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Co-Creating Smart Cities – Design Thinking for 21st Century Urban Planning

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Abstract:

Purpose: *The main aim of this paper is to analyze the applicability of the design thinking methodology to the co-creation of smart city solutions. Furthermore, it also examines the evolution of the smart city concept, from the initial Smart City 1.0 model, to Smart Cities 3.0, rooted in civic participation and user-centered urban planning.*
Methodology: *The text includes a review of relevant literature in the field of design thinking and smart city facilitation, in combination with a case study of the Bristol Approach for citizen sensing – a Smart City 3.0 project, utilizing an adaptation of the design thinking framework to co-create a smart solution to air quality deterioration.*
Findings: *The findings of the case study suggest that the co-creation of smart solutions, combined with the application of design-thinking principles, may significantly increase civic participation and feelings of ownership over public initiatives by local populations. Said inclusivity constitutes a key characteristic the Smart City 3.0 model, and may thus aid in the development of sustainable human-centered urban environments.*
Practical implications: *The world is becoming increasingly urbanized, placing a growing emphasis on the importance of urban planning. By fostering collaborative practices, the design thinking methodology may offer a practical guideline for public entities to enable user-centered smart city solutions. Successful implementations of said framework, such as that of the Bristol Approach, illustrate how cities may modify the design thinking model to best suit their purposes of co-creation with local populations.*
Originality/value: *The research paper concerns the application of design thinking to the facilitation of smart city solutions. The utilization of said framework in the creation of smart initiatives may positively impact public management pertaining to urbanization – a global phenomenon of growing significance. The obtained results may be of interest to representatives of the public sector, as well as private entities seeking cooperation with public authorities in the realm of smart city development.*

Keywords: *Design thinking, smart city, sustainability, urbanization, public management.*

JEL codes: *H54, O18, O33, R11.*

Paper Type: *Research Paper, case study.*

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1. Introduction

The world is becoming increasingly urbanized. Since 2007, more than half of the world's population has been living in cities. Said share is expected to rise rapidly, with the United Nations (2018) projecting the number of people living within cities to rise to 5 billion people by the year 2030. By 2050, almost 70 % of the global population is predicted to live in urban areas, adding almost 2,5 billion people to the current urban population of 4,2 billion (Mensonen the Af Hällström, 2020). As the number of people living in cities grows, so will the impact of urban planning – the management of which may either help, or hinder sustainable global development. The United Nations (2018) argues, that poorly planned urbanization can be seen in some of the vast, globally occurring slums, tangled traffic, greenhouse gas emissions and sprawling suburbs all over the world, leading to the worsening of air quality and an overall decrease in societal welfare. Properly implemented urban planning demands an increasing role of public participation (Sittig, 2009), constituting a cornerstone of democracy and civic engagement (Mensonen the Af Hällström, 2020).

One solution for the management of urbanization is the smart city concept, with a growing number of cities around the world applying said concept to solve their urban problems (Yang, Kwon, and Kim, 2021). Smart cities use integrated information and communications technology (hereinafter: ICT) in order to help their citizens and organizations deal with the challenges of urbanization, safety, and sustainability (Ooms *et al.*, 2020). Many cities have proposed smart city development strategies to capture the opportunities brought by ICTs. Streitz (2017) argues that a central aspect of the "smart everything and everywhere" paradigm is to "keep the human in the loop and in control".

Thus, a citizen-centered design approach is needed, in order to transform urban spaces into humane, sociable and cooperative cities. However, little attention has been given to the systematic implementation of co-creation, as well as to whether and how the smart city concept acts upon human happiness (Zhu, Shen, and Ren, 2022). It is the aim of this article to showcase the current development of the smart city model, as well as how the design thinking methodology – an increasingly adopted approach by businesses to develop innovations – may aid in the co-creation of human-centered urban environments.

2. Smart Cities

The 21st century constitutes an era of connectivity enabled by the internet, of sharing resources over collaborative platforms, of collecting data and using artificial intelligence to reveal insights hidden in data, and of automating large segments of human existence (Komninos, 2019). Streitz (2017) argues that due to the increasing penetration of the Internet of Things (hereinafter: IoT) and the proliferation of smart services based on AI algorithms, one can speak of a "smart everything" paradigm,

permeating very diverse spheres of society. Said paradigm determines personal and public life in many ways, with its impact being expected to increase with the dawn of technological advancements of the Fourth Industrial Revolution (Oztemel and Gursev, 2020).

