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The Scandinavian Third Way as a Proposal for Sustainable Smart City Development—A Case Study of Aarhus City

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Abstract: The practical implementation of the goals of smart sustainable cities has different forms. This paper explores an example of the Danish smart city Aarhus, through which the so-called ‘Scandinavian third way’ of smart city development is being proposed. The foundations of the ‘third way’ are directly derived from the Scandinavian tradition of cooperation; it is supposed to be an alternative to the more commercial American model and the more centrally-controlled Asian tradition. The paper aims to identify how the Scandinavian collaborative model has influenced the process of developing the smart city Aarhus, to analyse the proposed ‘Scandinavian third way’ of smart city development, and finally to assess its applicability in other urban centres. To achieve these goals, the method of literature analysis and a case study along with qualitative analysis of existing data and individual in-depth interviews with decision makers and observers of political life were applied. As the results show, the Scandinavian tradition of governance and political decision-making present in Denmark is not without significance for the functioning form of the smart city of Aarhus. Its foundations have been adopted by the Aarhus municipality in the implementation of its smart city activities, creating a unique modern city management model.

Keywords: smart city; smart sustainable city; Scandinavian third way; smart city governance; Aarhus



Citation: Baraniewicz-Kotasińska, S. The Scandinavian Third Way as a Proposal for Sustainable Smart City Development—A Case Study of Aarhus City. *Sustainability* **2022**, *14*, 3495. <https://doi.org/10.3390/su14063495>

Academic Editor:
Mariacristina Roscia

Received: 30 December 2021

Accepted: 14 March 2022

Published: 16 March 2022

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1. Introduction

As indicated in the report entitled Mapping Smart Cities in the EU, among the currently proposed concepts of urban development it is the smart city that has become the dominant direction of contemporary urban development in both Europe as well as globally [1]. The smart city concept as a modern proposal for managing the urban organism in the face of mass urbanisation and climate challenges has gained importance and popularity over the past two decades. It is now emerging as a new paradigm of smart urban development in which modern technologies and socio-economically sustainable growth play a special role [2,3]. On the basis of the smart city concept, attempts are being made to deal with such contemporary urban challenges as, for example, air pollution [4,5] and increased water [6–8] and energy consumption [9–12], as well as waste disposal problems [13,14], traffic problems [15–17], and an increase in crime [18]. Moreover, with the digital means used by smart cities there are growing hopes of strengthening civic control over political urban life and consolidating grassroots democracy; citizens eventually gain access to simple tools by means of which they can participate in decisionmaking processes concerning issues that directly affect their mode and place of life [19]. Thus, smart city activities are supposed to contribute to cost reduction and increase the effectiveness and efficiency of the city’s activity in various fields of its public policies implementation while at the same time taking care of the environment and strengthening the position of city inhabitants. As Gotlib and Olszewski [20] point out, in view of the complexity of processes taking place in modern cities, effective management of urban centres is no longer possible without the appropriate support of advanced technologies.

The emerging modern city governance challenges require new and innovative approaches from those in power to make cities more resilient, sustainable, and safe. The

aspiration to implement actions to achieve that objective is one of the 17 Sustainable Development Goals included in The 2030 Agenda for Sustainable Development [21]. In this sense, the main idea of the smart city concept is the design and implementation of initiatives that will contribute to more efficient and effective functioning of the city and, above all, increase the quality of life of its inhabitants. However, the very concept of a smart city is not self-evident. Based on the analysis of the literature on the subject, four main approaches to the smart city concept can be distinguished, namely, the technocentric, socio-economic, people-oriented, and critical approaches [22]. In the technocentric approach, the smart city concept is understood exclusively through the prism of smart devices and technologies that are supposed to support local governments in managing available resources more wisely, effectively, and efficiently in order to reduce their negative impact on the environment, save energy, and consequently improve the quality of offered services and of inhabitants' lives. It is worth mentioning the definitions of the smart city presented in the works of Barrionuevo, Berrone and Ricart [23], Washburn, Sindhu, et al. [24], Bibri [25], and Yigitcanlar et al. [26]. The socio-economic approach, in addition to emphasising the need to use information and communication technologies (ICTs) in ways that contribute to economic growth and a better quality of life, indicates that urban governance processes should take place in a context of partnerships and cross-sectoral collaborations, influences the development of social capital as well [27–29]. The significance of social participation in smart cities is extensively described in the work of Kapackova et al. [30], Jang and Gim [31], and Lim and Yigitcanlar [32]. The people-oriented view rejects the idea of modern technologies being the key element in terms of smart growth; instead, people's individual and collective needs are emphasised, and the focus is on the essential role of human knowledge and skills in the management process [19,33,34]. Finally, it is worth mentioning the critical approach, which presents a critical or even negative attitude towards the idea of the smart city and in which the smart city itself is perceived as a utopia or dystopia driven mainly by IT corporations [35–37]. Importantly, in each of the affirmative approaches reference is made to the significance of sustainable development, including the achievement of sustainable economic growth. This orientation towards satisfying needs in a way that does not diminish the chances of meeting the needs of future generations means that, increasingly, the word 'sustainable' is being added to the phrase 'smart city' in order "to ensure that 'sustainability' is not overlooked at the expense of fancying ICTs" [38] which are promoted within the smart city framework. According to Elgazzar and El-Gazzar, it was the International Telecommunication Union's focus groups that, after analysing more than 100 smart city definitions, proposed the concept of smart sustainable cities, explaining that it refers to "an innovative city that uses information and communication technologies (ICTs) and other means to improve quality of life, efficiency of urban operations and services, and competitiveness, while ensuring that it meets the needs of present and future generations with respect to economic, social, environmental as well as cultural aspects" [38].

The practical implementation of the goals of smart sustainable cities can take different forms. In the case of American cities, it is popular to form public–private partnerships to implement an innovative smart city project. With the help of IT corporations, local governments try to develop new solutions to urban problems based on advanced technologies and sometimes assign public tasks to these corporations. In this cooperation, the secondary sector provides resources, knowledge, and creative solutions, while the city offers space to develop new innovations, become more familiar with the business processes, and access valuable new data sources. Local governments are keen to use private sector talents and resources to support their problem-solving capacity, as well as for the resulting cost savings. For instance, public–private collaborations are developing smart cities in San Francisco [39], Kansas City [40], New York [41], San Jose [42], and the Lake Nona district of Orlando [43]. In Asian countries, on the other hand, the examples are mostly of building more centrally-controlled smart cities from scratch which, while often being a kind of urban living experiment, are intended to benefit economic growth as well and to become a kind of a technological hub and a model for the development of 'cities of the future'; Sejong,

Songdo, and Cheongna in South Korea [44], the Xiong'an New Area in China [45], and Masdar City in the United Arab Emirates are examples worth mentioning [46].

This paper presents the example of the Danish smart city Aarhus, through which the local authorities wish to propose an approach called the 'Scandinavian third way' to smart city development based on co-governance and co-management between city stakeholders and citizens. Its foundations are directly derived from the Scandinavian traditions of cooperation and participation. As the founders of Smart City Aarhus indicate, this model is an alternative to the more commercial American model and the more centrally-controlled Asian tradition [47]. The aim of this paper is therefore to identify how the Scandinavian collaborative model has influenced the process of developing the smart city in Aarhus as well as to analyse the proposed 'Scandinavian third way' approach to smart city development by city authorities, and finally to assess its applicability in other urban centres.

Aarhus was ranked second in the 2014 European Smart Cities ranking, which compared medium-sized European smart cities [48]. This shows that both the management methods adopted by the government and the implemented smart solutions have been successful in comparison to other European smart cities, and can serve as a point of reference for the creation of smart development strategies for other local governments. The model is therefore worth a thorough analysis, especially as the 'Scandinavian third way' approach to smart city development has not yet been discussed in the scientific literature (although the smart city of Aarhus itself and its technological solutions have been the subject of academic exploration [49–51]). Thus, this paper fills a research gap in the area of current trends in smart city governance and discusses a largely unknown (though well-established in Denmark) alternative model of smart city development. In order to analyse this novel and valuable example, well-known and acknowledged analysis spaces developed by Giffinger et al. were used [52]. This analysis is all the more important as the existing models of smart city development are not-infrequently criticised in the literature.

