Special Issue Future of Smart Cities

FUORI LUOGO

Rivista di Sociologia
del Territorio, Turismo, Tecnologia

Guest Editors
Monica Bernardi
Luca Bottini

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Luca Bottini[1]

The future of smart cities and the role of neighborhoods in influencing sustainable behaviors: A general overview[2]

Introduction

Contemporary cities are entering a phase in which their centrality in mitigating the effects of climate change and reducing anthropogenic greenhouse gases in the atmosphere is crucial. At the beginning of the 19th century, the major cities of the Western world went through a major transformation, from a "pre-industrial" to an "industrial" urban model (Mela, 2018), basing their economies on manufacturing, which resulted in a consequent massive expenditure of fossil-derived energy to sustain the economic development. Since then, anthropogenic activities have been consistently growing due to social and economic development involving the Western world and a good portion of so-called "developing" countries. This exceptional economic growth has gradually released into the atmosphere an impressive amount of carbon dioxide from economic and individual activities that, since 1950 to the present, is reported to have increased sixfold.[3] Cities are the hub of the global carbon cycle, with a high volume of carbon dioxide emissions (Nangini *et al.*, 2019), positioning them as the main form of human settlement responsible for the climate change we are experiencing. Therefore, cities can and should be places where the irresponsible and disrespectful use of natural resources are adapted into new sustainable behaviors. Cities, with their high concentration of ideas, professionalism, intangible resources, and opportunities for social, technological, and economic innovation, represent the perfect place for experimentation with new sustainable lifestyles, subsequently spreading such practices to the rest of the region, territories, and states. The great challenge, then, is the reduction on a global scale of carbon dioxide emissions produced by human activities – a "decarbonization" in which cities are the main protagonists (Linton *et al.*, 2022). Based on these premises, since the early 2000s, the general debate in the study of cities, including such fields as the social sciences, urban planning, computer science, and engineering, has shifted towards the concept of smart cities (Dezi *et al.*, 2018). This concept refers to a series of strategies aimed at improving the quality of urban life through an efficient interaction between the material dimension of the city and society, aiming to achieve goals of social, economic, technological, and environmental sustainability (Caragliu *et al.*, 2009; Dall'O, 2014; Haarstad, 2017). The concept of a smart city can find application when considering a city as the result of a composition of smaller areas and communities. Neighborhoods, in fact, represent the fundamental elements for the construction of a city as a whole. A "smart" approach to urban policies cannot be achieved by considering the city as a single and homogeneous context. The achievement of "smart" objectives must necessarily harmonize with the specifics of each neighborhood, each with its own social, urbanistic, cultural, and identity factors. Decarbonization policies are therefore one of the fundamental challenges of future smart cities, and the achievement of these objectives necessarily involves the interaction between a macro and micro spatial dimension. To better understand this interaction, it is necessary to first choose the perspective or approach one intends to adopt to focus on the problem. The relationship that ties decarbonization to urban societies can be investigated by assuming two levels of analysis: a "macro" level on the one hand and a "micro" level on the other. The macro level includes policy choices and models of urban and territorial governance, such as supporting the reduction of greenhouse gas emissions through regulations, political actions, and social and economic development models aimed at achieving these goals. At the

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3 "Our World in Data, 2021" (https://ourworldindata.org/co2-emissions).

"micro" level, however, the urban community and its citizens are put at the core of the analysis and studied at the neighborhood level. Indeed, literature on smart cities has started to focus on the role of neighborhoods in making cities more sustainable, confirming the idea that dividing a city into smaller communities can act as a catalyst to build a macroscopic effect that steers the city towards a "smart" ideal. In this sense, references to the concept of a "smart neighborhood" have emerged in the literature, emphasizing the "smart" component of urban neighborhoods as factors that can contribute, from the smallest level of a city, to generating positive macroscopic effects (Li & Smeaton, 2014; Nakano & Washizu, 2021; Pahl *et al*., 2013). Residents, through their daily and repeated practices over time, can mitigate the effects generated by the carbon footprint by renewing their lifestyles and changing their consumption of natural resources and food and their use of everyday objects.