The concept of the smart city emerged as an effect of the research into smart urban environments, with the term being understood as a city having a certain intellectual ability, which refers to innovative sociotechnical and socioeconomic aspects of growth (Makieła *et al.,* 2022). In practical terms, a smart city utilizes ICTs and other related technologies to enhance the performance efficiency of regular city operations, as well as the quality of services (hereinafter: QoS) provided to urban citizens (Silva, Khan, and Han, 2018). It integrates ICTs with various physical devices connected to IoT networks, with the aim of improving the performance of public tasks and procedures. Most elements of social infrastructure – ranging from roads, to buildings, to the electricity grid, may be controlled through a city operations center.

Collected data may then be used to provide real-time travel information, manage the energy supply and control lights (Caragliu and Del Bo, 2019). Said approach is often led by partnerships between public entities and large technology companies, and may substantially aid in the promotion of energy efficiency of social infrastructure. Sustainability constitutes a cornerstone of smart city development, with there being a growing academic consensus that it is crucial to reduce the consumption of non-renewable energy sources, as well as safeguard natural heritages (Silva, Khan, and Han, 2018; Shruti, Singh, and Ohri, 2021). Silva, Khan, and Han (2018) outline an interdependence between sustainability and the other attributes of a smart city, visualized in Figure 1.

According to Zhu, Shen, and Ren (2022) the following features are usually present in smart cities:

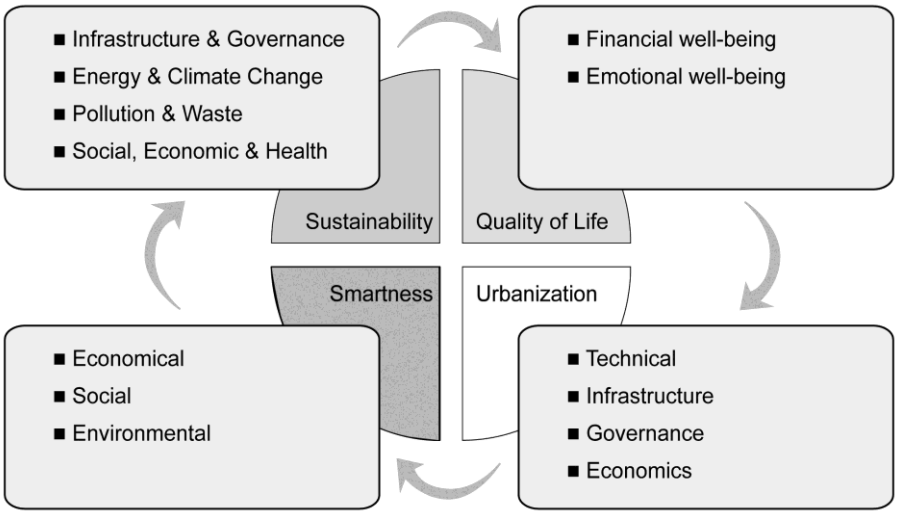
- Accessible and secured ICT infrastructures;
- Reliable and efficient physical infrastructures;
- A productive and innovative economy;
- An equal and inclusive society;
- A sustainable and resilient environment;
- Participatory and transparent governance.

Komninos (2019) proposes three phases of the development of smart cities, defined as Smart City 1.0, Smart City 2.0, and Smart City 3.0.

Smart City 1.0 refers to intelligent cities in the earliest phase of creation. The creators of technological advancements encourage cities to implement their solutions, with the aim of improving the efficiency of urban management (Szarek-Iwaniuk and Senetra, 2020). Technology is the key element of the Smart City 1.0

concept, with technological innovations often being implemented in cities that are not fully prepared for this process. An example of a Smart City 1.0 can be found in the Songdo International Business District in South Korea, with computers being built into the buildings and streets, and sensors gathering data on water flow and energy use. One of the primary aims in Songdo was sustainability, with the water infrastructure being designed to prevent drinkable water from being wasted in showers and toilets (Rugkhapan and Murray, 2019; Sonn, Shin, and Park, 2017).

