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Public Open Spaces: connecting people, squares and streets by measuring the usability through the Villanova district in Cagliari, Italy

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Abstract

Growing spatial and social injustice, vulnerability to environmental hazards, and the Covid-19 pandemic have underlined the need of a radical re-conceptualization and transformation of Public Open Spaces (POSS). Within this perspective, the usability of the public space emerges as a fundamental condition that influences the individuals' well-being by affecting central human capabilities, including bodily health and integrity, control over the environment, and attachment to people, objects, and places. Usability is herein defined as the potential of spaces to expand human capabilities by supporting autonomy, active mobility and utilitarian, leisure and social activities. Consequently, with a combination of space syntax and spatial analysis techniques, this study structures an analytical method to identify central spaces for pedestrian activity, assess their usability and underline major criticalities. The analytical method encompasses a set of quantitative indicators related to both intrinsic geometric, functional, social attributes and to configurational extrinsic properties of spaces. The case study concerns public spaces within the historical district of Villanova, Cagliari, Italy. The case study analysis will underline that the integration of space syntax techniques and spatial analysis methods is instrumental to the comprehensive understanding of intrinsic and extrinsic spatial attributes affecting patterns of outdoor activities, and to the identification of intervention priorities with regards to the redevelopment and regeneration of public spaces. Consequently, this study represents a valid contribution to the topic of Active mobility and urban redevelopment, in the urban planning session of the conference. In conclusion, the study underlines the relevance of the proposed analytical method as a framework supporting data-informed design solutions and smart decisions within a planning perspective centred on strengthening inclusion and equality of the urban realm.

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Keywords: Usability; Space Syntax; Walkability; Capability; Morphology

1. Introduction

The increasing centrality of urban areas as the crucible of human condition in the Anthropocene is a twofold process: on the one hand, the city consolidates its pre-eminence as the place where wealth, knowledge, innovation are produced and as the place where the encounter with the difference, transfer of knowledge, cultural contamination determine the production of new identities, subjects, ideas and practices (Secchi, 2013; Zampieri, 2012). The city, thus, can be regarded as the stage-set where the drama of social life unfolds, in the continuous alternating of spectators and actors (Mumford, 1937). On the other hand, the city is also the place where the detrimental dynamics of the Anthropocene are magnified (Chan, 2019). Within this perspective the public space and its usability become a central aspect of the discourse on equality, spatial justice and co-existence of different identities within the contemporary city (Bates, 2018; Carmona, 2019; Fainstein, 2014; Gehl, 2011; Ignatieff, 2017; Jacobs, 2016). The physical aspects of the public space embody, indeed, opportunities for the encounter with the difference, for social contacts, and for access to urban opportunities and to employment. These opportunities, thus, affect sociality, cooperation, trust and inclusion by reinforcing people's engagement in the political, economic, cultural and social processes of the urban realm (Anderson et al., 2016; Chan, 2019; Ignatieff, 2017; Secchi, 2013).

The objective of the proposed article is the definition of a method for the quantitative analysis of aspects of urban morphology that incorporate opportunities for social contacts, access to urban amenities and meaningful experiences of the urban realm. The concept of usability is introduced to denote the property of the built environment to incorporate opportunities that influence individual and collective practices. The definition of a method for measuring the usability of the built environment is instrumental to support informed decisions on spatial planning by enabling the understanding of the distribution of opportunities across the urban realm and by individuating critical areas of marginal usability. The proposed method is applied to investigate patterns of usability in the historic district of Villanova, in the city of Cagliari, Italy. The results demonstrate the proposed method relevance to understanding the built environment and to supporting informed decision-making processes.

The article is structured in six sections. After the introduction, the concepts of capability, usability and morphology are presented in section 2. Section 3 focuses on the description of the methodological framework. Findings from the application of the analysis method are presented and discussed in section 4 and 5. Lastly, the conclusions section outlines the hypotheses for the future development of the research.