2. Materials and Methods

Beginning in the 1930s, the Nordic countries have been distinguished as a special case of a political system referred to as the Norwegian or Scandinavian model, although the term itself was introduced into academic discourse in the 1960s and only became popular in political debate in the 1980s [53]. The Scandinavian model can be found in the countries of Denmark, Finland, Iceland, Norway, and Sweden. The term refers to the model solutions adopted by these countries for the development of their economies and democratic institutions as well as their welfare state policy measures, which together have resulted in a very good quality of life and a high level of security in these countries [54]. The explanation of the specificity of developing the smart city concept within such a unique system requires referring to historical elements related to the process of forming, in this case, the relations between local government, business and citizens, in Denmark as well as to axiological and institutional aspects. The exploration of these issues will be based on the method of literature analysis, presented in the first part of the paper. This characterisation will provide a political and social interpretative context for the presentation of a case study of the Danish smart city of Aarhus.

The case study consists of two parts. The objective of the first part is to provide an overview of the institutional context and the implementation strategy of the smart city concept in Aarhus. Both a qualitative analysis of existing data, i.e., materials presented in reports and on the city hall's website and a reactive method in the form of individual in-depth interviews with decision makers in the city and observers of political life are applied. The same methods are used in the second part of the presented case study to identify and characterise specific smart actions implemented by the city of Aarhus. Relevant in this field are the six characteristics of a smart city distinguished by Giffinger et al. [52], namely, smart governance, smart mobility, smart economy, smart environment, smart people, and smart living. As this categorisation has found numerous applications in practice and has

been well substantiated and documented [1,55], it has helped to identify smart projects. In these smart undertakings analyses special attention is paid to the authorities' intentions during the implementation of the projects in question as well as to the private and social partners involved in their development and implementation. The Smart Aarhus website, which collects information and presents smart city achievements, was particularly helpful in identifying smart city investments. Individual in-depth interviews were conducted with a city councillor in order to identify decisionmaking models and smart city governance strategies, with the team leader of the City Lab (Open Data, IoT and Smart City in the Department of Information, Technology and Creativity, a part of the Department of Culture and Citizens' Services) to present smart city governance methods and the techniques and technologies used in co-management processes, and with a retired political scientist with a background in academic research at Aarhus University and in local government administration in order to deepen the contexts explored and to obtain comments on the addressed research questions. The case study was conducted from May to September 2019. The research presented here is intended to contribute to the main objective of the paper, namely, to characterise smart city development within the 'Scandinavian third way' and to assess its applicability in other urban centres. These conclusions are presented in the final part of the paper, and are preceded by a discussion of the main assumptions of smart city development within the model proposed by the city of Aarhus.

3. The Scandinavian Model of Cooperation: The Example of Denmark

Danish democracy developed in the Scandinavian tradition is an example of a system characterised by high activism and a high level of civic participation in public life. Denmark regularly tops rankings of well-being, standard of living, or happiness of residents; in the Numbeo Quality of Life Index by Country 2019, Denmark ranked first [56]; in the Best Countries for Quality of Life, U.S. News and World Report [57], it was second; and in the OECD Better Life Index 2020, which measures life satisfaction, the Danes ranked third [58]. Cultural characteristics such as equality, fairness, and collectivism are considered more important than elitism and individualism.

The Nordic countries are characterised by a long tradition of political democracy based on a high level of public participation and on respect for human rights and law and order. The administration of the Nordic countries is characterised by high transparency, accessibility, openness to citizens, and a consensual decision-making style as well as by a decentralised structure and strong local governments with a high degree of autonomy; local governments are responsible for a significant proportion of public sector services [54].

The origins of Danish local government can be traced back to the 7th–9th centuries. In the territory of contemporary Denmark, there were three provinces with their own assemblies that established laws and elected their authorities. These lands were unified in the 10th century, and the assemblies lost a number of powers to the monarch. Denmark is one of the few countries in Europe with a political system that continues to be based on a constitutional monarchy. The unique nature of government–citizen cooperation in Denmark is often shaped by the community on a bottom-up basis. Social participation, typical of Scandinavian countries, is a popular and long-standing phenomenon [59]. The restoration of state representation in 1831 was an important moment in the formation of both Danish self-government and Danish democracy. The provincial assemblies of the time were composed of representatives of all estates, including peasants, who were thus incorporated into the political life of the country. Interestingly, it was the bourgeoisie that demanded the implementation of the local government idea from the royal administration, which was of great importance for the development of local communities. As a result, in 1837 Denmark passed its first municipality law to provide local communities with limited legally-guaranteed powers [60].

The core of public participation is broad participation of the community in various areas of political, economic, and social life, with the aim of promoting economic efficiency, improving the ability of communities to manage their own problems, and enriching and

equalising the living conditions of families and individuals [61]. Citizen–government cooperation has been strengthened in Scandinavia for centuries. As early as in the 16th and 17th centuries relations based on equality were developed, for example, in the interaction between the municipal self-government organised by citizens and the powerful centralised states of the time [62].

As the Scandinavians moved from agricultural to post-industrial societies, their scope of political participation expanded. Kubka [62], who discusses this issue extensively in his book *Models of Democracy in Scandinavia*, writes that “the high level of political mobilisation of citizens is one of the most important historically shaped ‘anchors’ of Scandinavian democracy”. He adds that although the political activation of society in the last decades of the 19th century was based on class divisions, it affected all classes and social groups equally, which was reflected in their respective high levels of political participation. Moreover, citizens at different levels of social organisation, both local and national, were able to participate in politics and the level of social equality was effectively increased. By the beginning of the twentieth century, Denmark had already established a strong institutional basis for democracy in the form of “universal suffrage, political parties and parliaments endowed with real power to control the activity of governments” [62].

It is in the specific relationship between an individual and a social group as developed in the course of shaping the above-mentioned foundations that Kubka [62] finds the genesis of Scandinavian social egalitarianism: “it has always been based on the conviction that a high level of individual activity is the best guarantee that deficiencies in individual resources will be compensated by collective, organised action. Thus, this egalitarianism of political participation led to the development of the principles of collectivism and the strong rooting of a collective style of action in the political sphere”. Moreover, as a result of transformations related to industrialisation and social modernisation, social democratic parties began to gain a dominant and eventually a hegemonic position in Denmark. The long time in which they were in power and during which they insisted on building and extending democratic principles in all spheres of social life additionally influenced the rooting of social democratic ideas in everyday Danish socio-political life.

The uniqueness of the Scandinavian model of cooperation additionally stems from the professed ideas, values, and beliefs in which equality, community, and solidarity play a fundamental role. Within the framework of these values, societies are held to develop through the confrontation of the ideas of various groups, usually leading to compromises and good solutions [63]. This was the effect, among other things, of social democratic beliefs, according to which politics involves the division of certain resources and acceptance of the principles and results of this division. This involves the rejection of the use of violence in the pursuit of political goals as well as the possibility of legitimising power on the grounds of possessing certain material resources; power was to be legitimised on the basis of democratic decisionmaking processes in which an important element was the inclusion of the working classes in political life, which gained a chance to equally “develop the methods, forms and content of social life” [62].

Developed under such conditions, democracy took a form in which “collective life and its manifestations are seen from the perspective of the ordinary citizen rooted in their everyday individual existence”. This has become a way of life that defines the rules by which individuals coexist with other individuals and groups in both private relations and interactions at the local and national level. As Strømsnes [64] observes, the individual’s central position in democratic processes has brought about a change in the civic attitudes of the Scandinavians. They are characterised by a more individualistic and direct involvement which goes beyond the traditional forms of political civic activity associated mainly with activity in parties or social organisations. Currently, this takes the form of, among other things, direct contacts with officials and politicians as well as the use of economic measures for political influence. This ‘politicised consumption’ is manifested in the discontinuation of purchasing of goods which, in the opinion of an individual, do not meet ethical and

environmental standards, as well as in the increased purchasing of goods with production methods in line with their beliefs.