Figure 1. *Characteristics of a Smart City*



Source: *Own elaboration based on Silva, Khan the Han (2018), p. 699.*

Smart City 2.0 is a phase in the development of smart cities with a predominant role of public administration (Makieła *et al.*, 2022). Public authorities introduce programs and projects which support the implementation of modern technologies in various areas, with the primary aim of said new solutions constituting the improvement of the citizens' quality of life (Szarek-Iwaniuk and Senetra, 2020). According to Makieła *et al.* (2022), the majority of cities currently implementing smart city projects belong to the 2.0 generation. An example of said phase can be found in the IBM operations center in Rio de Janeiro – a project of IBM's Smarter Cities program. The multi-million dollar venture grants the city's emergency management team access to a vast array of data, from weather forecasts to information about local hospitals, to enable a more efficient coordination in the response to natural disasters (Bittencourt *et al.,* 2013).

Since 2015, a new approach to the creation of smart cities has been observed – the *Smart City 3.0* model, in which civic participation plays a crucial role in urban planning (Makieła *et al.,* 2022; Szarek-Iwaniuk and Senetra, 2020). A growing number of contemporary cities is encouraging the active approach of citizens to create smart social infrastructure, with public authorities encouraging citizens to use

modern technologies and allowing them to create their own technological solutions (e.g., through open data) (Makieła *et al.*, 2022). While the Smart City 3.0 still concerns the use of modern technology to improve the citizens' quality of life, the area of its interest has expanded. A Smart City 3.0 pro-actively tackles issues pertaining to equity, sustainability and ecology, with a growing emphasis on the sharing economy.

An example of a Smart City 3.0 initiative can be found in the growing prevalence of repair cafés – venues in which people gather to work on repairing objects of everyday life, such as electrical and mechanical devices, computers, bicycles or clothing. Said publicly enabled emphasis on community repair may aid a city in its pursuit toward a sustainable circular economy (van der Velden, 2021), sharing-oriented initiatives however require courage from municipal authorities, to accept the increasingly influential participation of citizens, as well as a shift in communication toward open dialogue (Makieła *et al.*, 2022).

As previously noted, the majority of cities currently implementing smart city projects belong to the 2.0 generation. Moving from a 2.0 into a 3.0 world therefor entails planning, goals, execution, commitment, and longevity – from both from the public authorities, as well as the private entities they decide to cooperate with.

3. Design Thinking and Co-Creation

Prior to addressing the possible implementations of the design thinking methodology to smart city development, one must address the different ways in which smart city solutions may be designed.

The first noteworthy pathway constitutes *supplier-centered design*, in which a designer or supplier (i.e., the public authorities) creates a solution they perceive the city or citizens to need (Medrano-Gil *et al.*, 2018). Supplier centered projects have the upside of easier planning and short-term cost effectiveness. They may however lead to less usable solutions, especially in the case of differing perceptions or information-asymmetry between the public authorities and citizens.

User-centered design (hereinafter: UCD) aims at shaping a solution to the user's point of view. The primary focus of UCD is the design of an innovative solution, rooted in information about the people who will ultimately use said solution (Dopp *et al.*, 2019). The goal of UCD is frequently achieved with the implementation of usability goals, repeated testing and rapid prototyping.

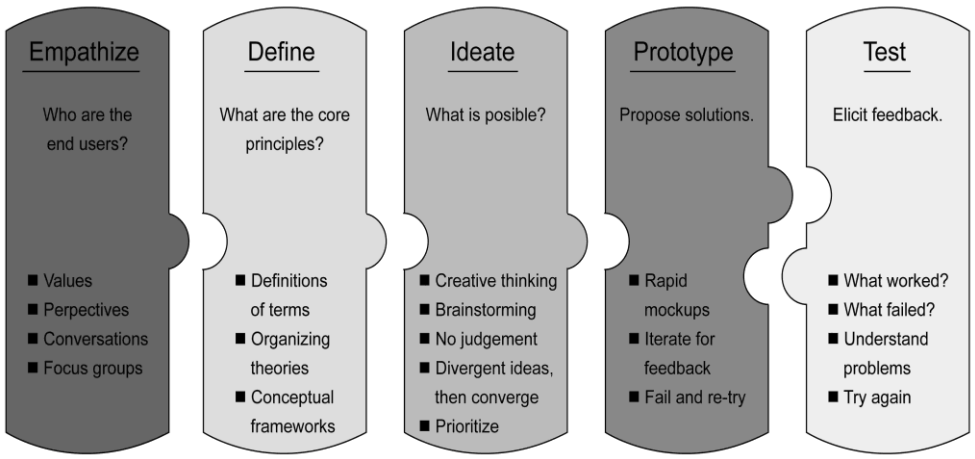
Lastly, there is *co-creation*, whereby the input from end-users plays a central role from the beginning to the end of the design process. According to Leino the Puumala (2021), co-creation lies in the breaking down of hierarchies between the local government, business life, universities, citizens and other relevant stakeholders.

