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Creating Better Public Spaces in a Smart Sustainable City: a Case of Berlin

Master Thesis

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Abstract

The urbanisation that started decades ago remains a significant trend nowadays. Cities' population worldwide continues to grow, and for many people, public spaces in urban areas have or will become a vital part of their everyday lives. However, in times of rapid urban development in the middle of the 20th century, the importance of public spaces was often diminished, which resulted in many poorly designed urban areas that still affect life in cities today. Therefore, urbanists and urban designers seek for solutions to improve existing public spaces and create new ones. On the other hand, the recent development of information technologies resulted in the global movement of smart and smart sustainable cities. These smart concepts for cities' development are considered to have great potential in solving cities' challenges. However, while studies on smart or smart sustainable cities and public spaces are present in the current body of research, the number of studies at the intersection of these topics is minimal. This research contributes to the existing research gap, using the case study of Berlin to investigate how to create better public spaces in a smart sustainable city. The extensive literature review that included various related topics helped to develop a sufficient theoretical framework, representing public spaces in the bigger context of smart sustainable city development. Furthermore, semi-structured interviews were performed with the representatives of different stakeholder groups in Berlin to further develop and validate the formulated framework. The data gathered from the interviews and the secondary sources on Berlin's urban development, city strategies and smart sustainable city initiatives for public spaces for the analysis. This research concluded that implementing such initiatives for public spaces helps create better public spaces and advances the smart and sustainable development of a city. The study also provides the explanation of attributes of better public space and define crucial aspects of the implementation of smart sustainable city initiatives for public spaces. These insights can be used by practitioners who are involved in public spaces development. Future research ought to build on this study's findings by investigating multiple cases to test the accuracy and generalisability of the developed framework. Moreover, the results of this study can be adopted to build theories on other domains of smart sustainable cities.

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Abbreviations

AI	Artificial Intelligence
ICT	Information and Communication Technologies
IT	Information Technologies
IoT	Internet of Things
GDP	Gross Domestic Product
SC	Smart City
SDG	Sustainable Development Goal
SSC	Smart Sustainable City
UN	United Nations

1 Introduction

If one tries to define global trends of modern life, what would be their first thoughts? Most probably, one would mention rapid population growth or increasing connectivity with the spread of Information Technologies (IT) like the Internet. Expert at The European Strategy and Policy Analysis System (ESPAS) Florence Gaub (2019) named the following "mega-trends": climate change, population growth, urbanisation, economic growth, increasing energy consumption, connectivity due to introduction of new technologies, and poly-nodality. However, it is outlined that the urbanisation trend may be placed in the very centre of all the other trends mentioned above as cities are and will be the place where, and the reason why most of the other trends happen. "Cities will consume 60-80% of energy resources, will be responsible for 70% of global emissions, account for 70% of the world gross domestic product and 35% of GDP growth" (Gaub, 2019, p. 12)

Various sources state that the global urbanisation rate exceeded 50% in 2015 (European Commission-Joint Research Centre, 2019) whereas in Europe, it already reached a mark of 70% in 2016 (EU Ministers Responsible for Urban Matters, 2016) and it tends to increase further even despite crises like, for example, recent COVID-19 pandemic, which affected cities, as densely populated areas, the most (Sharifi & Khavarian-Garmsir, 2020). Furthermore, according to numerous sources, by 2050, two-thirds of the world's population is expected to live in urban areas (National Georgraphic, 2009).

Thus, a city has or will become a home for a significant part of the global society, where they grow up, live, and eventually pass away. And the city landscape, predominantly consisting of public spaces like streets, squares and parks, form their daily experience and surround their existence when they commute to work or school, take a walk with their pet, go out to meet with their friends, or meet new people, and so on. Thus, public spaces dramatically influence both people's bodies and minds and define how each city, in general, looks and functions (Carmona, 2021).

The study of public spaces, their attributes and usage has become an essential topic among urban design researchers. It is no secret that many big and heavily populated cities around the world were intensively developed in the middle of the 20th century or even before that (Carmona, 2021). The main issue related to that is the fact that urban planning strategies in the times of rapid urban development 1960s neglected the importance of public life and interaction between life and public space, imagining people as machines commuting to work and back home (Gehl & Svarre, 2013).

Therefore, the new generations of urban citizens, who have different lifestyles and different value systems, whose habits and needs are heavily affected by IT, receive those outdated and poorly designed public spaces as a significant part of their reality. One can even feel as if they are travelling back in time while staying in such places. Urban designers urge that this underestimation of public space as a vital part of an urban landscape, absence of self-conscious design results in "cracks" in the city, the areas that increase fragmentation and interruption of public life. This leads to various consequences, both social, environmental and economic (Carmona, 2021). This issue became evident to many researchers and resulted in many studies being published in the recent decades that were outlining the importance of public space and the potential values public spaces can have for societies and cities in general (Carmona, 2021; Carr et al., 1992; Gehl, 2011; Loukaitou-Sideris, 1996; Madanipour, 1996). They urge that actions are needed to be taken to reimagine the public spaces so that cities would meet the needs and the values essential for modern society, not people who were living in these cities decades ago (Argin et al., 2020).

Practitioners also recognised the need to tackle the issue related to public spaces. For example, in 2015, the UN development goals were redesigned. They became Sustainable Development Goals, which, compared to the previous edition, included goal 11: "Make cities and human settlements inclusive, safe, resilient and sustainable". In addition, the goal has ten targets, among others, target 11.7 that is explicitly focused on public spaces: "By 2030, provide universal access to safe, inclusive and accessible, green and public spaces, in particular for women and children, older persons and persons with disabilities" (United Nations, 2021).

On the other hand, the trend of technological development allowed the rise of Smart Cities (SC). Governments often seek solutions to urban challenges in the domain of information technologies. For example, disruptive technologies such as the Internet of Things or Cloud Computing, which allow gathering data from physical objects, have the potential to make the urban environment more adaptive and efficient. The implementation of these and many other IT has the potential to turn cities into connected and IT-empowered landscapes (Woetzel et al., 2018). Now the term smart city is often used in research and practice; it even became a "buzzword" that pops up here and there, gaining more and more attention. For example, there's a noticeable upward trend in Google searches for the term "smart city" throughout the last ten years (Google, 2021). This concept has been extensively studied in recent years by researchers in the domain of social and computer sciences (Dameri, 2013; Lara et al., 2016; Neirotti et al., 2014; Su et al., 2011).

The introduction of Sustainable Development Goals (SDGs) by the United Nations and spreading awareness of sustainability issues catalysed the rise of the concept of Smart Sustainable City (SSC). This is the representation of the smart city and sustainable city concepts together (de Azambuja et al., 2020). The development of this concept has led to the hope that these smart cities of a new, sustainable type would be more effective in improving urban sustainability and less technocratic. These are the aspects, which early smart cities are often criticised for (Kostakis & Drechsler, 2020).

These concepts were adopted by many cities worldwide and started the whole global movement of smart cities (Woetzel et al., 2018). They have found their implementations in various projects improving life in cities, and among others, in creating better public spaces.

There are many smart sustainable city initiatives for a public space, both minor improvements and the creation of a whole new public space, incorporating both information technologies and new approaches in urban design. For example, if talking about small but impactful changes driven by technologies, it can be smart sustainable furniture, like benches with solar panels by Strawberry Energy, providing not only sitting infrastructure at a public space but also sustainable device charging points (Strawberry Energy, 2021). Or, on the other hand, a prominent and viral project of smart and sustainable redefining of public spaces driven by changing the urban design approach rather than utilising new technology is Superblocks in Barcelona. Of course, the concept of superblock – an area of the city with no car passage – has been there for years. Still, this massive initiative in Barcelona, also supported by such smart technologies like sensors for traffic lights on the crossroads, not only reduced air pollution, which was the primary target. It also achieved better social interaction among the residents and enhanced business activities in the districts where it was implemented (Energy Cities, 2016; Mueller et al., 2020; Vox, 2016).

However, despite the growing interest and need for smart city initiatives for public spaces, very few studies present this topic in the current body of research. As was outlined above, a significant number of studies can be found in the domain of urban design discussing the new approaches to create public spaces. At the same time, research related to the topics of smart cities or smart sustainable cities is heavily focused on the conceptualisation of these terms. If one tries to perform a search on Web of Science using the topic “smart city”, the search will return 10 133 results; if the topic is “public space” – 10 983 results. However, the inquiry: “topic: (“smart city”) and topic: (“public space”)” returns only 44 articles, and most of them are very technical. For example, the most cited article among

the search results has 85 citations – “An Architectural Framework and Enabling Wireless Technologies for Digital Cities & Intelligent Urban Environments” by Yovanof et al.

Therefore, this study is conducted to address the existing research gap, attempting to put public spaces in the bigger context of a smart sustainable city. This study seeks to answer the question: *How to create better public spaces in a smart sustainable city?*

Answering this question would not only provide a new conceptualisation of smart sustainable city elements and functions but could help to tackle the problem of reimagining public spaces and making them more beneficial for people living in urban areas and to support the sustainable development of urban regions through creating public spaces in a smart way. Therefore, the following sub-questions were formulated to guide the research process: *What are attributes of a better public space? How can public spaces contribute to the smart and sustainable development of a city? How to implement smart sustainable city initiatives for public spaces?*

To answer these research questions, a case study research design was adopted. The semi-structured qualitative interviews were performed with the respondents from Berlin, representing different stakeholder groups according to the theoretical framework formulated based on the literature review. This thesis consists of five more chapters, apart from this introduction. The literature review provides a comprehensive overview of the publications on topics of public spaces, urban design approaches and frameworks used to create and assess public spaces, which then is followed by theories on smart and smart sustainable cities, lastly paying special attention to the studies presenting cases of smart sustainable initiatives for public spaces. The methodology first presents a theoretical framework proposed in this study. Then, it provides the reasoning of the different aspects of the current research design, such as methods, case selection, data collection and analysis, and lastly, it elaborates on the possible limitations. The results present a case background and a summary of insights gathered from the interviewees’ responses, structured according to the topics covered in the interview protocol. Finally, the discussion analyses the findings, compares them with the insights from the literature review and answers the research questions. The conclusion indicates the theoretical and practical implications of this study, as well as gives suggestions for further research.

2 Literature Review

This literature review presents an overview of the related studies. The chapter first discusses topics related to urban design, paying attention to the aspect of creating public spaces. This is followed by an overview of such concepts as Smart City (SC) and Smart Sustainable City (SSC), also focusing on the implementation of these concepts to public spaces. This literature formed a comprehensive background for the later research and served as a basis for formulating the theoretical framework.

2.1 Public Spaces and Urban Design

As "public space" is one of the core terms used in the current thesis, we first present definitions of public spaces. Later, the arguments of scholars and practitioners about the purposes public spaces serve and what they change about living in a city are presented. However, as the creation and management of public spaces is part of the more prominent topic of creating and managing the physical landscape of a city, the following subsections present an overview of the concepts related to the physical development of urban areas. The concepts discussed are urbanism, urban planning, and urban design. This helps to put public spaces in the bigger picture of urban development. Thus, the definitions of these concepts are presented and existing approaches and recent trends in these fields. Lastly, a closer look is taken at the specific implications of these concepts to public spaces, meaning the detailed public spaces design and evaluation frameworks.

2.1.1 Public Spaces Definition and Functions

Everyday life of people in cities happens in the context of two types of environment: open spaces and buildings. Both of these spaces may be private, semi-private or public (European Urban Knowledge Network, n.d.). The publicness of any of these places may be defined based on two aspects: ownership and use. Some authors define public space as the "space that is not controlled by private individuals or organisations…" (Madanipour, 1996, p. 144). Others instead focus on the usage aspect, saying that public spaces are those which can be accessed by every citizen with no exception for any reason. Thus, they form the experience of vast groups of people, unlike private ones (European Commission-Joint Research Centre, 2019). In this research, as well as in many other studies on similar topics presented below, the term "public spaces" is mainly applied to open public spaces with more focus on their use rather than ownership. The following paragraphs explain different definitions of public space and its uses proposed by researchers and practitioners in recent decades. This is followed by a definition proposed by the author based on these sources.

Many researchers, while talking about public spaces, define green spaces as a separate category. For example, according to the European Urban Knowledge Network (n.d.), there are the following forms of public spaces: streets, sidewalks and bicycle paths; green spaces; squares and similar environments. Therefore, the research on green spaces represents a separate research stream that focuses on the evaluation and design of parks, gardens, green belts, etc. This type of research goes beyond the scope of this study. Therefore, the specific peculiarities of parks and similar exclusively green landscapes will not be discussed thoroughly; however, we do not exclude such public spaces from the scope.

Sir Stuart Lipton, Chairman, CABE (2004), defines public space as "all around us, a vital part of everyday urban life" (p. 2), outlining that this includes streets and sidewalks people use to get to their places of work and study, playgrounds where children spend time after school, places like parks and green zones where people can encounter the wildlife or do sports or walk dogs, or simply square or public yard where one can take a moment to relax or spend his time working (Woolley et al., 2004). This definition also supports the previously stated notion that, while discussing urban development, the focus is rather on the usage of open public spaces.

Another explanation of what public space represents is given by Rogers et al. (1999):

> to achieve urban integration means thinking of urban open space not as an isolated unit – be it a street, park or square – but as a vital part of urban landscape with its own specific set of functions. Public space should be conceived of as an outdoor room within a neighbourhood, somewhere to relax, and enjoy the urban experience, a venue for a range of different activities, from outdoor eating to street entertainment; from sport and play areas to a venue for civic or political functions; and most importantly of all a place for walking or sitting-out. Public spaces work best when they establish a direct relationship between the space and the people who live and work around it (as cited in Ward Thompson, 2002, p. 61).

A crucial role of public spaces and the ways people can utilise them was recognised even in ancient Greece. According to Carmona et al., there are seven central notions about public spaces that were relevant for discussions in the ancient Greek polis, which still resonate in today's urban society. Those are the following: public space being multifunctional; public space being a place for democracy, giving people chance to discuss issues and state their position; public space being used for commercial purposes; public space being a place for socialisation and interacting with the community; aesthetics of public spaces being important aspect giving rise to pleasure; public space being restricted for some social groups, leaving them out of its benefits (Carmona et al., 2008).

The latter is instead a problem that is often not yet solved for many public spaces nowadays, as can be derived from recent studies (Varna & Tiesdell, 2010).

As also highlighted by Vikas Mehta (2014), historically, public spaces in cities served various purposes, ensuring that basic survival, communication and entertainment needs are met and performing several political, religious, commercial, civic and social functions. One can think, for example, of the execution of criminals right on a public square, which, of course, is not something that would be a function of public space in modern democratic society. Obviously, with the development of institutions and construction technologies, many of these functions have moved to private, virtual realms, privatised, parochial spaces (Banerjee 2001; Brill 1989; Rybczynski 1993, as cited in Mehta, 2014). However, people living in cities still depend on public spaces for various reasons and occasions, like functional, social and leisure activities as "for travel, shopping, play, meeting and interaction with other people, and even relaxation" (Mehta, 2014, p. 55).

Gehl (2011), a Danish architect and urban design consultant, in his famous book "Life between buildings", goes beyond a simple listing of activities public spaces serve for, but defines three specific types of outdoor activities and, together with them, the public spaces where those activities happen can be mapped. The first category of activities is "necessary", the name of this category speaks for itself. These are activities related to going to school or work, shopping, waiting for a bus or a person, etc. The public places for these purposes may be roads, pavements, squares, transportation hubs etc. As the activities of this category are necessary, people cannot avoid doing them. Thus, they cannot avoid spending time in these places. This means that they will come to these places despite their perception of their utility and design; however, the improvement of these facilities may dramatically improve their everyday experience. The next category is "optional" activities – such activities as taking a walk to get a breath of fresh air, standing around enjoying life, or sitting and sunbathing. The main difference to the previous group is that these activities may only occur if the exterior conditions are considered attractive and favourable. These activities may take place in the same public places as "necessary" ones, but additionally in recreational places like parks, playgrounds or places that invite to stop, sit, eat, play, and so on. This relationship is particularly important in connection with urban planning and design because such spaces define the frequency and the manner of "optional" activities performed, as if the exterior is unpleasant or unsafe, only the bare minimum of activity takes place. Lastly, "social" activities are "all activities that depend on the presence of others in public spaces". Gehl (2011) also adds, "social activities include children at play, greetings and conversations, communal activities of various kinds, and finally – as the most widespread social activity – passive contacts, that is,

simply seeing and hearing other people". These activities may, of course, occur in different kinds of private spaces like workplaces or private yards. Still, if applied to public spaces, they usually happen together with the activities of the first two types, as people are spending their time in the same public spaces. Thus, as well as for "optional" activities, the frequency and manner of "social" activities is highly dependent on the design and attributes of public spaces.

Other academics emphasise the group of "social" activities, underlining the social dimension of public space. For example, Crowhurst-Lennard and Lennard (1987; 1995, as cited in Mehta, 2014) performed a comprehensive literature review and derived a list of social functions served in public spaces: learning, the development of social competence, the exchange of information, the facilitation of social dialogue, the fostering of social awareness, the enhancement of integrative social functions, and the encouragement of ethical conduct.

On the basis of presented above literature, mainly inspired by Gehl (2011), the following definition of public space was formulated by the author, which combines both physical attributes of the space as well as activities that public spaces serve for: *A public space is a part of an urban landscape which is accessible for all citizens and provides physical infrastructure (pavement, sitting space, lightning, greenery or other) for their daily activities such as necessary (like working, walking or commuting), optional (like playing, doing sports or walking a dog) and social (like attending a concert, visiting a market or meeting a friend).*

As it was explained above, citizens perform a significant part of their everyday activities in public spaces. Therefore, the latter is essential for the functioning and the quality of life of cities and regions. Carr et al. (1992) outline that they provide "the channels for movement, the nodes of communication, and the common ground for play and relaxation" (p. 3) for citizens. But, of course, there are other functions of public places that go beyond providing space and environment for citizens to perform different activities and socialise. The public space provision may be beneficial for businesses, as placemaking and pedestrian zones encourage people to engage more with local shops and cafes, for example). Moreover, public spaces are valuable for governments as a way to improve the sustainability and attractiveness of a city or as a space for democracy and communication with the citizens. Thus, how public spaces are created, what purposes they serve and what strategies they support are crucial questions local governments have to solve while developing an urban landscape of a city.

Coming back to our motivation for this thesis, we can see that the provision of the public space is a critical urbanisation matter that can be turned into an opportunity if adequately

managed. Both researchers and practitioners outline that good public spaces may contribute to solving many urbanisation challenges from very different domains like climate, economy, mobility, equality etc. (Maring & Blauw, 2018). Global Public Space Program by the United Nations Human Settlements Programme (n.d.) mentions various sustainable development goals, which provision of public spaces is contributing to; those are: Good Health and Well-Being, Gender Equality, Reduced Inequalities, Sustainable Cities and Communities, Climate Action, Partnerships for the Goals (as seen in Figure 2.1).

Source: United Nations Human Settlements Programme (n.d.)

Figure 2.1 The Sustainable Development Goals related to the Global Public Space Programme

On the other hand, to support these goals and fulfil the needs of society, public spaces need to be planned and adjusted accordingly. Lifestyles, value systems, attitudes to nature and sustainability, communities themselves are changing, so should public spaces. For example, if a public space should contribute to the SDG 10, "Reduced inequalities", it should have an inclusive design. In Britain, up to 16% of the present population is disabled people. Moreover, many of them experience mobility problems (The Urban Task Force, 1999). Thus, it is essential to provide better access for such groups to public spaces. Another example may be that public spaces are vital for such, maybe, unobvious part of life as politics. In democratic societies, often also described as "melting pots", where a lot of cultural and social differences may be observed, urban public spaces not only provide a possibility for demonstrations but also can be seen as a representation of democracy in practice if designed according to diverse needs and traditions of the minorities forming the city's population (The Urban Task Force, 1999).

In other words, to achieve the goal of public spaces being efficient and effective, serve the public good, solve urbanisation problems and support the sustainable development of a city, they need to be planned and designed thoroughly. Unfortunately, though, as outlined by the British architect Matthew Carmona (2021), urban design, as it is closely attached to social life and many other aspects, cannot be depicted into a series of defined steps with concrete outcomes. Thus there are no "good" or "bad" decisions, but rather

"better" and "worse", which can only be defined after continuous evaluation. Thus, in this thesis, the collocation "*better public spaces*" is used. By this, the author means *those public spaces that not only successfully support necessary, optional, and social activities of citizens but also facilitate sustainable development of a city and address urban problems*.

2.1.2 Urban Design Concepts and Frameworks

As one could derive from the name of the current chapter, the following paragraphs focus on the recent trends in urban design. However, as this work remains in the domain of social sciences, it is crucial first to give essential explanations of terms like urbanism, urban planning, urban design, and their interconnection. This is done for purposes of providing better context and insights into how public spaces, as well as urban landscapes in general, are developed and designed nowadays. This overview is followed by reasoning the focus on urban design while discussing the creation of public spaces. Finally, the chapter is concluded by presenting the current trends in the domain of urban design.

While analysing the literature, making a distinction and providing a clear understanding of interrelations between terms urbanism, urban planning, and urban design becomes a rather ambitious goal to achieve. Many authors state that there is no established system of definitions, and in many sources, some of them are used interchangeably (Abd Elrahman & Asaad, 2021; Cozzolino et al., 2020). For example, urban design is often seen as a part of urban planning practices (Abd Elrahman & Asaad, 2021). However, in the following paragraphs, the definitions formulated by renowned researchers are presented, and the general assumptions on the core aspects of these domains are drawn based on those definitions.

As defined by Professor of urban and regional planning Jeremy Németh (2010), urbanism is "a lens through which to view and interpret the city". This means that urbanists try to understand how "economic, political, social, ecological and cultural characteristics of place affect urban form and social life" (Németh, 2010). In the context of this study, extremely interesting becomes a term "smart urbanism". Marvin et al. (2015) explained that it represents an emerging intersection of urban places, technologies and infrastructures. However, the authors outline that the field is emerging, and there is a lack of understanding of threats and opportunities of the implementation of this concept (Marvin et al., 2015).

Urban planning, as defined by Susan Fainstein (2020), is about designing and regulating how the space in a city is used. It is the process that focuses on both undeveloped areas

as well as functioning districts; it uses strategic thinking, forecasting and public consultation to create better landscapes in the city. Whereas urban design is

> … a creative and purposeful activity with collective and public concerns that deals with the production and adaptation of the built environment at scales larger than a single plot or building. Its main scope is to impress a certain degree of order in the shaping of new physical developments and in the creation and management of the public realm. It operates in two main ways: first, by visualising the physical outcome of particular projects through drawings or, second, by providing rules to deal with the physical forms of future transformations. This practice requires the capacity to analyse the current state of affairs, sketch out possible workable scenarios and implement them in reality" (Cozzolino et al., 2020, p. 8).

