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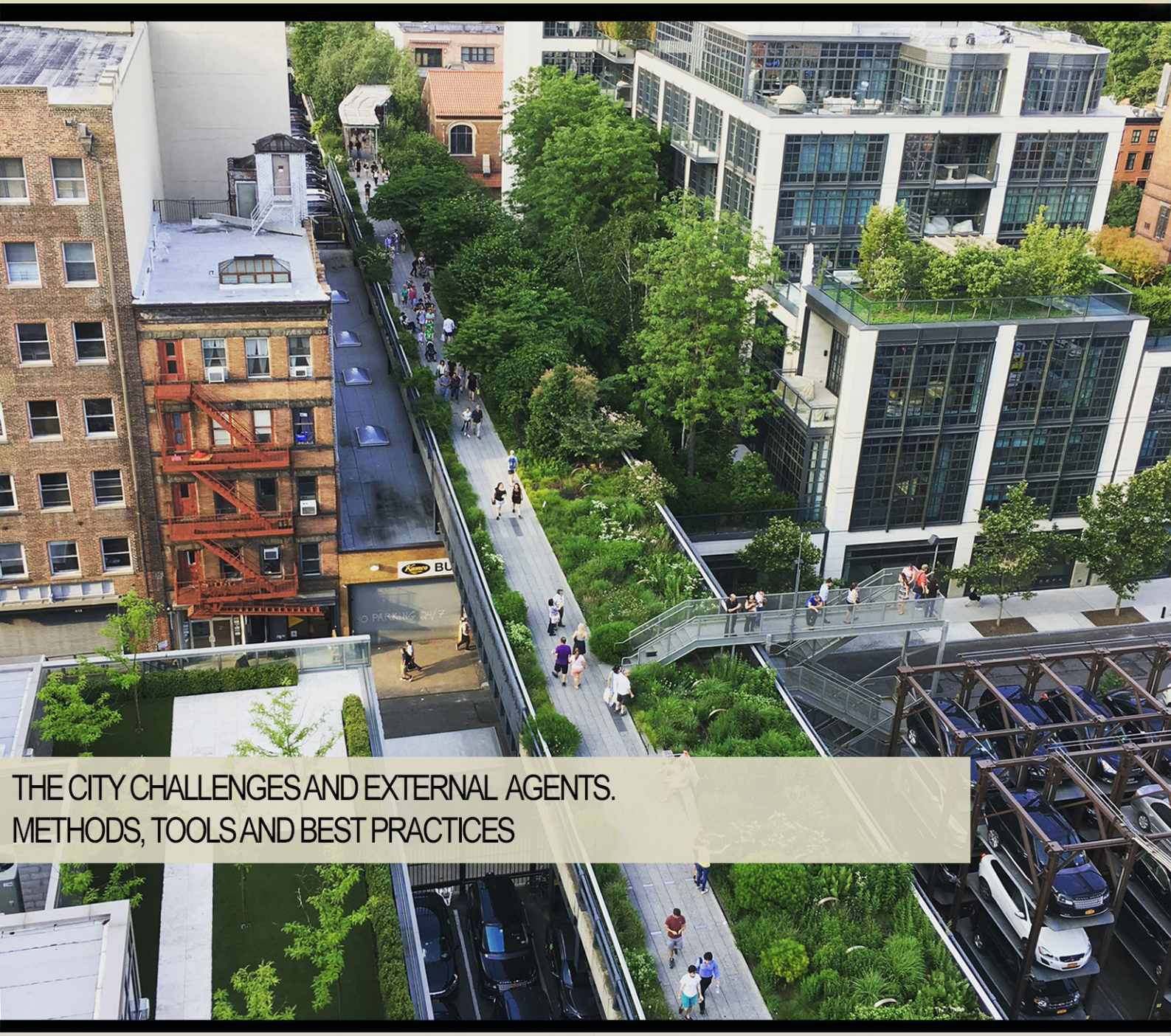

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REVIEW NOTES – Economy, business and land use