Instead of presenting a top-down supplier-centered design approach, co-creation involves a multi-directional, more democratic pathway to problem solving.

As in the Smart City 3.0 model, civic participation plays a crucial part in urban planning, UCD and co-creation are expected to play a role of growing significance in the implementation of smart solutions. In both – academia and practice, little attention has however been given to the systematic implementation of co-creation in smart city design, with public authorities lacking standardized guidelines for the involvement of citizens in social infrastructure planning. The design thinking methodology – an increasingly adopted approach by businesses to develop innovations – may aid in the co-creation of urban environments, bringing us closer to a broad 3.0 Smart City implementation.

Design thinking has traditionally been used to frame complex business problems, uncover hidden needs, and develop more desirable solutions by adopting a collaborative, user-centered approach. Insight is one of the key sources in design thinking, and does not usually come from the realms of quantitative data, but rather from the observation of actual interactions of (future) end-users with products or services. The design thinking methodology consists of five distinct phases, which are visualized in Figure 2.

Figure 2. *Phases of the design thinking process*



Source: *Own elaboration, based on Lewis et al. (2020), p. 4.*

During the *empathy phase*, the emphasis is placed on capturing the end-user requirements, while keeping the human element in perspective (Pande and Bharathi, 2020). In practice, this step usually utilizes qualitative research methods, such as empathy maps, customer journey maps, service safaris and the creation of primary and secondary personas.

The *define phase* is characterized by synthesizing the users' needs and pain points observed in the previous phase into attainable goals . A commonly used tool in the second phase of the design thinking process is How Might We's, or HMWs – a method intended to generate creative solutions, usually utilized in teams (Catiri, 2017).

During the third phase of design thinking – *ideation*, design teams brainstorm with the goal of generating concrete ideas for products and services, with the primary aim of meeting the previously outlined user needs. With design thinking placing a large emphasis on democratic decision making, methods such as dot voting are frequently implemented in this phase, as to avoid occurrences of the HIPPO effect, whereby the opinion of the highest paid team member sways the direction of the design thinking process (Dalton, 2019).

The *prototyping phase* of the design thinking methodology highlights the importance of generating tangible prototypes of proposed designs as early in the process as possible. Said prototypes possess numerous usability benefits. They enable the teams working on solutions to easily visualize the final product, thus being more likely to empathize with the end-user. In addition, early prototype testing may be implemented to gather feedback of future users – which may be accomplished via paper prototyping (e.g., in the case of designing online spaces), or rapid prototyping, using 3D printing technology.

The last phase of the design thinking process – that of *testing*, is crucial to project success and usability of the created solution. In said phase, the prototype is demonstrated to the customer with the aim of soliciting feedback about how close the prototype is to the product/service visualized by the user. Areas of improvement are then identified, usually leading to the amendment and re-testing of the prototype. Only once no major flaws can be defined during the testing phase, does the product or service go into implementation. Thus, the last two stages of design thinking may be viewed as a cycle, which only ends with the positive feedback of the focus group.

In summary, design thinking presents a user-centered approach, offering a systematic methodology to prioritize user experience and satisfaction. This method is increasingly adopted by firms to develop innovations (Nakata and Hwang, 2020), and has become one of the most powerful creativity and innovation methods worldwide (Primus and Sonnenburg, 2018). That, combined with a growing trend of teaching design thinking courses in higher education – particularly in the business and management disciplines, created a major shift in the process of designing solutions.

It is however important to note, that design thinking was initially developed with an emphasis on the development of private-sector goods and services. In the public-sector application thereof, elements of the methodology, such as the testing phase, may need to be altered with regards to the specificities of the public project at hand.

