PARTICIPATORY DESIGN FOR SUSTAINABILITY

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ABSTRACT

The conventional design of the cities and buildings significantly contributes towards the pollution of the environment. The sustainable design based on participatory principles and Citizens Science (CS) can substantially assist the delivery of resilient spaces, buildings and communities which incorporate the needs of the residents. This paper examines the concepts of citizen participation, design science and citizen design and their potential for implementation in participatory design to provide integration of the demands of the key stakeholders in the process, as well as to empower them with scientific tools and methods and support their decision-making process in a complex design and contextual environment. In that regard relevant projects of CS in design are compared by utilizing the Content Analysis Method. Also, methods and tools for Citizen science are investigated, which address certain urban issues, data collection, data analysis, motivation of stakeholders etc. Additionally, several management methodologies and standards are compared, as well as sustainable management methodologies and in that regard certain aspects are identified which can be applied in the citizen science management process. The possibilities of collaborative design platforms are noted, as a knowledge base for the promotion of Citizen Science in the urban planning. The findings show that Citizen Science can have a significant role in integrative and sustainable design processes. Moreover, the establishment of collaborative CS platforms for design can utilize and incorporate the concept of the 'smart cities' to enhance their success in the participatory design process. The findings contribute towards the development of sustainable, inclusive, and participatory Citizen Science platform for the design of the living environment.

KEYWORDS _ *participatory design, Citizen Science, Collaborative design, Sustainable design, Design Management*

INTRODUCTION

The contemporary society is faced with the challenge of a changing climate. The construction industry, the cities and the buildings are held responsible for the pollution of the environment and its detriment. Also, the dominant part of the world population lives in the cities which have a constant increase due to migration from the rural to the urban areas. Therefore, it is of high importance to improve the cities` sustainability, to reduce the adverse effect they have onto the environment, by delivering sustainable, resilient and climate sensitive participatory urban design based on the local needs of the residents. In the past years, the innovation was focused on utilizing novel technologies and data mining technologies in order to optimize the cities design, an approach known as smart city (Mueller et al. 2018)we present Citizen Design Science as a new strategy for cities to integrate citizens' ideas and wishes in the urban planning process. The approach is to combine the opportunity of crowdsourcing opinions and thoughts by citizens through modern information and communication technology (ICT. The most common definition describes the smart city as an "innovative city that uses information and communication technologies (ICT) and other means to improve quality of life, efficiency of urban operation and services, and competitiveness, while ensuring that it meets the needs of present and future generations with respect to economic, social and environmental aspects" (Kondepudi 2014).

On the other hand, the citizens are most often passive stakeholders in the process of designing the urban environment. However, the concept of citizen science enables them to be active participants in such a process as it offers powerful tools for tackling these challenges. Considering that the citizen science (CS) is a rigorous process of scientific discovery it can substantially contribute towards solving local urban problems related to different aspects, such as: urban density, urban traffic, urban greenery, biodiversity etc.

Therefore, novel strategies are emerging for addressing the fore mentioned issues and enriching the smart city concept by focusing on human-centred technologies with an intention to actively engage the citizens in the urban planning, process, approach labelled as Smart City 2.0 ('SMART CITIES 2.0 | Jason Pomeroy' 2017), Fig 1. Additionally, the term Responsive City describes the change over from top-down governed cities towards citizen-centred and citizen-inclusive governance in the best way (Goldsmith and Crawford 2014).

