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# Analyzing the Criticalities of Public Spaces to Promote Sustainable Mobility

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**Abstract**

The massive spread of private cars has led to the progressive reduction of public space quality. Public space is one of the city components necessary to give life to the city itself and should have the characteristics of quality, safety, and accessibility. With a view to the sustainable development of the urban environment, these needs should be met through targeted interventions, with particular attention to the integration between urban planning and mobility. Therefore, in this paper, we study the urban regeneration of public space in favor of sustainable mobility. A methodology for the definition of the cognitive framework in urban regeneration processes is proposed. The methodology is based on three different strongly interconnected phases: the first phase is the analysis of the urban context, the second is the analysis of the perception of space by the user, while the third and final phase proposes some preparatory solutions for the subsequent design phase. The technical analyzes are based on observations on the site, measurements, and the use of thematic maps. On the contrary, the perception phase is based on the direct involvement of citizens through a survey. The methodology is applied to the case study of the San Bartolomeo district of the city of Brescia. The results show a connection between the technical characteristics of the road and the perception of space by the users. Furthermore, they are useful for the design of a public space weighted to the needs encountering.



*Keywords:* public spaces; sustainable mobility; public participation; citizen involvement; district councils; regeneration

## 1. Introduction

At the end of the nineteenth century, the massive spread of private cars, both in cities and in smaller towns, led to a gradual reduction in the quality of public spaces, invaded by motor vehicles. Moreover, vehicular traffic has

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caused severe pressure on the road network, resulting in a decrease in the usable space for pedestrians and cyclists. Only from the first half of the twentieth century, the issue of the conflict between vehicles and pedestrians began to be addressed. Initially, the solutions were based on separation models of vehicular traffic from pedestrian traffic. Subsequently, the solutions moved to models based more on the concept of integration between different road users (Tiboni, 2004). The growth of problems related to pollution and congestion of spaces has led the new urban policies in favor of the transition from the use of private cars to sustainable mobility systems. The orientation to alternative modes of transport (e.g., on foot, bicycles, collective public transport, or electric micro-vehicles), introduces the theme of the public space redesign. Therefore, sustainable mobility plays a central role in the regeneration of public spaces. A necessary condition for sustainable mobility system development is that the urban environment is safe, and accessible (Colarossi et al., 2007). Moreover, these characteristics are a fundamental prerequisite for encouraging users to adopt sustainable mobility systems. Transportation planning and soft mobility networks should proceed hand in hand with a more coherent urban planning (Bertolini, 2017). Consequently, the non-built public space assumes a specific role, not only because it connects the various functions present in the territory, but also because it is itself a place of sociality. Also, a space suitable for everyone and above all for vulnerable users (i.e., children, the elderly, people with disabilities) (Mahapatra et al., 2021).

The redevelopment interventions should be aimed at connecting the places that play a central role, favoring sustainable mobility and discouraging vehicular traffic with traffic calming interventions. In general, the use of traffic calming solutions involves an urban redevelopment plan and can also affect terms of increasing social security. The emblem of these techniques is the Dutch *woonerf*, officially approved in 1976: the effect was to make the public space more livable and shared, like an extension into the street of the private space available to residents (Tiboni, 2010).

The introduction of traffic calming is not just a technical issue, but a broader process that involves the entire community. Residents can play an important role in identifying problems and helping to find possible solutions. The direct and continuous involvement of all stakeholders from the beginning of the planning process is provided for by the Sustainable Urban Mobility Plans (SUMP) encouraged by the European Union (Wefering et al., 2014). Consequently, for the first time, public participation is incorporated as an integral part of the planning process with appropriate procedures and methods. Among the various tools that can be used, focus groups, workshops, public conferences, or interviews can be mentioned (Ignaccolo et al., 2019). However, whatever the method used, it is important that the public participates in the decision-making process, understanding the problems under discussion and the potential impacts of the proposed solutions (Giuffrida et al., 2019). The public involved is limited to those who have interests in the issues dealt with, in general to groups of stakeholders or small samples of citizens (Le Pira et al, 2017).