Modern science and technological progress have not been insignificant in the formation of Danish socio-economic traditions and values over the course of state development. Such progress has served to improve public services, including at the local level, and strengthen the level of public participation. Local governments take advantage of the frequent online presence of citizens to extend e-governance practices, and thus involve them in governance processes. To this end, they spend their budgets both on developing information on the Internet and on communicating and handling matters virtually. Several municipalities are experimenting with citizen IT panels, allowing citizens to participate in local governance created for people who cannot participate in meetings and political work due to work and family reasons. This solution ensures that these groups do not have to feel excluded from political debates; thanks to such panels, they can participate in debates regardless of their location and time [59]. Smart city solutions are used to improve the level of public involvement. This works in two ways; the municipality creates opportunities, and the community has more and more tools tailored to their needs, and is willing to use them. The main features of the Scandinavian model described here are presented in the Table 1.

Table 1. The characteristics of the Scandinavian model of governance.

The Characteristics of the Scandinavian Model of Governance	
•	Respect for human rights and the rule of law
•	Social egalitarianism
•	High transparency and accessibility of public administration for citizens
•	A consensual decisionmaking style
•	Great autonomy in local self-government
•	High level of activism and civic participation in public life
•	Respect for social democratic ideas such as equality, justice, collectivism, and solidarity
•	Perception of collective life through the prism of the individual

4. Results

Aarhus, founded as a fortified Viking settlement in the 8th century, is considered one of the oldest cities in Scandinavia. Aarhus is Denmark's second-largest city. It has an area of 91 km² and a population of over 273,000 as of 1 January 2018. Aarhus is the seat of the Aarhus Municipality (Aarhus Kommune), which has more than 340,000 inhabitants [65]. Although 'old at heart', Aarhus is called 'young in spirit'; with over 40,000 students and over 48,000 people under the age of 18, it is demographically Denmark's youngest city. The young population of Aarhus, which has grown dynamically since the second half of the 20th century, has contributed to an increase in creativity in the region. The city has entered a period of rapid economic growth in which services play an increasingly important role. It has developed a strong community of cutting-edge high-tech and creative sector companies, research and development departments of leading international technology companies including Google, Uber, and eBay, and a group of more than 20,000 professionals in the field of the Internet of Things, Big Data, Data Science, and similar fields. As Smart Aarhus points out, this has resulted (among other things) in a "rich ecosystem of startups", of which, for example, Startup Geast ("Airbnb for meeting rooms") has been acquired by Airbnb itself [66].

In the 2014 European Smart Cities ranking comparing medium-sized European smart cities (with a population of 100,000 to 500,000), Aarhus was ranked second [48]. The favourable conditions created by the Danish government for cities to implement smart city measures were of significance for this success. Denmark is a highly digitalised country. The country's digitalisation strategy, which aimed to create a smarter public sector, was already established in 2001. It included initiatives related to strengthening e-administration, primarily in terms of digitising methods of communication between public authorities and citizens and achieving digital integration of individual public institutions, as well as the

e-health sector [67]. In 2012, Denmark ranked second in the EU in terms of broadband penetration [67] and was declared by the UN as the fourth most-developed country in the world in terms of e-governance, thus leading the way in the number of existing online interactions between citizens and public authorities [68]. The fact that Danish citizens were among the most frequent users of the internet, social media, and smartphones was used by Danish authorities to transfer communication with residents from paper to electronic form in 2014 [50].

Political power in Aarhus is exercised by a city management board, which is responsible for implementing decisions made by the city council. The board is represented by a mayor, five councillors who chair the city magistrates, and three councillors “without portfolio”. Jacob Bundsgaard, a Social Democrat, has held the office of mayor from 2010. The concept of the Aarhus smart city is based on cooperation between the public and private sectors as well as the non-governmental sector. The knowledge of the scientific sector and the opinions of the citizens are important in smart investments, which stems from the very understanding of the term ‘smart city’. Martin Brynskov, a member of the Smart Aarhus Secretariat, a cross-sectoral organisation undertaking smart city activities in the city, explains that the term refers to both cities and communities that acquire digital solutions on a common technical basis and that have an organisational structure that enables residents to engage in innovative ecosystems to increase sustainability, prosperity, and durability [69].

The city formed a partnership to implement smart city activities back in 2012. Smart Aarhus is represented by the city as well as by other public institutions, research, and business centres. In addition to the city, the Smart Aarhus group includes the Region of Central Denmark, Aarhus University, Alexandra Institute, VIA University College, It-Forum, and the Danish Institute of Technology, as well as representatives from the business sector, Creuna and Systematic [47]. Through its activities, Smart Aarhus engages many other public institutions and companies as well as citizens to cooperate. Interestingly, Smart Aarhus began as a grassroots initiative which was born when a few employees of the Alexandra Institute (a private non-profit company that helps public and private organisations to develop innovations based on IT products and services) and Aarhus University met with several managers and directors interested in digital technologies; the idea was enthusiastically received by the city and subsequently put into practice.

Coming from different backgrounds, the founders of the Smart Aarhus idea focused on both technical and humanistic issues when developing the Smart Aarhus operating principles. Smart Aarhus calls itself a “digital marketplace, creating value to address social, environmental and economic challenges” [70], and its operating model is based on engaging stakeholders to work together through partnerships. Partnership-based collaboration between the city, the public, and the non-governmental and private sectors as well as universities and citizens represents a way for Smart Aarhus to combine efforts to find joint effective and sustainable solutions to the challenges faced by modern cities. In this formula, Smart Aarhus has the ambition to become the leading international Scandinavian urban development model. Furthermore, the activities of Smart Aarhus are guided by two objectives:

- (1) solving or addressing social challenges related to, among other things, insufficient resources; and
- (2) consolidating the digital economy and creating jobs.

To be able to accomplish its objectives, Smart Aarhus questions the traditional roles of citizens, the public sector, and private companies and creates a new framework for the functioning of urban collaboration. It states that “we need to create a new way of collaborating and creating public services that involve the public sector, citizens and the business community. Citizens and businesses must accept a higher level of responsibility. The public sector must create the best possible framework for this collaboration, for example by making data available to the public” [47]. In view of the above, it puts emphasis on openness and stakeholder’s involvement in its projects. “Being experimental through pilot projects” should be helpful in the achievement of its goals as well; it wants to act fast, take

risks, introduce changes, and thus develop in a smarter way [47]. Smart Aarhus sees digital technologies as both a challenge and a way to develop the city of the future.

As the Smart Aarhus organisational model is based on collaboration, it has abandoned a hierarchical management system in favour of a steering committee. It is composed of key representatives of city stakeholders, including representatives of the local business community, research institutions, and municipalities. The steering committee provides the organisation with general guidance on the development and needs of the city. Its daily tasks are handled by a secretariat represented by the local government and its leading stakeholders; however, no entity has formal managerial authority. The role of the secretariat is to bring together stakeholders interested in cooperating within a smart city and to enable them to take action on a voluntary initiative basis. The key element in the structure of Smart Aarhus is the working group. These can be established by anyone interested in taking action to improve the city's functioning. Such a person is responsible for engaging the team in action. Groups with similar initiatives are merged or coordinated in the name of the philosophy of "we look for solutions together, we do not compete with each other" [50].