Based on these sources, urban planning and urban design can be seen as a practical implementation of urbanism as a field of knowledge and research. Even though the experts in these domains may be using different approaches or operate on a different level of abstraction, they follow the same outcome. This is because the object of their work is the same physical realm of a city (Devries et al., 2005). However, it can be concluded that urban design is more focused on the physical attributes and appearance of urban spaces. In contrast, urban planning is more focused on a higher level of urban development, considering the reasons and outcomes of specific city design and development strategies. Based on that, for the current research, the literature in the domain of urban design is the most relevant, as it operates on a more local level and focuses on shaping different urban spaces, like public spaces, that this research is focused on. Thus, the following paragraphs present the recent trends in urban design, attempting to put public spaces in the context of the process of shaping the cities.

Matthew Carmona (2021) names the following recent streams existing in urban design practice and research: the Visual-Artistic tradition, the Social Usage tradition, the Place Making tradition, Sustainable Place-Shaping. The Visual-Artistic tradition is the tradition of thought that reflects the earlier understanding of urban design, which is relatively narrow and primarily focuses on physical and visual qualities of a space, rather than seeks for its effects and interconnections with cultural, social, economic and other aspects of urban life related to the space. Whereas the Social Usage tradition confronted its predecessor and emphasised the way people utilise spaces. One of the proponents of this stream, Jane Jacobs, underlines that spaces in the city reflect life itself. While life is a complex and agile substance, we shouldn't see spaces as some work of art or architecture in a vacuum (Jacobs, 1961, as cited in Carmona, 2021). Similar arguments are drawn by Jan Gehl, whose work was presented in the previous chapter while discussing the

functions of public space (Gehl, 2011). Thus, the practitioners working in this stream tend to focus on designing with a clear linkage to the intended use of this space and try to integrate infrastructure for activities to be performed there. The Place-Making tradition ultimately integrates the ideas of both Visual-Artistic and Social Usage streams. It emerged in the latter part of the twentieth century by synthesising the two earlier traditions and eventually became the mainstream tradition in contemporary urban design practice and research. It is concerned both with physical and aesthetic aspects as well as behavioural. Lastly, during the 2000s, a new form of Place-Making emerged, which is now called Sustainable Place-Shaping. Easily derived from its name, this stream in urban design supports not only previous notions about aesthetics and usability of a space but also emphasises such aspects of sustainability, like adopting carbon zero strategies, for example (Carmona, 2021).

Apart from the overview presented by Matthew Carmona, a few recent and popular works are summarised to give further insight on the values that urban design supports nowadays. For example, in Alexander Garvin's (2016) work "What Makes a Good City", the following notions about the public realm are presented: "is open to anybody; offers something for everybody; attracts and retains market demand; provides a framework for successful urbanisation; sustains habitable environment; nurtures and supports a civil society" (as cited in Carmona, 2021, p. 20).

Another noticeable publication is "Toward an Urban Design Manifesto" by Jacobs & Appleyard (2007). It provides a pretty sufficient list of urban design goals that are "essential for the future of a good urban environment" (p. 115), those are: Liveability – a city should provide a comfortable living for everyone; Identity and control – spaces should provide a feeling of ownership as well as responsibility, encourage people to participate in their development; Access to opportunity, imagination, and joy – cities design should not lead to creating a dull and heavily restricted environment, on contrast, it should provide opportunities for fun and self-development. Authenticity and meaning – cities should represent their societies' values and cultures, as well as being understood by citizens. Community and public life – the design of cities should encourage citizens to participate in public life rather than separate them from one another. Urban self-reliance – cities have to move towards being self-sufficient in energy and other resources. An environment for all – cities should distribute resources equally, be genuinely pluralistic and inclusive (Jacobs & Appleyard, 2007).

There are many more studies worth mentioning. However, as this research focuses on public spaces rather than urban development and design in general, a more detailed look

is taken in the following paragraphs at the studies and publications around designing public spaces specifically.

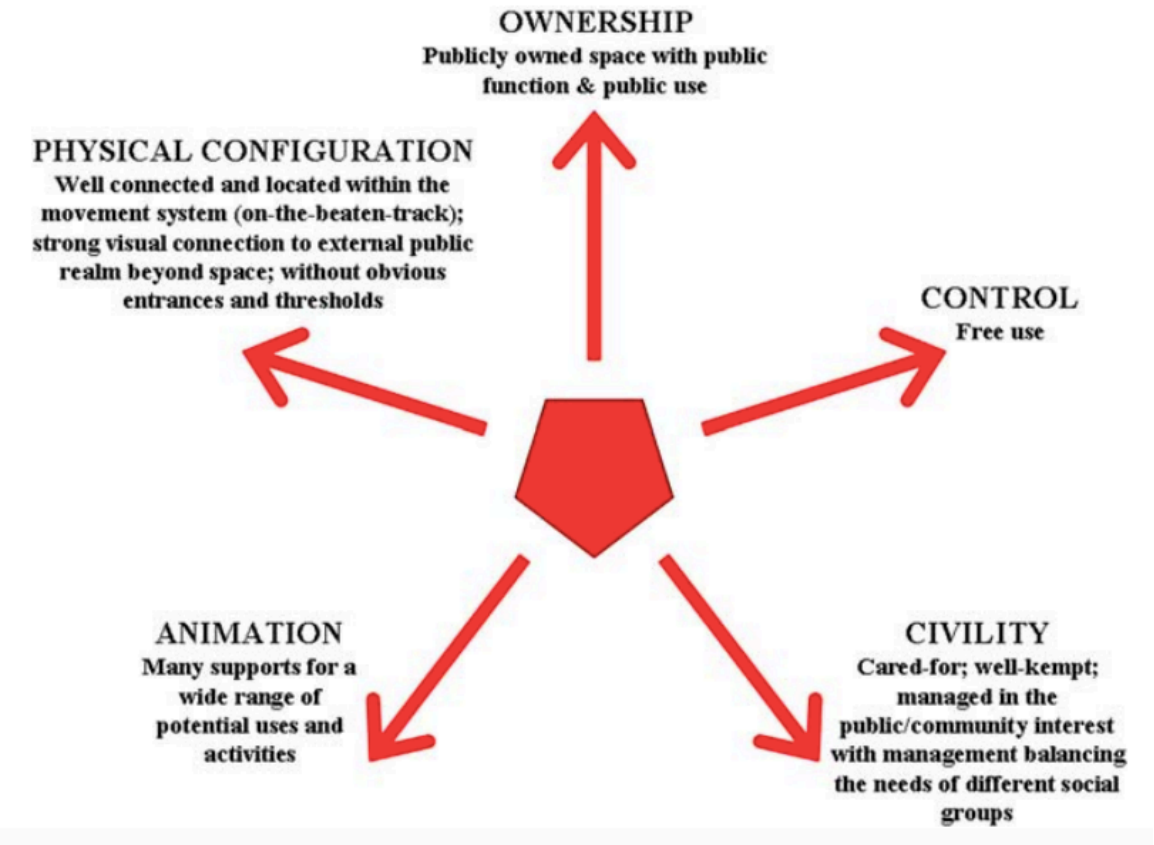
2.1.3 Public Spaces Design and Assessment Frameworks

As was already mentioned, urban designers and other stakeholders involved are aiming to develop better public spaces so they can serve for better living in a city and many other purposes. However, if this process of public spaces development is poorly planned or performed, the quality and the use of such public spaces is questionable. According to Loukaitou-Sideris (1996), the urban spaces with the absence of quality, that he named "cracks", may be described as places, where urban continuity is disrupted; spaces left undeveloped or underused; the physical constructions that separate social worlds; the areas where development resulted in harmful fragmentation or interruption. This section presents an overview of practices and theories developed to create better public spaces and avoid them turning into such "cracks".

Around two decades ago, in the very beginning of this century, researcher Catharine Ward Thompson (2002), in her work "Urban open space in the 21st century" was elaborating on changes in perception and use of public spaces are happening and are predicted to happen in the future, changing how and for what they should be designed. She outlined several main points. First of all, public spaces should serve all cultural and social constructs of diverse modern societies. Thus, in democratic societies, the degree of inclusivity of the public space serves as an indicator of governments strategy and willingness to meet people's demands. Urban public space network serves as social space, and given the cultural context, it may have different forms from mainly promenades (in Spain, for example) to more public parks (in Britain). On top of that, public space should provide a possibility for contact with nature, as many cities turned into a concrete jungle, which is proved to have adverse effects on people's health and well-being. On the other hand, natural landscapes and natural parks may be feared by some social groups like women and children. Therefore, the balance between a unique experience and a safe environment should be found. Moreover, public spaces with greenery provide the environment not only for humans but for other species, which also need their place and comfortable conditions not to leave the city area and provide biodiversity. Another critical point is that in the information age, public spaces may take up new roles and extend their functionality with, for example, screens providing the information about the area and closest attractions, or new events and meetings held in public spaces that are organised through online platforms. Additionally, as people from the countryside are coming to cities still want to keep their habits, and the idea of responsible consumption is gaining more weight, the need for public spaces such as community gardens is expected to grow

(Ward Thompson, 2002). This piece of research is noticeable due to a comprehensive list of suggested views and aspects of public spaces worth attention and further research. However, it did not present any systematic approach to public spaces, like methodology or theory, whereas some other authors did.

One great example of a method that can be applied to public space evaluation as well as design is "The Star Model of Publicness" by Varna & Tiesdell (2010). As can be derived from its name, this framework's primary purpose is to evaluate the publicness of a space. Authors define two levels of publicness: conceptual and practical. Using inductive and critical realist approaches, they attempt to provide a conceptual and generalisable method for public space evaluation. The "Star" model consists of 5 meta-dimensions of publicness. Those are ownership, control, civility, physical configuration and animation (see Figure 2.2).



Source: Varna & Tiesdell (2010), p.589

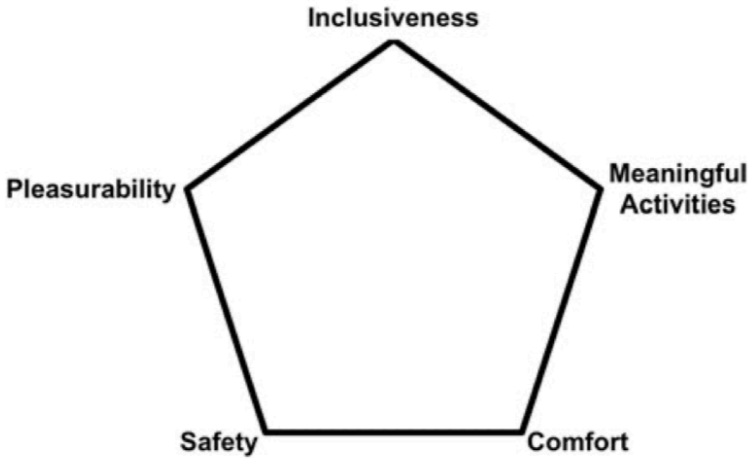
Figure 2.2 The Star Model

Ownership refers to a place's legal status; for example, spaces with public ownership, function, and use are the most public. Control is a managerial dimension, public spaces with a lot of human and electronic surveillance considered by authors less public. Civility

may be generally expressed through maintenance of public space, for example, well-kempt; managed in the public interest; management balancing needs of different social groups are very public, whereas those under- or over-managed are less. Physical configuration relates to the design of a place, both internally and design of its connections with the outside city. Finally, animation refers to possibilities of use of the space and performing activities in it, those with fewer activities options perceived less public (Varna & Tiesdell, 2010).

The "Star" model is a noticeable development in the theory of public spaces; however, it is not ideally relevant for the current research due to various reasons. Most importantly, it is very focused on an aspect of publicness, which is, of course, crucial for a public space. However, it is not sufficient alone while talking about creating and designing public spaces.

One of the most noticeable frameworks that structurally and reasonably decouples public space into high-level design aspects that was found in the recent research is the "Five Dimensions of Public Space" by Mehta (2014) presented in Figure 2.3.



Source: Mehta (2014), p. 58

Figure 2.3 Five Dimensions of Public Space

This public space evaluation framework is based on the considerations of two great researchers. First, it includes a holistic and comprehensive public space description formulated by Carr et al. (1992). Thus, suggesting that ideal public space is responsive, democratic and meaningful (Carr et al., 1992). Second, this framework is based on activities public spaces serve for, proposed by Gehl (2011). Those are, namely, necessary, optional and social groups of activities (previously discussed in detail in the chapter 2.1.1 Public Spaces Definition and Functions). Public space dimensions presented in this

framework are “Inclusiveness”, “Pleasurability”, “Safety”, “Comfort”, and “Meaningful Activities” (Mehta, 2014).

Inclusiveness represents the number of activities possible to perform in a public space and the range of actors able to perform those activities. Therefore, the more accessible public space is, the more inclusive it is. Accessibility can be represented through two aspects: the possibility to reach the area and the opportunity to enter and perform activities in it (Mehta, 2014).

Meaningfulness of the public space may be formed by prior familiarity, and historical and political events. However, this framework represents meaningfulness in terms of public space being able to support activities that “are symbolically and culturally meaningful to individuals or groups, and when it supports sociability” (Carr et al., 1992, p. 59).

Safety, on the other hand, is often named among crucial attributes of public space. The safety of public space has various dimensions and may be achieved through different means. For example, safety in terms of crime prevention may be ensured not only through proper infrastructure or VC or police surveillance but also through the presence of the public in this place, so-called “eyes on the street”. Some empirical studies also showed, for example, that public spaces are perceived as safer if there are stores and other non-residential properties (Perkins et al., 1993). Another essential dimension of public space safety is traffic safety because public spaces are primarily targeted to pedestrians (Mehta, 2014).

Another dimension is comfort, which may be represented in two main aspects. Firstly, comfort is highly dependent on the infrastructure providing comfortable microclimate like protection from sun, wind and rain, as well as psychologically comfortable setting. For example, Hass-Klau et al. (1999), after conducting a study in 20 towns and cities, came to a conclusion that social activities were mainly happening in sunny spaces with not much wind. Secondly, on top of climate and overall setting, comfort is based on facilities supporting activities in a public space, like sitting areas, walking paths, street furniture, etc.

The last public space dimension proposed by this framework is pleasurability which can be explained through spacial factors like human scale, sense of enclosure and “imageability”, which is, as formulated by Lynch (2008), the ability of space to form coherent impressions through shape, colour and other vivid attributes. Its authors implemented this five-dimension framework to evaluate existing public spaces. However, it is outlined that it also has excellent potential to be used in planning and designing new

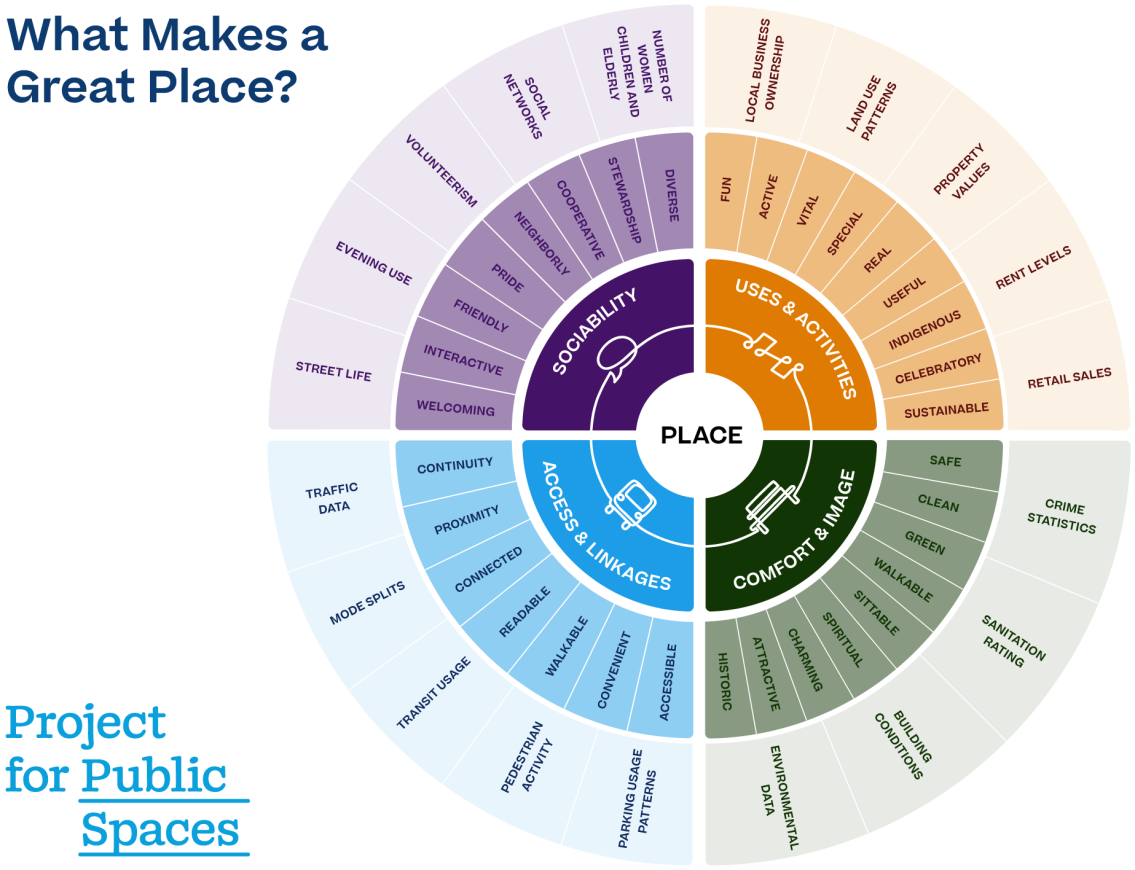
public spaces or developments of existing ones in order to better meet the needs of the society (Mehta, 2014).

Another author who evaluated public spaces was Matthew Carmona (2019). In his work, he compared successful public spaces across London city and derived principles that make a good public space. According to him, successful public spaces are those that are:

1. Evolving (whether formal or informal in nature).
2. Diverse (avoiding one-size-fits-all).
3. Free (with secure rights and responsibilities).
4. Delineated (clearly public in their use).
5. Engaging (designing in active uses).
6. Meaningful (incorporating notable amenities and features).
7. Social (encouraging social engagement).
8. Balanced (between traffic and pedestrians)
9. Comfortable (feeling safe and relaxing).
10. Robust (adaptable and distinct in the face of change) (pp. 57-58)

Another noticeable approach to public spaces design is the “great place” definition developed by Project for Public Spaces (2019), presented in Figure 2.4. This concept is based on another peace research that was a three-year study conducted by Gallup of the 26 communities across the United States attempting to determine the factors that attach residents to their communities and if this attachment plays a role in the economic growth of the region (Knight Foundation, n.d.). As a result, researchers derived three qualities of a place that lead to place attachment: Social offerings (meaning opportunities for social interaction); Openness (meaning the appearance of the space being welcoming for users); Aesthetics (physical appearance and green spaces) (Knight Foundation, n.d.).

These are the factors that served as a basis for the “great space” concept presented in Figure 2.4.



Source: Project for Public Spaces (2019)

Figure 2.4 What Makes a Great Place?

The concept consists of four parts that represent four key attributes public space should have: Access and linkages, Comfort and image, Uses and activities, Sociability. All these attributes have intangibles represented by adjectives one could describe such space, for example, “safe”, “sittable”, “walkable”, etc. Attributes also have measurements – to make success tangible, for example, “crime statistics” or “environmental data”. This framework, perhaps, presents the most general yet detailed overview of attributes or characteristics associated with public space.

To provide an overview of the frameworks and models discussed in this chapter, Table 2.1 presents a summary of attributes and characteristics of a public space suggested in the observed literature. The table includes only summaries of works that presented structured representation of public space. The works that provided less structured analysis are also discussed above, but were not added to the table as they are harder to compare in such type of representation.

Table 2.1 Public space design frameworks and models

Title	Author, year	Summary
The Star Model of Publicness	Varna & Tiesdell, 2010	Public space dimensions, defining its publicness: ownership, control, civility, physical configuration and animation.
Five Dimensions of Public Space	Mehta, 2014	Design aspects: inclusiveness, pleasurability, safety, comfort and meaningful activities.
Principles for public space design, planning to do better	Carmona, 2019	Successful public space principles: evolving, diverse, free, delineated, engaging, meaningful, social, balanced, comfortable, robust.
What makes a great place?	Project for Public Spaces, 2019	Public space attributes: access and linkages, comfort and image, uses and activities, sociability.

2.2 Smart Sustainable Cities and Public Spaces

As was outlined earlier, for many challenges cities are experiencing, information technologies are offering endless solutions. As this thesis is dedicated to the investigation of such possibilities in the context of public spaces development, the current chapter is focused on an overview of such innovative concepts as smart cities and smart sustainable city at last presenting the state of research related to the implementation of these concepts to urban design and public spaces development in particular.

2.2.1 Smart Cities Frameworks

The following paragraphs present an analysis of the literature focused on the conceptualisation of Smart Cities (SC). The definitions of smart city are presented and discussed first, followed by various frameworks depicting this complex concept, lastly, criticism of smart city concept is provided.

Many authors outline that there is an inconsistency in definitions of a smart city in academia, as it is a new and very complex phenomenon (Dameri, 2013; Neirotti et al., 2014). Therefore, they attempt to depict the smart city concept into building blocks or aspects which, in their opinion, combined all together, make a sufficient representation of what a smart city is.

Renata Paola Dameri (2013) dedicated her research to finding a comprehensive definition of a smart city. Based on the analysis she performed, she proposed various building blocks and looked at the concept from different perspectives. Firstly, smart city development path: governance, vision, goals, projects, actors, technology. Dameri (2013) identified three crucial aspects regarding the definition of smart city (terminology; components; boundaries and scope) and based on that proposed a comprehensive definition: "a Smart City is a well-defined geographical area, in which high technologies such as ICT, logistic, energy production, and so on, cooperate to create benefits for citizens in terms of well-being, inclusion and participation, environmental quality, intelligent development; it is governed by a well-defined pool of subjects, able to state the rules and policy for the city government and development" (Dameri, 2013, p. 2549).

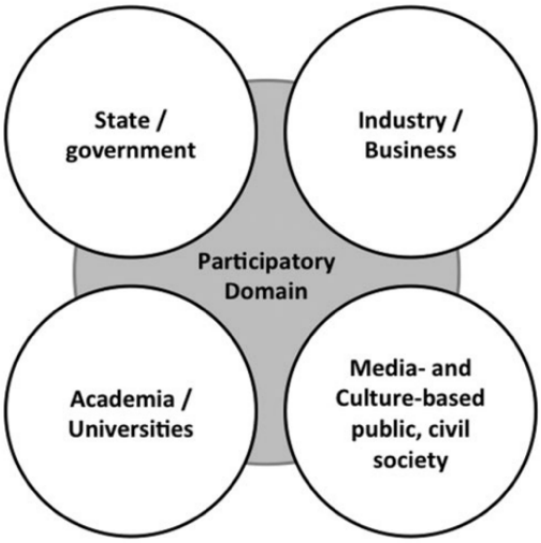
Su et al. (2011), in their work "Smart City and the Applications", use the following definition: "Smart City is defined … as the use of information and communication technology to sense, analyse and integrate the key information of core systems in running cities. At the same time, a smart city can make an intelligent response to different kinds of needs, including daily livelihood, environmental protection, public safety and city services, industrial and commercial activities." (2011, p. 1028). Authors perform further analysis of a concept and, as a result, propose the "Technical Architecture of a Smart City", consisting of three layers, namely application layer, network layer and perception layer (Su et al., 2011). However, the technicalities of this paper go beyond the scope of the current research.