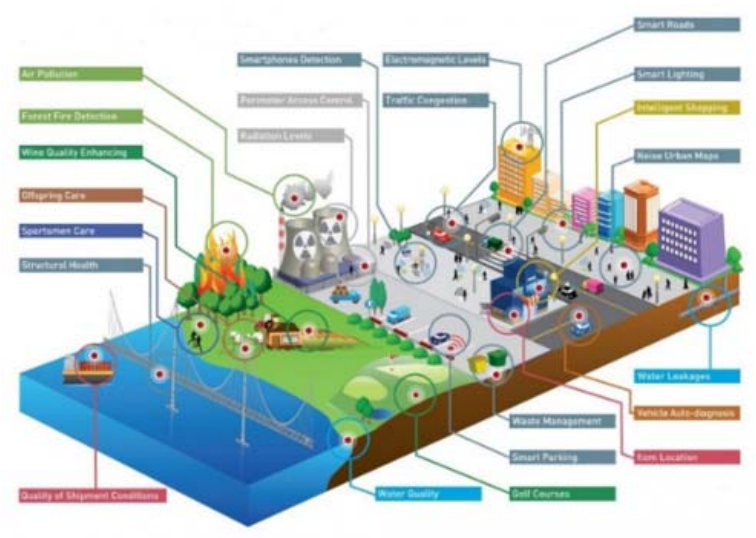

Figure 1: Smart city 2.0 ('SMART CITIES 2.0 | Jason Pomeroy' 2017)

For a successful outcome of the CS it is necessary to have a scientific process which is properly designed, carried out, and evaluated. Such a process can provide sound science, efficiently generate high-quality data, help solve problems and initialize promulgation of new policies. Also, the development of new Information and Communication Technologies facilitates the CS and the establishment of collaborative platforms can significantly contribute towards solving urban issues.

Hence, the objective of this research is to examine the potential of citizen science for delivering a high-quality participatory urban design which integrates the relevant stakeholders in the process, enables them with the tools and methods of the scientific approach and supports the decision-making process regarding the urban planning.

The aims of the research are to examine relevant projects of CS in urban planning, to investigate the possibilities for development of collaborative urban design platform that will support the Citizen Science, to show that the Citizen science can be applied in a participatory approach for the urban design context and can contribute towards solving local urban issues and improve the cities sustainability, to investigate appropriate tools for Citizen science for participatory urban design, to investigate the instruments which can be applied in CS in promulgation of urban planning policies, to investigate the integrative design method and tools as an underlying concept for future development of participatory development of city neighbourhoods and to contribute towards development of sustainable, inclusive and participatory Citizen Science platform for the design of the urban environment.

THEORETICAL APPROACH OF PARTICIPATORY CITIZEN SCIENCE

From the review of the state of the art literature and analysis it is concluded that citizen science has been applied in various urban topics, such as: urban air and noise pollution, urban design, mobility, urban memory, biodiversity and ecological issues, green parks development, flora and fauna monitoring, city mapping, water monitoring, the social fabric in the urban areas, identification of environmental aspects that contribute to chronic stress and the perception of comfort and discomfort, investigation on visual pollution in urban areas, urban slum upgrading etc. The different levels of participation in the citizens science as presented in Fig. 2.

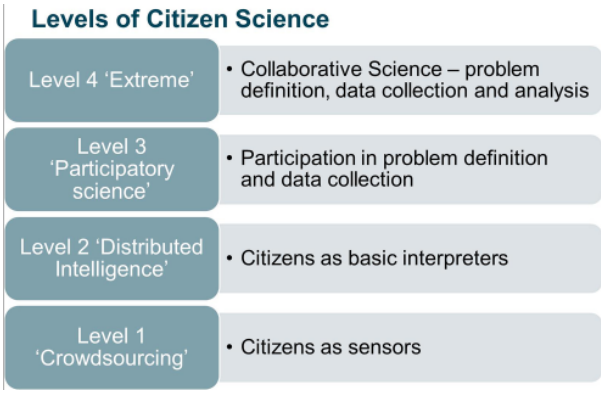

Figure 2. Levels of citizen science (Lotfian et al. 2018)

The concept of participatory urban planning is consisted of urban planning processes with citizen participation which several authors agree that it strengthens the role of the citizens, enhances the democratic decision processes and the community development. The investigation of several examples of participatory citizen science for urban design has pointed that the main issues which determine the data quality, and the success of the project are reliant on the equal distribution and selection of citizens, the citizens` knowledge and willingness to contribute, choosing appropriate

communication channels (to prevent prevailing of certain citizen groups over others etc.) and similar.