Citizen science: involving citizens in research projects and urban planning

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Abstract
Starting from the relationship between urban planning and mobility management, TeMA has gradually expanded the view of the covered topics, always following a rigorous scientific in-depth analysis. This section of the Journal, Review Notes, is the expression of a continuous updating of emerging topics concerning relationships among urban planning, mobility and environment, through a collection of short scientific papers. The Review Notes are made of four parts. Each section examines a specific aspect of the broader information storage within the main interests of TeMA Journal. In particular, the Economy, business and land use section aims at presenting recent advancements on relevant topics that underlie socio-economic relationships between firms and territories. The present note tackles the issue of citizen science, a new data collection methodology for research project that generates sustainability benefits, and that is recently finding applications in urban context to solve social and environmental issues while providing useful information that can be also used to develop urban plans.

Keywords
Citizen science; Research projects; Urban planning; Urban areas; Citizen engagement.

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1. Introduction

The involvement of different stakeholders in a process of participatory urban planning guarantees a trustworthy relationship between public organizations and other relevant actors towards a process that fosters economic growth and social cohesion (United Nations, 2015). Forms of collaboration between public and private actors democratize decisions by empowering relevant stakeholders to contribute to the sustainable development of cities (Staricco et al., 2020) in a so-called participatory planning process (Innes & Booher, 2004). In particular, recent literature is focusing the attention towards the role of citizens that are recognized as a possible resource for data and insights (Åström, 2020). Among the techniques developed to involve citizens in participatory projects, Citizen science (CS) is emerging as an effective tool thanks to the development of technologies that favor technology-mediated interactions between citizens and public organizations (Cappa et al., 2020; Sauermann et al., 2020). CS aims at involving citizens, without any particular knowledge requirement, in research projects aimed at solving social and environmental problems (Conrad & Hilchey, 2011). In such a way CS allows the democratization of science favoring stakeholders engagement and public participation towards tackling Grand Challenges (European Commission, 2020). CS practically consists of involving citizens as volunteers in research projects with the aim of collecting or analyzing large quantities of data at lower costs (Kullenberg & Kasperowski, 2016). Indeed, to respond to the need of intense data collection or analysis by researchers, such as signaling bird species in the city or mapping polluted water spots in the river, citizen scientists may allow to achieve these objectives in a faster and cheaper way. At the same time for citizens is provided a pleasurable experience with a technology intensive projects, and the possibility to increase their literacy.

Due to its proved effectiveness, CS role is rapidly evolving, and it is now considered as a valuable instrument for engaging people in decision-making processes (Bottero et al., 2017), even if they don't have a background in collecting data or in the specific topic of the analysis (Wildschut, 2017). In other words, CS engages people, that is external to a given organization, as source of knowledge, and the ease to involve crowds through information technologies is spreading the phenomenon (Cappa et al., 2019; Mueller et al., 2018). This means that CS is a relevant instrument both for public managers and policy makers. In their paper, Kullenberg and Kasperowski (2016) report examples of some interesting CS applications: in the field of humanities the project "Ancient Lives" asks citizens to transcribe ancient Greek text from the Oxyrhynchus Papyri collection. In the health sector, MalariaSpot uses mobile technologies to ask citizens to provide information about malaria cases in order to have a bigger dataset that allows to study the phenomenon in a more finely grained manner. In fact, the digitalization, and in particular the spread of the internet and mobile devices, allows organizations to involve citizens overcoming geographical and socio-economic barriers, potentially connecting volunteers from all over the world if they are interested in the topic (Cappa et al., 2018). This opens new opportunities to organizations to collect large amount of data from different sources to tackle grand challenges towards a sustainable development also in urban contexts (Tira, 2020). In particular, through CS it is possible to collect and analyze data to a scale that would not otherwise be possible without the help of citizens. Such projects, that have socially and environmentally aim, allow to reach the scientific objective in a faster and cheaper way. In addition, CS projects also have an educational scope as they increase the scientific and technological literacy of volunteers contributing into these projects (Åström, 2020; Boudreau et al., 2011). By contributing to these different social, economic and environmental goals, CS represents a sustainable tool. European Commission, indeed, is promoting such projects as instruments to develop sustainability and social innovation (European Commission, 2020) and thanks to the possible benefits provided by CS, there is increasing scientific, managerial and policymaking interest towards this phenomenon. Among the different fields in which it is possible to apply CS, urban development is one of the most relevant and most suitable to the implementation of participatory activities involving citizens, as urban areas are characterized by high concentration of living people and of social, economic and environmental issues (Bai et al., 2018; Gargiulo & Russo, 2017). In other

words, the critical mass of individuals affected by such challenges that affect several people, makes the urban context a major setting for CS. The aim of this review note is to shed lights on recent advancements in literature about CS in the urban context. The next paragraph highlights research and practical example of CS applied to the relationship between cities and citizens. Finally, we provide discussions and concluding remarks.