In addition to its own activities, Smart Aarhus is willing to brand smart growth initiatives of external organisations as long as their product or service is in line with the Smart Aarhus principles. In such cases, it allows them to use the Smart Aarhus emblem of Made with Aarhus, indicating that the organisation uses a cross-sector partnership model when making particular investments, involves stakeholders, and aims to make the city more liveable and sustainable [50]. In this way, Smart Aarhus aspires to represent the 'Scandinavian third way' of smart city development based on collaboration with stakeholders and citizens, as an alternative to the more commercial American model and the more centrally-controlled Asian tradition [47]. The subsequent part is an analysis of the manner in which it is carried out, with reference to the six dimensions of smart city functioning developed by Giffinger's team and described in detail in the European Parliament's report as a category combining the elements that make up a smart city. These include smart governance (e.g., initiatives making it possible to manage the city in a manner connecting and integrating public, private, and social organisations and involving cooperation with other metropolises, taking up inter-operational activities based on the analysis of data acquired from the city space and opening access to them, and using e-administration in decisionmaking or e-service processes), smart economy (supporting e-business, e-commerce, and digital entrepreneurship, creating conditions for the development of innovation, new business models, smart clusters, etc.), smart mobility (ICT-enabled integration of various means of transport both urban and individual, creating transport logistics systems, and supporting clean, safe, sustainable transport), smart environment (a category gathering initiatives related to smart energy, measurement, control and monitoring of pollution, promotion of environmentally-friendly buildings and green urban planning as well as sustainable use of resources through smart lighting and smart waste and water management), smart people (e-skills, working in an ICT-supported environment, access to education and training, openness, participation in city life) and smart living (a reference to a certain lifestyle, ICT-based behaviour, and consumption as well as healthy living, good-quality housing and living conditions, safety, and access to a variety of cultural attractions). In this approach, multidimensional strategies are the most valuable as they allow the implementation of many synergistic and supporting projects from different areas into the city space.

4.1. Smart Governance

The most valuable resource in the technological sphere of the smart city is data. Data provide the necessary information about what is happening to the city and allow for forecasting. The head of the City Lab explains that data collected from the Aarhus space are primarily used as a tool to support the decisionmaking process. He considers the main benefit of such a solution to be the fact that the analysis and visualisation of data obtained through smart technology allow authorities and managers to make decisions on the basis of

facts rather than intuition. He admits that this is extremely helpful for the local government in terms of making the right choices.

It was emphasised that, for Aarhus, providing open access to large amounts of data from public institutions, educational institutions, and companies is the basis for creating a smart city. The first open data access platform (and the first in Denmark in general), Open Data Aarhus (ODAA), was launched by the city government in 2013. The aim of ODAA is to “promote democracy, transparency and growth” [71]. All interested parties, including entrepreneurs, can use the data as raw material to create their own services, initiatives, applications, analyses, or new businesses. ODAA is the main project developed within the Smart Aarhus initiatives. In addition to collecting relevant data sets, it creates standards that allow for easy and secure use of data. ODAA’s activity is based on engaging stakeholders to work together. The platform supports working groups consisting of citizens from the municipality of Aarhus and the Central Denmark Region, students and researchers from Aarhus University, and representatives from organisations and companies such as the Alexandra Institute, IBM, and Creuna. In doing this, it promotes the implementation of joint projects and the expansion of opportunities to use data to address specific problems and improve urban services. Importantly, the ODAA in cooperation with the Central Denmark Region is the initiator of the Open Data Denmark network, initiating cooperation in data sharing between the largest cities in the country and the Central Denmark Region. Open Data Denmark promotes the interests of open data on the national agenda while working on a common platform for the use of open data. The aim is also to make it easier for smaller municipalities to start working with open data. ODAA has joined the international collaboration of Open and Agile Smart Cities, which focuses on creating common open data sharing standards.

In order to standardise the large amount of data from smart systems and above all to be able to use them in real time and make decisions based on them in management processes, the city is participating in the three-year EU IoT Crawler programme. Launched in January 2018, this programme attempts to address the biggest smart city challenges related to working with real-time data. The first of these challenges concerns the difficulty of linking and standardising data from different sources, while the second addresses the fact that data cannot always be applied in terms of individual solutions. Through IoT Crawler, Aarhus is exploring how data collected from city spaces can be applied to new smart city services for the benefit of citizens and the local government. The programme enables the testing of the developed solutions. The requirements concerning the application of the technologies developed in the projects are defined by the local government in cooperation with citizens, city stakeholders, and other entities involved in the development of the Internet of Things [72]. In this project, the Municipality of Aarhus is partnered by, among others, Aarhus University and foreign partners such as the University of Surrey (UK), University of Murcia (Spain), Siemens Aktiengesellschaft Oesterreich (Austria), and Digital Worx GmbH (Germany) [73]. The programme is intended to support data analysis and visualisation along with the development of semantic tools to make data readable by computers, enabling the creation of real-time applications to improve the functioning of the smart city and its management.

As far as Aarhus’ resources allow, the municipality tries to use open source software that does not have a built-in tracking and advertising layer, thus limiting the outsourcing popular in the ‘American model’. This is intended to ensure greater security and control over the processed data, and to avoid forcing citizens to use the services of a particular private corporation. At the same time, however, it recognises that commercial providers, as a highly creative, intelligent, and innovative sector with many good solutions to offer. For this reason, the local government is keen to cooperate with corporations in various smart city projects. The City Lab: Open Data, IoT and Smart City team leader emphasises: “we attempt to have a holistic view of these kinds of big platforms and their providers to make sure that citizens’ needs are satisfied first of all”. Thus, he criticises the close collaboration between the Toronto city government and corporations in the construction of the “city of

the future”, during which, he says, citizens and their privacy as well as the correct and ethical way to collect, store, and use data were disregarded. He does not believe that the relationship between big companies and the city should be as close. In this sense, he prefers the Nordic approach in which the city tries to encourage corporations to pursue joint projects while at the same time preventing them from managing the city within a given technology or infrastructure. For this reason, Aarhus works on open data as well as on its own sources and software. In 2014, it launched an action plan called ‘Open Source’ to promote initiatives increasing the use of open source and standards software. This is important because the use of smart city solutions often leads to the need to collaborate with different companies, and licenses purchased from them often prevent compatibility and interoperability with software used in the city systems. Aarhus has therefore decided that it needs software in the form of modular components that can be easily combined, if necessary; in this way, the municipality wants to be free from being blocked by IT suppliers and thereby ensure the city’s interoperability. This work on open digital solutions creates conditions for the development of a new manner of urban operations in which the functionality of the system will be defined by the actual needs of the city authorities and its residents, not by commercial interests.

In this way, the authorities attach increasing importance to ensuring that all data generated by the city smart systems are owned by the city, even if the systems are operated by commercial providers. While the municipality of Aarhus recognises and appreciates the power of corporations in the smart city market, at the same time it looks for solutions that, wherever possible, help it to be an independent leader managing the city’s technological infrastructure. For this reason, it is the municipal office that houses the department that manages data collected in Aarhus, and its analysis is handled by government officials rather than corporations. Thus, the city is able to ensure increased safety of the information systems as well as to better tailor their functioning to its needs.

As the head of the City Lab explains, the office is evolving as a result of the expansion of city management tools and methods. It is becoming more akin to a large IT company, in that employees use different IT devices and technology, information technology is an essential tool for all of them to do their jobs, and for many it is their main area of work. The city councillor stresses that this new reality forces the administration to update its methods of organising the office. In addition to departments established to manage the open data, IoT, and smart city infrastructure, the Aarhus City office has created an internal innovation unit called the Centre for Innovation in Aarhus, or CFIA. It is responsible for implementing day-to-day improvements for the citizens of Aarhus, including new solutions in the field of social welfare, and is a place for consultation on innovation projects for all office departments. “We believe that the best solutions come from collaboration among institutions, professionals, and citizens—by engaging and co-creating with the relevant stakeholders”, reads a statement on the website of the agency, which employs architects, designers and anthropologists. To create innovative solutions, CFIA has adopted design thinking, prototyping, business development and civic design methods. These new management methods are designed to enable staff to take a non-standard approach to solving urban problems and undertake collaborative teamwork. Their application is the result of adapting to the contemporary reality based on data, information, technologies, and networks. All projects undertaken by the CFIA place human development at the centre, as this solution “is the most effective way to create value in the public sector”. The institution was established as part of the local authority’s broader strategy called Innovation in Aarhus—new paths to welfare and growth. The CFIA is located close to the city centre, which, it points out, ensures close interaction with citizens [74].