2. Literature review on capability, usability and morphology

The discourse on the impact of public space morphology on patterns of behavior builds on the notion of soft determinism (Annunziata and Garau, 2020; Chan, 2019), to reflect on the more general issue of the relationship between the built environment attributes and well-being. The latter, in turn, implies the issue of defining well-being in a way that is meaningful for informing the project of the public space. Within this perspective, Ferdman (Ferdman, 2019) defines objective well-being as a condition dependent on the successful development of human faculties and capacities. More precisely, the concept of human capabilities is the foundation of a conceptualization of well-being as an objective condition. Capability is defined as the ability of an individual to achieve a condition – or functioning – deemed as valuable (Sen, 1993). Nussbaum (Nussbaum, 2011) defines central capabilities as the set of attainable conditions whose achievement and exercise is central to good human living. Central capabilities incorporate the internal dimension of individual abilities and the extrinsic dimension of factors of the environment embodying opportunities and constraints. The central capabilities related to the attributes of the public space include bodily health, control over one's environment, affiliation, attachment to place, objects and people, and play. As a result, the creation of equal opportunities for developing central capabilities emerges as a central factor of policies aimed at promoting inclusion, equity, and social justice. The extrinsic dimension of opportunities is herein framed within the concept of usability. Usability expands the notion of walkability (Garau et al., 2020a, 2018; Campisi et al., 2020b; Ewing et al., 2015; Ewing and Handy, 2009) and is herein defined as the potential of the built

environment to facilitate social contacts, encounter with the difference, access to services, amenities, employment. Usability is thus a complex configuration of opportunities for human-environment transactions, embodied in the morphology of the public space. Building on the Conzenian notion, morphology is defined as a complex structure which incorporates five dimensions: the network of open spaces, including paths and nodes; the system of plots and the arrangement of buildings on plots; land use patterns, the configuration of the transportation system (Conzen, 1960; Li et al., 2020; Ye et al., 2017; Zhong et al., 2020) and the configuration of the urban green infrastructure. These components of morphology are related with different conditions of the urban environment which are conducive to vitality and to the plurality of practices across the urban space. These conditions include walkability, co-presence (Hillier, 2007), diversity of primary and secondary uses (Jacobs, 2016), density and accessibility (Li et al., 2020; Ye et al., 2017) and are embodied by both extrinsic and intrinsic geometric properties of public spaces (Annunziata, 2020). More precisely, co-presence refers to the simultaneous presence of people in a space. Co-presence is the resultant of patterns of natural movement which are affected by the configuration of the urban layout (Cutini and Hillier, 2010; Garau et al., 2020b; Garau and Annunziata, 2020; Hillier and Hanson, 1984). Configuration refers, in fact, to the set of spatial relations among parts that comprise an overall structure. The properties of Closeness centrality and betweenness centrality are the focus of configurational analysis and refer, respectively, to the distance of a space from all other destination spaces and to the probability that a space is comprised into the shortest path from any origin space to all potential destination spaces (Garau et al., 2020a; Serra and Hillier, 2019; Hillier et al., 1993). These configurational properties encompass the two dimensions of accessibility, respectively the to-movement potential and the through-movement potential of a space, hence the relevance of a space as a destination and as a route. Furthermore, gradients of accessibility influence the distribution of pedestrian movement and, thus, the distribution of economic activity and the formation of local and global centers across the urban layout (Hillier, 1999). A further relevant condition is the availability of green infrastructure components; it embodies, in fact, opportunities for meaningful experiences of nature. The latter affect human nature connectedness, which encompasses the capability of commitment towards other species and is a significant predictor of well-being (Ferguson et al., 2018; Ngom et al., 2016). The operationalization of these properties in terms of quantitative indicators and the method for the assessment of the usability of the public space are discussed in the next section.

3. Methodology

The proposed method is aimed at assessing the usability of the public space and combines spatial analysis and space syntax techniques. The area of study is the historic district of Villanova in the City of Cagliari. The city of Cagliari is selected because of the policies implemented by the Municipality to promote sustainable mobility as a means for strengthening local economy and social inclusion. Within this context, the Villanova district emerges as a central area in terms of density and diversity of primary uses, pedestrianization of the street network and bottom-up practices of sharing and transformation of the public space (Fig.1). The unit of analysis is the 100m*100m cell of a regular grid superimposed to the area of study (Ye et al., 2017). The method is articulated on five dimensions, representative of distinct conditions of usability and related to the central aspects of morphology.

