A Literature Review on Urban Usability and Accessibility to Investigate the Related Criteria for Equality in the City

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Abstract. The environmental issues and, in recent years, the Covid-19 pandemic determined an increasing consensus around the need for urban policies aimed at re-shaping the urban realm. The issue of equality and the related conditions of accessibility and usability emerge as critical requirements in the re-shaping of the urban landscape and mobility. As a consequence, the proposed article discusses a comprehensive literature review on the topics of usability and accessibility and of the complementary notions of disability and exclusion. The objectives of the literature review are to define a taxonomy of the different dimensions of usability and accessibility, to assess the relevance of the different forms of usability and accessibility across disciplinary fields related to urban and transportation studies, to identify the co-relations among specific aspects of urbanity and mobility and conditions of accessibility and usability. The proposed literature review is the preliminary stage of a study aimed at defining a methodological framework for quantitatively describing the urban environment in terms of its accessibility and usability. The proposed defines the theoretical framework of an analysis method for evaluating inequality incorporated into the urban environment and for facilitating smart decisions and holistic design in the context of urban planning.

Keywords: Usability · Accessibility · Urban equality · Vitality · Urbanity · Morphology

1 Introduction

The concept of sustainability emerges as a central aspect of the development and transformation of urban areas. The increasing consensus on the need for a sustainable development of the city, formalized in the intersecting images of the city as smart, resilient,

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anti-fragile, walkable, is reinforced by the recognition of limits of the current organization of urban areas, underlined by the Covid-19 Pandemic and by emerging environmental issues [1–3]. In particular, land-use distribution and configuration of transport systems and of public open spaces determine patterns of mobility incompatible with needs of social distancing, local-scale movements and soft mobility engendered by the Covid-19 pandemic and by environmental issues. Moreover, the notion of sustainability incorporates a social dimension and embodies the ethical implication of equality. In social terms, a relevant aspect of sustainability is the construction of a public space conceptualized as a convivial place and as the place of the exposure to difference [4–7]. These dimensions partially overlap and embody two fundamental ethical implications: on the one hand, the idea of the public space as a place where the encounter of diversity facilitates recognition and acceptance of difference [6, 8, 9]; on the other hand, the idea of the public space as an inclusive place, accessible and usable by all people, builds on the concepts of the just city and of the right to the city [10, 11]. Inclusion and equality incorporate the components of usability and accessibility. Usability is herein defined as the potential of public spaces to enable users with different individual abilities to engage in different activities [12]. Accessibility refers to the distribution of financial, spatial, cultural, social capital determining opportunities and constraints to access urban facilities, cultural services, and to engage in sociality [13–16].

The notions of usability and accessibility are thus related to the conditions of disability (different social participation caused by difficulty to develop personal activities) [13] and exclusion. The proposed article presents a literature review on the topics of usability and accessibility. The objectives of the literature review include: i) the definition of a taxonomy of the dimensions of usability and accessibility, based on the different forms of disability and exclusion; ii) the evaluation of the relevance of specific dimensions of usability and accessibility across disciplinary fields related to urban and transportation studies; iii) the determination of co-relations among specific aspects of urbanity and mobility and the different dimensions of usability/disability and accessibility/exclusion.

The proposed literature review is the preliminary stage of a study aimed at defining a method for the quantitative analysis of accessibility and usability in the urban environment. The relevance of the proposed study is twofold: the definition of a taxonomy of co-relations between dimensions of accessibility and usability and aspects of urbanity and mobility; and the usefulness of analytic methods for supporting smart decisions and holistic design in the context of urban planning.

The article is structured on five sections: After the introduction, notions of usability and accessibility are presented. Then, in Sect. 3, the methodology and the case study are presented. In Sect. 4 the results from the literature review are presented and discussed. Finally, in the Sect. 5, Discussion and Conclusions summarise the findings of the study and illustrates hypotheses for the future development of the research.