In this paper, we aim to turn our attention to the micro dimension of urban decarbonization, soliciting theoretical reflections on the spatial causes that can influence sustainable and pro-environmental behaviors. More specifically, we aim to investigate the role of the social, physical, and symbolic urban environment in influencing pro-environmental behaviors (PEB) in citizens at the neighborhood level. While this subdivision of urban space constitutes the smallest level of analysis of cities, neighborhoods also represent small communities with their own identity, architectural features, social vitality, and amenities; thus, neighborhoods are a sort of small city within a city and, together, make up the overall nature of the city itself. Neighborhoods, through such co-presence of resources and elements, can produce phenomena of social and cultural innovation, including new consumption trends and practices (Semi, 2015; Zukin, 1995). The hypothesis advanced in this article is that the neighborhood, framed as a multidimensional phenomenon (Galster, 2001), may be able to influence individuals' sustainable behaviors. In the complex set of variables that may act causally in the solicitation of these types of virtuous attitudes, an interpretive model called "NPSB" (neighborhood-perception-sustainable behaviors) will be proposed at the end of the article. The model relates the neighborhood to its material and immaterial characteristics (genius loci, quality of the urban environment, and culture), the perception of these characteristics by individuals (place attachment, environmental evaluation, and residential satisfaction), and, finally, the social outcome of sustainable behaviors (pro-social behaviors, pro-environmental behaviors, and circular behaviors). This model aims to provide a theoretical framework for understanding the involved process and has not yet undergone experimental verification. Therefore, this is the perspective from which it should be understood.

1. The interaction between a neighborhood's environment and its residents

Analyzing the neighborhood as a driver of social innovation and sustainable behaviors means looking at the city and selecting a small part of it—a portion of the territory that by social, physical, and identity characteristics makes itself autonomously distinguishable from other neighborhoods. Turning attention to the neighborhood, then, means focusing on that part of urban space that physically interfaces with groups of individuals: significant places, buildings, and, in general, all those architectural and urban structures in which the life of the urban citizen must measure itself daily (Dezi *et al*., 2018). The neighborhood, due to its limited territorial extension, becomes associated with the idea of community. Indeed, urban sociology has a long tradition of conducting studies on urban neighborhood communities, which have highlighted how within the smallest component of the city, social networks, relationships, and opportunities for individuals and groups to develop new lifestyles and social innovation are built (Flanagan, 2010; García *et al*., 2015; Moulaert, 2010; Moulaert *et al*., 2010; Moulaert & Van den Broeck, 2017; Van Dyck & Broeck, 2013). The neighborhood not only constitutes an urban sub-community where a wide variety of populations share the same space, but its multidimensional nature, both material and

immaterial, interacts with the subjectivities of its members, soliciting imaginary, perceptions, and evaluations (Costales & Zeyen, 2022; Hoseini & Mokhtari, 2013; Hyman, 2002; Rollero & De Piccoli, 2010; Ujang, 2012; Zhu, 2015).

Given the high complexity of the nature of a neighborhood, the best way to attempt to reduce this vagueness lies in framing it as an object that incorporates multiple dimensions within itself. In this sense, the definition proposed by Galster (2001) is very useful for the purposes of this article. According to the scholar, a neighborhood should be understood as a place where multiple dimensions coexist and are strongly intertwined. This idea refers to the physical infrastructural component of the urban space, the sociodemographic structure, the types of classes of resident populations, the environmental qualities, the quality of the public services, the political characteristics, the quality of sociality and social vitality, and the affective dimension, which includes the concept of "genius loci" that will be discussed later. Framed in this way, we realize that the neighborhood is something very close to an "organism," enabling the growing of the city itself thanks to the interaction between citizens' social practices and the "non-human" dimension of urban spaces (Searles, 1960). On the other hand, as far as social-level effects are concerned, there is evidence that the perceived quality of the neighborhood enables specific human behaviors, such as community participation (Bottini, 2018; Zhu, 2015), the propensity to prefer sustainable ways of urban mobility (Caiello & Bottini, 2020; Leyden, 2003) and focusing on health and subjective well-being (Galster, 2014; Sampson, 2003; Veitch *et al.*, 2012). There is evidence that the perception of the neighborhood in its complexity and multidimensionality (Galster, 2001) can influence not only the cognitive dimension but also the practices implemented by individuals. In a way, living in a specific context with specific characteristics can generate in individuals a greater inclination towards a specific social action.