These aspects are operationalized in terms of five category indices, including: Urban green areas availability index; Road system structure index; Building Density index; Availability of Primary and secondary uses; Transportation system structure index; Urban green areas availability refers to the distribution of urban green infrastructure components, determining opportunities for meaningful nature experiences; It encompasses the indicator surface area of UGAs in the service area of the *i*-th cell and ratio of the *i*-th cell surface area covered by vegetal canopy. The road system structure index measures the configurational and geometric properties of the system of streets and squares across the area of study. The morphology of the street network, in fact, affects patterns of natural movement, co-presence and convenience and comfort of pedestrian surfaces. The configurational properties of the street system are operationalized in terms of the indicators segment angular choice and segment angular integration, measuring respectively, the centrality of a space as a route and its relevance as a destination. A further indicator, accessible public space, measures the surface area of public space accessible from the *i*-th cell, within a radius of 800 m. The geometry of street spaces is operationalized in terms of the indicators of slope and width of pedestrian surfaces. The Building Density index measures the configuration of plots and of buildings

located on plots, and it is operationalized in terms of the indicators floor area ratio and ground surface index, measuring, respectively the ratio of total floor area of buildings located in the i -th cell to the surface area of the cell, and the ratio of the area of the projection of buildings located in the i -th cell to the area of the cell. The availability of primary and secondary uses is operationalized in terms of the density and diversity of Points of interest – including cultural heritage components, financial, education and government services, shops and restaurants – in the service area of the i -th cell. Both population density and availability of primary and secondary uses are identified, in the seminal studies by Jacobs and Gehl, as conditions conducive to the intensity and concentration of pedestrian activities in the public space (Yamu et al., 2021; Zhong et al., 2020; Delclòs-Alió and Miralles-Guasch, 2018; Gehl, 2011; Jacobs, 2016).

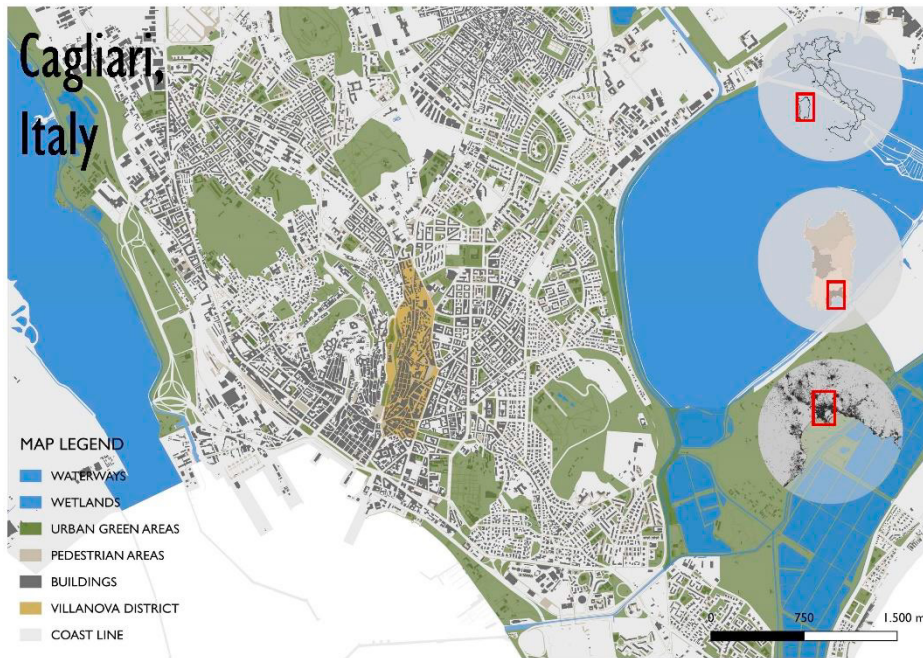


Fig. 1. The Area of Study: The Villanova District in the Metropolitan area of Cagliari, Italy.

Lastly, the transportation system structure index is calculated as the average normalized cost distance from the centroid of the i -th cell to the two closest nodes of the transportation system. Proximity to transportation nodes is considered, in fact, as a condition conducive to inclusion, sociality, participation to city life and access to employment and cultural and political practices. The individual sub-indicators are then normalized via a linear function and expressed by a value ranging from 0 – least positive condition of the i -th cell with respect to the j -th indicator – to 1, representative of the optimal condition. The category indices are then calculated by aggregating the individual indicators through a compensatory approach. Lastly, the five category indices are added so as to calculate the synthetic index of usability (I_{USP}). The latter is thus expressed by a value ranging from 0, representative of the least convenient condition, to 5, indicating the optimal level of usability of the public space. In the following section, the results of the assessment of the public spaces within the Villanova district are presented, and the usability of the selected public spaces is analysed.