Also, drawbacks of the participatory design are evidenced, such as, its time- and cost-intensiveness, as well as the notion that community design is often not entirely representative and citizen participation in general may bring up explicit problems for discussion, but not the latent ones. One solution to overcome them is by surrogating the user by social scientists and other experts in design discussions leading to citizen indirect participation.

The concepts to make the urban planning and governance processes more transparent, by utilizing 'open data' or 'open-governance' and including different forms of dialogue with authorities and decision makers, are named as 'e-governance'. The concept of E-Governance is a development of the web 2.0, Fig. 3, that shows how local and national governments are looking for means of connecting with citizens that includes their feedback during the policy making process as well as conducting citizen science (Hachmann, Jokar Arsanjani, and Vaz 2018).

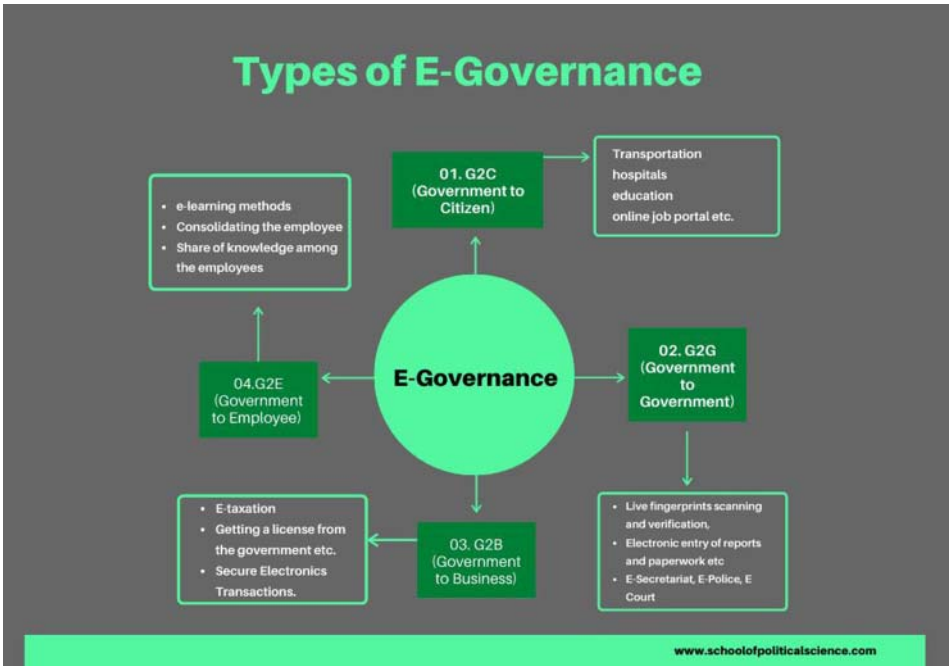

Figure 3. Types of E-Governance (Biswas 2020)

In the conventional approach the governments supply services to their citizens. However, the bottom-up practices of e-Government enable citizens to actively provide information to their government regarding their everyday realities, thus the "citizens become more visible to the state" (Verplanke et al. 2010). These activities are most commonly present on different social media platforms. The social media have also assisted in the promotion of GIS as a medium for social interaction and communication (Sui and Goodchild 2011), because of which are considered as a promising source of information for spatial planning (Campagna 2016).

Furthermore, there is a variety of tools and devices which are employed in Citizen Science Urban Planning projects, depending on the research question and projects` aims and costs. The tools and techniques can be classified as digital and analogue (storytelling, focus groups, mental mapping, interviews, creating collages or diaries with artifacts and similar). The most widely used digital tools are the smartphones/tablet-based supported by appropriate custom applications. Also, there is a multitude of wearable sensors for monitoring: air quality, time-stamped data, skin temperature, blood

volume pressure, heart rate, heartbeat inter-beat interval, electro dermal activity (EDA), novel smart materials and textiles etc. However, the main issue is the data quality for which statistical packages are used to organize, clean, geocode, and visualize the biometric data.