The topic of perceiving the spatial characteristics of the neighborhood is associated with another equally relevant issue concerning the affective dimension of individuals in relation to the urban living environment. This refers to the place's ability to evoke attachment development (Lewicka, 2008; Livingston *et al.*, 2003)Lviv (Ukraine, previously Lwo, Poland, influenced by multiple variables such as exposure time to the place, including length of residency (Lewicka, 2005, 2011) postulated in literature, between place attachment and civic activity, the other is the sociological claim that there is a negative relationship between place attachment and a person's social and cultural status (cultural capital. Among the factors that induce individuals to develop place attachment, there can be a sense of identification with the place itself, which is referred to in the literature as "place identity" (Iv *et al.*, 1994; Rose, 1995), connected to the genius loci. The phenomenon has intersected studies in social sciences (Barnes, 2004; Neri, 2001) and architecture and urban planning (Norberg-Schulz, 1980). This is not the appropriate context to extensively discuss the concept of genius loci in urban sociology studies; however, it is worth mentioning its rediscovery in territorial studies as an intangible factor with limited scientific understanding but that is expressed through feelings and practices of an associated group of individuals within a spatial context. Genius loci can be framed as the most intimate part of a place that stands as the outcome of a constant layering of practices and uses happening over time. Such intimate heritage attached to a place solicits affection and bonding in the population that inhabits it, consolidating relationships among community members through a form of "syncretic sociality" (Bleger, 1967). The idea that places can solicit the development of a shared identity and a sense of belonging allowing a group to recognize themselves has thus also appeared elsewhere in the social sciences. However, there is no consensus among scholars for a reliable and solid definition of genius loci useful for sociological research. This is due to the high complexity of the concept and its empirical comprehensibility.

Overall, the material and immaterial factors we have illustrated above set the basis for a neighborhood that generates a vibrant context. This vitality is a crucial ingredient for initiating social innovation processes that guide urban neighborhoods towards a sustainable identity aligned with decarbonization processes – a fundamental objective for future smart cities.

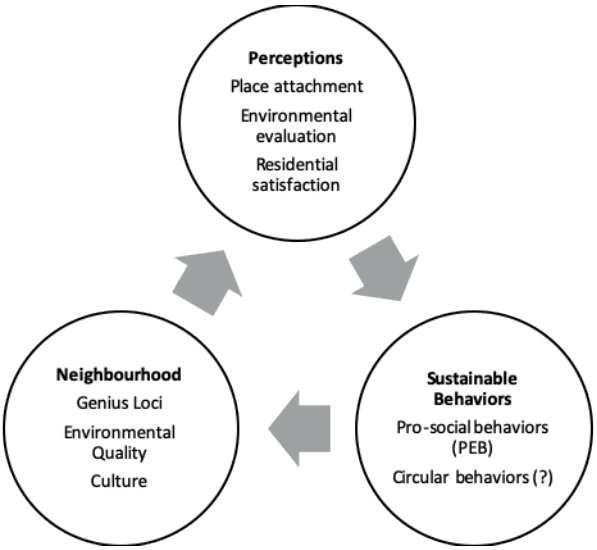
2. Neighborhood and pro-social behaviors