4.2. Smart Environment

Beginning in 2007, Aarhus Municipality has taken an active role in climate protection. The climate initiative established by the city at that time aimed to combine sustainable urban development with economic growth. On this basis, Aarhus has developed a number

of projects to optimise energy consumption and reduce carbon emissions. The city focuses on engaging businesses and citizens, because as it points out, “they account for 75% of total CO₂ emissions” [75]. Furthermore, beginning in 2012, Aarhus has established more than forty strategic climate partnerships with private companies. In this way, it wants to combine joint efforts for climate and economic growth. This is done, among other things, through the organisation Go Green with Aarhus, which focuses on developing the city towards ‘green and blue’, i.e., using energy efficiently in innovative partnerships. Individual departments such as the Technical Services and Environment Department, Aarhus Water, and Department of Waste and Heating cooperate with both local and international companies and research institutions to develop solutions in the provision of public services ensuring better environmental protection and resource saving. One of the tasks of Go Green with Aarhus is to educate and change the behaviours of the public in order to be more environmentally friendly. Children and young people are invited to develop sustainable solutions; they are taught how social behaviour, consumption, and technology create climate challenges, as well as that cooperation and responsibility in addressing local and global problems matter.

The city has switched from coal to biomass, which has enabled it to produce heat and energy with significantly lower CO₂ emissions; the 2017 indexes decreased to less than a third of the 2016 values [76]. In 2016, Aarhus launched a total of around 3100 photovoltaic installations, increasing the share of renewable energy sources in energy production; Aarhus already has twenty wind turbines. By 2030, Aarhus wants to introduce wind power into the heating system, thereby reducing dependence on biofuels [50].

In 2018, the local government replaced mercury fixtures in 29,000 street lamps with more environmentally-friendly LED technology as part of the LED Street Lights project, intended to reduce electricity consumption by 30%. The stronger light output is expected to guarantee greater traffic safety. This investment is an important step towards the accomplishment of Aarhus’ climate ambition of becoming a carbon neutral city by 2030.

It is becoming increasingly important for the city to collect, analyse, and use data concerning energy production and consumption in order to better manage its energy consumption [77]. Ways in which new technologies can support the transition to a greener, more resource-efficient economy is being explored by the city directly in residential buildings through the EU-supported READY project. Interestingly, data from 5000 metering points installed in municipal buildings have been made available to schools in Aarhus for educational purposes, both to analyse energy consumption in individual buildings and to make young people aware of existing climate challenges [78].

Energy saving is implemented by Aarhus in another dimension; Aarhus was one of the first cities in the world to establish a so-called narrowband network covering the entire municipality. The network is based on the open LoRaWAN standard belonging to the Low Power Wide Area Network solution, which makes it possible to send small data packages over distances of up to 15 km with very low energy consumption; this is used in systems that enable communication between Internet of Things devices. It has provided the municipality with completely new opportunities to use long-life sensors in rooms, buildings, fixtures, and vehicles to send data independently to the city’s smart systems. The success of this implementation is attributed to Smart Aarhus, which has expanded the city’s ability to use new technologies and at the same time to engage citizens in collective action [79]. The new network has wide applications in all areas of the city’s operations, including traffic measurement and optimisation, parking, telemedicine, renovation, and even alerting city services that trees are absorbing too much salt. One of the first applications of the network was to detect unexpected temperature fluctuations in municipal heating wells in order to prevent leaks and cracks in the pipes.

4.3. Smart Mobility

Between 2014 and 2016, Aarhus implemented a Smart Mobility project to address the growing urban traffic congestion caused by urban sprawl. Through the Smart Mobility

Project, the local authority primarily wanted to influence the behaviour of traffic users by implementing a series of cheaper solutions on a smaller and thus faster scale than long-term infrastructure projects. A user-oriented model was adopted in implementing the individual tasks, and solutions were developed on the basis of citizens' everyday experiences. The project's premise was to change road habits using soft instruments. In order to do this, the general behaviour of traffic users was monitored and, on the basis of research and consultations, mobility problems in the city were adequately addressed. Direct cooperation with traffic users was helpful in diagnosing needs. Using an anthropological method the municipality of Aarhus focused on several target groups, selecting them to ensure a diversity of cases in terms of their place of residence, access to transport, age, living situation, and mode of transport. One of the groups under analysis was students, because, as the city points out, they are the road users of the future and thus it was important to find out when young people in Aarhus buy their first car and how their mobility habits are formed. While the city did not organise any campaigns, it was in direct contact with volunteers. The implementation of new solutions based on cultural research was the effect of the city's desire to understand the complexity of Aarhus citizens' everyday lives, which should be facilitated rather than complicated by transport [80]. The implementation of the project is expected to reduce the costs of large future infrastructure investments that are to be carried out more accurately and, above all, to involve the more conscious use of transport.

These activities have been used, for example, to develop (in cooperation with the Alexandra Research Institute) a prototype for the Opture service designed to connect commuters in order to reduce the number of single-occupancy car trips on the road [81]. As part of the Smart Mobility initiative, the city launched the a 'bike library' programme several times between 2015 and 2018. During this time, residents were able to borrow and test for free various types of bicycles (electric, cargo, ultralight, folding, or bikes with trailers) in order to find the best possible type of bike for both everyday use (primarily for commuting) and recreational purposes [82].

The city began to promote cycling on a larger scale in 2009 with the launch of the Aarhus Bicycle City programme. Within the framework of this programme, the local government undertook initiatives to build the necessary cycling infrastructure and gathered a group of ambassadors from among the city's citizens whose actions were supposed to encourage other residents to switch to bicycles. In 2015, 37% of Aarhus population used this mode of transport daily, and 48% used it to commute to work [83].

More bikes on the road, however, simultaneously requires more parking spaces for cyclists. The city has built terminals resembling parcel machines [84] which make it possible to store bicycles in a safe place, and a large car park with two-storey Bike and Park racks has been built at the main train station. With regard to parking, it is worth mentioning the automated car park set up near the city centre in the Dokk1 building as, among other things, a solution to the problem of cars roaming the streets in search of parking spaces, which increases air pollution. In this solution, rather than leaving their vehicle in a car park, the driver takes it to a special lift that automatically transports and parks the car underground without human intervention. This helps to save residents the time they would have spent finding a parking space. The car park can accommodate 1000 cars, and is the largest automated car park in Europe [85].

In order to develop automated systems that can be used in transport (as well as in agriculture and environmental monitoring) through automated vehicles, machines, drones, or marine units, the city has implemented the TAPAS programme (Testbed in Aarhus for Precision Positioning and Autonomous Systems). TAPAS is a science and research project aimed at verifying to what extent improved infrastructure can contribute to taking full advantage of the technical achievements of the new Global Navigation Satellite Systems (GNSS). Geodetic reference systems are the fundamental infrastructure that provides the basis for precision positioning and navigation using GNSS. GNSS is expected to enable faster and much more accurate positioning in real time, thereby improving smart city

operations and management [86]. Aarhus Municipality is developing the network in close cooperation with GNSS experts from DTU Space, Denmark's National Space Institute. The network is open to third parties, allowing them to test their own ideas and innovative technology prototypes.

4.4. Smart Economy

The development of the information technology sector has become a priority for Aarhus in terms of economic growth, as reflected in the presence of companies such as IBM, Google, and VMware in the city. About twenty years ago, the Danish government provided funds to the regions to implement innovative activities on the condition that these be financed from both public and private sources. The city of Aarhus together with Aarhus University allocated their funds to create the aforementioned Alexandra Institute, currently one of the nine most advanced technology institutes in the country. The Alexandra Institute develops user-centred IT solutions and collaborates with IT companies, including Google [50].

In order to support economic growth, Aarhus has established the IT City of Katrinebjerg, a 150,000 m² urban district near the city centre and the university campus where the city conducts IT research and business activities in cooperation with the private sector and the university. It is here that Aarhus University has relocated all of its IT-related units and research centres. One of them is the Centre for Digital Urban Living, which focuses on new forms of urban living enabled by digital technologies.

As Smart Aarhus points out, "IT City Katrinebjerg has for 20 years been the most dynamic IT innovation environment in Denmark with 350 employers, 2500 students and 20,000 IT professionals (. . .). In Katrinebjerg, world-class innovation is created between science, education and business" [87]. The Katrinebjerg network comprises more than 100 organisations and research institutes, for instance Mjølner Informatics, Redia, Bookbite, Partisia, Scalgo, and the Danish division of Google. Together with Aarhus University they work on developing IT research and turning them into innovative projects, as well as on creating new IT-based products and services. As the city's knowledge base is not located at the university but in the private sector economy (in the IT sector, 90% of innovations are made by private entities and only 10% by universities and public research institutes), the IT City of Katrinebjerg supports the development of intensive relationships between businesses and the city's research institutes, and thus encourages more IT companies to move to Aarhus [88].