Apart from the works presented above, there are two views of conceptualising smart city that were defined in the literature review. Some authors (Lombardi et al., 2011, 2012; Nam & Pardo, 2011; van Waart et al., 2016) focus more on the stakeholders involved in the development of smart cities, their collaboration and processes related to this. Others (Anthopoulos, 2017; Giffinger et al., 2015; Rucinska, 2014) instead investigate the topics or streams of innovation and technologies that improve and digitalise the way cities function.

If talking about the first group, one of the most famous works related to a smart city concept is a framework by Lombardi et al. (2011) and based on the triple helix model of innovation previously theorised by Etzkowitz & Leydesdorff (2000). This extended triple helix model suggests that innovation in a smart city happens through collective efforts of three groups represented by nodes: University, Industry and Government. On the one hand, they act as generators of intellectual capital, creators of wealth and regulators of standards, respectively. Still, on the other hand, while cities are becoming smart, they utilise this smartness to support social learning, market-based entrepreneurial capacities

and knowledge-transfer abilities. Every two actors create an attribute while interacting. Knowledge, learning and market are evolving and improving due to the interaction of every pair of actors involved (Lombardi et al., 2011). This paper, if used to formulate the concept of smart city, is lacking attributes related to the results of innovation, explanation of what kind of solutions are considered. Thus, it is not sufficient on its own while building a conceptual representation of the smart city concept. However, it does provide a solid understanding of possible actors involved in the process and interconnections between them.

Later on, some researchers suggested that the quadruple version of the helix model of innovation that includes more actors/factors like media- and culture-based public, civic society or environment (Carayannis & Campbell, 2018) can also be applied to smart cities. For example, Figure 2.5 presents the adaptation of the quadruple helix by van Waart et al. (2016). The society here is included as the fourth actor, and all stakeholders interact through a participatory domain.

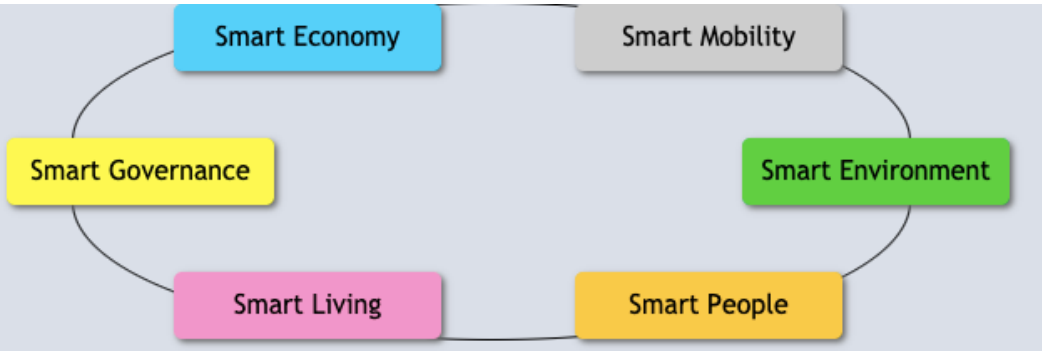


Source: van Waart et al. (2016), p. 712

Figure 2.5 The quadruple helix in the participatory domain

While focusing on the topics of innovation in a smart city, as Lombardi et al. (2012) also note in their later work, the exciting piece would be “The smart city model” by Giffinger et al. (2015). According to the authors, a smart city can be described as presented in Figure 2.6. These are critical areas of smart development identified, namely: smart governance, smart economy, smart mobility, smart environment, smart people and smart living (Giffinger et al., 2015). Based on these key areas, the authors proposed a system of

measurement and evaluation of the success of smart cities and published rankings using this approach.



Source: Giffinger et al. (2015)

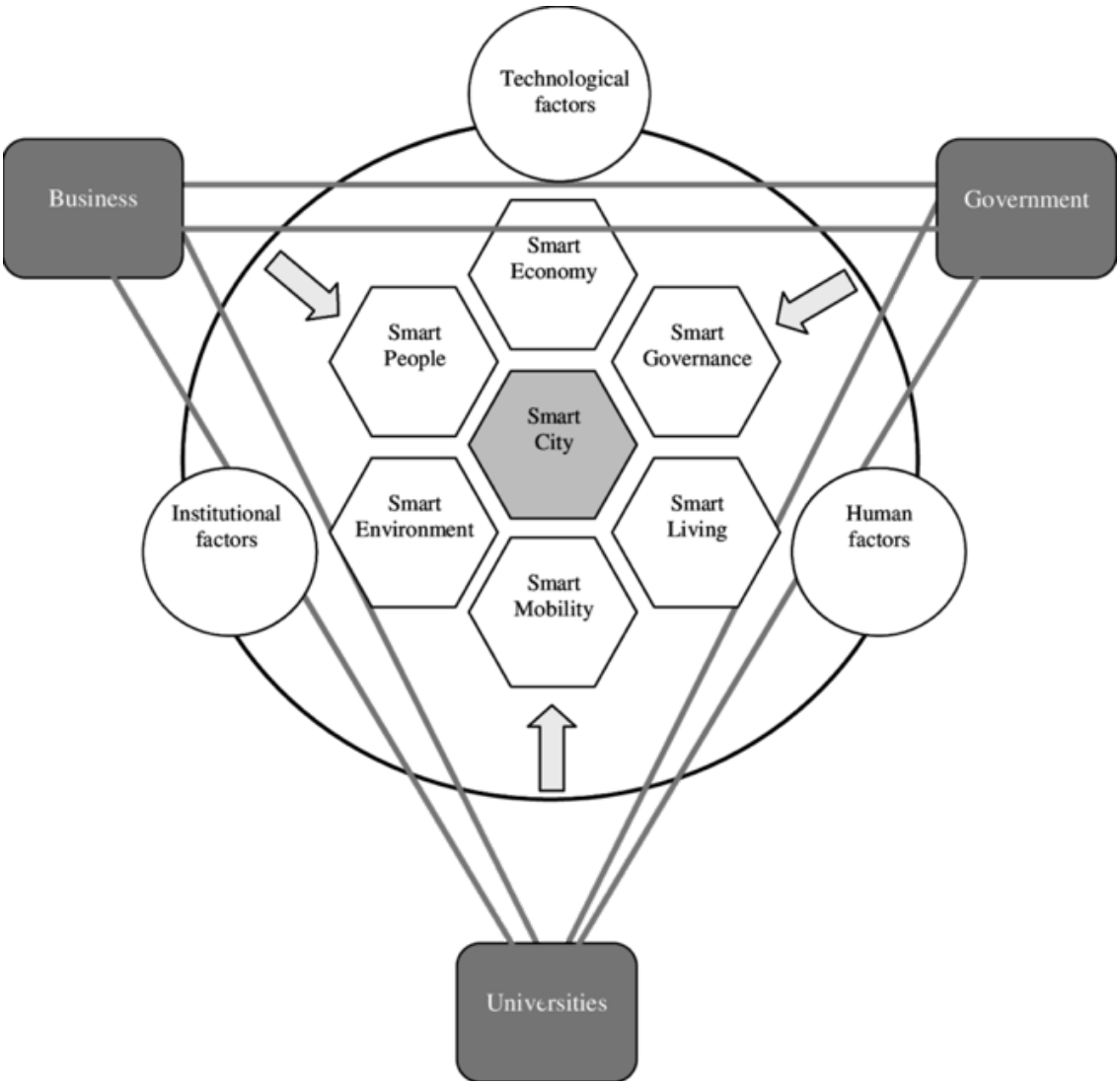
Figure 2.6 The smart city model

Even further with such an approach went Leonidas G. Anthopoulos (2017). After performing an extensive literature review that, among other works, also included works mentioned above (Giffinger et al., 2015; Lombardi et al., 2012), the author proposed the representation of a smart city, that has not only previously formulated by Giffinger et al. (2015) aspects like smart living, smart people, smart environment, smart governance, smart economy and smart mobility, but was also updated by such building blocks like smart infrastructure and smart services (Anthopoulos, 2017).

In our opinion, the choice to focus only on functional components is not optimal. Since many papers included in the literature review were taking different points of view, as for example, Lombardi et al. (2012) do mention the functional components derived from Giffinger et al. (2015). However, the focus of the paper is still on the triple helix proposed by authors and the interrelations of the helices. Whereas Hollands (2008), mentioned in the literature review, though not present in the proposed framework, performed a critical analysis of self-designated smart cities and offered a number of notions, also paying particular attention to the roles of the actors involved in the process. For example, he mentioned that truly progressive smart cities should find a balance of power between the use of ICT by government, business, communities, and others (Hollands, 2008).

Since in this research we do not go into technicalities of implementation of smart city concept, the representations of the concept through different technical infrastructures and layers, like, for example in Su et al. (2011), is not that relevant. Whereas papers discussing actors and processes (Lombardi et al., 2011, 2012; van Waart et al., 2016) as well as functional blocks or components (Anthopoulos, 2017; Giffinger et al., 2015) are definitely of use, though they do not represent the complete picture on their own. This is

it was decided to include another research in the current review. The paper by Rucinska (2014) includes an attempt to put together considerations of the two streams of research presented above. Such framework (Figure 2.7) not only represents the components of a smart city but also underlines its continuous development performed by actors represented by helices and affected by factors placed around the system. This framework thus provides a more comprehensive overview of the smart city concept than previously discussed papers.



Source: Rucinska (2014), p. 782

Figure 2.7 Connection of components of smart cities and Triple Helix model (Learning smart city?)

Table 2.2 summarises the main aspects of smart city frameworks discussed in the current chapter. It mentions the focus of each framework discussed, as well as summarises the key points.

Table 2.2 Smart city frameworks

Title	Author, year	Focus	Summary
An Advanced Triple-Helix Network Model for Smart Cities Performance	Lombardi et al., 2011	Stakeholders and innovation processes	Actors or stakeholders: university, industry, and government. Additionally includes three elements: knowledge, learning, and their institutionalisation within the market are produced by the interplay of the three nodes.
Quadruple helix in the participatory domain	Carayannis & Campbell, 2018	Stakeholders and innovation processes	Actors or stakeholders: state or government, industry or business, academia or universities, media- and culture-based public, civic society or environment.
The smart city model	Giffinger et al., 2015	Functional domains of innovation	Domains or aspects: smart governance, smart economy, smart mobility, smart environment, smart people and smart living.
Smart city components	Anthopoulos, 2017	Functional domains of innovation	Domains or aspects: smart living, smart people, smart environment, smart governance, smart economy, smart mobility, smart infrastructure, smart services.
Connection of components of smart cities and Triple Helix model (Learning smart city?)	Rucinska, 2014	Stakeholders and innovation processes, functional domains of innovation	Domains or aspects: smart governance, smart economy, smart mobility, smart environment, smart people and smart living. Actors or stakeholders: universities, business, government. Factors: technological, institutional, human.

It is important to note at last that the concept of a smart city is largely criticised for not being as smart as it should be, judging from its name, and its effects on the lives of citizens are questioned. The most common critiques of smart cities that can be found in the literature are the following: technocratic and corporatised forms of governance, hackability, panoptic surveillance, predictive profiling and social sorting, the subjectiveness of data and algorithms (Marvin et al., 2015).

For instance, Wolfgang Drechsler and Vasilis Kostakis (2020), in their article "Is the Smart City a Good City?" argue that if a city is a smart city, it does not necessarily mean that it became "intelligent", but it's rather about the simple implementation of information technology in a city aimed to improve the performance of urban services and to cut costs and resources consumption where possible. However, effective engagement of citizens and focusing on the improvement of their lives, in their opinion, come last or practically doesn't happen at all (Kostakis & Drechsler, 2020).

2.2.2 Smart Sustainable Cities Concepts and Frameworks

The criticism of the smart city concept presented above resulted in a significant shift in the literature, as authors started to specifically emphasise that the smart city concept is too technocratic and limited (Lara et al., 2016; Nam & Pardo, 2011), whereas it should consider ICT only as a tool, not as a result. The result should be value for the city and citizens, and the concept should become more citizen-centric (Lara et al., 2016).

One of the common ways to express those values cities are trying to achieve is sustainable development. As outlined by some researchers (D'Auria et al., 2018), a smart city can be considered a system of tools and guidelines to transform a city, whereas a sustainable city is more of an approach and philosophy that may be applied to such transformation.

Even though the question of sustainability started to gain attention a long time ago, with the introduction of the 2030 Agenda for Sustainable Development, adopted by all United Nations Member States in 2015, the topic of sustainable urban development became a topic of wide discussion and institutions all over the world became integrating 17 Sustainable Development Goals (SDGs) in their operational and strategic acts, as well as cities now necessarily have a sustainability strategy. In the context of cities, many SDGs are applicable. However, the most relevant is the 11th goal as it states explicitly, "Make cities and human settlements inclusive, safe, resilient and sustainable" as well as specifies various targets like 11.3 "By 2030, enhance inclusive and sustainable urbanisation and capacity for participatory, integrated and sustainable human settlement planning and management in all countries" or target 11.7 "By 2030, provide universal access to safe,

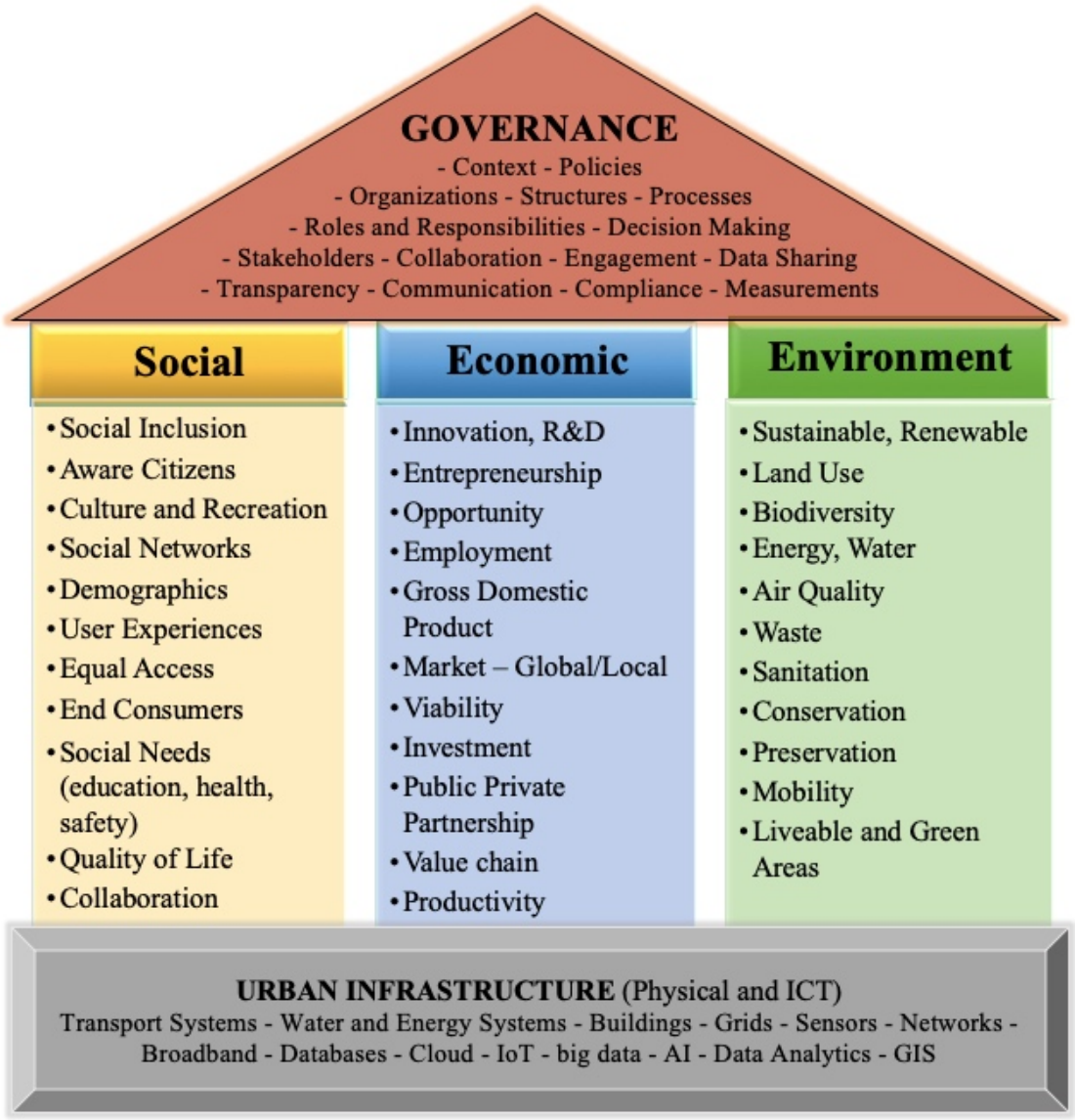
inclusive and accessible, green and public spaces, in particular for women and children, older persons and persons with disabilities" (United Nations, 2021).

However, some studies argue that despite increased awareness of the urgent need for responding to sustainability challenges, there are still few initiatives making an impact in shifting urban development to a sustainable, resilient and climate-neutral path. According to McCormick et al. that investing in the improvement of governance and planning is crucial to foster the transition (McCormick et al., 2013). Smedby & Neij (2013) in their work on experiences in urban governance for sustainability support, also express the need for further development and investigation of processes for urban governance for sustainability.

Such need for sustainable development merged with the need for the shift towards less technocentric research around smart cities resulted in the development of a concept of Smart Sustainable City (SSC). However, as outlined by de Azambuja et al. (2020), as well as in the research stream related to smart cities, the smart sustainable city concept has different explanations and remains somewhat fuzzy.

Though, in their research, de Azambuja et al. (2020) take an attempt to clear the fog around the concept and propose their own definition. According to the authors, *Smart Sustainable City (SSC) is an approach for overcoming the urbanisation challenges with the help of Information Communication Technologies (ICT)*.

Moreover, the study suggests a comprehensive representation of smart sustainable city attributes (Figure 2.8) based on the literature review that underlines the three pillars of sustainability (social, economic and environmental), urban infrastructure connecting the SSC elements, and the governance dimension. As emphasised by the authors, the latter is often ignored while defining a smart sustainable city (de Azambuja et al., 2020).



Source: de Azambuja et al. (2020), p. 634

Figure 2.8 Smart Sustainable City Conceptual Framework

As we can see, both in urban design and smart development, sustainability transforms the discourse and forms a whole new stream of research and practice. Therefore, we find it crucial to perform our research using the term smart sustainable city instead of just smart city. In this research we do not give a new definition to this concept but use the explanation given by de Azambuja et al. (2020).

2.2.3 Smart Sustainable Cities and Public Spaces

While attempting to conceptualise both smart and sustainable cities, many researchers outline a liveable and healthy environment as an essential element. For example, Giffinger et al. (2015) smart environment and smart living are crucial dimensions of a

smart city. At the same time, Renata Paola Dameri (2013) supports that, saying that it should create “benefits for citizens in terms of well-being … environmental quality” (p. 2549).

However, if one tries to search the literature related to the topic of public spaces in a smart or smart sustainable city, it turns out that it is somewhat limited. As was mentioned before, most of these articles that come up on Web of Science, Google Scholar or Limo while using search combinations like: [“Smart City” AND “Public Spaces”], [“Smart Sustainable City” AND “Public Spaces”] or [“Smart Public Spaces”] are rather technical and provide no systematisation or conceptualisation of this field, nor they provide an interrelation of public spaces and smartness or sustainability of a city. Many of these research papers are focused on rather lower-level view and discuss possible smart initiatives or technologies implemented in public spaces. In this chapter, some examples of such papers are presented, attempting to systemise possible solutions in the topic of smart sustainable city initiatives for public spaces.

To bring more clarity to the systematisation presented below, as well as for the later parts of this research, the following definition was formulated based on the literature observed: *Smart Sustainable City Initiatives for Public Spaces are the solutions for creation, improvement, or management of public spaces, that are advancing sustainable development of an urban area by using smart approaches.* It is crucial to additionally note that by smart approaches we mean utilisation of data-driven and IT-empowered methods, however, these methods can be not only incorporated in the solutions themselves, but also support the development of such solutions. An example to illustrate this idea can be Superblocks in Barcelona, as the planning and the assessment of these projects included extensive data analysis and use of IT tools, however the core solution is more related to the implementation of new urban design, restricting car passage in the city area and creating walkable public spaces, rather than technology implementation (Vox, 2016).

The first group of studies identified is focused on the implementation of data-driven solutions, meaning both collecting data through IoT sensors and other means and enhancing public spaces performance through analysis of that data, for example, using Artificial Intelligence. Such papers seem to form a significant part of this field and may be related to different provisioned values like better mobility, economic growth, energy efficiency. Some of them contribute to the smart urbanism field, for example, discussing solutions for data-driven development of the brownfields in a city (Thomas, 2002). Or another example would be a study related to maintenance and utilisation, where authors elaborate on the technology for the sensors specifically for public spaces, aimed to collect

various types of data associated with public space, like weather conditions or utilisation, at lower cost (Lau et al., 2018).

The second stream, noticeable in the smart city literature regarding public spaces, focuses on solutions enhancing citizens' social engagement and participation in the life of their neighbourhoods. An example for this type of studies can be “Exploring Requirements for Joint Information Sharing in Neighbourhoods: Local Playgrounds in The Hague” by Slingerland et al. (2019), where authors performed workshops with citizens of different neighbourhoods to identify locations and the type of information citizens would like to discover, share, and create. Some of the examples of proposals for playful interaction and information sharing drafted based on the results of these workshops can be seen in Figure 2.9.

Source: Slingerland et al. (2019), pp. 312-313

Figure 2.9 Design options

The third stream lies in the intersection of smart technologies and urban design. Such studies try to urge about changes in citizens’ habits and needs that need to be integrated in contemporary urban design. Such studies may be related to the emerging fields of smart urbanism or sustainable urbanism. One of the examples might be the research performed in Ghent city in Belgium, authors of which were observing citizens’ behaviour in public space trying to analyse their awareness of the surroundings. The conclusion was that people spend a significant part of their time in public space looking at their gadgets, therefore, not paying much attention to the physical attributes of the space (like pavements, for example). That made authors to urge researchers and designers to adjust spatial analysis methods and rethink the public space, possibly integrating the virtual and the physical aspects of it (Argin et al., 2020).

The fourth group of topics is focused on the implementation of different types of applications and technologies, most often, to improve the experience of users in public spaces or to engage them to use them more. One of the examples might be a study on Artistic Social Labs (ASL). These ASLs are experiences of mixed reality designed to

provoke social engagement and reflection in public spaces. This was achieved through social touch as play (Lancel et al., 2019). The photograph of citizens exploring the tool is presented in Figure 2.10.

Source: Lancel et al. (2019), p. 303

Figure 2.10 Participants are exploring in the Artistic Social Lab. Connecting Cities

The last stream identified is related to safety in public spaces and, quite often, to the implementation of surveillance in public spaces. One of such papers provides an extensive analysis of the state of the art wireless visual sensor networks for surveillance. Based on this analysis, the authors make a conclusion that with the development of computing powers, surveillance cameras tend to become more intelligent and more connected. That offers many possibilities to get more insights from public space surveillance with better energy efficiency (Abas et al., 2014).