2. The application of Citizen Science in urban contexts

With reference to urban development, previous research has analyzed the relationship between CS and urban contexts as cities are the contexts in which the highest share of social and environmental issues are concentrated (Lai et al., 2020; Sakshi et al., 2020). Most of the studies have devoted attention to the methodologies useful to motivate citizens to participate as much as possible to CS projects in order to collect the highest number of information possible from them (e.g., Tinati et al., 2017) as the higher the amount of data collected, the higher the quality of the outcomes both in terms of scientific results and decision-making quality and reliability (Mueller et al., 2018). CS is gaining increasing relevance in practice as well. According to a report developed by the European Commission, CS is a tool that helps cities in becoming smart, raising awareness in the population about relevant topics and strengthening the community (Craglia & Eds, 2014).

There are several reasons why citizens get involved in CS projects and they may change depending on their characteristics (Laut et al., 2017). Rotman and colleagues (2013) identify two citizens typologies, named professional scientists and volunteers. The first group is moved by scientific advancements and career development, while volunteers do that for *"curiosity and commitment to conservation and related educational efforts"* (Rotman et al., 2013, p. 225). Volunteers, instead, get involved in CS projects to contribute to the development of something they care about. This is evident in the case of urban development, where citizens can give their contribution to collect data and information that may drive the development of their city or, to narrow down, their neighborhood. The case of Brooklyn Atlantis in New York is emblematic in this perspective. It is a project where New York citizens are asked to tag waste into a canal in Brooklyn, in order to map the major spots of pollution. By collecting such information, it is possible to understand which the most polluted spots in the canal are. In turn, this information may serve to public administration to design future ecological plans and strategies differentiated from a neighborhood to one another.

On the other side, why should administrations trust citizens? First of all, it has been evidenced that having high quantity of data may assure a high level of quality of the outcomes. Moreover, citizens participation allow the engagement of all the relevant actors involved in the decision making rather than a top-down approach (Åström, 2020) that could make the city smarter (Aldegheishem, 2019). In addition, administrations that manage CS projects have the chance to collect information at relatively low costs (Nov et al., 2014).

Previous studies have highlighted that administrations can effectively implement CS practices to engage citizens in a virtuous stakeholder engagement process that helps in designing effective urban plans (Mueller et al., 2018). One of the first examples of CS applied in urban context regards the preservation of birds in cities. As discussed by McCaffrey (2005), the involvement of citizens in bird monitoring in several areas of Canada and United States helped administrations to design bird-related ecological projects. The research carried out by Cappa et al. (2020) showed instead that through the collection of citizens data about their appliance usage public organizations could use such information to nudge people towards a more effective usage of high consumption electronic devices aimed at energy efficiency. Other studies evidenced the benefits of CS for cleaning waters or monitoring air pollution (Cappa et al., 2018; Young et al., 2019). Thus, by solving social and environmental problems through research projects, CS also appear to provide useful tools to urban planners to solve such related issues. There are several examples of application of CS projects in urban contexts. With reference to European Union, for example, has been recently launched the MICS (Measuring Impact of Citizen Science), an initiative that coordinate some CS project and evaluate their impact for society. The following boxes provide interesting examples of CS projects mainly referred to urban contexts.