To test innovative smart city solutions developed in Aarhus, the local government has established the Aarhus City Lab. The lab enables both the city and its partners to undertake research and develop new programmes and projects directly in the urban environment. The centres are intended to test solutions in a smaller area before their overall application, and make it possible to work on innovative solutions and technologies at an early stage of development. In this way, Smart Aarhus tests various types of smart infrastructures, including WiFi networks, 5G, and LoRaWAN or precision positioning technologies. Priority areas here include projects in the fields of communication, mobility, and waste management as well as digital art and culture. Projects implemented within the Aarhus City Lab include the IoT Crawler, TAPAS, and Open Data DK, described above. One of the main tasks of the City Lab is to initiate dialogue between citizens, businesses and the city. As part of this initiative, Smart Aarhus engages in cooperation with local SMEs, start-ups, knowledge institutions, and other partners. As pointed out, for them the Aarhus City Lab becomes an opportunity to promote themselves by showing and testing their ideas. On the other hand, the opportunity to operate in a real urban environment facilitates the acquisition of knowledge and expertise. It is the city's ambition that projects within the Aarhus City Lab be undertaken by different actors, simultaneously supporting the city's development and being able to be implemented and commercialised. For this reason, Smart Aarhus promotes national and international cooperation between cities and regions; the Smart Aarhus Secretariat plays a leading role in coordinating the activities of the Danish Smart City

Network and the Connected Smart Cities network, which provide international forums for smart city solutions. This position confirms Aarhus' experience in implementing initiatives and good practices within the Smart Cities concept.

4.5. Smart Life

Important projects aimed at improving the quality of life by means of innovative technological solutions take place in the health and welfare sector in Aarhus. One such example is the CareWare innovation and collaboration platform. CareWare, initiated by Aarhus in 2010 in the form of a conference, provides a place for dialogue for the development and implementation of new technologies in the field of health services. It is part of the city's strategy to strengthen cooperation among the municipality and companies, research institutions, educational programmes, and public institutions interested in health both in Denmark and abroad. The CareWare project supports research on technological developments oriented towards supporting the health and independence of citizens, a better working environment, and increased efficiency in the health and social care sector, especially in the care of the elderly and people with disabilities [89].

A place that requires special attention from the city in terms of improving the quality of life and especially housing conditions is the Gellerup neighbourhood. As the interviewed political scientist claims, it is inhabited by people of 85 different nationalities. Many of its inhabitants have been charged with various crimes. The district was developed at the turn of the 1960s and 1970s within the framework of the 'Gellerup Plan' as an answer to an urgent housing problem in the city. The development, inspired by Le Corbusier's functionalist ideas, provided Aarhus with almost 2500 new flats. Built from prefabricated concrete slabs, however, the buildings soon required costly reconstruction and repairs. Originally slated for demolition, they eventually underwent minor renovations. The flats vacated by resettling citizens found new tenants, mainly immigrants and socially disadvantaged people. This led to increased social degradation of the area and growth in criminality. In 2014, 80% of the population in the residential area of Gellerupparken were either migrants or their descendants from non-Western countries. Over 52% of them were unemployed, and almost 4.8% had criminal records. Only 57.1% of people aged 30–59 had a primary education [90]. Gellerupparken is currently the poorest neighbourhood in Denmark.

In response to these pressing problems, the local government created the Masterplan Gellerup project. Its aim is to transform a "particularly sensitive residential area" into an attractive urban area. The city decided on an "innovative approach" that would combine changes to the physical environment with initiatives supporting the establishment of new jobs, businesses, cultural venues, and increased safety. The Gellerup Masterplan project is spread over twenty years and is expected to be completed in 2030. It is being carried out in cooperation with the Brabrand Boligforening housing cooperative and the city of Aarhus, and is co-financed by, among other entities, the Danish Ministry of Social Affairs. Local stakeholders and residents are involved in the project as well, and their suggestions are the basis for the implementation of individual investments.

Aarhus wants to support quality of life in the city by means of drones. It believes in their great potential to be used for public purposes, e.g., to monitor construction sites, conduct quality checks in inaccessible places, and perform tasks in the event of emergencies. The drone application and development project is promoted by Smart Aarhus as part of the SmartDrones initiative, which has been in operation since 2015. As the organisation indicates, "the use of drones is a logical choice to support Aarhus as a smart city", and can rationalise the handling of tasks, thus saving resources and above all expanding the range of services performed [91]. SmartDrones Aarhus offers specific services, from common ones such as recording videos and taking pictures to traffic control, measuring pollution, and collecting and storing data, and plans to soon begin measuring heat and identifying energy losses from buildings. SmartDrones is intended to help city departments begin practical testing and to identify opportunities for drone use. SmartDrones has signed a cooperation agreement with the fire service to strengthen the use of drones in emergency

situations. The drones are to be used, among other things, to inspect a fire outbreak and reach places inaccessible to people. It is noteworthy that Aarhus shares its experience in using drones for public tasks with other municipalities.

4.6. Smart People

The percentage of employees with a higher education in Aarhus is twice as high as the national average. Aarhus has ten universities with a total of around 40,000 students, the highest number in the whole of Denmark. The city's largest university, Aarhus University, is in the top 100 universities in the world and top 20 in Europe. In such an environment, the city seeks to build a civil society and encourage citizens to participate in the co-management of the city.

In order to improve residents' dialogue with the local government, in 2014 the city initiated the Digital Neighbourhood project (in Danish: Digitale Bydele). The project served to explore how, through digital media, the public sector could achieve civic engagement in the development of the city and its services. To this end, the Digital Neighbourhood uses different types of communication and data visualisation methods to gain an overview of the opinions of the municipality's residents on specific policies as well as to involve them in the decisionmaking process. In one pilot project, the local government placed digital installations in several neighbourhoods of the municipality with different spatial and socio-demographic patterns, in the form of a traditional telephone booth equipped with a telephone handset, keypad, and screen. The combination of an analogue solution and a digital one was intended to encourage both younger and older people to participate in the project. The installation required users to pick up the phone and follow on-screen instructions to answer questions about their needs and ideas concerning development in their local community. Responses were recorded, transcribed, categorised, and published on the project website [92]. During the pilot phase, the city received 150 ideas from 'callers'. These were categorised, and the city selected ten specific projects which were then illustrated and estimated in terms of the financial resources and manpower necessary to carry them out; the implementation of the ideas was to be handled by residents themselves. For this purpose, a Facebook group was established for each neighbourhood initiative to enable those involved to discuss and promote them, as the next step was voting for the projects. Votes were cast in phone boxes using coded tokens that each resident received. These allowed the city to identify more and less active neighbourhoods. The municipality said that through this project it had gained knowledge about the needs of the inhabitants and successful forms of cooperation and broadened its outlook on how future urban development projects might look [93]. Digitale Bydele is the result of cooperation between the Citizen Service Centre (in Danish: Borgerservice) at Aarhus City Hall and the Alexandra Institute. The projects that received funding were implemented in cooperation with citizens.

The municipality has dedicated the Dokk1 building, a smart interactive urban centre built in 2015 and located on the city's waterfront, to all those seeking knowledge, inspiration, and a sense of community. Dokk1 houses, among other things, the city's main library and *Borgerservice*. The building is suited to organising a range of cultural and social activities and networking; there are a number of projection rooms and study rooms as well as playgrounds there. Dokk1 serves as a meeting place for Smart Aarhus organisations. The centre aims to address the growing public need for lifelong learning and to provide access to new technologies and media. Dokk1 collects statistical data on the building's users via installed sensors. They collect anonymous data from mobile phones and computers via Bluetooth and WiFi, and the data are additionally encrypted for further analysis. The strategic goal is to gain factual knowledge about citizens' use of the library premises, allowing the centre's operations to be adapted in terms of opening hours, programmes and services, and interior design in order to meet the needs of its users. A team of researchers including anthropologists and participants from other public libraries and research institutions in Denmark and abroad has worked on the Smart Library project. Designed as an urban space than as a 'library of the future', Dokk1 is the largest building investment the local

authority has undertaken thus far. Integrating various services in a single building will facilitate relations between residents and the city, as Dokk1 houses most of the departments serving the public as well as the Innovation Centre. Dokk1 aims to foster democracy and strengthen communities by creating spaces for cooperation and personal development.