4. Results

The assessment of the usability of the public space within the Villanova district underlines adequate levels of usability, ranging from a value of 1.61 calculated for San Saturnino Street, to a value of 2.89 for Vincenzo Sulis Street. Analyses of central tendency reveal a mean value equal to 2.18 and a median equal to 2.15. Measures of dispersion indicate a standard deviation of 0.27, and an interquartile range of 0.37, comprised in the interval 1.98 -

2.35, revealing that 50% of cells are characterized by adequate levels of usability, 25% by inadequate levels of usability and the remaining 25% comprises space relevantly conducive to active mobility and engagement in utilitarian, leisure and social activities (See Fig.2).

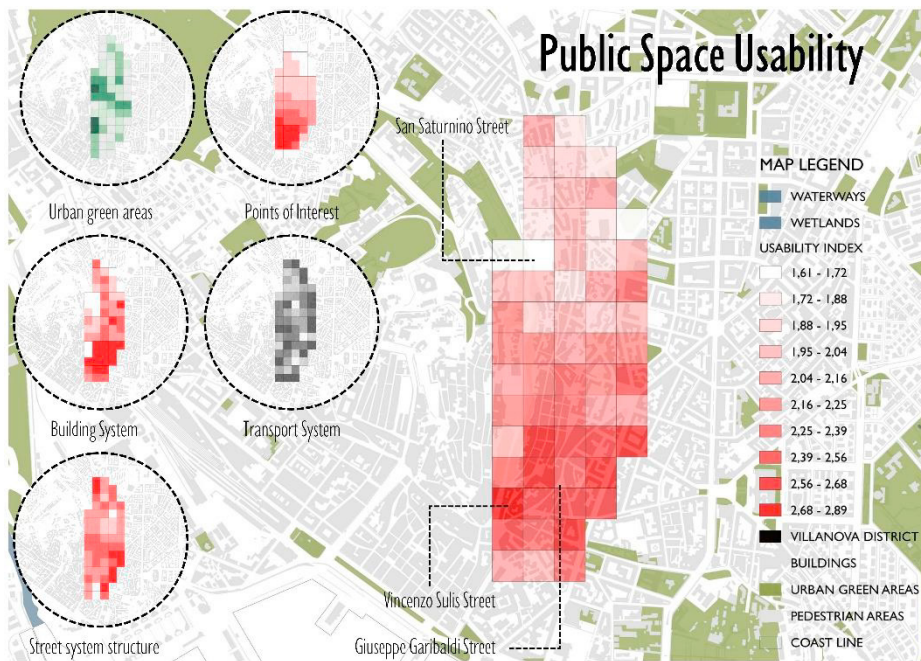


Fig. 2. Levels of usability in the Villanova District in the Metropolitan area of Cagliari, Italy.

With respect to the Urban green areas' availability index, values range from 0.01 to 0.23, thus revealing a marginal availability of components of green infrastructure, determined primarily by the modest surface of urban green areas within a buffer of 800 meters, and by the modest density of the vegetation coverage, calculated via the Normalized Difference Vegetation Index. The Road system structure index underlines levels of suitability to pedestrian movement ranging from 0.21 to 0.5. Spaces most conducive to active mobility are concentrated along the south-eastern edge of the Villanova district. The Building Density index reveals values of density ranging from 0.01 to 0.82, Analyses of central tendency determine a mean value and a median equal to 0.45. Measures of dispersion result in a standard deviation of 0.20 and in an inter-quartile range equal to 0.28, indicating a significant variability, across the area of study, of the levels of building density. The Availability of Primary and secondary uses index reveals a clear pattern of density and diversity of points of interest: Vincenzo Sulis Street and Garibaldi Street emerge as foci of a consolidated urban center, located in the meridional edge of the district. The analysis reveals values ranging from 0.21 to 0.67, indicating a relevant availability of diverse activities and points of interest in the 800 meters buffer calculated from the centroid of each cell. Lastly, the values of the transport system structure index are included in the range 0.70 to 1.00, indicating an optimal level of access to the transportation system. Measures of central tendency underlines a mean value of 0.89 and a median of 0.9. Measures of dispersion indicate a standard deviation equal to 0.08 and an inter-quartile range of 0.14, indicating uniformly distributed optimal conditions of access to the transport system across the area of study. The results presented in this section, and their implications in terms of the definition of criteria for actions of urban regeneration are discussed in the sub-sequent section.