In the previous section we pointed out that the neighborhood, in its material and immaterial multidimensionality, interacts with the community of inhabitants, both at the individual and social levels.
The achievement of environmental sustainability goals at the neighborhood level can be attained by focusing attention on virtuous behaviors aimed at improving collective well-being. In this regard, the concept of "pro-sociality" is introduced. Pro-sociality can be defined as the propensity of individuals to contribute for the good of their neighbors and for the good of the community (Brief et al., 1986; Eisenberg & Miller, 1987; Fang et al., 2022; Lenzi et al., 2013). Within this category, individuals exhibit a degree of willingness to act for the cause at hand by infusing more or less energy and increasing the cooperation of other individuals (Fang et al., 2022). Thus, the propensity to act in this way is not necessarily total but has different intensity within the individuals. In the wide range of such phenomena that individuals can enact, we mention pro-environmental behavior as environment-oriented pro-social practices (Neaman & Mariò, 2015), defined as behaviors that individuals implement to reduce the environmental impact of human actions on the natural and artificial world, such as reducing energy consumption and waste generation (Kollmuss & Agyeman, 2002). Research has, indeed, shown an association between pro-social preferences and PEB (Andre et al., 2021; Fuhrmann-Riebel et al., 2021), documenting a tie between individual attitudes toward pro-sociality and the enactment of pro-environmental behaviors. If pro-sociality is somehow a precursor to certain attitudes, it is necessary to clarify the association that exists between the multidimensionality of the neighborhood and the pro-sociality of individuals. In this regard, the evidence accumulated so far seems to respond positively to this possibility. Lenzi et al. (2012) verified the existence of a link between the social resources of an Italian neighborhood (social cohesion, social opportunities, place attachment) and the encouraging of pro-sociality in a sample of adolescents. Similarly, PEB is associated with the level of perceived urban stress and local identity (Meloni et al., 2019), the rhythm of urbanization of the city (Qing et al., 2022), and, more relevantly, place attachment (Carrus et al., 2014; Scannell & Gifford, 2010; Song & Soopramanien, 2019). The spatial dimension, linked to the socio-physical context of the neighborhood (Stokols & Altman, 1987), fully falls within the variables capable of influencing a type of pro-social behavior such as PEB.
Insisting on this concept and its relation to PEB phenomena, Kaida (2015), for example, conducted a study on the propensity to act pro-environmentally, distinguishing it into three types of pro-environmental action and the degree of attachment of cases collected within a survey. Attachment was measured referring both to the living neighborhood and to the city in general. The study revealed the presence of a greater propensity to act pro-environmentally in those who possessed a specific attachment to the neighborhood rather than to the city, confirming how social life at the urban neighborhood level can create the environmental conditions for virtuous pro-environmental behaviors to arise. The empirical evidence thus seems to confirm two facts: on the one hand, that the role of the urban and social neighborhood environment can foster pro-social attitudes, and on the other, how, within this context, specific behaviors aimed at sustainability issues can take shape. Neighborhood attachment is among the most interesting variables that the literature is gradually confirming as a driver for PEB.

3. The "NPSB" model (Neighborhood-Perceptions-Sustainable Behaviors)

In light of the evidence described so far, this section intends to present a summarizing scheme enabling a general overview of the phenomenon here analyzed. Schematically, the following process is intended as follows:

Fig. 1 – The "NPSB" model (Author: Luca Bottini)



The proposed model constitutes a possible interpretation of what happens in reality, and the likelihood of the phenomenal outcome must be understood not in a linear but in a probabilistic sense. The process should be interpreted as follows: the multidimensional nature of a neighborhood interacts with individuals, influencing their cognitions and emotions (i.e., place attachment, residential satisfaction, environmental evaluations). Then the individuals' perceptions can turn into sustainable behaviors, acting pragmatically for the sake of the community, improving the quality of the neighborhood itself. Below, we will discuss each of the components of the NPSB model.