It is worth mentioning that the city promotes cultural initiatives based on new technologies that aim to raise knowledge and awareness of certain social problems and challenges. An example of such projects is the digital exhibition 'Sleep in the City', through which its authors, Virgile Novarina and Walid Breidi, invited the public to reflect on the importance of sleep in urban life and the surrounding environment. City residents were invited to participate in the event; volunteers were asked to record short videos showing their favourite places in Aarhus during the day, while others were engaged as part of the performance to sleep wearing armbands that measured their brainwaves. The recorded videos were transformed on the city's LED screens into the form of dream images based on the brainwaves received from the city's sleeping residents, and the unique videos were screened during the 2019 Internet of Things Festival in June. Thus, art was combined with city spaces, participation, and new technologies.

5. Discussion

The above analysis of smart city activities shows that Aarhus has indeed developed some form of smart city governance model. "We wanted to find a third, indirect way so that we as a city could cooperate with businesses, of course, but also do it on our terms and make sure that the needs of our citizens are in fact the basis of all implemented solutions", explains the head of the City Lab team. This Scandinavian model is meant to stand in opposition to those typical of the United States and Asian countries. In fact, the need to involve residents in the joint management of the city as well as to identify their opinions on given policies and solutions has been emphasised in almost every smart city project.

Through cross-sector collaboration, which is the basis of the Scandinavian 'third way', Smart Aarhus wants to better manage the effort and achieve more efficient and sustainable solutions to the challenges the city faces. This unique approach to cross-sector collaboration and public participation is highlighted in the way in which Smart Aarhus operates. The structure of the partnership established to implement smart city actions has the form of a network; there is no hierarchical structure, rather, a steering committee is composed of representatives of different stakeholders of the city and the local government. However, none of the representatives has a leading role. The aim is to enable the members to take action on an equal footing, allowing the confrontation of their ideas to contribute to social compromises and better solutions. In this model, citizens and the business sector are granted a higher level of responsibility for the space in which they operate, while the city authorities create conditions for cooperation and exchange of opinions.

Although this manner of working requires a longer time to make political decisions, the Danes see greater value in decisions being made as part of a broader consensus. Participatory and multi-sectoral governance is a way to gain both financial benefits in terms of cost savings and more efficient processes while verifying whether a project really meets the needs of people living, working, and doing business in Aarhus. The need for new management methods stems from these objectives of the municipality as part of a broad social collaboration. In addition to consultations, the municipality attempts to recognise the needs of Aarhus residents through experimental methods undertaken, for example in the Digital Neighbourhood project, such as digital phone boxes and tokens. They aim to increase citizen participation in city development activities. The city identifies the opinions and needs of its residents on the basis of traditional surveys and by analysing the petitioners' questions addressed to officials at the Citizen Service Centre in Dokk1. The wide range of methods of gathering residents' opinions on important urban and social policy issues is a reflection of their value to the city management in the Scandinavian model. On this basis, city managers can shape policies and make decisions based on the real needs of the city residents as articulated by the residents themselves.

As the head of the City Lab points out, the office is the originator of many projects engaging citizens. One example is hackathons, in which the city invites students and various companies to participate in weekend collaboration events. The aim of such meetings is to attempt to solve urban problems using open data. The city often uses methods from the field of design thinking to develop ideas. Although in practice the municipality is usually not able to fully handle a particular problem, it sees added value in this collaboration in the exchange of knowledge, skills, and competences of the people who meet; the staff of the open data department know how to access and use data according to the needs of the city, the experts are knowledgeable in the specific fields of the city's functioning as well as urban problems, and the companies and students have creative and technical skills in data analysis. This exploration of data in a specific problem area allows for better identification of the problem and a broader approach in formulating proposals for solutions on the basis of a collaborative prototype that all parties feel responsible for.

The leader of the City Lab: Open Data, IoT and Smart City team places this way of managing Aarhus somewhere between a top-down and a bottom-up model, because, as he explains, there is a great deal of flexibility in the possibilities for interested groups to propose city initiatives. These often find their way 'up', receive funding, and are put into practice. A good example of such bottom-up activities is Smart Aarhus itself, which was created as a joint initiative of a non-profit organisation, a university, and several businesses. Another initiative mentioned by the political scientist was pressure exerted by the sports community to submit joint applications with the city to host the World Sailing Championships and the World Cross-Country Championships in Aarhus. Each of these events was eventually organised as a grassroots initiative by the people involved, and thanks to these activities the city can now boast that sailing is Aarhus' sports brand. Thus, top-down creation of tools for bottom-up public participation encourages independent actions and initiatives that increasingly take a bottom-up form. It is worth mentioning the openness of the administration in contacting stakeholders and answering questions, which fosters the development of dialogue and improved information. For example, on almost every subsite of the Aarhus Municipality or Smart Aarhus website describing the city's initiatives and activities there is information concerning the person responsible for communication within the project.

The Scandinavian 'third way' promotes greater independence from corporations, and encourages as much self-sufficiency as possible in software or data handling while supporting collaborative initiatives with all sectors of the economy in designing innovative solutions. Aarhus City Hall employees therefore need to continue to upgrade their skills. However, Aarhus City Hall needs to move with the times as well. This includes using innovative work and team management methods typical of corporations and creating new departments within Aarhus City Hall to analyse data and develop new applications and facilities to improve the quality and efficiency of work. This is how the local government wants to fulfil its principles concerning greater independence from business in terms of data processing, including sensitive data, and to ensure greater control of system security. It further guarantees that the solutions designed for Aarhus will not be dictated by the laws of the market and will rather be developed based on the needs of the city and its residents.

Aarhus' ICT-enabled projects are increasingly the result of research in which expert teams try to determine how the emerging new technologies and the data they collect can be used to the benefit of citizens, politicians, and the entire city. The system is therefore intended to be both technically functional and above all user-friendly and practical. As the political scientist we interviewed emphasised, technologies are supposed to support the economy, improve traditional infrastructure, and promote civic social activities, and especially to enable the inhabitants to participate in decisionmaking processes. Thus, technologies have a specific mission in the service of the city and its citizens. Above all, they are a tool alongside the many other available smart city management methods and techniques (although they are often their activator, being the basis of their operation as a medium). In this sense, the head of the City Lab assesses that the smart city strategy is

gaining maturity in Aarhus, as it is becoming more and more responsive to the real needs and problems of the city. Previously, the local government used to acquire and implement available EU projects and simply introduce emerging innovations; however, it is now trying to connect technology more deeply to the city's foundations and its real problems. It does this, for example, through research projects undertaken by the IT City of Katrienborg and the Centre for Digital Urban Life, as well as through initiatives such as OpenData and IoT Crawler. Importantly, the municipality does not keep the results of its research projects only for itself, sharing them with other entities both at home and abroad. The idea is not to make money on technologies, it is for cities to jointly benefit from good practices and improve them even further on the basis of common experience.

6. Conclusions

The Scandinavian 'third way' of smart city development, which is considered an alternative to the solutions proposed by American and Asian cities, focuses on involving city stakeholders, especially the inhabitants, in the processes of co-management and co-governance of the city. By jointly developing and sometimes implementing public policies, individual partners assume responsibility for the functioning and development of the city and have an opportunity to participate in decisionmaking processes. This model promotes greater independence from corporations in terms of software and data handling. However, the implementation of the management methods behind the concept of public governance will not be possible if the level of civil society, social capital, and political culture is not adequate. The application of this model of smart city management in its holistic formula will therefore not be possible in every city, especially those built from scratch as commercial projects (such as Masdar or Songdo) or those developed under authoritarian systems (such as in China), or in those where the level of social involvement and willingness of managers to cooperate with the social sector is low.