The only study found that can be compared with the current research is “The Study of the Smart City Concept Development, Based on Public Open Space Elements (case study: Kambang Iwak and Opi Jakabaring Lake)” by Amalia et al. (2020). This study attempts to elaborate on the interconnection of smart cities and the attributes of public space. After performing a qualitative assessment of two open public spaces in Palembang City, they came to a conclusion that there are elements of public open space that can support the smart city concept, specifically in such aspects as smart living, smart environment, and smart infrastructure. This study gives an intriguing insight that the current research is challenging.

3 Methodology

This chapter begins with presenting the research questions and explaining the theoretical framework formulated based on the literature review, followed by the methods chosen to conduct this study. The chapter is concluded by remarks on possible research limitations, analysing the potential downsides of the data gathering and analysis approaches chosen.

3.1 Research Questions and Theoretical Framework

The aim of this research is to put public spaces in the bigger picture of smart and sustainable development of urban areas, investigate their interconnections as well as provide insights on mechanisms and stakeholders who can advance smart sustainable city initiatives in the domain of public spaces. Based on the identified gap in the literature and further literature review, the following research question was decided to be asked in the current research: *How to create better public spaces in a smart sustainable city?* The hypothesis that was formulated based on the literature review suggests that *the implementation of SSC initiatives for public spaces supports the creation of better public spaces and strengthens the positive impact public spaces have on smart and sustainable development of a city*.

To guide the current research, the following sub-questions were additionally formulated:

1. *What are attributes of a better public space?*
2. *How can public spaces contribute to smart and sustainable development of a city?*
3. *How to implement smart sustainable city initiatives for public spaces?*

Since throughout the literature review, it was discovered that no framework describing the place of public spaces in smart sustainable cities is present in the literature, it was decided to integrate the theories on public spaces and smart sustainable cities to come up with a new framework for this research. This framework attempts to fill the gap present in the literature explaining the interconnection of public spaces and the overall smart and sustainable development of cities.

The suggested theoretical framework “Public Spaces in Smart Sustainable Cities” (Figure 3.1) represents the interrelation between parts of the concept of a smart sustainable city and public spaces as part of the urban landscape. It attempts to give an overview and present a bigger outlook on public spaces as a part of city development strategies. The following paragraphs explain the linkages between the current framework and scientific papers included in the literature review.

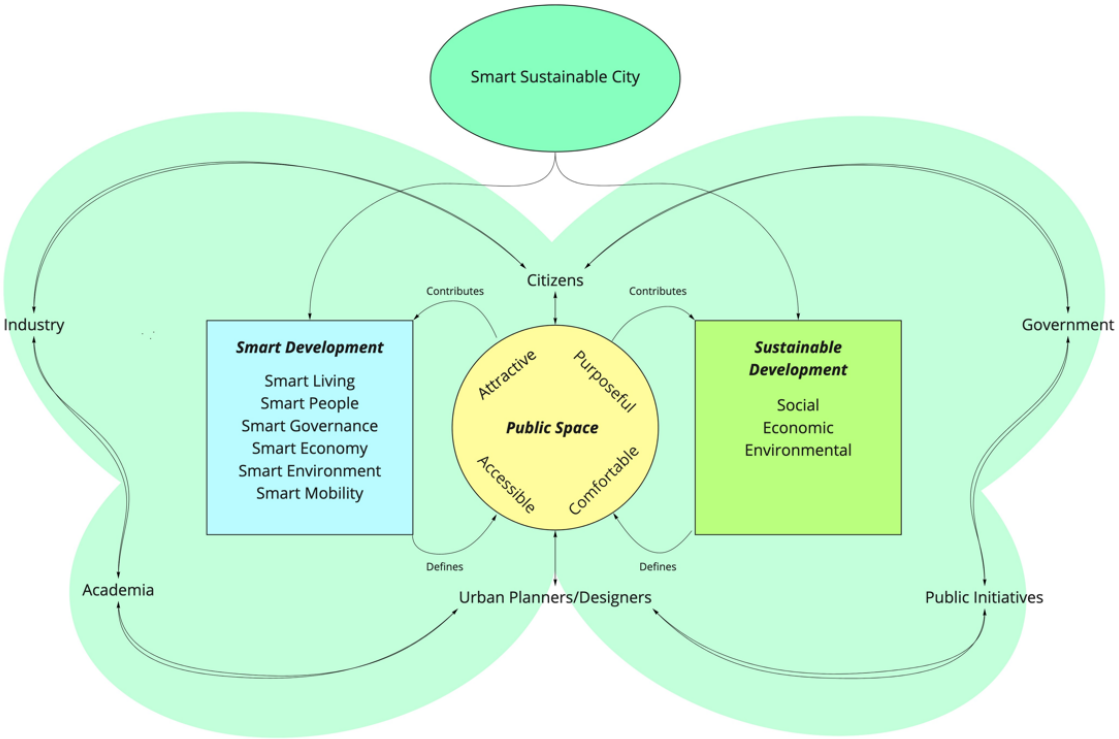


Figure 3.1 Theoretical framework: Public Spaces in Smart Sustainable Cities

Following Figure 3.1, the centre of the framework represents a public space itself. Such representation of the concept of the public space is chosen not by chance. Many authors (Mehta, 2014; Project for Public Spaces, 2019; Varna & Tiesdell, 2010) of both practical and academic papers mentioned previously in the literature review were representing public spaces with a circle or a hexagon that included different aspects or metrics over public space as sections of this circle or nodes of the hexagon. Therefore, this framework follows the same approach presenting essential attributes of a public space design and functions as sections of a public space circle. Those aspects are derived mainly from the works previously discussed in the literature review (Mehta, 2014; Project for Public Spaces, 2019). Namely, they are:

- Attractive – meaning both aesthetic aspects as well as being inviting and engaging.
- Purposeful – provides space and infrastructure for meaningful activities.
- Accessible – can be easily reached through different means of transportation and by foot, as well as not restricted to any groups.
- Comfortable – provides safe, healthy and comfortable space for everyone.

Based on the part of the literature review, which was focused on concepts of smart cities and smart sustainable cities, the context where public space is placed in the suggested framework is reflecting the derived notions regarding smart sustainable cities. Therefore, according to the concepts analysed in the literature review (de Azambuja et al., 2020; Giffinger et al., 2015) it was decided to interpret smart sustainable city as two main directions of city development that are supported by this concept, those are Smart Development and Sustainable Development.

The framework mentions functional domains as specific directions of smart development. Those are smart living, smart people, smart governance, smart economy, smart environment and smart mobility; which are widely used by various authors in the literature (Giffinger et al., 2015; Lombardi et al., 2012; Rucinska, 2014). Whereas the sustainable development part is represented by three pillars of sustainable development – social, economic and environmental sustainability (United Nations, n.d.) – that are also integrated into the works on smart sustainable city considered in this study (de Azambuja et al., 2020).

The last aspect of the framework is graphically represented as the butterfly wings. Those are actors involved in the process, as well as interconnections and communication links between those actors. This way of representation also follows the literature in the domain of smart cities that is focused on actors involved in the innovation processes (Carayannis & Campbell, 2018; Lombardi et al., 2011; Rucinska, 2014). All of the actors are connected to each other with two differently oriented arrows. This represents the flow of the information and collaboration between them. The collaboration is through, meaning that all of the actors are interacting with one another even though they are placed in the different parts of the framework and not connected with direct arrows.

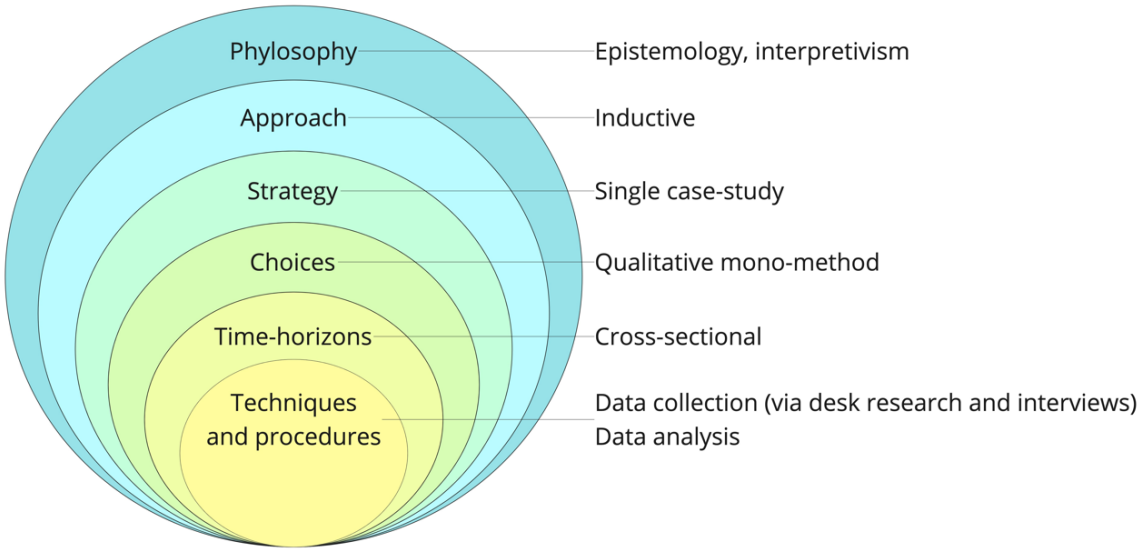
The first three stakeholders: industry, academia and government, are derived from the famous concept of the smart city triple helix (Lombardi et al., 2011). As was mentioned earlier, some authors also emphasise the necessity to include citizens in such a model (van Waart et al., 2016) as well as build the overall concept of a smart city with a strong focus on citizens as end-users of the innovations (Lara et al., 2016). Thus, citizens were put in the very centre of the framework and the linkages they have not only connect them to the other actors involved but also to the public space circle. This underlines that this group has the closest relation with the results of the innovation and utilises the space after its creation, thus, supposed to be involved in the process. Furthermore, since the literature related to public spaces emphasises the aspect of design and urban designers and urbanists as important actors in the creation and improvement of public spaces (Varna & Tiesdell, 2010), they were also added to the framework. Unlike government or academia, who are

rather involved in the higher-level processes like, for example, knowledge creation, urban designers are planning the final outlook of the space. Therefore, they work on the lower level and have a significant influence on the overall practical result. Thus, they are, as well as citizens, connected with public space representation on the framework visualisation with direct connection arrows. Lastly, some studies outline that non-profit or civic organisations can have a significant role in smart city initiatives (Nam & Pardo, 2011). Therefore, they are also represented as one of the stakeholder groups.

This theoretical framework (Figure 3.1) is an attempt to contribute to the existing gap in the literature related to the development of public spaces in smart sustainable cities. It is summing up the insights gathered through a literature review and serves as a basis for later parts of the current research.

3.2 Research design

This chapter is dedicated to the explanation of the research design deployed in this study. To achieve better clarity and accuracy of the structure of the research process, the research design was first represented using the approach of "research onion" proposed by Saunders et al. (2009). The adopted version of such a design is presented in Figure 3.2.



c.f. Saunders et al. (2009), p. 108

Figure 3.2 Methodological approach

Based on this representation, a more detailed step-by-step research process was formulated (Figure 3.3). This graphical representation provides an overview of the more detailed information on methods, case selection, data collection and analysis that is discussed in the following paragraphs.

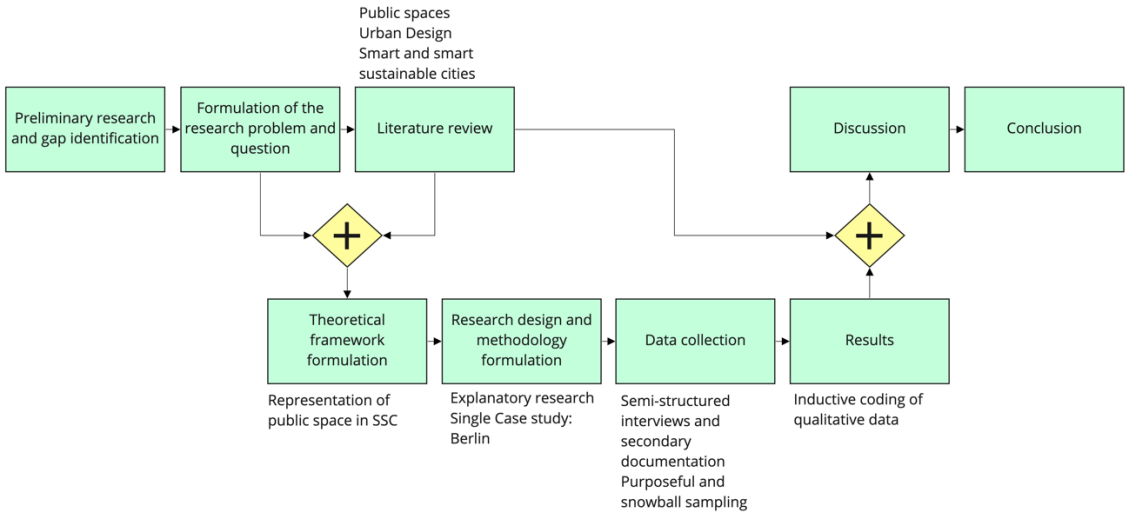


Figure 3.3 Research process

3.2.1 Methods

As indicated in the graphical representations above, this study adopts a case study approach to collect insights on public spaces in SSCs. The definition of this research approach used in this work is given by Abercrombie et al. (1984):

> Case Study. The detailed examination of a single example of a class of phenomena, a case study cannot provide reliable information about the broader class, but it may be useful in the preliminary stages of an investigation since it provides hypotheses, which may be tested systematically with a larger number of cases. (p. 34)

As outlined by Schramm (1971, as cited in Yin 2018), the essence of a case study is to illuminate a decision (or a set of them), emphasising why they were taken and how they were put into life. Thus, the approach of a case study was chosen because it suits best for answering the research questions that require an in-depth analysis of a phenomenon, in particular, research questions with “how” or “why” question words. Also, it is a suitable approach in such situations when the author has no control over behavioural events under investigation, and the study focuses on a contemporary, not yet thoroughly studied phenomenon (Yin, 2018). Since very little research was performed in the domain of public spaces in smart or smart sustainable cities and the concept of a smart sustainable city itself is very young, this approach was considered the most appropriate to use.

The findings could assist the current academic research field on smart sustainable cities and public spaces development providing the linkages between existing theories in both domains. If any new results could not be explained well by the current literature, this will

lead to the suggestions and hypotheses on smart sustainable initiatives implementation for public spaces that can be validated in future studies. In this way, a case study research design provides both possibilities to test existing theories as well as building new theories (Flyvbjerg, 2006). The current research both tests the existing theories related to public space design and smart and smart sustainable cities as well as builds new knowledge, as it proposes a new theoretical framework that is built upon the existing studies. However, it suggests a new interpretation and combination of the elements and knowledge domains, never presented in the literature before.

Single case studies are often criticised for being less generalisable than other research methods (Flyvbjerg, 2006). For example, (Yin, 2018) gives examples of multiple case studies elaborating on the idea that such studies provide space for finding similarities or, on the other hand, contrasting and comparing the cases. Obviously, single case studies do not share such advantages. However, the current study was aimed to provide an extensive description of some social phenomena that was never described before. Thus, given limited time and resources, it was concluded that providing an "in-depth" analysis of one practical example would add more to the current state of research rather than a less comprehensive view on several cases.

3.2.2 Case Selection

According to Yin (2018) a case could be defined as a geographical area, which suits the goals of the current research. In this particular case, the case under investigation can be a public space or a whole city, including its public spaces. The decision was made in favour of the latter option since, according to the formulated research questions, an attempt to put public spaces in the bigger picture of the overall smart sustainable development of an urban area is taken. Thus, having public space as a case without having a context of a city as a whole wouldn't fit with the defined research questions. Based on this logic, it was decided to consider smart sustainable cities as potential cases for the current research.

Apart from a necessity of a case being defined based on and accordingly to the initial research question, Yin (2018) underlines the importance of data availability. That was a vital aspect as the author chose to perform a single case study. Thus, some blockers or insufficient data could put at risk the whole research (Yin, 2018).

Among the reasons that led to the selection of Berlin, it is that it can be considered a SSC. Berlin ranks 23th in top smart cities (*Top 50 Smart City Governments*, n.d.) and 38th in Smart City Index rating in 2020 (IMD, n.d.) which makes it one of the well-developed and leading smart cities globally. Additionally, Berlin holds 18th place in Sustainable Cities Index (Binst, 2018) which, if put together, makes it a successful smart sustainable

city. However, there are many other cities around the world that would fulfil such criteria and what narrowed the case search to the case of Berlin is data availability.

As the author of the study was in cooperation with Green City Solutions GmbH, a representative of the tech industry in Berlin, providing smart solutions for public spaces, this allowed getting better familiarity with the case before conducting the research. This resulted in two significant upsides of conducting research on the Berlin case. First, familiarity with existing smart and sustainable initiatives helped to better structure the study and form adequate expectations and hypothesis about the results of the research. And second, physical presence in Berlin and cooperation with the industry was a significant advantage while performing the data collection.

Apart from the reasoning provided above, what makes Berlin stand out is its historical perspective. Due to the existence and the end of the Berlin Wall in the nineties, despite being an old and big European city, Berlin urban landscape remains very flexible, still being defined and goes through the stage of intensive development. It's the first inter-agency model for long-term, sustainable development since the reunification of Germany in 1990 was formulated just less than a decade ago (Hebes et al., 2015). This makes it incredibly insightful to look into the public spaces' aspect of the city development.

On the other hand, the smart aspect of city development is now being redefined in Berlin as a city is adopting a new smart city strategy in 2021 (CityLAB Berlin, 2021). This provided a chance to also look at the case retrospectively to evaluate how did smart strategy of a city change in terms of integrating sustainability aspects and recognising the importance of public spaces creation and improvement.

3.2.3 Data Collection and Analysis

This study attempted to investigate the interrelations of various elements as well as processes and actors involved not to compare or assess them but to provide insight and ground for further research. Therefore, the author used secondary documentation to get more insights about the case as well as semi-structured qualitative interviews to collect primary data from respondents from Berlin from the actor groups presented in the theoretical framework (Figure 3.1), which are Government, Industry, Academia, Urban Planners/Designers, Public Initiatives, and one additional group – Middle-agents. Later the results were structured and analysed using inductive coding. The more detailed information is provided below.

Since this study is focused on the contemporary phenomenon and uses a single case study approach, it was decided that collecting qualitative data would give the best result in terms

of insights and explanations. Among the qualitative research methods, semi-structured interviews were chosen to be used. This is because such interviews are more flexible than structured interviews, though they do provide more participant guidance than unstructured ones (Gill et al., 2008). They contain some crucial questions; however, they leave room for discussion and elaborations on some topics. Therefore, they allow participants to address topics or aspects that the interviewer may not have considered while designing the interview (Gill et al., 2008).

This study's interview questions were developed based on the literature review and the framework formulated based on this literature. The interview protocol consisted of three parts tracing back to the topics presented in the literature review: Urban Design and Public Spaces; Smart Sustainable City; Smart Sustainable City Initiatives for Public Spaces. As interviewees had different degrees of familiarity with the topic or had expertise in only some or one of the topics discussed, the interviews were focused on different parts of the interview protocol based on the interviewee preference and expertise.

The interviewees were provided with the interview protocol (Appendix A) prior to the interview upon request. All interviewees were warned in both written and oral form that the interview would be recorded. The verbal consent from all of them was received prior to starting the recording. All interviews were conducted in a format of a video call via MS Teams that took between 40 and 60 minutes. The interviews took place in the period from 10.06.2021 until 12.07.2021, such a long period of time is defined by the sourcing strategy chosen, which is explained in detail below. All the recordings and transcripts are privately stored in the cloud drive[1].

The author used a convenience sampling method represented by a combination of purposeful and snowball sampling to source interviewees. The purposeful sampling is based on the selection of candidates that would provide the best answers to the research questions. Thus, one assumes that certain groups (in the particular case of this research – the groups formed based on the literature review and presented in the framework Figure 3.1) should have a unique, different or important perspective on the topic (Robinson, 2014), so they worth including in the sample. This was combined with snowball sampling, which is a widely used practice (Parker et al., 2020) since snowball sampling allows to reach further participants through the current participants, thus is helpful in reaching out to groups that are not easily accessible. This, for example, may be useful for minorities or vulnerable groups (Parker et al., 2020). Still, in our case, it is just experts with tight schedules that are easier persuaded to talk with a warm intro rather than cold outreach.

[1] Access link: https://drive.google.com/drive/folders/1xgq9CRUqBVF41S32vLV0yxDG56bWhPCo?usp=sharing (permission required to view the content)

This approach creates a ‘snowball’ effect, and the outreach stops only after the intended number of participants is achieved (Parker et al., 2020).

Initially, it was decided to contact representatives from all the stakeholder groups presented in the framework (Figure 3.1), except for the “Citizens” group, and send invitations to at least five persons per group. These persons fell under the following criteria: (a) they represent at least one group mentioned in the framework, (b) they are active with their professional occupation in Berlin.

The important note is that due to using snowball sampling as one of the approaches, another group organically emerged. Based on recommendations of existing participants, it was discovered that funds and accelerators, which were named “Middle-agents” in this study, are also playing a significant role in the implementation of smart sustainable initiatives in public space in Berlin. Thus, representatives of one extra group, not previously formulated based on the literature review, was included in the sample. The sampling was finished when the intended number of 10 participants was achieved, with at least one participant from each group.

The primary data collected from the interviews was qualitatively analysed through means of inductive coding. This method represents a process in which the researcher reads and interprets raw textual data to develop concepts and make interpretations based on data (Chandra & Shang, 2019). This approach was found suitable for the current research as it is often implemented while analysing data in areas with limited knowledge or emerging fields of research (Chandra & Shang, 2019), which can be applied to public spaces in SSCs.

The coding was performed using a software package for qualitative and mixed methods research MAXQDA2020. The analysis resulted in 292 coded text sections. The “code cloud” – a compilation of the most popular codes, those with the frequency of at least four mentions across all transcripts – is presented in Figure 3.4.

Figure 3.4 Code cloud

The code system was organised into groups for the convenience of further analysis. The group names are: “Berlin smart development: Progress and directions”, “SSC initiatives in public spaces: How-to”, “SSC initiatives in public spaces: Examples”, “Public spaces: Attributes and functions”, “Berlin urban development: Progress and directions”. The complete code system is presented in Appendix B.

It is important to note that the theoretical insights were gathered through the literature review and the data collected from secondary documentation and semi-structured interviews, including different groups of stakeholders to represent different views and perspectives on the same topics. Thus, data source triangulation – the approach of collection from various data sources (Carter et al., 2014) – was used to ensure the validity of the current study.

3.2.4 Limitations

The first concern that might be drawn regarding single case study design is “putting all eggs in one basket” situation, that as suggested by Yin (2018) if any blocker or issue occurs might ruin the whole research. This was a risk the author had taken when chose such a design. However, the substantial evidence was that data for the selected case would be available, which turned out to be accurate as the desired number of interviewees was reached, and essential insights were collected. Thus, such a flaw of the single case study research design did not affect the results of the current research.