The awareness of the need for a quality urban environment has prompted several cities to promote the regeneration of public spaces to achieve better conditions of social, environmental, and economic sustainability. Therefore, this paper contributes to the existing literature by proposing a methodology for the construction of the cognitive framework of public spaces. The methodology considers technical (i.e., road characteristics, user behavior) and perceptive observations of the space, involving citizens in the decision-making phases. Besides, attention is also paid to improving the quality of urban life for the most disadvantaged people (Gonzalez-Urango et al., 2020; Cecchini et al., 2018).

This study aims to propose a methodology for analyzing public space by studying the characteristics of the urban environment, the mobility network, and the perception of those who live in the neighborhood. It differs from the study methodologies of the urban environment of Tira et al. (2018) and Rossetti et al. (2014) in that it mainly considers the perception of users.

The remaining document is organized as follows: Section 2 presents the methodology, framing it in three different types of analysis; section 3 presents the results of the survey; section 4 concludes the work and discusses the limitations of the study, highlighting some future directions of the research.

## 2. Methodology

From these reflections, a methodology is defined for the construction of the cognitive framework. The methodology is divided into three distinct but strongly correlated phases. In the first phase, an analysis of the urban

context takes place through technical observations and analyzes, while in the second phase, the user's perception of space is analyzed. Finally, the information obtained is combined with some preparatory solutions for the subsequent design phase.

### *2.1. Urban context analysis*

This first phase includes different types of studies. The analysis starts from the definition of the urban environment characteristics, determining the spatial link existing between the different urban areas, mapping the functions present in the urbanized areas, and the types of social services. By social services, we mean all those services available to citizens (e.g., school, welfare, health, hospitality, and security services).

Subsequently, the soft mobility system is analyzed, which involves the study of the different types of pedestrian, cycle, and public transport routes. The objective of this analysis is to verify the continuity of the various networks in the area to allow the movement of each type of user. It starts with an overall cognitive picture of the different types of routes, to identify where they intersect and where possible interchange areas are created. Therefore, the overall view is followed by the specific one for the different paths. In the first place, the pedestrian paths on the carriageway sides and in the public parks are identified. Thanks to this analysis, it will be possible to verify the continuity of the pedestrian network obtained by the presence of crosswalks or the discontinuity due to the sidewalks' interruptions for the driveways. Secondly, cycle paths are analyzed to identify the network continuity within the urban spaces and public parks. Within this network, the bike-sharing service stops are also highlighted. Finally, the Local Public Transport (TPL) lines routes are mapped with the relative stops.

To ensure accessibility and use of public space by all types of users, the environment should have the characteristics of quality and security. Consequently, this analysis aims to verify, from a technical point of view, the presence of these peculiarities in the area. The road section analysis is aimed to understand the geometric characteristics of all the road elements and focusing on their criticalities. Accordingly, all the road components (such as carriageway, sidewalk, cycle path, and pedestrian crossings) are geometrically measured, identifying characteristics and criticalities. Moreover, the criticalities found are analyzed in more detail, locating them in the territory.

From the literature research, it was noted that the road users' behavior, especially pedestrians and cyclists, is variable and unpredictable. Therefore, it is necessary to analyze the behavior of the users, to create an environment consistent with the needs encountering. On the one hand, this analysis allows quantifying the extent of pedestrian flows, on the other to know the behavior of pedestrians when crossing a street. Therefore, the aim is to represent pedestrian flows (especially while crossing) to identify which routes users prefer and, when possible, improve to make them safe.

The data useful for the analyzes can be obtained through direct observations on-site, using open databases such as Google Maps (https://www.google.it/maps) and Open Street Map (https://www.openstreetmap.org), and using specific thematic maps. Finally, thanks to the Geographic Information System (GIS), it is possible to connect the various analyzes and create a graphical representation by overlapping layers with the respective information. In this way, the strengths and criticalities of the territory are highlighted.

### *2.2. Perception analysis*

The urban context analysis provides characteristics and criticalities of the territory only from a technical point of view. For the environment redevelopment, which considers the characteristics of quality, accessibility, and safety, it was also necessary to define the users' perception of the surrounding environment. Therefore, the participation of the users is particularly interesting.