3.1 Neighborhood

As seen, the neighborhood constitutes an object that is both material and immaterial, in which remarkable functions and additional objects converge, making the neighborhood a "place" instead of a "space." There is something symbolic and non-material that is collectively recognized by the members of a neighborhood, but it cannot be directly measured and seen. As seen above, the genius loci constitutes that invisible and empirically challenging-to-identify factor that can serve as the basis for identification between individuals and the spatial context of reference. The genius loci is thus the first factor of a neighborhood that constitutes the fundamental variables regarding the neighborhood for the model. The second proposed factor is represented by the perceived quality of the neighborhood, which refers to the average evaluations of the socio-physical characteristics perceived by the residents of the neighborhood. This includes satisfaction with the built environment (Fornara *et al*., 2010) and residential satisfaction (Gan *et al*., 2019; Grillo *et al*., 2010). These factors, all together, give a useful account for understanding how the neighborhood environment is perceived as positive or negative by its residents. Finally, the third factor concerns the cultural and identity dimension of the neighborhood. In a city, neighborhoods represent the element which tells the story of urban multiculturalism and the individual stories of social and urban development that have shaped the trajectories of urban neighborhoods (Harding & Hepburn, 2014; Rosenstein, 2011; Semi, 2015; Zukin, 1995)" Genius loci, quality of the urban environment, and culture are therefore three factors that, together, constitute the first element of the presented cyclical NPSB model.

3.2 Perceptions

The second step of the NPSB model concerns the processing of individual perceptions of the neighborhood. At this phase of the process, the community interacts with the multifactorial resources of the place, processing ideas, imaginary and evaluations of the features that constitute the living neighborhood. This is a process that requires constant exposure and sufficient residence time to become familiar with the environment and reach a degree of knowledge that allows for the elaboration of an overall assessment (Bonaiuto *et al.*, 1999; Hidalgo & Hernandez, 2001; Sampson, 1988). The perceptions that individuals activate in relation to the neighborhood are the result of a bidirectional interaction between the socio-physical environment and mental cognitions. This relationship has been theorized by environmental psychology through a transactional paradigm, where the environment influences human behavior and vice versa, in an exchange that involves both individuals and their environments (Bonnes & Secchiaroli, 1992; Gifford, 2002). The perception of the neighborhood and its multidimensional characteristics, as mentioned earlier (Galster, 2001), is not an end in itself but interacts with the inner world of individuals and their beliefs and ideas about the living context. These factors, in turn, represent the foundations that guide individuals' behaviors. In this sense, the works of Ajzen are useful for framing the process that influences the production of behaviors by individuals (Ajzen, 2005). Ajzen's Theory of Planned Behavior posits that three kinds of beliefs influence the production of behaviors: a) behavior beliefs, b) normative beliefs, and c) control beliefs. The world of perceptions, therefore, influences the practices and social behaviors of individuals in neighborhoods, either facilitating or hindering them. Naturally, the reasoning proposed here assumes that the emergence or absence of behavioral intentions of a certain type, such as pro-social attitudes, has a probabilistic nature. Thus, reasoning in linear and deterministic terms is not effective for understanding the subject of this article.

3.3 Sustainable Behaviors

The perception of the neighborhood by individuals can influence behaviors and social practices toward it. Among the possible behaviors that members of the neighborhood community may enact, we have placed emphasis on the phenomena of pro-sociality to PEB. In light of the literature presented earlier, in the model presented here we hypothesize that based on the genius loci, environmental quality, and cultural aspects of the neighborhood, citizens develop a virtuous way of managing natural resources in daily life as well as the neighborhood itself. The final effect hypothesized here, in fact, predicts that the behaviors implemented by the so-called "active" inhabitants are aimed at maintaining a high level of quality in the urban environment and that the behaviors themselves trigger a self-feeding virtuous process. Within this phase of the process, a question mark has been put on "circular behavior" (Ali & Choe, 2022). Unfortunately, the effects of the urban environment in enabling circular behavior still need attention by the scholars. Although, following the NPSB model, the probability to find out an association between the neighborhood's characteristics and circular behaviors performed by the citizens could be hypothesized. This hypothesis might be motivated by the fact that circular behavior can be included in the general category of environmental behaviors, which are strongly connected to the environment's characteristics, as highlighted previously.