The small sample size and excluding the citizens from this study would also be a fair criticism of the current work. However, the author is convinced that the strategy taken was the most optimal given time and resource limitations. Even though the sample is small, the attempt was taken to provide diverse views and avoid bias by representing all the expert groups included in the framework.

Citizens were excluded, though, because the fair representation of such a big group could not be done in the same manner as all the others. This would require a different approach to sampling and data collection and a whole separate analysis since there was no possibility to perform semi-structured interviews with a massive sample of participants. Thus, since all the experts who participated are also citizens, they indirectly provide their view on the process from the position of the user as well. Most importantly, public initiatives also represent concerns of significant parts of society. Thus, citizens were not absolutely excluded from the study.

4 Results

This chapter provides an extensive overview of the data gathered through secondary documentation analysis and interviews. It starts with a general overview of the case, providing the background on Berlin city structure and government, urban development in Berlin and the city's smart and sustainable development in past years. This is followed by a deeper look taken onto the topic of public spaces and their role in the smart sustainable development of the city. The latter part is organised accordingly with the interview protocol; however, it integrates not only insights from the interviews but also information from the secondary documentation.

4.1 Case Background

The city of Berlin is The capital of Germany and the largest city in the country by both area and population (von Wartenburg, 2020; Waltner, 2019). It has a population of over 3,6 million people with makes it the biggest city in the European Union according to the population living inside city boundaries (Statistik Berlin-Brandenburg, 2020). However, the city population has declined over the year 2020. Moreover, the was the migration population loss recorded, of -1,958, for the first time since 2000 (Statistik Berlin-Brandenburg, 2021). Berlin is surrounded by the State of Brandenburg and contiguous with Potsdam, Brandenburg's capital. Together they form Berlin urban area (Joint State Planning Department Berlin-Brandenburg, 2021).

Since reunification on 3 October 1990, Berlin has been a city and a Land of the Federal Republic of Germany – a state. The executive body of Berlin is the Senate of Berlin. The Senate consists of the Governing Mayor, and a maximum of ten other Senate members, two of them holding the title of "Mayor" as deputy to the Governing Mayor. The House of Representatives – the city and state parliament, which has 141 seats (The Berlin House of Representatives, 2016).

The Governing Mayor also has titles of Lord Mayor of the City of Berlin and Minister President of the State of Berlin. Since 2014 the office is held by Michael Müller, born in Berlin, representing Social Democrats in the Berlin House of Representatives since 1996 (The Governing Mayor of Berlin Senate Chancellery, 2021a).

The structure of the city government is rather complex. Berlin consists of 12 boroughs or districts Figure 4.1. Each borough has subdistricts or neighbourhoods. Many residents strongly identify with their neighbourhoods, colloquially called Kiez (Berlin Tourismus & Kongress, n.d.-a; The Governing Mayor of Berlin Senate Chancellery, 2021b).

Source: Haake (2021)

Figure 4.1 Berlin Kiez guide

Each borough is governed by the Borough Assembly, the Borough Office and has the Borough's Mayor. Nevertheless, the boroughs don't have full independence. They are still under the Senate of Berlin. The Boroughs' Mayors form the Council of Mayors, which is led by the city's Governing Mayor and advises the Senate. The Governing Mayor meets the Council of Mayors at least once a month. The neighbourhoods don't have any more local government bodies (The Berlin House of Representatives, 2016).

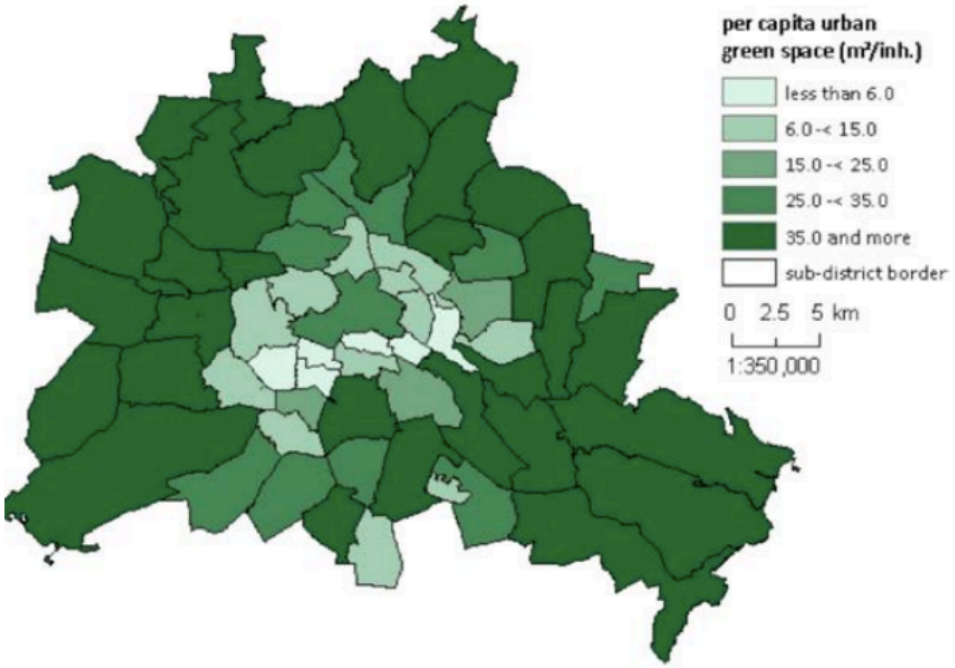
4.1.1 Berlin Urban Development

After the Fall of the Wall and the reunification of the city in 1989, a period of intensive urban development in Berlin has begun. In the 1990s, large-scale constructions in areas around Potsdamer Platz, near the new seat of the Federal Government, on the banks of the river Spree and in the historical centre of the Friedrichstadt were organized. This development was intended to attract investment, visitors, and human capital to the city of Berlin, promoting the "new Berlin" era. However, these actions did not give an as significant boost as expected, and in the 2000s, Berlin was still far from becoming an economic powerhouse of global importance like London or New York. Whereas the government of the Berlin city region nearly faced bankruptcy in 2001 (Colomb, 2012).

This resulted in a mass culture of temporal use of the brownfields and voids present in the city, with was later recognized by the city government and followed-up by policies, setting up a trend promotion of concepts of “creative city” and “creative spaces” motivating different citizen initiatives to use the former “urban voids” (Colomb, 2012). This significantly affected the overall landscape of a city we can see today with its club scene, startup culture and so on.

When it comes to the latest developments in a city, the overall picture is positive. According to Mercer (2019), Berlin ranked number 13 in the Quality of living city ranking in 2019. This is, though, not the best result in the country – Munich, Düsseldorf and Frankfurt were included in the top ten.

Regarding the development of open public spaces, it is often emphasized that Berlin is doing good in terms of the provision of green spaces (Kabisch, 2015). In most of the Berlin sub-districts, residents have access to sufficient urban green spaces (see Figure 4.2).

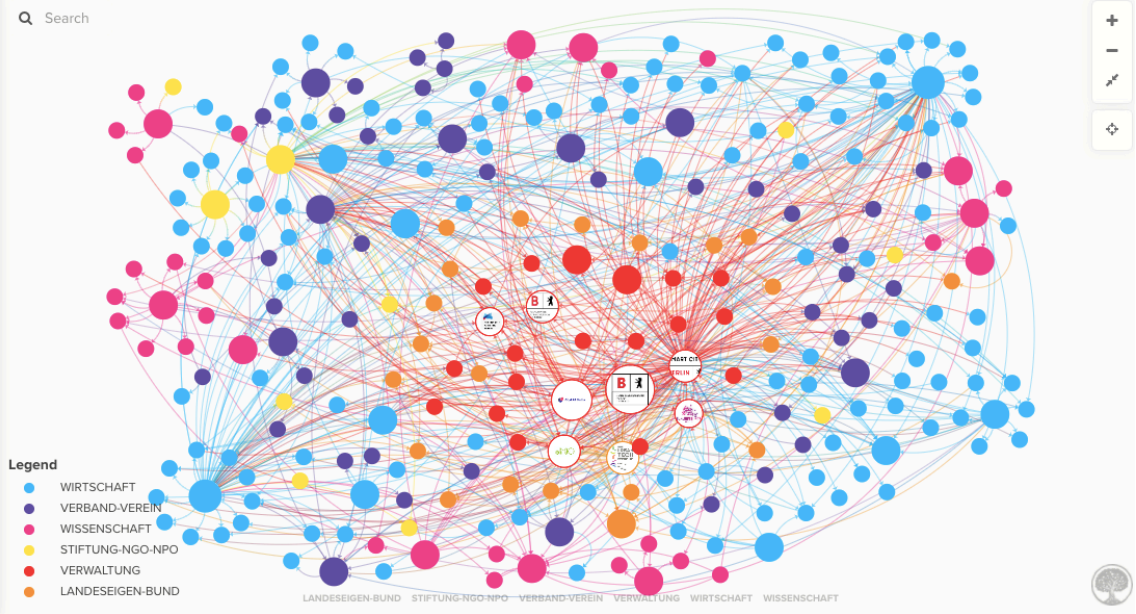


Source: Kabisch (2015)

Figure 4.2 Per capita urban green space in the sub-districts of Berlin

4.1.2 Berlin Smart Sustainable Development

Over the past decades, as well as many other cities, Berlin adopted the smart city approach becoming the 23rd among smart cities globally (*Top 50 Smart City Governments*, n.d.) implementing numerous projects in the domains of sustainability, administration, security, health, urban and district development, education and social issues, citizen participation and many others (The Berlin Partner für Wirtschaft und Technologie, 2021). As well as establishing a wide network of partnering organisations to drive the innovation together (see Figure 4.3). The Governing Mayor of Berlin Senate Chancellery is supervising the process of smart development of a city, performs planning and managing state politics. The main drivers and executors of the smart development are the Senate Department for Economics, Energy and Public Enterprises and the following organisations, formed and owned by the state: Technologiestiftung Berlin, CityLAB Berlin, Geschäftsstelle Zukunftsorte as well as a public-private partnership Berlin Partner (Senatsverwaltung für Wirtschaft, Energie und Betriebe, 2021).



Source: Senatsverwaltung für Wirtschaft, Energie und Betriebe (2021)

Figure 4.3 Map of actors

Berlin has had a smart city strategy since 2015. "The objectives of this smart city strategy include expanding the international competitiveness of the Berlin-Brandenburg metropolitan region, increasing the resource efficiency and climate neutrality of Berlin by 2050, and creating a pilot market for innovative applications" (The Berlin Partner für Wirtschaft und Technologie, n.d.). The main dimensions of the strategy are smart administration and urban society, smart housing, smart economy, smart mobility, smart

infrastructures and public safety (Senate Department for Urban Development and the Environment, 2015).

Now, as part of the "Smart Cities Model Projects" programme, a new smart city strategy is being developed for Berlin. It is a new, ambitious approach that focuses on participation, people and social good. This new strategy is formulated in a way that it would not have a technological focus, and instead, it should have co-design and inclusion as its core values. The strategy development and implementation, thus, include active dialogue with Berlin's diverse urban society and active citizen participation. With such proposal, Berlin applied to be a smart city model project in the program organised by the Federal Ministry of the Interior and got funding to implement this vision in the coming years (CityLAB Berlin, 2021).

With this shift of values present in the new smart strategy, Berlin is making a step from just smart to a smart sustainable city. However, having a separate sustainability strategy, Berlin was implementing a lot of environmentally, socially and economically important initiatives for years (Senate Department for the Environment, Transport and Climate Protection, 2020).

4.2 Findings

This part of the chapter presents the insights on public spaces in the smart sustainable city gathered from the interviews with representatives from Berlin, also reflecting on the secondary documentation studied. Table 4.1 presents the information about the interviewees and the codes assigned to them based on the stakeholder groups from the theoretical framework of this study that they represented. Interviewee code is composed of two parts. First, the letter reflects the stakeholder group: G – Government, A – Academia, I – Industry, P – Public Initiatives, U – Urban Planners/Designers, M – Middle-agents. The second part of the code represents the number of the interviewee in the stakeholder group.

Table 4.1 Interviewees

Interviewee code	**Interviewee profile**
A1	Researcher at LABOR K Lab, TU Berlin
A2	Researcher at TU Berlin, creator of Urbanu project[2]

[2] https://urbanuguide.com/

G1	Consultant at CityLAB Berlin, Technologiestiftung Berlin
G2	Consultant at Berlin Senate Department for Economics, Energy and Public Enterprises
I1	Partnership manager at Green City Solutions
U1	Author and consulting expert on urban and mobility futures
P1	Individual activist, creator of Park Project Berlin[3]
P2	Spokesperson at Volksentscheid Berlin autofrei
M1	C-level manager at Berlin Innovation Agency
M2	Project manager at Berlin Partner

The following paragraphs are structured accordingly to the questions asked in the interviews.

4.2.1 Urban Design and Public Spaces

To first gather more insights on the case, the questions regarding the assessment of the current urban development of the city were posed. When asked: "How would you assess the current practices of urban development in Berlin? (Would terms like, for example, "urban sprawl", "placemaking", "sustainable urbanism" apply?)" many respondents from both practitioners, government, civil society and academia (P2, M2, G1, A1) were emphasising that urban development in Berlin is very unequal and the development strategies taken in one part of the city may significantly differ from strategies in the other parts. Moreover, the distribution of public space is unequal too (A1). Some districts are taking sustainability more seriously than others. Thus differences might be radical, like, for example, a disappearing bike lane while following the same street but entering a different district (P2). This can be explained by the high complexity of the city structure and high autonomy of the districts, as well as by the complicated past development of the city when it was split into two by the Berlin Wall (Colomb, 2012). Almost all respondents agreed on the fact that Berlin has a very complex governance system, which causes differences in many parts of the regional agenda (P2, M2, M1, I1, G2).

Among the main problems that the city is facing in terms of urban development, participants named: the shortage of housing (P2, M2, G1, A2, A1), gentrification (U1,

[3] https://parkprojectberlin.com/

P2, A2, U1), the orientation of the infrastructure towards cars (U1, A2, G1) and urban sprawl (U1, P2, G2, A1, A2). It is important to note that if taking into consideration the historical perspective of the city having a lot of brownfields and undeveloped spaces, many respondents were emphasising that the strategy of massive development and privatisation of the space taken in the early years after the fall of the Berlin Wall was not optimal (U1, A2, A1) and possibly contributed to the housing shortage and inequality of public spaces distribution Berlin is experiencing now (P2).

"The city of Berlin sold a tremendous space of public space to private investors. And the sum of all this area summed up to an area of the size of Kreuzberg. So it's a huge amount of public space or publicly owned space has been sold to private investors. And, obviously, none of these private investors had any interest in sustainability but only in earning money, as much as they can earn."

(Interviewee U1)

Nevertheless, the emerged culture of temporal space usage by citizens, which was recognised by the government and followed up with policies, formed a specific attitude and will among social groups to influence the distribution of the public spaces and create a comfortable and thriving environment, attracting new human capital, innovation, and investment to the city.

"It's neighbourhood groups that are coming together and saying "Okay, let's do something, let's start a community garden on this vacant land". It gets popular, a lot of tourists come to see it. And then, all of a sudden, it becomes an economic draw engine."

(Interviewee A2)

Additionally, as stated by the governmental representative, the remaining brownfields in the city form a potential that is not present in fully developed cities to significantly improve the quality of life and sustainability of a city if the right decisions are taken (G2). On top of that, while discussing recent developments, some interviewees emphasised that they are satisfied with the infrastructure being green and sustainable. Participants were outlining that there are many green and urban public spaces are preserved and created in recent years (C1, P2, P1). However, the city does not actively utilise placemaking or sustainable place shaping as a dominating urban design approach (A2).

"I'd say it's a mixed picture, some sustainable actions mixed with some very unsustainable actions. But I wouldn't say that there's urban sprawl, I think, Berlin has a lot of green spaces, and I think they're relatively well protected."

(Interviewee C1)

While discussing specifically public spaces and their role in the life of the city, as well as in the city's sustainable and smart development, many important aspects were brought up. Participants were mentioning a lot that public spaces, especially green spaces, first and foremost, have a significant impact on the environmental sustainability of a city (A1, A2, G2, I1, M1, M2, P2). This incorporates many aspects such as, for example, increasing biodiversity and reduction of heat islands:

"A good example would be the Tempelhofer Feld. You know, this is a clearly popular project, which people called for because they need to have a space. But of course, it helps with many aspects of sustainability because it increases biodiversity, the animals which live there, it cools down the city, because it's an open space, which isn't covered in concrete."

(Interviewee P2)

Another important example outlined by just a few respondents is access to water (A2, P2). Not only in terms of drinking water but especially in terms of access to "blue" public spaces. Apparently, respondents were concerned about lakes and other water areas being underestimated in terms of their importance as public spaces. It was emphasised that some of these spaces are being privatised, which is a negative tendency as the access to water for citizens is a crucial benefit such spaces can provide.

"And I think the wider role of climate change will mean that water will become a new kind of public space discussion about who has access to water, not just in terms of drinking it, I think that, hopefully, will be guaranteed, but who can go and use it. And I already hear the discussions about trying to stop people from going in the water. So should that mean that people will only have the house at the front to go in the water or not? I think it's going to become a huge question in the next 20 years."

(Interviewee P2)

When it comes to such public spaces like streets, interviewees were outlining the potential in driving climate neutrality and reducing fine dust levels through the creation of pedestrian streets, bike lanes, sustainable mobility modes infrastructure and reduction of car lanes (U1, P2, P1, I1, G2, G1, A2, A1). Such initiatives additionally improve traffic safety (A1) as well as ease mobility, and improve the connectivity of other public spaces (A2).

In terms of public spaces social and economic sustainability, an important point that was brought up is the increasing of the area attractiveness. Respondents were suggesting that great public spaces not only attract more residents and tourists to visit the area of the city but also increase the value of the property around it and help small businesses to thrive (A2, A1).

Another important notion was that public space is a political space as well. It provides a possibility for the government to communicate some messages to the public (I1) as well as a possibility for the public to state their opinion, not only in the form of a protest but also by various means of public participation that can be embedded in a public space (I1, G2, A1).

"There might be a public Wi-Fi or some information outlet, but maybe today you have a smart wall of some news running or an advertisement screen where you can search for something or provide feedback."

(Interviewee G2)

On top of that, respondents were suggesting that the public spaces empowered with data-gathering technologies, like IoT sensors, are providing crucial insight on safety, weather and many other topics (I1). But, as was outlined before, to fulfil these and other functions, public spaces should be created in a certain way. To define the most important aspects of a public space, respondents were asked to describe how they view a good public space, based on both private and professional experience. Figure 4.4 presents an overview of the topics observed in the answers.

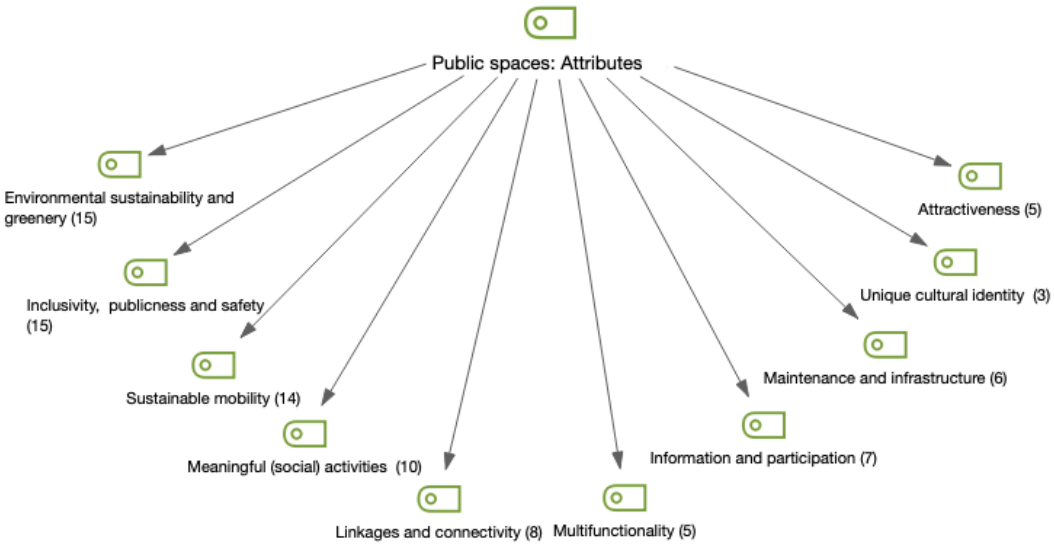


Figure 4.4 Public spaces: attributes

One of the most important characteristics that make up a good public space is its publicness. This can be decoupled into two main streams. First, there should be no physical, financial or other restrictions to stay in a public place. The design of public space should not restrict its usage by any representative of the society, based on his financial status, gender or any other reason (A1, G2, I1, M1, U1).

"And we have to transfer this to a city for women, and we have to transfer this to a city where the public has more relevance, and then the private issues."

(Interviewee U1)

The second aspect of publicness named by interviewees is physical inclusivity. This means that space should be accessible for not only people with good health and physical shape but for people with illnesses and disabilities. This can be achieved through providing, for example, smooth and barrier-free pavements, seating infrastructure, enough space for passage and so on (G2, P2).

The next important feature of a public space is safety. This means people spending their time in a public space should not only be safe, in fact but also, they should feel safe. Thus, they would come to this public space and spend time there. This is defined by inclusive design and focusing on the features important for safety for vulnerable groups of people. This is important to close the existing inequalities in public space usage and access (U1, P2, M2). However, the safety aspect of a public space not only includes safety from crime but also safety from traffic (P1).

Another discussion heavily linked to the previous aspect of safety from traffic is brought up by many respondents. This is an infrastructure for sustainable mobility modes and pedestrians. Since society is changing their mobility habits and becoming more conscious about the sustainability of their daily activities, many people are choosing to not use private cars but to travel sustainably, for example, by bike. Respondents were outlining that they consider public spaces with bike lanes, reduced car lanes, pedestrian streets, bike parking spaces to be better (U1, P2, P1, M1, I1, G2, G1, A2, A1).

"You definitely have a shift of where the stakeholders in the cities are trying to find new ways on try to find new modes of transportation, try reduce and then change the modes of transportation so that they are better for the environment."

(Interviewee I1)

The connectivity of public spaces was also emphasised in the discussion. Different means of transportation and easy connections make public space easier to reach. Thus it is better utilised (U1, P1, M2, M1, G1, A2, A1).

"Of course, public spaces should not be remote. A city has its core value because of the mobility you can create the accessibility of products, information and services. And that's why mobility is important in the public space."

(Interviewee M2)

The most mentioned feature of a public space was green infrastructure and environmental sustainability. The provision of greenery in a public space not only has positive effects on the environment but makes a space more attractive, pleasant, and enjoyable for visitors. Importantly, it has positive effects on both the physical and mental health of the residents (P2, M1, I1, G2, A2).

When further elaborating on the infrastructure of a public space, respondents were mentioning the provision of city furniture, especially providing a place to sit down, so people could spend more time in at a place. As well as amenities inviting for some meaningful activities and social interaction. An important note regarding social interaction is that it is considered one of the main functions of a good public space by most interviewees (P2, P1, I1, G2, A2, A1).