2 Theoretical Framework

Usability and accessibility are central aspects of the discourse on the re-structuring of the contemporary city [17, 18]. Moreover, the existing literature reveals the multidimensional character of these concepts, thus underlining the risk of overlooking the compound

effects of different, yet intertwined, components of usability and accessibility. Accessibility is primarily conceptualized within the discourse on mobility; it refers to the extent to which a space can be approached, entered or used, or to the extent to which land use distribution, configuration of the urban layout and transport systems enable individuals to reach different destinations [16, 19, 20]. This conceptualization hence focuses on the spatial dimension of exclusion of specific group of users. Yet, spatial segregation reflects and reproduces patterns of social, cultural, technological marginalization. More precisely, social exclusion, can be defined as a multi-dimensional process, in which various forms of marginalization are combined, including marginalization from decision-making and political processes, employment and material resources, and common cultural processes; these processes, when combined, determine acute forms of exclusion in particular districts [21–23]. Technological exclusion, encompasses the notion of digital divide and refers to the uneven distribution of information and communication technologies in society, resulting in inequalities in terms of political engagement, access to service, knowledge and information [24]. Spatial exclusion, refers to spatial segregation and to inequal distribution of spatial resources, including infrastructures and facilities, limiting engagement in sociality, cultural activities and employment and reproducing combined forms of social marginalization [15]. Consequently, accessibility is herein defined as the extent to which the distribution of spatial, social, cultural and financial capital enables individuals to engage in interpersonal relations, sociality, political, cultural and economic activities. On the other hand, usability is related to the concept of Universal Design and partially replaces accessibility within the discourse on disability: usability, in fact, encompasses an activity component and refers to the extent to which a space, product or service can be meaningfully utilised by users with different individual abilities [12, 25]. Universal Design, furthermore, encompasses a design paradigm focused on the project of spaces inclusive and meaningful for all users. As a consequence, universal design embodies the concept of usable, imageable, and understandable spaces, designed taking into consideration the needs of the greatest number of people [25–27]. In particular, Universal Design prefigures spaces whose material, geometric, perceptual properties are modulated taking into account the different forms of impairment - including physical, emotional, cognitive/developmental, visual, auditory, mental, and situational disability. Moreover, the concept of situational disability, introduces in the design of public space, the notion that all individuals can experience in a particular moment, a condition of temporary or permanent disability. Two considerations emerge: first, the refusal of strategies of spatial distinction that relegate particular categories of users in specific spaces, ‘designed for’; Secondly, the need to take into account a comprehensive conceptualization of disability, that encompasses the different dimensions of impairment, and that underlines also the need of users affected by mental health issues - including bipolar disorder, psychosis, schizophrenia, anxiety, attention deficit - by emotional disability - including depression, anxiety or stress - or by the impairment of specific cognitive functions, including autism [28]. The discourse on disability, as well as the discourse on exclusion, thus underlines the ethical dimension of planning and design of the contemporary city. More precisely, the concepts of usability and accessibility involve the ethical notion of equality and its formalization in the claims for the ‘right to the city’ and for the construction of the just or the good city [7, 11, 29]. The analysis of the impact and centrality of the concepts

of usability and accessibility within the existing literature on the planning and design of the urban environment is presented in the following sections.

3 Methodology

This study investigates the existing literature on usability and accessibility to identify components of urban form involved in the reproduction of patterns of exclusion of vulnerable users. The literature review is articulated on six stages: i) retrieving articles related to the complementary concepts of accessibility/ exclusion and disability/usability, via the queries ((“urban design” OR” public spac*”) AND “disability”)); ((“universal design” OR “public spac*”) AND “disabilit*”))); ((“exclusion” OR “access*”) AND (“injustic*” OR “inequalit*”) AND (“urban” OR “city”) AND (“servic*” OR “facilit*”))); the time span considered ranges from 2012 to 2021; ii) refining sets retrieved in stage i via the criteria Categories: (Social Sciences Interdisciplinary OR Architecture OR Geography OR Green Sustainable Science Technology OR Environmental Sciences OR Urban Studies OR Environmental Studies OR Sociology OR Engineering Civil OR Transportation Science Technology OR Regional Urban Planning OR Transportation); iii) definition of criteria for retrieving articles, from set defined in stage ii, related to specific dimensions of usability these criteria, are: “visual”, “auditory”, “situational”, “physical”, “mental”, “emotional” and “Intellectual” or “Developmental” or “Learning”, individuating specific dimensions of disability and, consequently, specific set of needs informing design for usability; iv) definition of criteria for retrieving sub-sets of articles related to different dimension of access and exclusion. These criteria are “cultural” “social” “spatial” and “digital”; v) evaluation of relevance of the concepts identified in stage i, iii and iv, via indicators retrieved from the WoS database and including Number of Items, Total Number of Citations (N_CIT), Number of Citations per item (AV_CIT) and H-index (H); vi) comparative analysis of most relevant articles from sets defined in stage ii aimed at investigating dimensions of usability and accessibility considered, related components of the urban environment, independent variables, forms of inequality considered, related dependent variables and co-relations among independent and dependent variables. The comparative analysis focuses on articles available from open access journals and repositories. Open access Journals, in fact, are considered as an optimal solution for the dissemination of research findings, thus maximizing their impact on the evolution of decision-making processes in the fields of urban and transport planning. The findings from the literature review and from the comparative analysis of the most relevant articles, is discussed in the sub-sequent section.