A smart city is understood by Aarhus in the way described by Manville et al. [1], that is, as creating and combining human capital, social capital and ICT infrastructure to generate greater and more sustainable economic development as well as a better quality of life. In this sense, it is consistent with the socio-economic view of understanding the smart city concept distinguished by Baraniewicz-Kotasińska, which stands in opposition to technocentric models.

The Scandinavian tradition of governance and political decisionmaking present in Denmark is not without significance for the way in which the smart city of Aarhus functions. As a result, the local government unit generally involves other stakeholders in its decisions. This culture has been shaped by a long history over the course of which respect for the values associated with equality, community, and solidarity has been developed in the Danish society. Its foundations have been adopted by the Aarhus municipality in the implementation of its smart city activities, and thus a unique modern city management model has been developed. On this basis, it is easier for local governments to create conditions for intersectoral cooperation, in particular with residents, as the Danish society is characterised by high activism and a high level of civic participation in public life as well as responsibility for social issues. This finding confirms the study of Gil et al., which showed that certain political ideologies (in this case socio-democratic ones) may influence sustainable policies, and thus the development of smart cities [94].

In the Scandinavian model, joint actions require a change in the traditional roles of local governments, citizens, and businesses. Citizens and the business sector are provided a higher level of responsibility for the spaces in which they operate, and city authorities must create appropriate conditions for cooperation and exchange of opinions along with an accessible and open decisionmaking style and management system for citizens. This model enables citizens to formulate and put into practice bottom-up initiatives; in this form, the city of Aarhus is an example of the third phase of smart city development as distinguished by Boyd Cohen. The 'Smart City 1.0' is a phase in which the vision of the city's future is driven by the private technological business sector. Urban space can

easily become ‘gadgeted’ and technologies are implemented without any analysis of their impact on citizens. In version 2.0, the leader of innovative changes in the city is the local government. It focuses on improving the quality of life through its actions. Phase 3.0 represents the time when citizens take the initiative in creating urban development [95]. This highest level of smart city advancement is manifested in the involvement of citizens in city governance and management processes. The participation of citizens and the third sector in developing urban policy with representatives of the local administration contributes to making political decisions that reflect the real needs of the local community. The core of this policy is deliberation, i.e., the need to exchange and consider different views in order to solve a problem and find a consensus. This, however, requires the inclusion of representatives of various communities in decisionmaking processes, including those marginalised and excluded for socio-economical or technological reasons, which in reality may pose a serious challenge both because of the need for greater involvement of the authorities in developing methods and tools to reach as many social groups as possible and because of the possible resistance of particular communities to participation in co-governance processes. Furthermore, such a ‘debating democracy’ requires that inhabitants have “the ability to submit to rational arguments and to put aside particular interests and opinions out of respect for general justice and the general interest of the community” [96]. The brief characteristics of the ‘Scandinavian third way’ of understanding and implementing the smart city concept is presented in the Table 2.

Table 2. The ‘Scandinavian third way’ of understanding and implementing the smart city concept using the example of Aarhus city.

Understanding the ‘smart city’ term	• Smart city understood as creating and connecting human and social capital with ICT infrastructure in order to achieve sustainable development.
General purpose of smart city	• Promotion of democracy, transparency, and sustainable growth • Creation of values in the public sector • Engaging stakeholders in the processes of co-management and co-governance of a city
Approach to technology issues	• Using technology to enhance social participation • Working on own sources and software in order to reduce outsourcing and greater independence of management processes from the corporations • Defining the functionality of systems based on the real needs of city authorities and residents • Focus on creating friendly and practical urban systems from the point of view of users
Governance characteristics	• Using engaging management methods to solve urban problems with various stakeholders • Engaging stakeholders (citizens, students, scientists, representatives of organizations and companies) to cooperate in the development of policies and smart solutions • A wide range of methods of collecting the views of residents on important issues of urban policy; analyzing the needs and verifying the benefits of implemented projects for citizens • Orientation to the needs of city users and political decisionmaking with their participation and based on the needs they articulate • Creating conditions for cooperation and exchange of knowledge, information, and skills within the framework of intersectoral cooperation • Enabling grassroots activities • Building partnerships on the basis of non-hierarchical networks of organization • Making citizens and the business sector more accountable for the space in which they operate • Solving urban problems by consensus as part of deliberative processes
Exemplary smart initiatives and projects	• Open Data Aarhus; IoT Crawler; Open Source; Center for Innovation in Aarhus; Go Green with Aarhus; Aarhus Bicycle City; Smart mobility; TAPAS; IT City of Katrinebjerg; Aarhus City Lab; Digital Neighborhood; Dokk1.

The Aarhus smart city governance model is part of the uniqueness of Scandinavian solutions, and for the reasons already mentioned it would be difficult to implement it

universally. Nevertheless, its particular elements, practices, and solutions, especially the technological ones, seem to be of a more universal nature and could represent a source of inspiration for other local governments. While implementation of participatory smart city governance models similar to the ‘Scandinavian third way’ may be a challenge for local governments, due to the benefits described here in terms of value creation, building of social capital, and increasing the city’s ‘smartness’, it is worth analysing and undertaking. This will require local administrators to go beyond often-bureaucratic governmental organizations and include partners from the private and social sectors in decisionmaking processes. For this purpose, it is necessary to develop new policies that guarantee greater openness in decisionmaking processes and the transparency of activities and that allow for co-determination by non-political groups. Such an inclusive approach forces rulers to distance themselves from their own political beliefs, and sometimes from party goals as well, because only then will they be able to approach the needs of all social groups with understanding. As Aarhus proves, the governance process requires great openness on the part of the apparatus of power as well as its readiness to make changes in the field of policymaking. Each city striving to implement a participatory model of smart city governance will face the need to develop appropriate mechanisms to help awaken democratic behavior in its inhabitants. Management methods identified in this case study, such as hackathons, living labs, prototyping, and civic design supported by design thinking, as well as urban forecasting and intersectoral analytical research teams, can serve this purpose. Moreover, such participation can be supported and facilitated by digital technologies, whether in the form of smartphone applications or ingenious installations placed in urban spaces, as in the example of telephone boxes in Aarhus. Although these methods may not always help the local governments to find an effective way to solve the urban problem, they will always provide a benefit in the form of the exchange of knowledge, experience, and identification of needs. For this reason, participatory governance methods should be developed based on a detailed analysis of the social structure and its behavioural characteristics. The results of this analysis could be used to develop an active local policy open to all members of the urban community, which would satisfactorily meet their needs while improving the quality of life in the city in line with residents’ expectations.

In this sense, the ‘Scandinavian third way’ may indeed be an alternative to other available models for implementing the smart city concept. The smart city governance methods proposed by Aarhus based on deep intersectoral cooperation and public participation are all the more valuable and worth analysing as they fit in with the sustainable development goals, which require “an integration of thinking across all sectors of the city and providing incentives for collaboration between national and international organisations as well as citizens to participate in the sustainable development decision making, policy-making, and governance” [38]. In addition, this policy enables a critical analysis of urban challenges based on exchange of the knowledge, information, and experiences of different city users and then solving problems through consensus. As Baraniewicz-Kotasińska and Haber [97] point out, cross-sector partnerships increase the creativity of decisions and urban innovation, as each of the collaborators provides knowledge specific to its sector (and at the same time its industry) and introduces an individual context for the analysis of local problems. This makes it possible to reconcile the interests and expectations of different social groups and, in consequence, to work out decisions acceptable to all partners even if they are not always fully beneficial to each party. In this context, intersectoral cooperation prevents or mitigates conflict situations and helps to build a sense of community and responsibility for local matters. For the city authorities, each project implemented under public partnership represents an opportunity to identify the needs of particular stakeholders in the city, which in turn allows for political decisionmaking in line with the interests of the city as a whole. As proved by the case of Aarhus, this form of cooperation translates into improved quality of management, which is of the greatest importance in smart cities.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The data presented in this study are available on request from the corresponding author.

Conflicts of Interest: The author declares no conflict of interest.

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