"I think the ideal use of public space would be that it is public in the first place. So that the public, the society, the people come together and meet each other. Like that's like the bare minimum, right. And when they meet each other, there normally is an exchange, there is debate, there is conflict, and all sorts of things happening around that."

(Interviewee A1)

However, social interaction is not limited to meeting people in this context. It could mean organising events, community meetings and initiatives. Some respondents were emphasising that public spaces that allow citizens to have their own agenda and events are more sustainable since they promote the feeling of responsibility and attachment in the local community (I1, G2).

"I think you need somebody that organises stuff that happens there, like inclusively organising life at the space. ... . Some circus there for kids or, I don't know, some art action. And I think you need to be a role model for this place to become alive."

(Interviewee G2)

This brings us back to the notion of public space as a political space discussed above. It was outlined that another feature that makes a great public space is the provision of information, or, even better, means for two-way communication with the authorities, citizen participation (I1, G2, A1).

Lastly, two more important aspects of a good public space are attractiveness and unique cultural identity. This incorporates the idea that public space should be aesthetically attractive, but also it should represent the culture of the society living around this space (U1, P1, I1). Moreover, some respondents believe that the non-functional but aesthetic attributes of a public space can be used to communicate some messages and affect people's mindsets (P1).

"The statues that exist in Berlin, over 90%, I think, out of 197 that are official monuments, only three are women. This is a problem, in my mind, of what is represented in the public space. And if, you know, we just always see men being celebrated in the public space, I feel like that influences the way what we perceive who's more important in our society."

(Interviewee P1)

All the previously mentioned aspects can be linked to the idea of multifunctionality, also often mentioned in the interviews. According to representatives of different stakeholder groups in Berlin, t is important for a public space to combine many aspects and functions to be effectively used and create more value for the citizens (U1, P2, I1, A1).

"I think a good public space is everything. It does not exclude functions. It incorporates relaxation, activity, an environmental setting, an educational space, a cultural space. So it is everything. … . For all these spaces, we need multifunctionality. We need everything in every space. And this is very, very important."

(Interviewee U1)

4.2.2 Smart Sustainable City

When talking about Berlin as a smart sustainable city, it is essential to take a closer look at the smart strategy that Berlin follows, as it sets the main principles of smart development and reflects the main areas of action. As was outlined before, Berlin is currently formulating a new smart city strategy. The process started in 2020, and in June 2021, the strategic framework for this strategy was published. This strategic framework

is a guiding draft that will be updated with the specific actions and targets in the Autumn of 2021 (CityLAB Berlin, 2021).

The previous strategy was structured according to the smart city functional domains, which were: Smart administration and urban society; Smart housing; Smart economy; Smart mobility; Smart infrastructures; Public safety (Senate Department for Urban Development and the Environment, 2015). Participants emphasised that it was a good and comprehensive strategy. However, it was too ambitious and vague, as well as too theoretical. It was trying to solve all the problems of a city at once, though, didn't bring as rapid development as was expected (M2).

"But the old version was, I would say, like a wholesale supermarket. It tried to attach, and it tried to address every field of a city. That means smart governance, smart mobility, smart infrastructure, smart economy, smart society, and smart housing. So the strategy, which tries to solve every problem, has a problem on its own."

(Interviewee M2)

Thus, some aspects were not followed up, and in some sense, the strategy remained just on paper (M2). According to the respondents, the main blockers related to the implementation of a smart strategy are the difficulty of organising proper communication with citizens and citizen participation (M2, G2, G1), lack of funding and commitment (M2), lack of political will (M1, I1, G1), difficulty of connecting multiple stakeholders (M2, G2). These challenges though not only applicable to the last strategy of the city but will remain important while implementation of a new one will be done (M1, M2).

The new strategy is being developed in Berlin is based on its old strategy (G1). However, it has significant differences compared to the previous one. First, the process of formulation of this strategy is more complex, and the main focus of it is collaborative creation (G1, G2). The CityLAB Berlin, the organisation responsible for the development of this strategy, incorporates a participatory approach to define how everyone sees the smart future of Berlin. So far, this strategy went through the following stages: Interviews with silent groups, combining insights from people from a refugee background, people with disabilities, people who are discriminated against because of their country of origin or sexuality, children and adolescents, people without a stable living situation; Interviews with politics and administration; Workshops with students from universities in Berlin to gather their ideas and thoughts on the future of the city; International Smart City Symposium "Redefining the Smart City" who could have been attended by everyone interested in the topic; Workshops with civil society, administrators and private sector representatives; Online participation for all Berliners; Online commenting on the written

draft, that incorporated insights gathered on all the previous stages; Integration of the feedback. On the 6th of June, a strategic framework for the new smart city strategy was approved by the Senate (CityLAB Berlin, 2021). Close to 2000 people were involved in the development of the Strategic Framework (Nägele et al., 2021)

"This is a smart city strategy that is written and designed bottom-up by the city. It was an ongoing participatory process that is not going to stop until, basically, the end of this process in five years. And the strategic framework of this, which is a public document, frames this development and was designed to educate the city on what the public opinion on what this smart city should be like."

(Interviewee G2)

The second difference is that the new strategy is going to be more focused on sustainable and citizen-centric development. It is less technology-focused and more result-driven, and citizen-oriented (G1, G2). The definition of a smart city given in the strategic framework is the following:

> ""Smart" refers to the way challenges are addressed – in a creative, open, participatory and purposeful way. "Smart" is the awareness that technology can generate social benefits and strengthen the democratic community. With the development of a new smart city strategy, the prerequisites are created to work on digitalisation and urban development in a coherent way. This will be done through the participation of the entire Berlin urban society, including business, science, administration, and civil society. The interaction is made possible by agile and transparent governance and modern ways of working that develop community-oriented solutions and consciously use technology. The development of Berlin smart city pursues clear and comprehensible goals and tests the effectiveness of measures. However, it also identifies lines of conflict and constantly negotiates the meaning of common good." (Nägele et al., 2021, p. 20)

As for the main structure of the document, it does not incorporate the smart city functional domains as it was before, but it sets the guiding principles, which should underpin the future smart development of Berlin. Those guiding principles are "sustainable", "oriented towards public good", "resilient", and "cooperative" (Nägele et al., 2021). It was also outlined that the new strategy is more focused on the sustainable development of a city (G1).

"The concept of sustainability, there's very much focus there. But then also, you can see that in all our future perspectives, where we go more into topics, in each of the

perspectives, we point out the impact and connection to the concept of sustainability. So we always try to organise the results from the participation in a way that we think about social implications, but then also the economic, and of course, environmental impact.“

(Interviewee G1)

On the other hand, practitioners also pointed out that such direction taken with a new smart city strategy is aligned with the tendencies in the smart industry. More and more sustainable initiatives are happening in the city. Start-ups that develop smart solutions also focus more on sustainability topics like social inclusion, green mobility, sustainable infrastructure, and others (I1, M1).

Another critical aspect of a new strategy that should make it more sustainable and help to make many more cities smarter and more sustainable is the fact that it incorporates open data and interoperability as a core requirement for smart solutions. This allows to scale the solutions and adapt them for different contexts (G1, G2).

“And part of the scope of these concrete projects was that they had to be open source and that they had to be transferable and scalable into other cities. So you can solve your Berlin-specific topics with public money, but you can take Berlin as a canvas and create solutions for problems like heavy rainwater, crisis mitigation and the software that comes out of that or the smart city result has to be applicable in Paderborn, Cologne and Munich or in smaller municipalities.”

(Interviewee G2)

Lastly, it is essential to mention that public spaces were not significantly represented in the previous smart strategy, apart from such suggestions like provision of energy-efficient lighting in streets and gathering and analysis of data from CCTV cameras (Senate Department for Urban Development and the Environment, 2015). However, a new strategy includes public spaces as one of the strategic directions. This was also formulated through the participatory process when many different stakeholders were outlining that public spaces are an important element of city life that should be included in smart development programmes (G1).

“What we saw in the participation was that many people, all different kinds of stakeholders wished for a more just distribution of public space as well. Because the way it is currently done, it's just not sustainable. Because it's not distributed equally, cars are taking way too much space. And also, it's just not future proof because of more heat in the city, it's just not a sustainable vision for the future. So there we have some ideas about how the public space should be created in a smart city.“

(Interviewee G1)

In the new strategic framework, there are various possible action areas suggested in the context of public spaces. It elaborates on the unequal distribution of public space and the lack of infrastructure for resting and other leisure. It is also noted that public spaces should be accessible and easy to reach, as well as they should provide an opportunity for communities to meet. The strategic framework also outlines that designing public spaces in a smart and sustainable way addresses issues such as mobility, housing and land scarcity (Nägele et al., 2021).

It is noted that Berlin's economy can support the development of public space in many ways. Innovations in the construction sector can make future building projects faster, cheaper, and more sustainable. The design of smart city squares opens opportunities for new business areas. By creating the basis for the multifunctional use of jointly managed urban space, smart city measures can be used to flexibly test and consolidate a holistic redesign of public spaces (Nägele et al., 2021). The framework further elaborates on social sustainability perspectives of such activities:

> "An open, accessible urban space creates an atmosphere of togetherness of Berlin citizens. From sports facilities to green spaces to playgrounds, concrete offers are supplemented with meeting places that consciously offer committed Berliners free space for their own design. In order to ensure that public spaces are used according to needs, various stakeholder groups are involved in Smart City projects at an early stage, with particular consideration being given to weaker users. Engaged citizens get involved in innovation processes and their impact assessment - supported by appropriate digital tools. Through new operator models, stakeholders can be actively involved in design and management processes and local self-government can be strengthened." (Nägele et al., 2021, p. 56)

Lastly, the environmental sustainability of smart city initiatives for public spaces is pointed out in the strategic framework. In the Berlin smart city, healthy and diverse ecosystems should be a natural part of public spaces. So public spaces would offer their visitors a comfortable climate and support vital ecosystems. Natural spaces and areas that increase urban biodiversity should be valued and protected. Smart infrastructures should support the reduction of CO2 emissions, implement effective climate protection measures for extreme weather, water shortages or pollutant concentrations (Nägele et al., 2021).

4.2.3 Smart Sustainable City Initiatives for Public Spaces

Moving on, from the strategies to actions and solutions, in the last part of each interview, respondents were asked to elaborate on smart sustainable city initiatives for public spaces. Many respondents emphasised that they agree that this topic deserves more attention, and more public spaces indeed need to be created, maintained, and improved in a smart and sustainable manner (U1, P2, M1, I1, G2, A2).

Among the main challenges related to such projects, the issue of funding attraction was mentioned (A1, I1, M1). The city government must tackle numerous pressing issues, like, for example, the shortage of housing. It is no question that everyone needs to have a space to live in, and surviving with no home, obviously, cannot be compared to having no access to public spaces. Thus, such issues are prioritised while planning the budget of a city or a region. Thus, practitioners suggest that smart city initiatives for public spaces should have a business model or should have the clear potential of improvement of economic sustainability in the area of implementation (M1). Another way to tackle this problem would be bundled innovation, meaning a combination of different solutions to increase the value of the smart sustainable city initiative (I1).

"Of course, everybody can be involved. But the question is: who pays? Right? And it's either the government or the corporate who goes the first step."

(Interviewee M1)

From the perspective of the industry representative, a possible blocker in the process of implementation of a SSC initiative in a public space can be getting the permissions for local authorities in case if a solution requires any construction in the public space. It was outlined that it might become a challenge to not only gather required documents but also achieve agreement with, maybe, not obvious actors involved, like, local businesses owners or an architect who designed this public space (I1). This notion was also supported by the interviewee A2, as he believes that this is also applicable for any design solutions. However, he was, unlike the industry representative, mostly concerned about achieving an agreement with the neighbouring residence. It was suggested that the project proposals and designs in this kind of smart sustainable initiatives for public spaces should be very easy, visual and should clearly communicate the concept, they could be created with the modern IT solutions for visualisations (A2).

Another complexity in the implementation of SSC initiatives for public spaces is the fact that many of them are related to either putting something in a public space or redistributing public spaces. Both these cases are taking some of the space from a part of

the society, even though they may add to the overall value of a public space. Thus, the actors involved in such projects should search for ways to maximise the added value to balance out the space being taken out (G1, I1).

> *"If you add something to a public space, it reduces this public space as well. So in the end, it needs to have several layers of value that it brings to the citizens but also to the city."*
>
> (Interviewee I1)

The political will was named as one of the crucial elements in the process and one of the main blockers if lacking. It comes important in the early stages of the initiative, as participant M2 was outlining that politics and representatives from the government might decline some projects due to the lack of procedure flexibility. However, it may also be a significant factor for the development of the project; many respondents agreed that many SSC initiatives for public spaces have temporary, pilot nature, and if not followed up by the government, eventually disappear (G1, M2, I1).

> *"What I understand is that they [initiatives] are always financed for a certain period of time. And then after that, if there's no strong demand… It's the wrong word. If the actors on the administration side don't want to continue the project, then it's often hard to continue."*
>
> (Interviewee G1)

Lastly, the challenge related to SSC initiatives for public spaces that was mentioned the most is the necessity to connect numerous stakeholders involved. The respondents named the following groups: governmental representatives like politicians and public servants from various levels like city government and local authorities in particular districts of the city, as well as from various functional departments both responsible for urban development, environmental planning and so on (I1); industry representatives, both corporations and start-ups, however, start-ups are considered to have more potential and their solutions are more welcomed by the society (M1); academics and researchers from both local universities as well as international, since it fosters the knowledge exchange (G1); public initiatives present in the city or district to gather the insights and ideas from the most active groups of the society (U1); citizens, including most silent and vulnerable groups, to maximise the value of the initiative for everyone (G1); and, of course, urban designers, city planners or architects, as their expertise in public space is important, even if the initiative does not involve construction activities as such (A1). Lastly, as was observed from the sampling process, as well as from the secondary sources

(Senatsverwaltung für Wirtschaft, Energie und Betriebe, 2021) and interviews, middle agents like city labs, funds and innovation agencies are important stakeholders in such projects since they consolidate the experience and knowledge as well as they have the expertise and capacity to help to bring the above-mentioned stakeholders together and find common ground (I1, M2, M1, G2).

"They bring stakeholders together in the end of the day. So that's bundled initiatives, with several layers of the value offering. And then they ensure that chances of having this implemented is also higher. In the end, they help you to bring more value to the project by involving more stakeholders. They are kind of intermediaries in this regard."

(Interviewee I1)

As possible additional measures to improve the success of smart sustainable city initiatives for public spaces, the following points were identified: incorporating and supporting citizen initiatives (U1, A1, A2), pop-up/pilot approach (I1, G2), the flexibility of public administration (M2), open data and scalability (G1, G2), private data security (M1) and transparency of technologies and processes (A1).

The suggestion that was mentioned the most is that it is important to cherish and support citizen initiatives and transfer them into permanent SSC initiatives. Respondents outlined that SSC initiatives can be implemented both top-down, bottom-up. Though the combination of those approaches works the best, especially having bottom-up movement as a starting point (G1, A2, A1, G2).

"We tend to trust our own processes and our structures and run this city top-down, and you can't solve the energy crisis top-down, or you can't solve the inclusion top-down. It has to be solved bottom-up and top-down with everybody involved."

(Interviewee G2)

This is because when the initiative is first proposed by the active citizens has higher chances to be welcomed by the whole community. On top of that, such projects may have constant support in maintenance and improvement from the society, as citizens would feel the attachment and responsibility for the project they asked for (A2).

"I think you can see that all over the world. You see it with one of the most famous ones, the New York Highline. … . That was just started by two guys, right? They suggested: "Let's take this railway and let's turn it into a park". And this project is one of the most iconic projects for public space. And it was a citizen initiative. And yes, there has to be lawsuits and struggles. But I think in the end, citizens tend to win in a lot of cases, and

the quality of the public space you get is great because not only is it born from citizens and a grassroots effort. But it's also supported by citizens over years."

(Interviewee A2)

Regarding the SSC initiatives that require IT development, respondents were in favour of small initiatives provided by start-ups rather than big technology corporations. However, this bottom-up movement of private solutions and innovations should also be supported by the government. Thus, the administration should increase the flexibility of their processes and procedures, be more open to trying out new things and solutions (M1, M2).

"We have to think not as in terms of a central monolith of digitalisation project, but rather multiple small hybrid environments where start-ups can digitalise. It can be anything. It can be a new way to structure Radbahn. It can be a new smart neighbourhood, a digital platform for neighbours. It could be an individual application for traffic management, that is even may be not connected to a central IT system."

(Interviewee M1)

What goes in line with the previous notion is the effectiveness of the pop-up/pilot approach, which was noted by various stakeholders. To ease the process of development and implementation of any kind of SSC initiative for public spaces creating a pop-up or a pilot – a temporal and small version of a project – might have serious benefits compared to the large-scale implementation (I1, G1). It allows to test the idea at the early stage and practically prove the benefits such initiative can provide as well as it allows to gather the feedback and possibly adjust the solution so it would create more value for the city in the end (I1).

One of the requirements that one should keep in mind while developing a SSC initiative is open data and scalability. Respondents outline that it is crucial for better adoption of the project as well as its improvement to keep data open and create open-source IT solutions (G1, G2). On top of that, even if an initiative is not related to the development of IT products but rather the creation of a new urban design, it should still be scalable and easily adaptable for other districts and cities (G2).

Lastly, private data security (M1) and transparency of technologies and processes (A1) were named as crucial success factors for such initiatives. This is mostly related to ensuring that citizens would trust implemented initiatives, especially if they are related to the implementation of technology that requires a lot of data operations. However, it was outlined that with increasing technology literacy and acceptance, the resistance and distrust to such innovative solutions is decreasing (M1, M2).

The very last part of this chapter presents the examples of SSC initiatives for public spaces in Berlin that were named by the interviewees. The information about these projects was gathered from respondents and from secondary sources to get more insights on the current directions and practical implementations of the SSC concept in the context of public spaces.

The most popular initiative among interviewees was Berlin TXL – The Urban Tech Republic and the Schumacher Quartier (Figure 4.5) – as outlined by respondent G2 is the biggest urban development area worldwide, which is situated in the centre of the city. The development plan includes a research and industrial park for urban technologies as well as a residential area consisting of the Schumacher Quartier and a 200-hectare landscape area. It is outlined that the project suggests the efficient use of energy, sustainable construction, environmentally-friendly mobility, recycling, the networked control of systems, clean water and the use of new materials (Tegel Projekt, n.d.-a).

The project utilises smart and sustainable approaches in both the development stage and as an outcome itself. The planning of the quarter included several rounds of offline and online citizen participation and gathering insights from the public (Tegel Projekt, 2021) as well as various prototyping technologies, for example, the 3D model of the whole area was developed and is available online (Tegel Projekt, n.d.-b).

Regarding the particular solutions and technologies that are to be implemented in the public spaces of the district, the following points are important to outline: climate-neutral and water-sensitive urban development; a car-free concept with bike paths, mobility hubs offering public transport, bike and car-sharing and e-mobility; urban data for smart environmental monitoring, traffic, energy and rainwater management; biodiversity as a planning principle - an animal aided design that supports habitat and retreat for a variety of animal species; around 30 hectares of public green spaces, playgrounds and city squares are being created, for example in the neighbourhood park for the residents (Tegel Projekt, 2020).

“It is going to be a climate positive lighthouse project. They start this year, and they have a solid plan of building the biggest settlement in wood with many green and public spaces, having a low energy net, using hot water to store energy and to provide energy into the houses. And they're going to implement a lot of mobility hubs and autonomous mobility infrastructure.”

(Interviewee G2)

Source: Tegel Projekt (n.d.-c)

Figure 4.5 The Berlin TXL

Another project, also often mentioned by the interviewees (P2, G2, A2, A1), is Tempelhofer Feld (Figure 4.6.). It is a big recreation area and one of the largest urban open spaces in the world. Also organised in the area previously occupied by an airport, it is now 300 hectares of space for skating, strolling, gardening, picnicking, bird watching, kiteboarding and so on. It also acts as a shelter in the middle of the city for rare animal inhabitants and protected plants (Grün Berlin, 2021b).

What makes this public space SSC initiative, apart from providing recreational areas and increasing the environmental sustainability of a city, is the way this public space is created and governed. The decision to make this area a recreational space was performed through citizen participation, and from that moment, its development, initiatives and projects organised in this area are defined through a governance system which includes online citizen participation as well as a coordination body, where both elected citizens and named governmental actors are represented (Senatsverwaltung für Umwelt, Verkehr und Klimaschutz, n.d.).

Source: (Berlin Tourismus & Kongress, n.d.-b)

Figure 4.6 Tempelhofer Feld

Another project that is focused on citizen participation is the participatory budgeting initiative in the district Treptow-Köpenick (G1). People in the local community can suggest and later select the improvements for public spaces in their district on the budget allocated by the government. The participation is performed via the participatory platform of Berlin – Mein Berlin[4]. Suggestions can be placed on the map of the district with a short description. Here are some examples of what can be found there: "Walk and cycle paths between S Köpenick and S Hirschgarten", "A public toilet at the intersection of Sonnenallee / Südostallee", "A dog exercise area at Mauerweg" (Bezirksamt Treptow-Köpenick, n.d.).

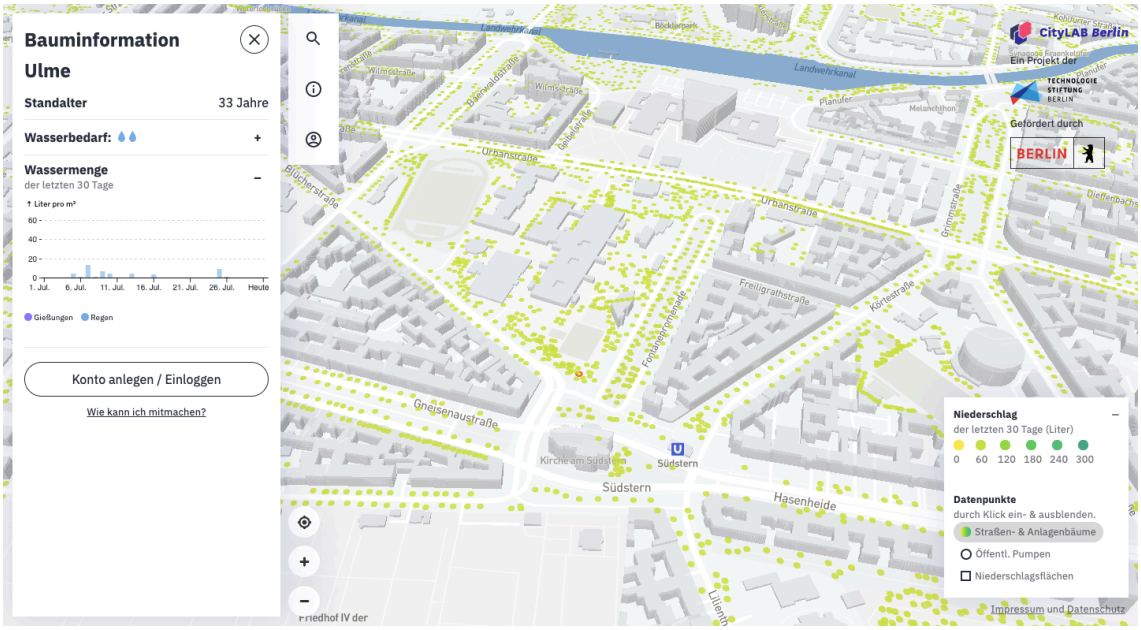
An example of a SSC initiative for a public space that evolved from citizen initiatives can be Park am Gleisdreieck (A2). Initiative groups of citizens started working on the creation of the park in the area of the former railroad site at Gleisdreick years ago. The residents of the surrounding area were involved in the park planning and design from the beginning of the process. In 2015 the continuous development of the park had been accompanied by the elected advisory board. Since then, it continues working as an elected body that consists of ten representatives of citizens, residents and important stakeholders from the surrounding neighbourhoods, representatives of the administration and Grün Berlin GmbH – the organisation responsible for the maintenance of open green spaces in Berlin. The advisory board has regular meetings where current topics, the future development of the park, emerging conflicts and possible solutions are discussed. For example, the current plan for further development of Park am Gleisdreieck involves the installation of playgrounds and sports areas (Grün Berlin, 2021a).