In this methodology, some critical issues (e.g., the high speed of vehicles or the presence of unsafe pedestrian crossings) were not detected from a technical point of view, but only from the perception of users. Consequently, a comparison with citizens is essential. Citizens are asked to fill in a survey, to better understand the inconveniences and requests of those who live in the area. The survey is submitted through the "Google Form" and is divided into three sections. In the first section, the answers are compiling, in the second they are multiple, while the third section provides the possibility to insert suggestions. The survey is divided as follows:

- General information: the aim is to identify user profiling, reporting information like age, sex, residence, interaction with the territory, frequency and dwell time, reasons, and ways of moving.
- Criticality found in the area: the aim is to report the criticalities found in the public space, including the perception of vehicular traffic, the behavior of motorists and users concerning the urban environment in which it is located.
- Suggestions for the area redevelopment: the aim is to supply some proposals for the public space improvement.

### *2.3. Regeneration hypothesis*

In the third and final phase, the information obtained from the urban context technical analyzes and those on the users' perception are combined. The aim is to create a first design hypothesis for the regeneration of public space in favor of sustainable mobility. For example, the project can introduce traffic changes, the introduction and/or elimination of new parking lots, the introduction of reserved cycle/pedestrian paths, elements of traffic calming, street furniture, and green areas.

## 3. Results

The methodology exposed is applied, by way of example, to an urban regeneration project in a district of the city of Brescia (Italy). The city in northern Italy (Lombardy) has about 200,000 inhabitants. In recent years, the municipal administration has introduced a series of territorial redevelopments to align itself as closely as possible with the sustainable development policies of the most virtuous medium-sized European cities. The case study for the application of the method is the San Bartolomeo district, with about 5,500 inhabitants, inserted in a redevelopment program for the entire northern area of the city (Figure 1a). More precisely, the municipal administration intends to redevelop the central area of this neighborhood, which over time has taken on the role of a small city center. However, this role conflict with the negative externalities of vehicular traffic affecting the studied areas.

### *3.1. Urban context analysis*

The analysis of the urban environment characteristics shows that the San Bartolomeo district is very heterogeneous, with the presence of well-distributed industrial, agricultural, residential, and commercial areas (Figure 1b).

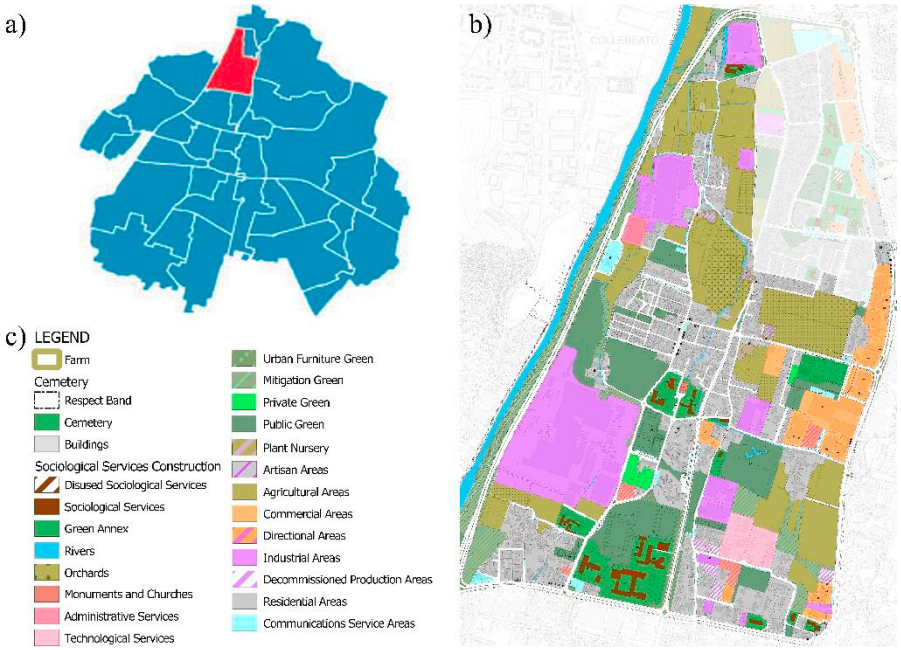


Figure 1. (a) Neighbourhood location; (b) Land use analysis; (c) Legend

The main industrial area is located to the west of the district: in this area the industries are medium-large, while the medium-small ones are located more internally, surrounded by agricultural and residential zones. To the east are the commercial areas, while the agricultural zone is concentrated in the north. Within the territory, there are most of the educational and childcare services such as kindergartens, nursery schools, primary and secondary schools. Focusing on the small city center, the main road is a street inserted in a residential context, with numerous shops and services along both sides of the carriageway, but without widespread parking.