Data quality needs a special attention as it is a critical issue for any citizen science project. Ensuring that the public can collect and submit accurate data depends on three things: providing clear data collection protocols, providing simple and logical data forms, and providing support (education materials, training, recruitment etc.) for participants to understand the protocols and submit the required data. Also, knowledge for the project volunteers/participants is needed regarding accepting, editing, and displaying data, analysis, and data interpretation, disseminate results, measure impacts, scientific literacy outcomes and similar. For citizen science to be accepted as a valid science with high quality data, new statistical techniques are developed to identify signals of change in noisy data collected by citizen scientists. Even though there may be some issues of data quality authors note that the positives outweigh the negatives.

From a political stance, the citizen science can be viewed as a socialist movement having at its core the community, and it has the potential to enhance the political awareness and consciousness of the citizens/participants. However, certain relations of power can influence how and how much of the knowledge produced from CS projects is integrated into the decision making or they may have an influence on promulgation of policies and legislation.

Further, there is term that has emerged, named Citizen Design Science, which is based on: Citizen Science which means the participatory aspects and the kind of data collection, Citizen Design which implies active design by citizens and Design Science which is essential for the translation of citizens' design proposals into the design of urban designers. The design science approach, and the effective public participation processes are based on: analysing the context, identifying the purposes of the participation effort, iteratively designing and redesigning the process accordingly; while more than 20 Design Guidelines for Public Participation are identified (Bryson et al. 2013).

There are certain variations in Citizen Science, such as: volunteered geographic information (VGI), community-led research, and crowdsourcing collections (Haklay 2013). Volunteered geographic information means data collection which is added to maps by citizens without knowledge on geography, cartography, or geographic information system (GIS). The emerging of online mapping tools, such as OpenStreetMap, Google Earth, ArcGIS Online, and MapBox, citizens can easily and quickly create maps, share information, or perform analysis. A VGI approach of rather qualitative nature constitutes the Human Sensor Web (HSW) project by UN-Habitat ('UN-Habitat - A Better Urban Future | UN-Habitat' 2023). It combines the concepts of VGI and e-Grievance, as it gives citizens the possibility to evaluate water services via mobile phone communication.

Crowdsourcing Collections is inherently related to citizen science. Crowdsourcing projects can represent more strictly an online and computing activity than citizen science. It is described that "Crowdsourcing uses social engagement techniques to help a group of people achieve a shared, usually significant, and large goal by working collaboratively together as a group" (Holley 2010). Community-led research, which is sometimes referred to as participatory action research, differs slightly from citizen science in that it involves a cohort approach, promoting close collaboration between scientists and participants.

CITIZEN SCIENCE PROJECTS AND PLATFORMS

Citizen science projects are applied in various of disciplines. Several projects are undertaken in order to document marine pollution events, such as: Marine LitterWatch ('Marine LitterWatch' 2023), The OSPAR Beach Litter Survey ('Beach Litter' 2023) etc. The surveys require that citizen scientists record litter at specific beaches using predefined monitoring guidelines. In that regard, Marine Debris is a

smartphone application developed in the United States which has a global coverage (Hyder et al. 2017). Native Bee Watch ('Native Bee Watch Community Science Program' 2023) is a citizen science project to for bees monitoring in a fast-growing urban centre in Colorado, USA. Considering that the project is reliant on citizen scientists the difficulties with which this project is faced are regarding data accuracy. Therefore, a protocol was developed for an accurate bee identification and monitoring whether the citizen scientists are following the protocol for collecting accurate data on bee diversity. Authors suggest that citizen science can be a plausible option for bee monitoring at the level of morphospecies, but the projects` success will depend on the extent of volunteer engagement and training (Mason and Arathi 2019).

Other researchers involve citizens in CS projects by means of mobile data collection and online data analysis. They propose toolbox which transfers desktop GIS geoprocessing to ArcGIS Online (Chmielewski et al. 2018). The city of Porto intends to establish an electronic citizen service and place the public discussions on the internet empowering citizens to comment on current city projects. Within the project Smarticipate, the cities of London, Hamburg and Rome try new ways of participation. Rome focuses on bottom-up initiatives, Hamburg on open data (also in regard of the planning process) and London engages its citizens through co-design and other participatory projects in two communities (Dambruch, Stein, and Ivanova 2016). Additionally, during the public discussions on urban design proposal as well as during the urban planning process, the 3D visualisations are of high significance for transparent presentation and understandable for the civic audience. Issues that emerge are the integration and representation of data and the appropriate level of detail in the model. The focus of visualisation tools in city planning is being produced for the sake of representation and not for an active design process with citizens using such tools.