An interesting alteration of the design thinking methodology to suit a public project will be showcased at a later point in this article, on the example of a case study. While not, by definition, a tool for co-creation, design thinking offers a more collaborative alternative to the more prevalent supplier-centered approach. This can be achieved by making the citizens, as well as other relevant stakeholders, part of the design team, as well as engaging them early on in the process via testing.

4. Design Thinking in Social Infrastructure – The Future of Smart Cities?

Urban planning is often criticized for reproducing existing inequalities and following path-dependent trajectories (Raynor, Doyon, and Beer, 2017). In this context, there is a need to create planning processes that are responsive, adaptable and participatory.

The importance of the end-users' perspective has been discussed in urban planning for some time, which can for instance be seen in the increasing referencing of theories outlined by Danish Architect Jan Gehl (Mensonen and Af Hällström, 2020). Gehl suggests revising the priorities of urban planning, with the creation of urban spaces for pedestrians to intensify social interactions; said proposals are constituting the basis for the reorganization of numerous cities across the world (Vershinina, 2020).

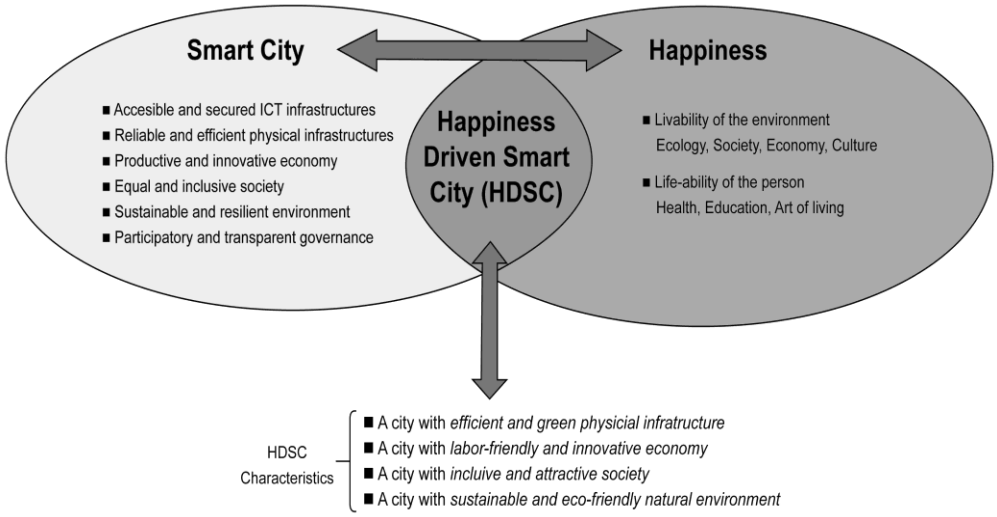
One of the proposed solutions to the future of urban planning, as well as a more collaborative approach to shared public spaces, is believed to lie in the public implementation of the design thinking methodology. Mensonen the Af Hällström (2020) argue, that by engaging citizens in the development process of public projects, ownership of the forthcoming solution and enthusiasm regarding its implementation is fostered.

Said ownership may make solutions easier to accept by the end-user, while also potentially reducing implementation and operation costs. Said expenditure reduction is particularly important in the public context, where problems are frequently interdependent and contingent on multiple stakeholders, with resources oftentimes being scarce.

Research of the Finnish urban planning sector conducted by Mensonen and Af Hällström (2020) however indicates a lack of an accepted standard definition of design thinking in an urban development setting, which could lead to future conflict, as many public agents are now including methods derived from design thinking in their work. With there being a widely accepted consensus on the design thinking methodology, outlined in the previous chapter, public authorities may benefit from educational opportunities, showcasing the methodological, as well as practical implementation of the individual design thinking stages in public projects.

An interesting proposal regarding a more human-centered approach in smart city planning has been made by Zhu, Shen, and Ren (2022), who introduce the concept of a Happiness Driven Smart City (hereinafter: HDSC), visualized in Figure 3.