Another example, which is a purely sustainable initiative, is Benching Berlin. The authors of the project claim that they are "creating places, (re)claiming public space, building benches"[5].

> *"I know that people that have lived in Berlin a long time feel like the benches are disappearing, and there are movements of people that are making their own benches. Are you familiar with Benching Berlin? That is a group. You can find them on Instagram. They give instructions on how to make benches with used wood. And then people have been making them themselves and putting them in places where they feel like there's a bench missing."*
>
> (Interviewee P1)

[4] https://mein.berlin.de/
[5] https://www.instagram.com/benchingberlin/

Gieß den Kiez is another project which is solving a very specific issue. However, it has a great impact on public spaces in Berlin (G1). It is a platform that helps to coordinate the irrigation of trees in the city. The map, developed as a part of this initiative, shows almost all trees in Berlin and provides information on water demand, age. This helps citizens to participate in irrigation in the dry periods of the year, so it will be more sustainable and informed. Citizens can also leave the information on what trees and when they have watered and also "subscribe" to trees, so they take responsibility for watering them regularly (CityLAB Berlin, n.d.-b).



Source: CityLAB Berlin (n.d.-a)

Figure 4.7 Gieß den Kiez

Among other SSC initiatives for public spaces related to the development of new IT solutions is a project called Ava named by interviewee M1. This is an AI product that is able to predict safety and risk for a specific location through monitoring various data from multiple sources. It is considering such categories of risks as crime, terrorism, natural forces, industrial disasters, and health issues (AVA Information Systems, 2021). This solution is heavily implemented for public spaces, though it can be used in different contexts, even in areas of military activities (M1).

Another technology-heavy solution that also can be count as a SSC initiative for public spaces is the CityTree (Figure 4.8). This is a piece of city furniture that combines inside natural moss, ventilation and arrogation systems, and IoT sensors that in combination provide air-filtering and cooling effect in the surrounding area (Green City Solutions,

2021b). However, as outlined by the respondent I1, the value of the CityTree for public spaces goes way beyond that.

> *"The CityTree has fine dust reduction effect, air cooling effect, plus you get a bio-organism in the city, something green, which also has a healthy aspect because if we see green, we just relax. The second layer is the interaction platform. Citizens can [using the screen on the CityTree] get additional information about things that are happening in the city, but they can also give suggestions to the city. And then, in the end of the day, it's also a data platform, a possibility to get more data about activities that are happening within the city, but also in order to push this smart city strategies and also to have a better planning overview on where are parts that can be improved. ... . Lastly, especially during the summertime, we want to relax, and sit down and rest. So in this regard, it is providing more seating opportunities and space for social interaction.*
>
> (Interviewee I1)

Source: Green City Solutions (2021a)

Figure 4.8 CityTrees at Walter-Benjamin-Platz

Lastly, many SSC initiatives incorporating new forms and ideas on the design of public spaces. Since one of the examples used to motivate this study were Superblocks in Barcelona, it is important to mention that there is a similar initiative present in Berlin (P2). The Kiezblocks is the initiative of transforming neighbourhoods' streets into safer, more sustainable, social and green areas. Any local community may join the program and collectively prepare their own plan for changing traffic in the area by making streets pedestrian, one-way or setting a traffic limit. They can also use special templates to plan the streets, adding any "Modalfilter" like flower pots, trees, street furniture, etc. These

plans are later submitted to local authorities, and if being accepted, implemented (Changing Cities, n.d.).

This idea of a fair distribution of public space is also followed by a project Reallabor Radbahn (Figure 4.9). The project aim is to rethink the elevated railway line along the underground line 1 in Berlin.

"Today, this whole area is just parking space. And cars are parked, on average, 23 hours a day. They transfer a parking space to a public space. And it's an eight-kilometre stretch from Zoo on the Western part to Warschauer Brücke. And when you transfer this eight-kilometre stretch from a parking space to a public space that is mostly devoted for bikes, it will tremendously affect all the neighbouring quarters. It will affect the way how we bike, how we cycle, how we walk, and how we perceive the city."

(Interviewee U1)

The project team aims to perform a reconstruction, creating a bike lane under the railway, as well as many surrounding public spaces. The project not only includes citizen participation, cooperation with external experts, interactive test site (paper planes, n.d.-b) but also includes the innovation competition that was organised to search for the best technologies and innovations to integrate into the concept. The winning proposal suggests a system of sensors detecting vibrations, collecting kinetic energy and transforming it into electricity to power the surrounding network (paper planes, n.d.-a).

Source: paper planes (n.d.-c)

Figure 4.9 Reallabor Radbahn

In the same direction goes the outstanding initiative of temporary bike lanes, organised as a reaction to the COVID-19 crisis. The project started in 2020 with the implementation of bike paths to protect people against infection but also relieve the burden on roads, buses and trains. With this initiative, Berlin created more space for cycling in the short term. The temporary bike lanes are set up where there is a particularly high demand, and new cycle paths are planned anyway. It is, therefore, a matter of temporary arrangements. The aim, however, is to replace them in the future with equivalent, permanent measures. This initiative helped not only to manage the traffic in times of pandemic but also to collect the data and test the feasibility of bike infrastructure plans in practice (GB infraVelo, 2021).

5 Discussion

This chapter presents the analysis of the findings of the current research. Furthermore, it provides an explanation of how these findings add to the understanding of the creation of better public spaces in a smart sustainable city. The city of Berlin was used as an example to investigate the relationship between the smart sustainable development of an urban area and initiatives in the domain of public spaces. The qualitative data gathered through semi-structured interviews was inductively analysed to provide insights on the topics previously investigated in the literature review as well as to test the framework formulated based on the theories on public spaces and smart and smart sustainable city concepts. To give a comprehensive overview of the topics and sufficient answer to the research question, this chapter summarises the essential findings and the conclusions of the performed analysis in three subjects, according to the sub-questions formulated. It first presents insights on the attributes of a better public space, then elaborates on the interconnection of public spaces and smart sustainable development of a city. Lastly, it provides suggestions on possible procedures and actions to implement smart sustainable city initiatives for public spaces, enhancing public spaces' contribution to an urban area's smart sustainable development. The chapter is concluded by presenting possible theoretical and practical implications of the current research.

5.1 Attributes and Characteristics of Better Public Spaces

According to the literature review, the main attributes of a better public space were defined as: attractive, purposeful, accessible, and comfortable. The interviews with the representatives of various stakeholder groups in Berlin allowed gathering many insights and detailed definitions of a public space, representing both attributes people think public spaces should have, as well as their roles and functions they serve. This allowed creating a more detailed representation of a public space than the one proposed in the initial framework (Figure 3.1). The new conceptualisation, incorporating the case study results, is presented in Figure 5.1. The formerly defined attributes remained relevant for the case; however, a new level was added, which represents the characteristics of a public space that form each attribute. It is important to note that no contradiction was observed in the interviewee responses and the previously observed literature on this topic.

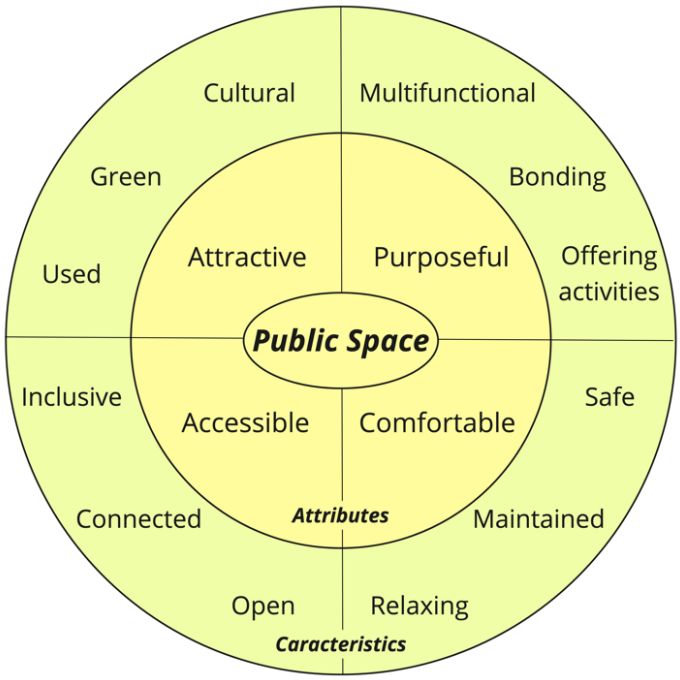


Figure 5.1 Public space: attributes and characteristics

Throughout the interviews, respondents outlined that they perceive multifunctionality, opportunities for strengthening the relationships among the local communities and infrastructure for various meaningful activities as essential aspects that should be present in a public space. Thus, characteristics "multifunctional", "bonding", and "offering activities" were added to specify the attribute of purpose in a public space. This is also supported by the literature observed, with meaningful activities and multifunctionality, for example, outlined by numerous researchers present in the literature review (Carmona, 2019; Mehta, 2014; Project for Public Spaces, 2019; Varna & Tiesdell, 2010). The characteristic of bonding represents two aspects present both in the case and in the literature. Firstly, it is an opportunity to strengthen interpersonal connections in a local community. Still, also it is bonding with a place itself, involvement in its management and maintenance, growing the responsibility for it (Jacobs & Appleyard, 2007).

Among the characteristics forming the attractiveness of the space, the green infrastructure was mentioned by most of the interviewees, which is, interestingly, was observed just in a few studies observed in the literature review on the public space design (Project for Public Spaces, 2019; Ward Thompson, 2002). However, this might be because it is considered to be part of such characteristics as pleasurability or visual attractiveness of the space (Mehta, 2014), thus, not explicitly mentioned in the high-level conceptualisations. As well as because, as was previously mentioned, public spaces and green spaces are often distinguished in the observed state of research. Furthermore, the

cultural characteristic is derived from participants ideas on good spaces. It represents the concept of a public space being an image of the society and its values, expressed through art or in some other way. This also goes in line with the literature since authors emphasise the importance of cultural identity, historical meaning, and authenticity of the space (Jacobs & Appleyard, 2007; Project for Public Spaces, 2019). Lastly, the characteristic "used" expresses that the place should be in active use and lively since most people would not be comfortable spending time in a public space being alone there. This was also described before by Carmona (2019) who called this "delineated".

The accessible attribute in this new detailed representation is formed by open, inclusive, and connected characteristics. Openness is derived from the suggestions of the interviewees that public spaces that are closed in some seasons or every day at night become less accessible have less value since the access is restricted, which is also supported by notions in the literature on the importance of publicness and open access (Varna & Tiesdell, 2010). Inclusiveness represents the incorporation of infrastructure and design that supports minorities and people with disabilities (Mehta, 2014; Project for Public Spaces, 2019). Finally, connectivity is related to the linkages and geographical location of the space that ensure easy access of the visitors (Project for Public Spaces, 2019; Varna & Tiesdell, 2010).

Lastly, such attribute as comfort was heavily supported by the interviewees. As well as the authors of the literature observed, they outlined safety both from crime and from traffic (Carmona, 2019; Mehta, 2014; Project for Public Spaces, 2019); maintenance, most importantly, ensuring the cleanliness of the space (Project for Public Spaces, 2019; Varna & Tiesdell, 2010); and, lastly, infrastructure and amenities, allowing to feel comfortable and relax in the space (Carmona, 2019; Mehta, 2014; Project for Public Spaces, 2019).

5.2 Public Spaces in a Smart Sustainable City

Together with attributes and characteristics of public spaces, the roles and functions that public spaces should have in cities today were identified in the analysis. The information gathered through semi-structured interviews performed in Berlin aligns with the current literature and the definition of a public space formulated in the current research. Participants were naming both necessary, optional, and social activities that public spaces support (Gehl, 2011).

Among the necessary activities, respondents were mentioning mobility, emphasising the importance of different mobility modes and mobility for disabled people. Among the optional functions, the possibility to interact with nature and organise one's leisure were

mentioned. Core and the most mentioned role of public space was the support of socialisation. Both interviewees and researchers emphasise the importance of meeting new people and strengthening social connections in public spaces (Carmona, 2019; Jacobs & Appleyard, 2007; Project for Public Spaces, 2019).

However, while looking at the interconnection of public spaces and smart sustainable cities, it was concluded that public spaces functions are not restricted by just supporting activities of individuals but have greater roles supporting the whole city. They support both the sustainability and smartness of an urban region.

Such functions named by participants like public participation and political rallies, community development and self-realisation, learning and information exchange can be linked to social sustainability as well as to smart people and smart governance dimensions of smart development (de Azambuja et al., 2020; Giffinger et al., 2015; Lombardi et al., 2012). Moreover, public spaces have a positive impact on people's health since they can provide better air quality, greenery, and design, supporting an active lifestyle and improve the environmental sustainability of a city (de Azambuja et al., 2020). Economic sustainability and a smart economy are supported by creating slow-paced districts with attractive public spaces that allow local businesses to thrive as well as attract human capital and innovative businesses to these areas (de Azambuja et al., 2020; Giffinger et al., 2015; Lombardi et al., 2012).

Since the current study was not focusing on the value of any public space but better public spaces, smart sustainable initiatives for public spaces were closely analysed to define their potential in improving public spaces attributes as well as strengthening public spaces' connection to the smart and sustainable development of a city. To provide more clear and structured evidence on the potential of public spaces in advancing the smartness and sustainability of an urban region, part of the analysis included mapping the SSC initiatives for public spaces in Berlin with the components of smart and sustainable development used in the research framework (Figure 3.1).

The results of the analysis are presented in Table 5.1. To define if each component is supported by the initiative or not, the studies, on which the framework was based were used: the smart development functional domains as explained by Giffinger et al. (2015) and Lombardi et al. (2012); and the sustainable development pillars as presented by de Azambuja et al. (2020).

Table 5.1 SSC initiatives for public spaces in Berlin

SSC initiative for public space	**Public space attributes**	**Smart development**	**Sustainable development**
Berlin TXL – The Urban Tech Republic and the Schumacher Quartier	Attractive, Accessible, Comfortable	Smart Living, Smart Economy, Smart Environment, Smart Mobility	Social, Economic, Environmental
Tempelhofer Feld	Attractive, Comfortable, Purposeful	Smart Living, Smart Governance, Smart People	Social, Environmental
Treptow-Köpenick	Comfortable	Smart Living, Smart Governance	Social
Park am Gleisdreieck	Attractive, Comfortable, Purposeful	Smart Living, Smart Governance, Smart People	Social, Environmental
Benching Berlin	Comfortable	Smart Living	Social, Environmental
Gieß den Kiez	Attractive	Smart Living, Smart Environment	Social, Economic, Environmental
Ava	Comfortable	Smart Living, Smart Economy	Social, Economic
The CityTree	Attractive, Comfortable, Purposeful	Smart Living, Smart Economy, Smart Environment, Smart Governance	Social, Economic, Environmental
Kiezblocks	Attractive, Accessible, Comfortable	Smart Living, Smart Environment, Smart People	Social, Economic, Environmental
Reallabor Radbahn	Attractive, Accessible, Comfortable	Smart Living, Smart Economy	Social, Economic, Environmental

Temporary bike lanes	Accessible, Comfortable	Smart Living, Smart Environment	Social, Environmental

Based on this analysis, it was concluded that SSC initiatives for public spaces can not only support and enhance public spaces attributes to make them better but also enhance their positive impact on the smart and sustainable development of a city. The examples of SSC initiatives in Berlin support all the dimensions of smart and sustainable development derived from the literature. The dimension of smart living in smart development and social sustainability are supported the most. This was an expected result since public spaces, above all, are made for the public. Interestingly, the dimension of smart people is supported the least. This domain of smart city can be measured through such indicators as lifelong learning or open-mindedness (Giffinger et al., 2015). Thus, it might be concluded that the learning function of a public space is now less represented in SSC initiatives for public spaces in Berlin and deserves more attention in the future development of a city. As in the literature regarding public spaces functions and roles learning, the development of social competence, the exchange of information were named as important social aspects of a public space (Crowhurst-Lennard, 1987; Lennard 1995, as cited in Mehta, 2014).

Another evidence to support the conclusion that the implementation of smart sustainable city initiatives for public spaces significantly strengthens public spaces' positive impact on smart development can be shown through comparison with the only similar study observed in the literature. Amalia et al. (2020) in their study observed just green public open spaces and showed the evidence that they are related to such smart city domains as smart living, smart environment, and smart infrastructure. In contrast, the current study presents evidence that SSC initiatives cover all the domains, which is twice more than in the mentioned study.

Additionally, the derived examples of SSC initiatives for public spaces in Berlin were compared to the present streams in the literature on this topic. The result of the analysis showed that most of the topics such as, for example, solutions for improvement of the experience in public spaces, implementation of smart and sustainable urban design, enhancing social engagement and participation, improvement of mobility, data-driven solutions are represented in the case. The only topic which was not observed in the case is solutions based on surveillance in public spaces. As was outlined by some respondents, this might be because the technology threatens the privacy of citizens as well as makes public space less public and inclusive, thus, not considered to be sustainable by many.

5.3 Smart Sustainable City Initiatives for Public Spaces

Lastly, the current research took an attempt to explain how to implement such smart sustainable city initiatives for public spaces. The analysis of the case of Berlin and the existing practices and initiatives in this city helped to further develop the initial theoretical framework (Figure 3.1) and create a more detailed and accurate version, incorporating the insights on stakeholders involved in SSC initiatives for public spaces and their roles, gathered from the interviews and documentation (Figure 5.2).

The framework initially inherited the approach of stakeholders' representation used by Lombardi et al. (2011). However, the current framework takes a step further and provides a detalisation of the core roles and functions of the stakeholders in the process of innovation for public spaces. Thus, as was observed in the case, the main input from the industry is represented by solutions and products they develop to support different attributes of public spaces. The government is responsible for formulating general strategies and policies, regulating and fostering the development in this field; however, it also implements top-down, often extensive and model projects – to set the example and best practices for private stakeholders and other regions. Urban Planners and Designers are delivering designs and master plans; however, this does not only include the planning of particular projects but also consulting and supporting the government with the formulations of strategies. Academia is involved in research and delivers new technologies and approaches later used by, for example, industry or urban planners. Public initiatives are proposing and implementing projects or ideas that are created by the community. Multiple respondents outlined that it is crucial for the government to support these initiatives, as they may be the most effective and sustainable way to implement SSC initiatives for public spaces since they would have long-lasting community support and maintenance. Lastly, citizens support the process of smart sustainable development through innovation for public spaces by accepting and evaluating SSC initiatives as well as co-creating solutions together with the government, industry, and urban designers through participation in various forms.

On top of that, through the snowball sampling, a new group of stakeholders were identified, presented in the updated framework as the middle-agents (Figure 5.2). These are organisations and agencies that support the innovative environment and eco-system, connecting various stakeholders for the co-creation of SSC initiatives for public spaces.

Additional information on challenges and successful approaches in creating better public spaces with SSC initiatives was derived from the analysis of the case. This information is not represented in the framework (Figure 5.2) in order not to overcomplicate it and keep the graphical representation easy to understand.

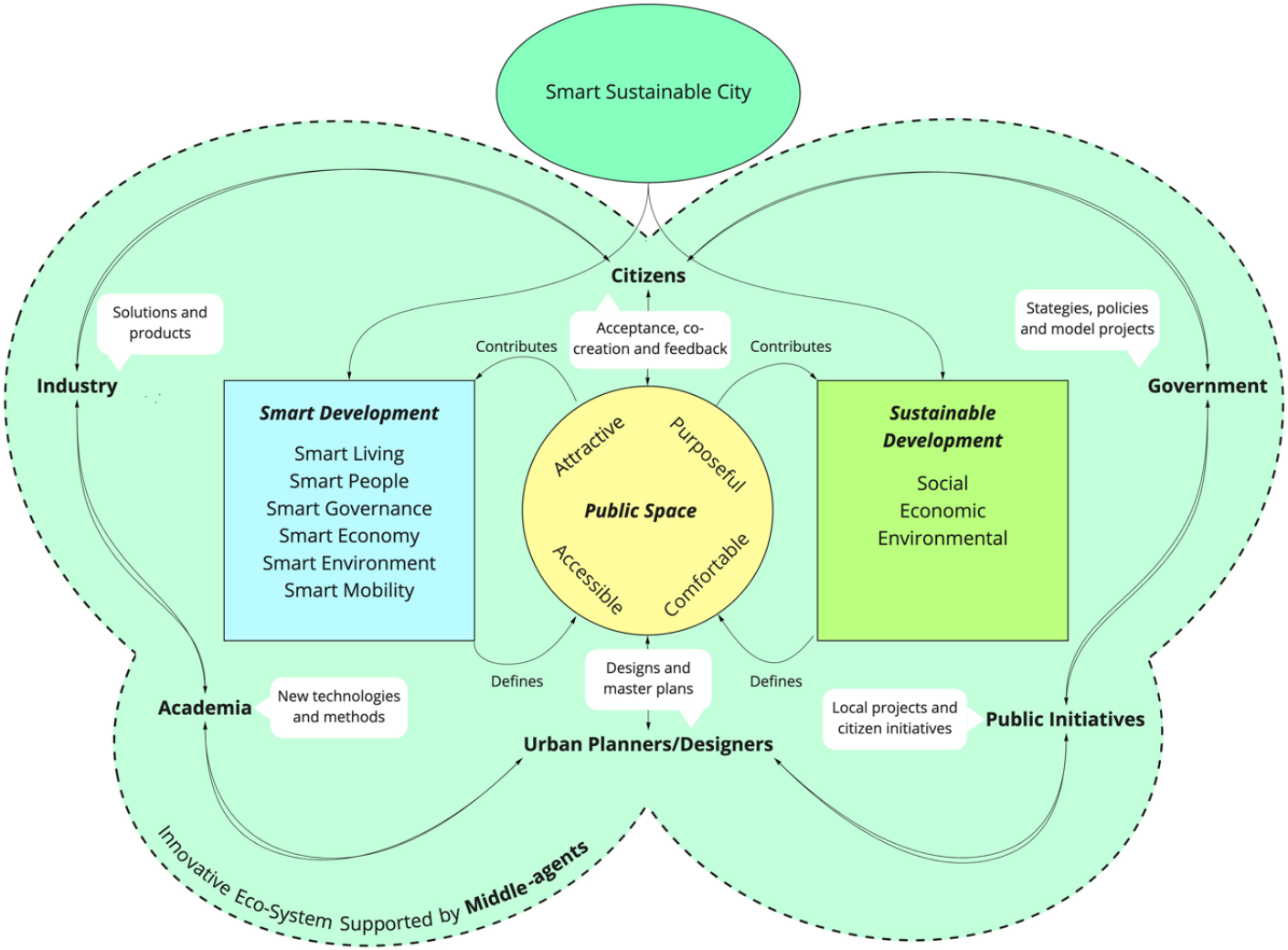


Figure 5.2 Updated framework: Public Spaces in Smart Sustainable Cities

Among the main challenges related to projects of implementation SSC initiatives for public spaces participants named connecting various stakeholders, communicating to citizens or organising citizen participation, attracting funding. This is an interesting insight because, if compared to the literature, funding attraction may be related to the "market" domain of the Triple Helix as described by Lombardi et al. (2011), whereas connection of stakeholders and communicating with citizens are mostly influenced by human factors, incorporated in the learning smart city model by Rucinska (2014).