4 Results

4.1 Universal Design, Usability and Disability

The Web of Science (WoS) database contains 86 items, respondent to the queries ((“urban design” OR “public spac*”) AND “disability”)); ((“universal design” OR “public spac*”) AND “disabilit*”)), and related to the categories pertinent to the disciplines of

urban and transport planning. The impact and centrality of the retrieved items is measured via the indicators Total number of citations (N_CIT), Average citations per item (AV_CIT) and H-index (H). Within this collection of articles, 42 items are available on Open Access OA journals or platforms. For these, the Number of total citations is equal to 186, the average number of citations per item to 4.43, determining an H-index of 8. The distribution of citations and publications per year, moreover, reveals an increasing centrality of the topics of usability, disability and universal design. Moreover, with respect to articles available from Open Access repositories, a significant increase in the number of publications is observed in 2018 and in 2020. This collection of articles is then refined utilizing criteria denoting specific forms of impairment (Table 1). Developmental disability emerges as a central topic of articles investigating usability, disability and universal design in the context of urban and transport planning. On the other hand, no direct references to auditory disability are retrieved. The comparative content analysis reveals the centrality of geometric and material conditions as factors influencing the usability of public open spaces: Geometric factors include the presence of obstacles, slope and width of pedestrian surfaces, the ergonomics of urban furniture components, presence and density of formal and informal seats, the continuity of pedestrian surfaces and the degree of separation between pedestrian spaces and vehicular lanes (Table 2) [17, 25, 27, 30, 31].

Table 1. Results of the analysis of the Relevance and impact of the set of articles retrieved from the WoS database and related to the topic of Universal Design, Usability and Disability

Category	N results (NR)	Sum of times cited (N_CIT)	Average citations per item AV_CIT)	H-index (HI)
Total set of pertinent articles	86	565	6.57	13
OA_pertinent articles	42	186	4.43	8
Developmental Disability	24	247	10.29	9
OA_Developmental_Disability	8	80	10	4
Emotional disability	3	45	15	2
OA_Emotional_Disability	1	9	9	1
Mental disability	7	103	14.71	3
OA_Mental_Disability	5	50	10	1
Physical disability	9	38	4.22	5
OA_Physical_Disability	4	23	5.75	3
Visual disability	1	0	0	0
OA_Visual_Disability	1	0	0	0
Auditory disability	0	0	0	0
OA_Auditory_Disability	0	0	0	0

Table 2. Results of the comparative analysis of the articles retrieved from the WoS

Papers	Total citations	Average per Year	Dimension of disability	Determinants
[17]	11	1.83	Functional impairment: Situational/ Physical/Visual disability	Absence of Obstacles (PO); Presence of perceptible Information Devices (PID); Condition of Ped Surface (CPS); Slope (S); Section (W); Doors Opening Functioning (DOF); Pavement Continuity (PEDC); Degree of pedestrian motorized movement separation (PMSEP); Ergonomics of components of Furniture (EFC); Density of Seats (DOS); Negative Impact of vegetation on pavements usability (NIVU)
[18]	10	1.43	Functional/ Situational disability	Implementation of Regulatory Standards on Universal Design (REGS)
[30]	6	1.5	Situational disability	Absence of Obstacles (PO); Presence of perceptible Information Devices (PID); Condition of Ped Surface (CPS); Slope (S); Presence/Size of Platform along Ramps (PLRAMP); Section (W); Doors Opening Functioning (DOF); Negative Impact of vegetation on pavements usability (NIVU); Degree of pedestrian motorized movement separation (PMSEP); Pavement Continuity (PEDC);
[25]	6	1.5	Situational/Visual/ Auditory/Bodily disability	Absence of Obstacles (PO); Presence of perceptible Information Devices (PID); Condition of Ped Surface (CPS); Slope (S); Presence/Size of Platform along Ramps (PLRAMP); Section (W); Doors Opening Functioning (DOF); Negative Impact of vegetation/Furniture on pavements usability (NIVU); Degree of pedestrian motorized movement separation (PMSEP); Pavement Continuity (PEDC); Presence of Supports at transit nodes (SUPNOD); Reflectance Levels (LRV); Absence of Lamps under pedestrians eye level (LSUND); Presence of Understandable information Devices (PUD); Colour Contrast among spatial components (CCOL); Accessible Areas from Transit Node (ACCTN);
[31]	6	0.86	Visual disabilities	Absence of Obstacles (PO); Reverberating Noise (RN); Persistent Noise (PLN); Condition of Ped Surface (CPS); Level of luminous comfort (LUMCOM); Presence of perceptible Information Devices (PID)