The NPSB model summarizes the interaction process that, starting from the multidimensional nature of the neighborhood, leads to social behaviors and passes through the cognitive processing of its material and immaterial characteristics. This model should be interpreted as a possible framework that shows how, by interacting with the fundamental characteristics of the neighborhood, individuals' perceptions can foster virtuous attitudes for the sustainability of the neighborhood itself. It is a theoretical model that needs to be empirically verified in the field, and the

relationship between the elements of this process does not aim to frame the phenomenon in a linear sense but rather in a probabilistic sense. Considering this logical premise, the model is represented in a cyclical manner as the elements involved in the process act upon each other, either positively or negatively. Favorable qualitative conditions of the neighborhood can prompt positive perceptions and increase the likelihood of generating positive behaviors in favor of the neighborhood. Such practices, in turn, can influence the entire process from its inception and thus contribute to the improvement of neighborhood conditions because of the positive practices implemented by residents who act in this way.

Conclusions

This article discussed the role of urban neighborhoods in promoting sustainable behaviors in future smart cities. Research on smart cities in recent times has been strongly driven to delve into the role of environmental sustainability in the construction of future smart cities. While most scientific reflections, even in the sociological field, focus on the macro dimension of the problem, investigating more sustainable policy practices, management, and urban development strategies, in this article a micro approach has been proposed. The main reason rests on focusing the attention on the city in its spatial, social, functional, and technological multidimensionality. This substrate, both physical and symbolic, is the result of the complex composition of smaller territorial units, i.e., the neighborhoods, which, together, constitute the backbone of a city. Investigating the micro level means taking a horizontal gaze and observing what happens between the members of an urban community and their physical environment of reference. The challenge of the future of smart cities is also and, we might say, especially played out at this level. Indeed, it is through social networks and interaction with individuals that the conditions are generated to propose phenomena of social innovation and sustainability.

In this sense, an interpretive model named "NPSB" (Neighborhood-Perceptions-Sustainable Behaviors) has been presented with the aim to frame the interaction process that takes place between the neighborhood and the cognitive/emotional processing of its inhabitants as premises for social outcome manifested by behaviors. Since we are interested in understanding whether the quality of the urban environment of neighborhoods could have a relationship with the issue of sustainability and urban decarbonization, we focused on pro-social behaviors, specifically pro-environmental behaviors. From the reconnaissance of the empirical evidence that has emerged so far, among the many variables involved, attachment appears to be the most important. Place attachment is directly linked to the concept of the "soul of a place" and thus the "genius loci," highlighting how in the realm of spatial perceptions, the imagery and affective emotions developed by individuals residing in a neighborhood are effective and constitute an important object of investigation in the field of urban sociology. The specialty and uniqueness of the neighborhood and the complex world of individual perceptions are the triggers for the emergence of PEB in the community of individuals in the neighborhood. So, the phenomenon of caring behaviors toward the urban environment and for a more sustainable use of natural resources (thus providing a contribution to decarbonization) is also rightfully part of the analytical reflections on the future of smart cities so that they are greener and more sustainable.

Finally, the end point of the considerations made so far involves urban development policies. Neighborhood care, which happens, at least partially, informally through bottom-up practices of social innovation originating from the neighborhoods themselves, is the main object of governance of local governments. Urban regeneration operations are very delicate phenomena that constitute a great opportunity to improve the physical quality of a neighborhood, as well as serve as a moment when social development, the organization of commercial and service offerings on site, can be rethought to converge as much as possible with citizens' needs. In this

sense, urban care policies have an indirect nexus with the process of development of quality of life in contemporary cities' neighborhoods and thus also with the processes of elaborating individual environmental quality that solicits the affective bond between residents and their urban living environment. Finally, the level of urban environment quality can predict the likelihood of sustainable behaviors. As can be thus understood, the action of territorial government is not only made explicit at the visible level through the choices of transformation of urban space made by the various successive administrations, but it also interacts with the lives of residents. Urban development policies at the minimum level of the neighborhood actually affect citizens' perceptions, imaginary, residential satisfaction and, ultimately, their sustainable behaviors for the neighborhood. The proposed NPSB model in the article attempts to bring together all these elements as part of the complex process that, starting from the interaction between citizens and the living neighborhood, can lead to pro-environmental social practices for better future smart cities. It is a theoretical model that would need to be empirically tested. The lack of evidence in this regard constitutes, in fact, both the main limitation of the article and at the same time the starting point for future development of what is described here.

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