men-hvad-er-smart-city-egentlig/. Last visited: [11-02-2025].

Nordic Innovation (2021). Nordic smart city roadmap. https://www.nordicinnovation.org/2021/nordic-smart-city-roadmap. Last Visited: 30/04/2025.

OECD (2021). Public sector innovation scan of denmark. https://oecd-opsi.org/wp-content/uploads/2021/03/Public-Sector-Innovation-Scan-of-Denmark.pdf. Last visited: 21/05/2025.

Open Data DK (2025). Hvad er open data dk? https://www.opendata.dk/hvad-er-open-data-dk. Last visited: 13/05/2025.

Patalon, M. and Wyczisk, A. (2024). Mapping digital transformation of municipalities through the lens of institutional isomorphism. *International Journal on Social and Education Sciences*, 6(4):600–635. https://www.ijonses.net/index.php/ijonses/article/view/701. Last visited: 23-04-2025.

Patrick Driscoll, DTU (2025). Transcription of interview, attached to the report. 05-03-2025.

Peter Bjørn Larsen, Smart city insights (2025). Transcription of interview, attached to the report. 11-04-2025.

Pinto, J. (2017). A multifocal framework for developing intentionally sustainable organizations. *Current Opinion in Environmental Sustainability*, 28:17–23. https://www.sciencedirect.com/topics/social-sciences/institutional-theory. Last visited: 10-04-2025.

Pring-Mill, D. (2023). Reliability and future-proofing in smart city technologies. https://www.policy2050.com/2023/08/13/reliability-and-future-proofing-in-smart-city-technologies/?utm_source=chatgpt.com. Last visited: 26/05/2025.

Radchenko, K. (2024). Factors influencing the content of smart city initiatives (particularly based on institutional theories of organisation). *Smart Cities and Regional Development Journal*, 8(3):55–64. Institute of Industrial Economy of the National Academy of Sciences of Ukraine, Paris-Lodron University, Salzburg, Austria. Last visited: 10-04-2025.

Rogers, E. M. (2003). *Diffusion of Innovations*. Free Press, New York, 5th edition. Last visited: 23-04-2025.

Rogers, M. (2001). Evolution: Diffusion of innovations. In Smelser, N. J. and Baltes, P. B., editors, *International Encyclopedia of the Social & Behavioral Sciences*, pages 4982–4986. Pergamon, Oxford.

Schneider, A. (2014). Stakeholder analysis. https://citieswithnature.org/wp-content/uploads/2019/02/ValuES-Methods-for-integrating-ecosystem-services.pdf. Last visited: 02-04-2025.

Shelton, T. and Clar, J. (2025). Uneven development and expertise in the 'smart city'. https://taylorshelton.info/publication/uneven-development-expertise-smart-city/uneven-development-expertise-smart-city.pdf. Last visited: [20-02-2025].

Smart byer Norge (2025). About smart cities norway. https://www.smartebyernorge.no/about. Last visited: 20/05/2025.

Smart Cities Library (n.d). The 3 Generations of Smart Cities. https://www.smartcitieslibrary.com/the-3-generations-of-smart-cities. Last Visited: 05/05/2025.

Smart city Sweden (2025). Smart city sweden. https://smartcitysweden.com/about/. Last visited: 20/05/2025.

SmartEcoCity (2025). Smartecocity index. https://www.smartecocity.com/smartecocity-index/. Last visited: 21/05/2025.

Snow, C. C., Håkonsson, D. D., and Obel, B. (2017). A smart city is a collaborative community: Lessons from smart aarhus. *California Management Review*, 59(1):92–108. https://journals.sagepub.com/doi/full/10.1177/0008125616683954. Last visited: 07/05/2025.

Snyder, H. (2019). Literature review as a research methodology: An overview and guidelines. *Journal of Business Research*, 104:333–339. https://www.sciencedirect.com/science/article/pii/S0148296319304564. Last visited: 25-02-2025.

Stig Hirsbak, Aalborg University (2025). Transcription of interview, attached to the report. 10-03-2025.

The city of Aarhus (2025). Aarhus university. https://psy.au.dk/forskning/forskningscentre/center-for-rusmiddelforskning/konferencer/narrowing-paths-transgressive-routes/the-city-of-aarhus. Last visited: 06/05/2025.

Thesis group (2025). Smart city survey. Online, https://docs.google.com/forms/d/1vZDy6zrOWSXZUu77CHLub6UumrBc438feWdtfnljEmA/. See Appendices also.

Toli, A. M. and Murtagh, N. (2020). The concept of sustainability in smart city definitions. https://www.researchgate.net/publication/326539234_Smart_about_Cities_-_Visualising_the_Challenge_for_21st_Century_Urbanism. Last visited: [21-02-2025].

Tristancho, C. (2023). Stakeholder mapping 101: A quick guide to stakeholder maps. https://www.projectmanager.com/blog/stakeholder-mapping-guide. Last visited: 02-04-2025.

United Nations Economic Commission for Europe (2020). Sustainable and smart cities for all ages. https://unece.org/sites/default/files/2021-01/SSC%20nexus_web_opt_ENG_0.pdf. Last visited: 21/05/2025.

Varvasovszky, Z. and Brugha, R. (2000). A stakeholder analysis. *Health Policy and Planning*. https://academic.oup.com/heapol/article/15/3/338/573312. Last visited: 02-04-2025.

Vejle Kommune (2018). Smart city i vejle kommune. https://fosako.dk/wp-content/uploads/Smart-City-Vejle.pdf. Last visited: 20/05/2025.

Wernick, A., Banzuzi, E., and Mörelius-Wulff, A. (2023). Do european smart city developers dream of gdpr-free countries? *Internet Policy Review*, 12(1):1–16. https://policyreview.info/articles/analysis/do-european-smart-city-developers-dream-gdpr-free-countries. Last visited: 14/05/2025.

WSB (2025). Smart cities umbrella. https://www.wsbeng.com/?da_image=smart-cities-umbrella. Last visited: 23-04-2025.

Yin, R. K. (2014). Case study research: Design and methods. https://d1wqtxts1xzle7.cloudfront.net/55619180/yincasestudy-libre.pdf?1516765504=&response-content-disposition=inline%3B+filename%3DCASE_STUDY_RESEARCH_Design_and_Methods_S.pdf&Expires=1716800018&Signature=SmmWdc7Iq5XxN2MdYIelY9jZhR7nnODFJ2kVf4cEA4OCwq5XFsjlxQHfi7OsLeix6uzaYfYIfC8VxDonu5kBQnNXJPBwceixf1hUd73U_&Key-Pair-Id=APKAJLOHF5GGSLRBV4ZA. Last visited: 28-04-2025.