"Globe at Night" CS project

Globe at Night is an international citizen-science campaign to raise public awareness of the impact of light pollution by inviting citizen scientists to measure & submit their night sky brightness observations. Citizens can easily get involved simply by using a computer or a smart phone. Citizens have to take pictures of the sky at night and the relative constellations. After that they should upload the pictures on a web-platform or on a smart phone app that will automatically collect data about date, time and location. The project thus collects data provided by citizens that allow to analyze sky pollution and monitor it constantly. The information provided by this data help scientists in the analysis of air quality and could also benefit administrations by providing a cheap tool to monitor sky pollution. In its 14 years of life, Globe at Night, a pioneering project, has collected more than 200,000 data collected from 180 world countries.

Co-design at Marzenego river

Among other projects, the MICS coordinates an initiative aimed at monitoring the quality of the water of the Marzenego river.
As the website states: "the Marzenego river begins its course in the north-east of the Veneto Region, Italy. Along its 45 km, the river crosses an extremely heterogeneous territory - characterized by rural, industrial and urban areas – ultimately channelling into the artificial Osellino canal which reaches the Venice Lagoon. As a result, the Marzenego receives water from a dense network of drainage canals, which modify the morphology of the watercourse and put areas surrounding the Marzenego at risk of flooding.
Nature Based Solutions (NBSs) aim to manage both the sustainable use of natural resources to address socio-environmental challenges, and the risk of environmental disaster; providing an integrated approach to conserve, manage and preserve the functionality of natural ecosystems. Along the Marzenego river, NBSs may include the restoration of natural habitats through the widening and remodulation of the riverbed, and the creation of wetlands for nutrient and sediment reduction; promoting biodiversity, reducing flood risk, and providing recreational areas for neighbouring communities.
NBSs are particularly effective when they are developed in a co-participative context, in which volunteers can have the opportunity to express their expectations and needs and be involved in the decision-making processes. Citizen science can further involve citizens by including them in the environmental monitoring of the NBS.
The NBS implemented along the Marzenego river provides a suitable case-study for MICS to evaluate; elucidating the impact of citizen science initiatives in this specific environment. To co-design the citizen science activities, MICS adopts and applies the best practice generated by the Ground Truth 2.0 project. This process has already begun with the first of three workshops, designed to identify and define the project and the environmental monitoring activities to be carried out by citizen scientists.
In December 2019, 40 citizens – including scientists, teachers, environmental experts and public authorities – were introduced to the river restoration project; the concepts of citizen science and NBS; and the MICS project as a whole. Through a series of activities – intended to facilitate an effective co-design of the project - the volunteers contributed their views on the issues surrounding flooding and poor water quality, and their expectations for what the project might achieve. Expectations were summarised as an infographic, and demonstrate increased well-being, increased biodiversity, environmental risk mitigation and social development as key issues in need of addressing."

3. Discussion and conclusions

Sustainability is phenomenon that is increasingly central and important both in private and public organizations (Franco, 2021; Klein et al., 2020). In line with sustainability principles, CS is a tool that helps research in collecting data from volunteer citizens, thus allowing scholars to collect large amount of information at relatively low costs. The phenomenon is increasingly developing and is mainly related to environmental issues. Most of the CS projects indeed are aimed at preserving biodiversity, monitoring pollution or reducing energy consumptions. Recent applications show that CS is spreading more and more even in urban context and that from mere research tool, it could be also used to involve citizens in a form of participatory process in line with the principles of democratization of science, stakeholder engagement and public participation (European Commission, 2020). In this vein, this note aims at giving attention to CS as a phenomenon on which regional and urban administrations should increasingly look with great interest given its possible applications in a wide range of issues, and in line with the principles of sustainability as it is mainly oriented to solve environmental

problems through the engagement of a key stakeholder, i.e. citizens. This is in line with the stream of literature that discusses the potential benefit of the involvement of citizens in urban planning and decision-making (Åström, 2020; Mueller et al., 2018). Possible future development in CS may indeed regard the inclusion of mechanisms that involve citizens in the decision-making process. This consideration may provide useful insights to policy makers to develop future plans for the sustainable development of cities in a stakeholder engagement perspective. Future studies should look at possible applications of CS in cities using both qualitative (e.g. case studies, interviews) and quantitative (e.g. surveys) methodologies, underlining peculiarities with respect to mere scientific applications, the activities through which it can be implemented, and the mechanisms that underlie its positive outcomes.

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