Figure 3. *Model of a Happiness Driven Smart City*



Source: *Own elaboration based on Zhu, Shen the Ren (2022), p. 4.*

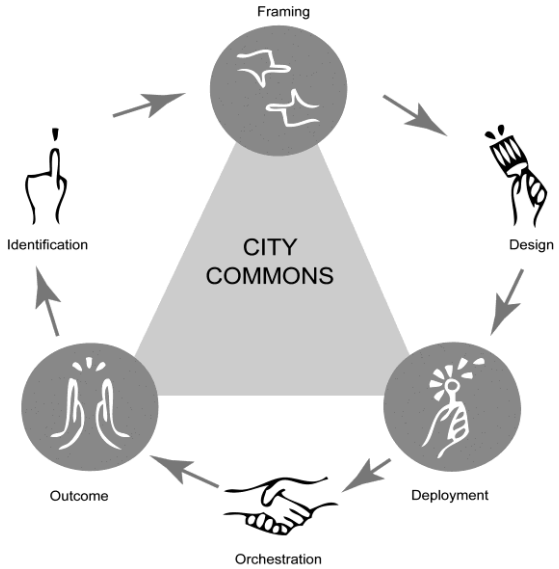
The researchers outline HDSC as possessing efficient and green physical infrastructure, being inclusive and attractive to society, as well as operating sustainably – leading to overall societal welfare, or "happiness". While the researchers do not directly reference design thinking methodology for the attainment of a HDSC, the aforementioned benefits resulting from a well-managed public design thinking implementation, may increase the likelihood of a more human-centered, co-creative urban environment.

5. Case Study – The Bristol Approach for Citizen Sensing

As previously noted, sustainability and environmental protection constitute crucial elements of the smart city concept. Adverse health effects caused by air pollution are increasingly being recognized and debated at an international level (Caplin *et al.*, 2019). To tackle the problems resulting from decreasing air quality, public authorities in East Bristol in the United Kingdom collaborated with the Knowle West Media Centre (hereinafter: KWMC) on a project called the Bristol Approach for citizen sensing. The initiative, which took place for two years between 2017 and 2019, co-creatively developed playful and accessible digital tools to help citizens collect and interpret air quality data, and then act on what they found (Balestrini *et al.*, 2017).

The methodology utilized in said project, called the Bristol Approach, offers a framework very similar to that of design thinking. The KWMC however adapted it to better suit the stakeholder needs in this particular project. A visual representation of the Bristol Approach is showcased in Figure 4.

Figure 4. *The Bristol Approach methodological framework*



Source: *Own elaboration, based on Balestrini et al. (2017), p. 2284.*

At the heart of the Bristol Approach project lie the *city commons* – which, according to the project organizers, characterize the complex socio-economic systems of the shared urban environment. Those living in the Bristol area all share the same space, and all benefit from (or suffer under) the same system of city management. Thus, it was the aim of the Bristol Approach to co-create more human-centered and inclusive commons.

The first of the six Bristol Approach phases described by Balestrini *et al.* (2017) is *Identification*, consisting of pinpointing the matters of concern that citizens care about and are prepared to give their time and energy to address. This step showcases many similarities to the "empathize" stage in the design thinking process.

Stage number two, *Framing*, involves exploring the resulting issues in more detail: analyzing how technology and data can be utilized to help tackle the previously outlined problems, as well as noting if there are any lacks in resources or knowledge that need to be addressed prior to tackling the issue. This step corresponds to the "define" stage of design thinking.

In the third stage, *Design*, the tools and interactions that are needed to tackle the issue at stake are conceptualized and designed. To ensure that people can effectively

contribute to the intervention, the stakeholders must identify the skills that are necessary for communities to develop and use the technologies, and then design the actions that are necessary to enable such learning. The Bristol Approach's design phase corresponds to "ideation" in the design thinking methodology.

The fourth stage, *Deployment*, consists of the created technologies to be tested "in the wild", and then, on the basis of the test findings, improved. By the early testing of the technologies, the participants can collect data on how people interact with the tools in their natural environments and without instructions. Said stage, when applied to design thinking, resembles the prototype and test cycle at the very end of the methodology. With the Bristol Approach however being a complex, inter-connected public initiative, the organizers decided to add two additional steps to the methodology, which lie outside of the design thinking scope.

The fifth stage, *Orchestration*, revolves around sustaining the engagement of the contributing community, as well as scaling it up to engage a broader group of people. This can be done by organizing events (such as hackathons or meetups) where participants with diverse skills can meet, and use the data that has been collected during the deployment to create visualizations or discover correlations. The aim of said stage is to instill a sense of meaningfulness by demonstrating the usefulness of the co-created public technology.