The urban API project moves in the direction of utilizing Citizen Design Science (Khan et al. 2014). One part of that project is to set up a 3D Scenario Creator showing ongoing planning decisions virtually in the model. Such a model facilitates the explanation of the problems and its solutions and contributes to the discussion among the different stakeholders. The alternatives to the proposed decision can be shown interactively however it does not allow any changes by the citizens themselves.

The review of collaborative platforms for co-design show that they can be organized in a centralized manner, decentralized manner, and there are also brave visions for a bottom-up organizing leading to a CS future. The differences between them are how they approach the issues of control, surveillance, and algorithmic management, as well as the decision-making process in the design and stakeholder involvement and tasks` organization. Therefore, the success of a collaborative design platform is strongly correlated to an underlying decision-making system during the design process and assigning appropriate weight to different stakeholders.

From the analysis on which criteria can contribute towards a liveable city it is concluded that it is culturally specific issue. However, imageability, enclosure, human scale, transparency, and complexity are noted to be of strong importance for making a district attractive for pedestrians. It is of crucial importance to involve the community and local representatives and volunteers in the realization of CS projects for urban design. Successful motivation, inclusion, management, and education are among the key aspects and recommendations for a successful integrative management of CS urban design projects and to address volunteer needs and to deliver sustainable urban design solutions that will meet the demands of the communities and citizens.

From the review of existing platforms, it is concluded that:

- the platform C3PO ('13016 C^{3}PO' 2020) is based on nourishing participative urban planning. Smarticipate ('Smarticipate – Opening up the Smart City' 2020) enables citizens to support decision making processes in the cities development.
- JPI Urban Europe ('JPI Urban Europe | Joint Programming Initiative' 2022) developed tools for urban living labs that enable different stakeholders to participate in urban development and the

accent is on improvement of energy-efficiency.
- Urban IxD ('UrbanIxD' 2022) project defined a coherent multidisciplinary research community working within the context of city/urban design etc.

The enhancement of city planning by co-design and collaborative platforms demands access to different information, requires visualization of relevant information for decision-making, the simulation of different scenarios, stakeholder communication support and similar.

From the review of the various platforms, it can be concluded that the establishment of citizen science collaborative platform for urban design can be based on the key functions of participative urban planning, such as: city data access, acquisition, transformation, analysis, management, and integration; applications development support and dissemination; enabling user (stakeholder) involvement, participation, and city co-design. Such complex platforms can integrate multitude of novel technologies, such as: GIS, BIM, open API, 3D modelling and visualization (3D, Augmented Reality and Virtual Reality), gaming tools, etc.

CONCLUSIONS

The enhancement of city planning by co-design and collaborative platforms demands access to different information, requires visualization of relevant information for decision-making, the simulation of different scenarios, stakeholder communication support and static and dynamic data. The analysis of the benefits for the stakeholders from the platforms is multifaceted. Data providers gain a data asset and new business opportunities are generated, citizens benefit from better liveability and engagement in their city, while the cities, have an improved decision-making process, and can timely and proactively respond and mitigate urban risks, sustainability issues and resiliency in the age of a changing climate.

From the research it is concluded that there is a strong public interest in joining in a citizen science urban design with benefits for all stakeholders. The theoretical establishment of collaborative platforms for urban design can be based on the concept of the future 'smart cities', meaning harnessing smart technology to an agenda of sharing and solidarity. However, one of the key issues for the efficiency and efficacy of the CS platforms for urban design is the setup of the organizational management, participants selection and their education and establishing a proper decision-making process in a highly dynamic participatory setting with an ever-increasing pool of urban data that will adequately represent the sustainable and resilient cities of tomorrow.

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