The soft mobility system analysis within the neighborhood shows the presence of different types of routes. For the pedestrian route, the sidewalk is present at least on one side of the main streets and ensures connections. On the contrary, the cycle path is located outside the center of the district and this involves the transit of cyclists in the area without any reserved path. Furthermore, in the study area, there are several stations of the BiciMia bike sharing service, and the neighborhood is crossed by a Local Public Transport (TPL) line (Figure 2a). The technical and geometric analysis of the road components defines their characteristics but also identifies the critical issues for their use. Particular attention was paid to the lighting elements, as one of the key features for user safety. Both from a technical point of view of identifying the path and the user, and from a perceptual point of view regarding criminal activities. The criticalities found by the analysis of road sections are located on the map using special symbols for an overview (Figure 2c). In the neighborhood, there is a lack of specific artificial lighting for pedestrian crossings. Architectural barriers consist of the presence of bins, telephone booths, and bus shelters that obstruct the passage. Only in some cases are they represented by the presence of sidewalks without descents for pedestrian crossing. Finally, the presence of holes and cracks in the ground indicates a lack of maintenance of the road surface.


Figure 2. (a) Soft mobility system analysis; (b) Legend; (c) Some critical issues

Regarding the small neighborhood center, the user behavior analysis shows that pedestrians cross the carriageway much more frequently outside of the established crosswalk (Figure 3). The observations were conducted in person on the study site, for 30 minutes, 3 times a day (morning, afternoon, late afternoon), for a total duration of two days, one in July, one in August. The routes were drawn on the map and then inserted into the GIS software.

The presence of shops on both sides of the street favors a continuous flow of users. Moreover, the internal position and the less traffic are some factors that influence the choice of the pedestrian to cross the roadway on a pedestrian crossing or not.