5. Discussion

Results obtained from the analysis of the Villanova district reveal an adequately vital and permeable district, characterized by patterns of usability, intensity of uses, centrality and building density reflecting its specific internal

structure and its relation with the urban and metropolitan system, determined, in particular, by the complex orography of the metropolitan area. More precisely, the compact structure of the inner area of the district, peculiar of the morphology of the medieval city, the system of large boulevards and open spaces constructed along the edge of the district, and the intensification of the urban fabric produced by the post-war reconstruction, are reflected by the distribution of values of floor area ratio, and ground space index. The former, in particular, reveals the intensification of the built-up areas along the edges of the district, which include the areas of expansion constructed in the 19th and 20th century, and informed by the prevailing building typology of the mid-rise point and block type buildings located along large boulevards destined for vehicular traffic. On the other hand, patterns of the ground space index underline the compact structure of the inner area, generated by a dense urban fabric constituted by narrow streets delimited by a continuous edge of low-rise blocks composed of buildings oriented perpendicular to the street axis.

Patterns of Density and diversity of points of interest and the configurational properties of the street system underline the emergence of a local urban center of intensely used public spaces along the meridional and eastern edges of the district, and a background structure of residential areas, concentrated in the inner area, yet informed by good conditions of access to primary and secondary uses. An issue emerging from the analysis of the public space, concerns the geometric properties of pedestrian spaces and, in particular, the modest width of pavements along intensely used boulevards, which maintain their original function as primary connections among the post-war areas of urban expansion and as spaces for rapid vehicular mobility. A relevant criticality concerns the marginal availability of urban green areas. Area and quality of accessible components of green infrastructure are considered, in fact, as a condition for the development of central capabilities, and for improving inclusion and participation. Consequently, a central objective of urban policies could be the construction of a continuous ecological infrastructure, designed as a basic underlying spatial structure of the urban fabric, via the regeneration of fringe areas and vacant lots and via the re-connection of existing green areas. On the other hand, a relevant positive condition observed in the area of study is the proximity of any unit of analysis to the nodes of the transport system. Access to the transport system is, in fact, a relevant aspect of spatial and social justice in the built environment: transport poverty can reinforce conditions of social exclusion by reducing access to employment and engagement in social, leisure and utilitarian activities. As a result, the analysis demonstrates that the area of study presents significant attributes of density, diversity of land uses, permeability and accessibility, conducive to vitality and urbanity and consistent with the criteria of the 15 minutes city, which inform urban policies in the pandemic era (Carpio-Pinedo et al., 2021; Clerici Maestosi et al., 2021; Tiboni et al., 2021; Campisi et al., 2020a; Lai et al., 2020). Lastly, a relevant methodological issue is represented by the quality of available data. In particular, data referring to primary and secondary uses, retrieved from open-source databases, are often inaccurate, incomplete and heterogeneous, thus requiring a comprehensive process of data verification and integration. Nevertheless, a validation process, based on information collected from internet-based street level imagery services (Google Street View) or from direct on-site observation, is time consuming and can reduce the replicability of the analysis and thus its relevance in facilitating the understanding of the built environment and in supporting planning processes.

6. Conclusions

The presented study focuses on the quantitative analysis of the aspects of urban morphology incorporating opportunities for co-presence, access to urban amenities and meaningful experiences of the public space. More precisely, the objectives of this study are two: first, the introduction of a specific conceptualization of usability. Usability emerges as a central aspect of urban policies aiming to foster sustainable practices and to promote inclusion and equality. Providing equal conditions of access to usable spaces, in fact, is central to ensure participation to political, economic, cultural and social activities. Second, the study aims to define a quantitative method of spatial and configurational analysis that enables information-based decisions on spatial planning by providing a quantitative description of urban morphology and of its impact on individual and collective practices. Within this perspective, the relevance of the proposed method lies in three aspects: first, in the identification of dimensions of urban morphology affecting the usability – and the vitality – of the public space; second, in the operationalization of the relation between usability and the system of paths and nodes, the structure of the built-up areas, the urban green infrastructure, land use patterns, and the structure of the transport system; lastly, it lies in the recognition and formalization of the effect of the configuration of the system of paths and nodes on patterns of

movement and practices. The analysis of the case study demonstrates the relevance of the method in underlining patterns of usability and individuating critical conditions – for instance, the marginal availability of urban green infrastructure components - constituting a focus for policies of urban regeneration. The future development of the research will address two aspects: the validation of results via the measurement of actual levels of pedestrian activity and the determination of the relative importance of individual built environment factors via decision-making techniques. The improvement of the method would address the need to structure analytic tools that facilitate the understanding of the built environment and assist urban planning processes in the definition of strategies of redevelopment and renewal of public spaces consistent with the criteria of the smart sustainable city and of the 15-minute city.

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