Lastly, the *Outcome* stage, involves reflecting on the intervention and assessing if and how the goals were achieved. This stage includes finding out what participants have learned, and sharing insights gained from using the framework.

When applying the Bristol Approach framework in practice, KWMC first organized networking events and conversations in hotspots with residents. This entailed talking to people in places where they congregate, such as at tattoo parlors, cafés and nail salons. Said method provided a nuanced understanding of everyday experiences of the local population. As a result of those activities, a broad group of participants was engaged – consisting of volunteers from local schools, universities and places of employment. Once the volunteers were gathered and divided into teams, each group developed their own air quality sensor designs at a local manufacturing space.

The final result was a palm-sized sensor resembling a ladybird beetle. Light and portable, these smart city sensors could easily be attached in public spaces to collect air quality information. The inclusion of Bristol citizens in the design process had a substantial impact on their behavior – participants of the project embraced the new air quality sensors, as they were involved in nearly every step of the development process, therefor feeling ownership. Project participants who took home sensors were inspired to drive shorter travel routes, as well as gained a deeper understanding of the air pollution issue. Users reported feeling inspired to not use their cars, as well as living more sustainable lives (Balestrini *et al.*, 2017).

Although the Bristol Approach for citizen sensing did not permanently improve the air quality of the city, it offers a very interesting pilot project of a framework adopted on the basis of design thinking, being used for a smart city initiative. The six phases of the above-mentioned methodology enabled a successful co-creation initiative, making the project participants – citizens of the area – feel ownership over the final results. The framework also provided a narrative that attracted and galvanized people under a shared vision, outlining how communities can design and use sensing technologies to address their concerns and aspirations.

While the applicability of the above-mentioned Bristol method to other public initiatives remains to be seen, and the KWMC organizers themselves argued for the Bristol framework not to be considered a blueprint for community engagement, the project offers an interesting initiative, combining design-thinking principles with public co-creation.

In addition, it is important to note that the Bristol Approach project showcased characteristics of the Smart City 3.0 model, in which civic participation and co-creation play a crucial role in urban planning. If a similar approach were to be implemented in other areas of social infrastructure, co-creative initiatives may also aid in the facilitation of a Happiness Driven Smart City outlined Zhu, Shen the Ren (2022), in which participatory and transparent governance plays a critical role for long-term urban sustainability.

6. Conclusions

Urbanization allows for a marshalling of resources and a scaling up of services (The World Bank and European Network of Living Labs, 2015). The growing concentration of people in urban areas creates a critical mass of diversity, which in turn provides opportunities for innovation in new technologies, services and business models. With cities also being increasingly perceived as hubs of entrepreneurial and innovative activity, a growing number of public entities is exploring and implementing smart technologies to improve the citizens' quality of life, as well as QoS of public infrastructure provision. This development is however presenting cities with challenges of how to further spur innovation in a cost effective and low risk manner, such that even the most resource constrained cities can invest in local prosperity and address core sustainability goals (The World Bank and European Network of Living Labs, 2015).

There is a growing consensus – in both academia, and practice, that the Smart City 3.0 model, via the fostering collaborative practices, may aid cities in the promotion of social innovation, while simultaneously enabling them to meet sustainability objectives. The design thinking methodology may offer a practical guideline for public entities to create smart, user-centered solutions, with successful implementations, such as that of the Bristol Approach project, illustrating how cities

may modify the design thinking framework to best suit purposes of co-creation with the civic population.

While an increasing number of public entities is now including methods derived from design thinking in their work, research indicates a lack of an accepted standard definition of design thinking in an urban development setting. This, in turn, could lead public entities to inefficiently manage design thinking oriented projects, thereby not being able to harness the full potential of the proper implementation of said framework. With design thinking having been practiced in the private sector for over a decade, there is a widely accepted consensus on its methodology.

Public authorities may thus benefit from educational opportunities, showcasing the methodological, as well as practical, implementation of the individual design thinking stages in public projects. Case studies of design thinking principles being successfully applied to the co-creation of Smart City 3.0 solutions, such as the outlined Bristol Approach for citizen sensing, may additionally provide useful guidelines for future smart solutions being implemented in a more human-centered manner.

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