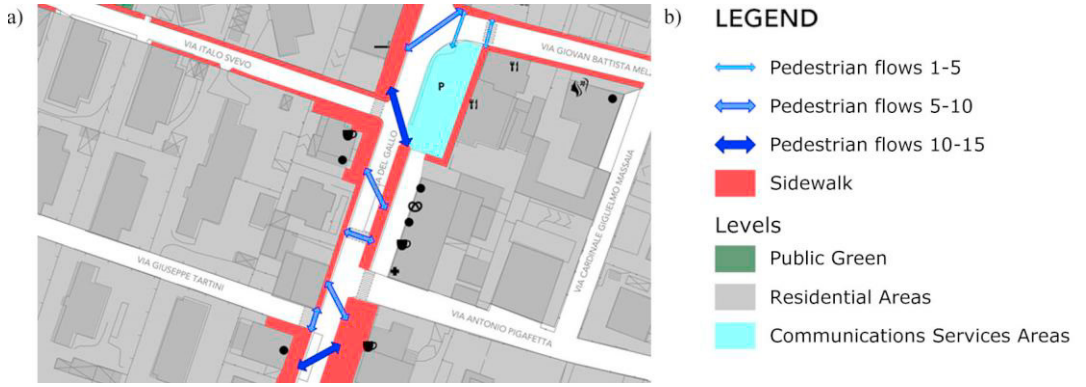


Figure 3. (a) Analysis of user behaviour; (b) Legend

### *3.2. Perception analysis*

The perception analysis of space by users was carried out with the support of the District Council. This organism is made up of people who live in the neighborhood and has a regular direct confrontation with the other inhabitants. Following an illustration of the technical analyzes, we submitted to the citizenship the survey previously illustrated. The survey was designed by the researchers based on technical analyzes and disseminated to the public thanks to the District Council. The survey found initial responses in a small sample of neighborhood residents active within the neighborhood council. From the user profiling, we note how the age of the participants showed a broad range (from 19 to 80 years old) and mostly women (61%). Participants mainly reside within 1km of the district center, 73% frequent this space, while 27% are just passing through. Those who frequent only passing through are mainly directed to their homes, restaurants, bars, or shops. The area is frequented every day by 62% of participants, once or twice a week by 25%, and sometimes a month by 13%. The maximum dwell time is about 15 minutes, especially during the morning or late afternoon. The most popular activities are necessities shops (i.e., baker, pharmacy, minimarket) and bars and restaurants. The places are reached on foot or by car. The section relating to the criticalities found in the territory highlights the lack related to the mobility of people. It is highlighted that unauthorized parking vehicles reduce the useful space in pedestrian paths and that crossings are few and unsafe. Also, the lack of cycle paths and parking spaces is underlined. The 59% of participants perceive high vehicular traffic, high speed, and parking in unauthorized areas. Therefore, regarding traffic, the urban environment is perceived by users as unsafe. Concerning the quality of the territory, they perceive it as unattractive, highlighting the lack of greenery and maintenance. Finally, in the suggestions section, users consider it important to create more protected pedestrian crossings, build traffic moderators, build cycle paths, and renovation of existing spaces (Figure 4). Besides, they suggest the construction of new parking lots, the establishment of one-way streets with traffic moderators, and forbidden the passage of heavy vehicles.

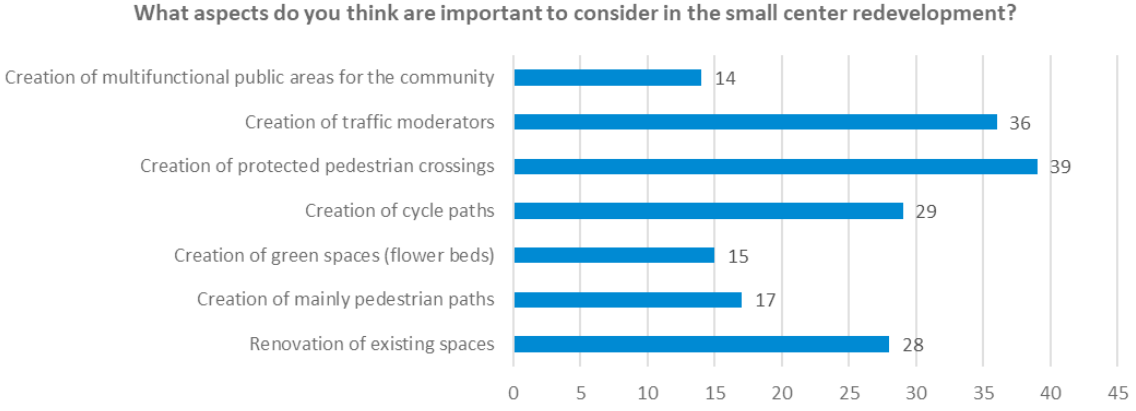


Figure 4. Citizen requests in the survey

### *3.3. Regeneration hypothesis*

From the analysis of the survey responses, it emerges that traffic problems, high speed, and lack of parking are recurrent. Consequently, the redevelopment of the small center of the San Bartolomeo district is necessary. Here are just a few useful tips for a later design phase.

A first intervention could be the modification of the viability of some neighboring roads, for the construction of parking lots on the sides of the carriageway. These interventions would be useful to reduce a load of illegally parked cars along the main street. Subsequently, the parking area to the north could be reduced to allow the creation of a small square that identifies the neighborhood and is a meeting place for young and old. Furthermore, the south sidewalk could be moved, and the space obtained would be useful for the insertion of parking lots along the carriageway and bins, so as not to constitute an architectural barrier. Finally, it is possible to hypothesize the creation of an elevated platform with StreetPrint treatment to bring the carriageway to sidewalk level and pay greater attention to the safety of pedestrians crossing the street (Figure 5).