Additionally, good practices for such projects were identified. Many respondents were outlining that bottom-up and top-down movements should be working together to achieve better results. However, small pop-ups, pilot projects and citizen initiatives were preferred instead of big projects, requiring a long time and big funding. The main notion that might be derived from these insights is that stakeholders in Berlin are in favour of flexible and collaborative development, highly focused on citizens ideas and needs. This is also reflected in the currently developed smart strategy of Berlin, which is, compared to the previous one, uses citizens needs and local problems as a starting point to come up with the overarching approaches and solutions (Nägele et al., 2021).

6 Conclusion

This study investigated the question of creating better public spaces in a smart sustainable city. The research gap identified in the preliminary research was significant as very few studies were present at an intersection of topics of public spaces and smart or smart sustainable cities. At the same time, a considerable part of these studies investigated very technical aspects of technologies implemented in public spaces. Thus, no research was found that would provide a comprehensive overview of public spaces' role in a smart sustainable city, nor an explanation of the stakeholders and processes related to the implementation of smart sustainable city initiatives for public spaces. Furthermore, the only research found that was attempting to map public spaces with smart city functional domains was rather limited as the analysis was based on only two cases of green public open spaces, thus, excluding the context of a city as well as restricting public spaces to just green spaces (Amalia et al., 2020).

To address the research gap, this study attempted to define the attributes of a better public space, provide an explanation of how public spaces can contribute to smart and sustainable development of a city, as well as described the implementation of SSC initiatives for public spaces. The literature review of several intersecting topics was performed, including topics of public spaces functions and design, smart and smart sustainable cities, lastly, providing an overview of different streams of SSC initiatives for public spaces present in the current state of literature. The theoretical framework that incorporated public spaces in the bigger picture of a smart sustainable city was formulated based on the literature review. The hypothesis formulated suggested that SSC initiatives for public spaces support the creation of better public spaces and strengthens the positive impact public spaces have on smart and sustainable development of a city.

To validate and optimise the framework as well as to gather insights on the implementation of smart sustainable city initiatives for public spaces and test the hypothesis, the case of Berlin was selected. The data for the analysis was gathered through 10 semi-structured interviews from the representatives of the stakeholder groups in Berlin and from secondary sources on Berlin's smart strategies and smart sustainable city initiatives mentioned by the interviewees.

Based on the case of Berlin, it was proved that better public spaces should be attractive, comfortable, accessible, and purposeful. The analysis allowed to formulate specific characteristics over public space that contribute to each of the four abovementioned attributes. For the attribute of comfort, the defined characteristics were relaxing, maintained, safe; for the accessibility – inclusive, connected, open; for the purpose – multifunctional, bonding, offering activities; for the attractiveness – cultural, green, used.

The connection between public spaces and the smart and sustainable development of Berlin was identified. Moreover, the analysis of SSC initiatives for public spaces present in Berlin showed that these initiatives cover all the attributes of better public spaces identified before but also support all the domains of smart development as well as all three pillars of sustainable development. This evidence proved the hypothesis on the importance of SSC initiatives' importance in the strengthening of public spaces contribution to smart and sustainable development of a city. However, it was observed that the Berlin case does not show a strong connection between SSC initiatives for public spaces and the smart people domain of smart development.

Further comparison of the Berlin SSC initiatives with the current streams in the academic literature that all the solutions and technologies discussed in the literature are present in the case, except for the surveillance in public spaces. Based on the respondents' opinions in this regard, this research suggests that surveillance is a less sustainable solution because it makes citizens uncomfortable about the privacy issues and makes spaces less inclusive and public.

Lastly, the SSC initiatives implementation practices were investigated, which allowed to specify the roles of the stakeholders involved. The analysis showed that in Berlin primary functions of the government in terms of creating better public spaces for smart and sustainable development of a city are the formulation of strategies and policies, implementing model projects; of the industry – producing solutions and products; of the academia – developing new technologies and methods; of urban planners and designers – making designs and master plans; for public initiatives – suggesting local projects and citizen initiatives; for citizens – accepting and adopting the initiatives and public spaces, co-creating and providing feedback. The new stakeholder group was defined, which can generally be called middle-agents. These are companies and agencies supporting the innovative eco-system and connecting all the other groups of stakeholders for collaborative work.

The critical challenges related to the implementation of SSC initiatives for public spaces in Berlin are connecting various stakeholders, communicating with citizens or organising citizen participation, attracting funding. The practices that were considered to be successful among the respondents were related to flexible approaches, a combination of top-down and bottom-up forces, using a pop-up method and implementing pilot projects.

As the result of the analysis described above, this research provides a comprehensive answer on how to create better public spaces in smart sustainable cities, incorporating both considerations on better public space attributes; SSC initiatives that can improve these attributes and make public spaces more effective in advancing smart and sustainable

development of an urban area; the practices and stakeholders to be involved in implementing SSC initiatives for public spaces. The essence of this answer and the main contribution to close the existing research gap is the developed framework "Public Spaces in Smart Sustainable Cities" (Figure 5.2). As the framework created in this study incorporates the existing theories on public spaces and smart sustainable cities, it not only suggests a new theory but attributes to the justification of existing ones by testing them on the case.

The current research provides a range of implications for both practice and research. For example, for practitioners in the local government, it may serve as a reference while developing strategies and plans related to both smart and sustainable development and development of public spaces in a city. While for the technology industry representatives, it might be a source of insight on possible aspects of public spaces they may incorporate in their future solutions, as well as what practices and challenges to consider while developing SSC initiatives for public spaces.

Regarding future research, the results can be adapted and serve as a basis for new conceptualisations of smart sustainable cities since the literature on this topic remains poorly developed and no commonly used definition is present yet (de Azambuja et al., 2020). Furthermore, the framework can be tested and justified using multiple case studies of different cities. It can also be adjusted and applied to various domains in smart sustainable cities, other than public spaces.

Lastly, this research intended not only to contribute to the current body of research but also emphasise the importance of public spaces, which is often diminished in both research and practice. As one of the interviewees (G2) fairly noted: "Public spaces need to be what churches were in the past and what internet is pretending to be now". In other words, public spaces are where life happens, and they deserve attention from both practitioners and researchers to make this life better.

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Appendix

A Interview Protocol

Interview Protocol

for the Master Thesis
"Creating Better Public Spaces in a Smart Sustainable City: a Case of Berlin"
by Elizaveta Pogasii

at the Ragnar Nurkse Department of Innovation and Governance
(Tallinn University of Technology)

Supervisor: Prof. Dr. Robert Krimmer
Tutor: Luiza Schuch de Azambuja, M.Sc.

Presented by: Elizaveta Pogasii
elpoga@taltech.ee

Foreword

Dear interviewee,

Thank You very much for Your willingness to contribute to the current research!

If You wish to get an overview of the topics to be discussed, please, consult the ***summary*** *of my research and the* ***preliminary questions*** *presented below.*

Looking forward to talking to You!

Kind regards,

Elizaveta

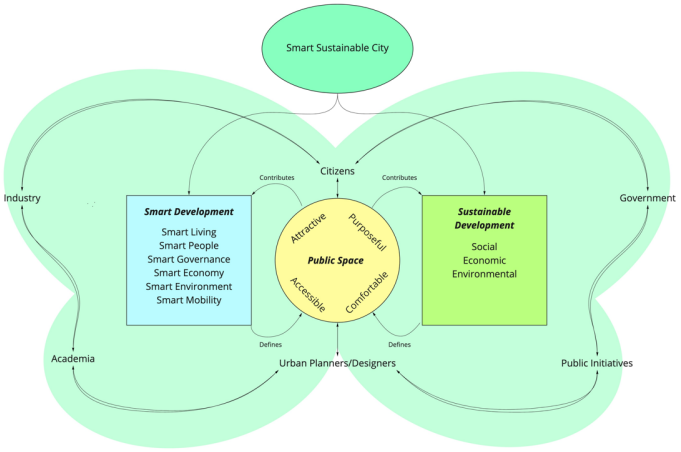
Summary

My master thesis is focused on the topic of urban development of smart sustainable cities with special attention to public spaces. I chose to investigate this topic as public spaces form the experience and influence the quality of life of millions of people around the world every day. In this research, I take **an attempt to put public spaces in a bigger picture of the smart and sustainable development of urban areas**. I hope that this work will add insights to the existing body of research and suggest possible improvements in sustainability and smart strategies for cities.

The question I challenged myself with within the current research is: "**How to create better public spaces in a smart sustainable city?**". To answer the research question, I also formulated the following sub-questions, that are guiding my research:

1. What are attributes of a better public space?
2. How can public spaces contribute to smart and sustainable development of a city?
3. How to implement smart sustainable city initiatives for public spaces?

Based on these questions the literature review was conducted. In this literature review, I focused on the publications related to the topics of urban planning and design, public spaces, smart cities and sustainable urban development. Based on those, I formulated the following **theoretical framework, which suggests high-level interconnections between public spaces, city strategies and actors involved**:



To validate the proposed framework and get a more detailed perspective on the interconnections and concepts of discussion, the case of Berlin was chosen. Thus, I am conducting interviews with representatives from Berlin of the groups presented in the framework: Government, Industry, Academia, Urban Planners/Designers, etc. As interviewees might have different degree of familiarity with the topic or have expertise in only some or one of the topics discussed, the interviews are semi-structured. This means that **the preliminary questions presented below should not necessarily be strictly followed (for example, some parts may be ignored, and others discussed in more detail) based on the interviewee preference and expertise**.

The interview is to be conducted in a format of a video call via MS Teams that will take around 30-45 minutes of Your time. **The recording of the call will be done**. This recording won't be disclosed with any third party and will be performed only to ease and speed up the process of transcribing and analyzing the results.

Preliminary questions

1) Urban Design and Public spaces

How would you assess the current practices of urban development in Berlin? (Would terms like, for example, “urban sprawl”, “placemaking”, “sustainable urbanism” apply?)

Is public spaces development a part of the agenda of Berlin urban development? What is currently done in this regard?

What do you think is the role of public space in a Berlin? (sustainability, living, economy, biodiversity…)

How would you define a good public space?

Can you think of a project in the public space domain you were involved/aware of that was successful and the one that failed? What went wrong and why you do not consider this a success?

2) Smart Sustainable City

Which, in your opinion, are the most important aspects/dimensions of smart city strategy of Berlin? Would you say this strategy includes sustainability as one of the core aspects?

What, in your opinion, are the biggest challenges related to the implementation of this strategy?

Would you say that the dimension of public spaces is represented in this smart strategy? If yes, in which way?

3) Smart Sustainable City Initiatives for Public Spaces

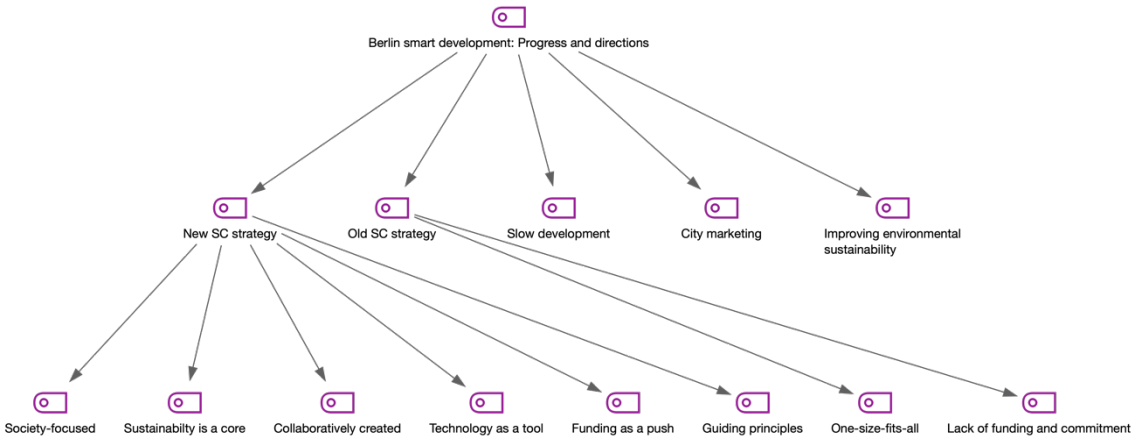
Should public spaces be enhanced with smart city projects? What smart sustainable city initiatives related to public spaces in Berlin are you aware of/ took part in?

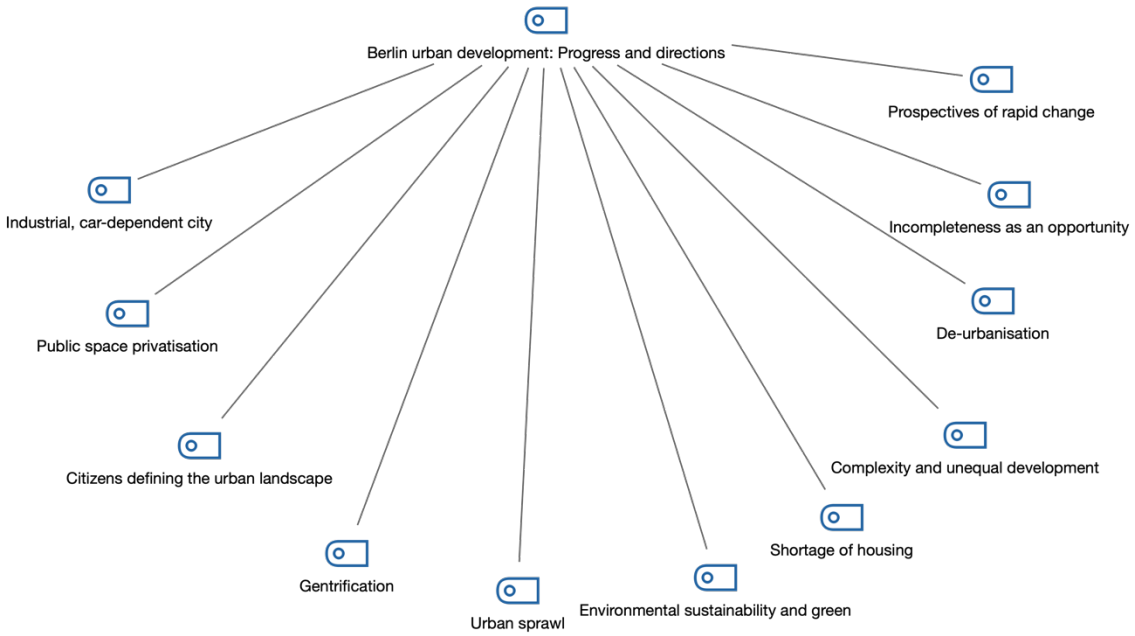
In your opinion/experience, what actors are/should be involved in smart sustainable projects for public spaces? What are their roles? Should citizens be involved? If yes, how?

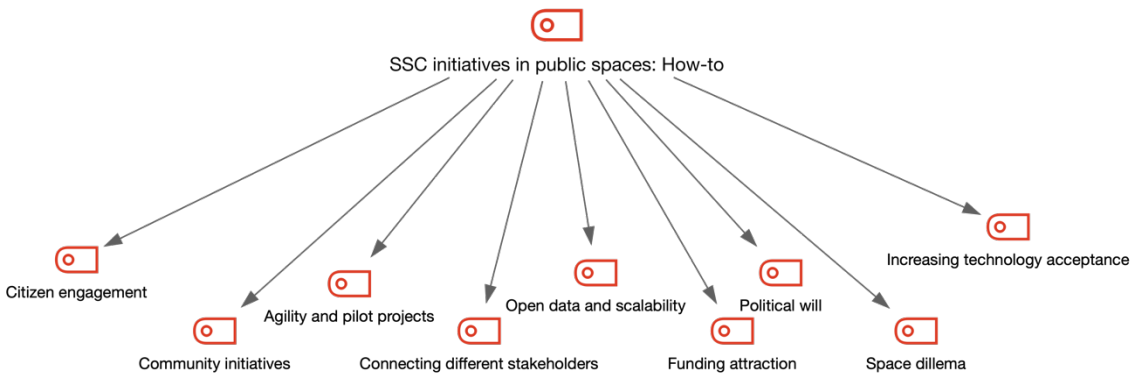
How would you describe such project? What are good practices in your opinion? (f.e. top-down/bottom-up, hackathons, accelerators, citizen initiatives etc.)

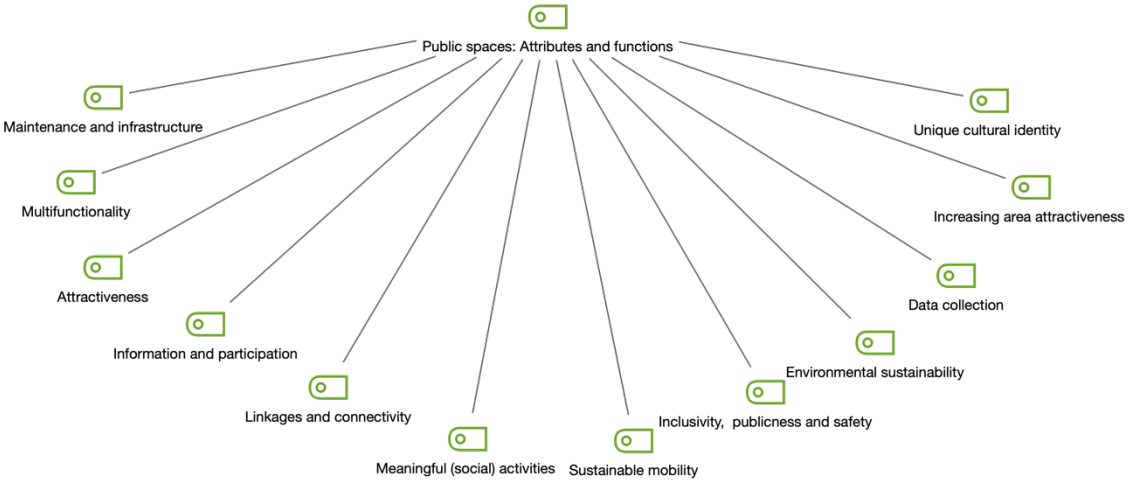
What are the main challenges related to development of public spaces or implementation of smart sustainable initiatives for public spaces, in your opinion?

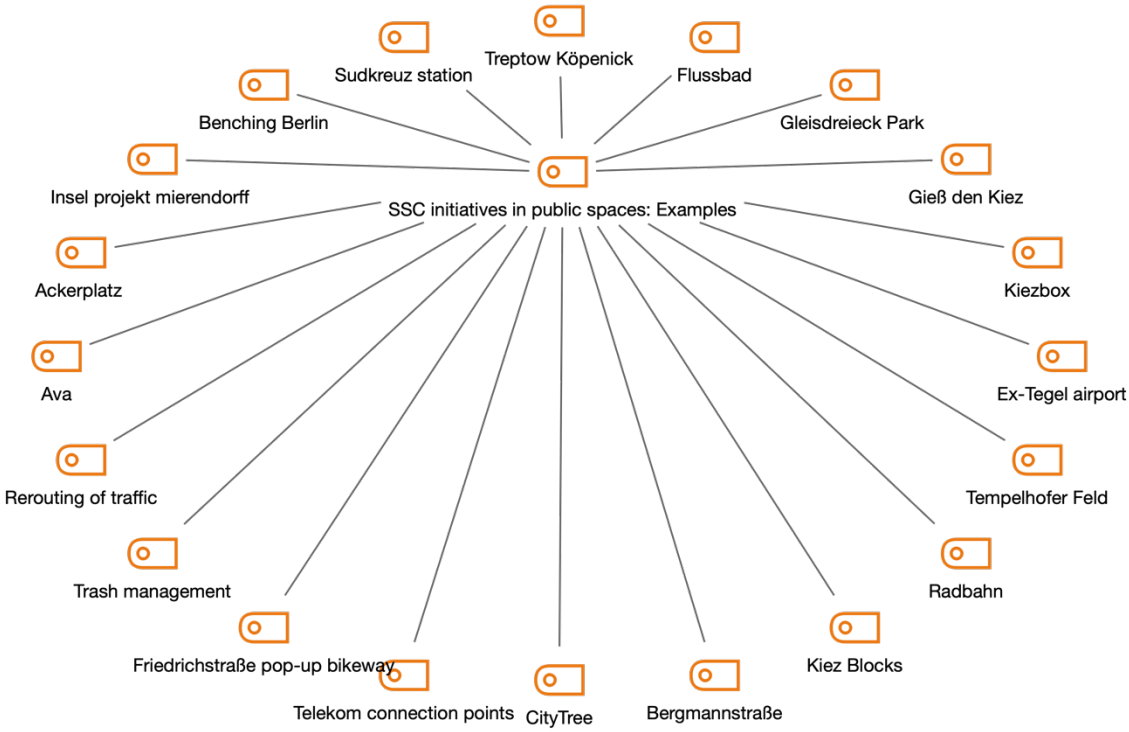
B Code System








Public spaces: Attributes and functions
Maintenance and infrastructure
Multifunctionality
Attractiveness
Information and participation
Linkages and connectivity
Meaningful (social) activities
Sustainable mobility
Inclusivity, publicness and safety
Environmental sustainability
Data collection
Increasing area attractiveness
Unique cultural identity


SSC initiatives in public spaces: Examples
Sudkreuz station
Treptow Köpenick
Flussbad
Benching Berlin
Gleisdreieck Park
Insel projekt mierendorff
Gieß den Kiez
Ackerplatz
Kiezbox
Ava
Ex-Tegel airport
Rerouting of traffic
Tempelhofer Feld
Trash management
Radbahn
Friedrichstraße pop-up bikeway
Kiez Blocks
Telekom connection points
CityTree
Bergmannstraße

Declaration of Authorship

I hereby declare that, to the best of my knowledge and belief, this Master Thesis titled "Creating Better Public Spaces in a Smart Sustainable City: a Case of Berlin" is my own work. I confirm that each significant contribution to and quotation in this thesis that originates from the work or works of others is indicated by proper use of citation and references.

Münster, 08 August 2021

Elizaveta Pogasii

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