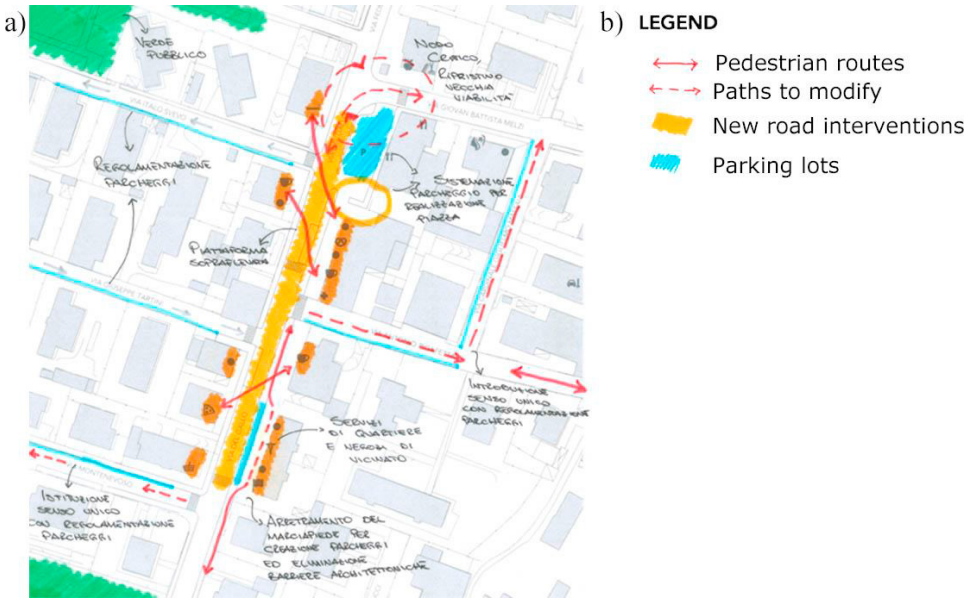


Figure 5. (a) First interventions hypothesis for regeneration; (b) Legend

## 4. Discussion and conclusion

In this paper, we study the urban regeneration of public space in favor of sustainable mobility. Following the industrial revolution, the spread of private cars has led to a gradual decrease in the quality of public space and the surface usable by pedestrians and cyclists. The problem was first tackled through solutions for the separation of vehicular and pedestrian traffic, then with integrated solutions, thanks also to the introduction of traffic calming techniques. These techniques act through direct interventions on the road and have the function of inducing the motorist to reduce the speed within an environment shared with pedestrians, cyclists, and public transport. However, reducing the speed and volume of traffic are just some possible solutions to increase the livability of the space. In fact, by freeing the areas occupied by parking and the passage of vehicles, reducing accidents and pollution, urban spaces are made more livable, bringing the city back to the measure of every citizen. Although the introduction of traffic calming techniques appears to have only a technical application, it encompasses a broader process that involves the entire community. Residents can play an important role in identifying problems and helping to find possible solutions.

With these premises, the paper aims to define a methodology for the construction of the cognitive framework of public space, which leads to the realization of a regeneration project concerning sustainable mobility. The proposed

methodology consists of three different phases. It considers technical analyzes (based on measurements, observations, and thematic maps), perceptual analyzes (obtained thanks to the direct involvement of citizens through a survey), and the definition of first design solutions for the regeneration of space. The methodology was applied to the San Bartolomeo district, north of the city of Brescia.

The analyzes are carried out to allow the definition of a complete cognitive framework that investigates the characteristics and criticalities found within the case studies, considering the real and perceived risk by the user and the requests of the users of the space themselves. The result of the multiple analyzes show that the perception of high traffic and speed on main roads pushes the users of the services to move with their own private vehicle even for short trips, instead of using sustainable mobility systems. Furthermore, the geometric characteristics of the spaces do not allow the creation of safer reserved lanes. Therefore, public space regeneration interventions are needed that encourage the use of sustainable mobility systems, without forgetting the peculiarities of quality, accessibility, and safety of public space.

The analysis of the urban context, the one on the soft mobility system, could be further developed considering the new types of transport such as e-scooters and self-balancing devices. The introduction of this new system involves several issues related to public space and road safety (Boglietti, Barabino, & Maternini, 2021). The work could be enriched with an analysis of the space used, vehicle speed, traffic flow, and the number of crashes recorded in the study area. Furthermore, the perceptual analysis phase of the work could be further integrated using other forms of participation, such as workshops and focus groups. Numerous participants allow the definition of a project that considers the instances of most users. Furthermore, this methodology applied to the neighborhood scale can also be used for larger-scale urban realities.

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