(*continued*)

Table 2. (*continued*)

Papers	Total citations	Average per Year	Dimension of disability	Determinants
[26]	4	1.33	Cognitive/ Mental disabilities	Shared Purpose (SPUR); Built-in Boundaries (BIB); Presence of Spatial Interfaces (SPINT)
[27]	3	0.75	Physical disability	Condition of Ped Surface (CPS); Slope (S); Absence of Obstacles (PO); P_Lots for Disabled (PLOTS); Ergonomics of Formal seats (EFC); Density of Seats (DOS); Density of Informal Seats (DOIS); Presence of anti-social Practices (ASOCP)
[33]	2	1	Physical disability	Utilization of IM Strategies [Video (V) or Images (I) or Interactive Games (IG)]

Material conditions refer to the properties of surfaces: slipperiness, stability, regularity and roughness of pavements are widely recognized as basic and central aspects of usable spaces [17, 25, 27, 30, 32]. Moreover, requirements related to the material conditions of surfaces affect the selection and arrangement of other components, including vegetation [17, 30]. The tendency towards the holistic design of public spaces, and the comprehensive consideration of the dimensions of disability, emphasize the relevance of perceptual properties [17, 25]. Within this perspective, the presence of perceptible information and the understandability of information conveyed by tactile, visual and auditive stimuli emerge as conditions for public space usability.

Understandability, in particular, embodies the issue of the disorientation engendered by incomplete, ambiguous information or by the conflict/interference among sensory inputs embodied in the built environment - and intended to assist impaired users - and context sensory stimuli engendered by activities across spaces. More precisely, reflectance levels, position of lights in relation to the line of sight, colour contrast, levels of reverberating noise and of persistent noise are factors that influence the legibility and understandability of spaces [25, 31]. Further aspects concern the governance and normative dimensions: in particular, the need to implement Regulatory Standards on Universal Design, emphasizes the demand for a paradigm shift from visitability/accessibility to usability, thus focusing on the multiplicity of opportunities – or affordances – for emotional, social interactions and activities incorporated into the built environment [18]. Lastly, the design of convivial places, hence of spaces of convivial encounter, highlights three social and configurational factors that affect the probability of shared activities: shared purpose, built-in boundaries, and the presence of spatial interfaces. Shared purpose refers to the promotion of group activities, focused on a common goal, that activate non-competitive interactions among different individuals. Built-in boundaries refer to social roles and rules enabling encounters and concurrently defining the limits in the time, place, and intensity of the interactions. Spatial interfaces refer to semi-public spaces along built edges that enable frequent, informal social contacts while ensuring the freedom to disengage [26].

4.2 Accessibility and Exclusion

The Web of Science database contains 318 items respondent to criteria incorporated into the query ((“exclusion” OR “access*”) AND (“injustic*” OR “inequalit*”) AND (“urban” OR “city”) AND (“servic*” OR “facilit*”))) and related to the categories Urban Studies, Environmental Studies, Sociology, Engineering Civil, Transportation Science Technology, Regional Urban Planning and Transportation. The total number of citations is 3372, the average number of citations per item is equal to 10.6, determining an h-index of 28. The values of the indicators N_CIT, AV_CIT and H-index, and the distribution of the number of publications and of citations per year, reveal the relevance of the topics of accessibility and exclusion, and the increasing impact of pertinent studies (see Table 3).

Table 3. Results of the analysis of the relevance and impact of the set of articles retrieved from the WoS database and related to the topic of Accessibility and exclusion

Category	N results (NR)	Sum of times cited (N_CIT)	Average citations per item (AV_CIT)	H-index (HI)
Access	318	3372	10,6	28
OA_Access	129	916	7,1	15
Cultural exclusion	21	253	12,05	8
OA_Cultural exclusion	8	56	7	5
Digital exclusion	12	185	15,42	5
OA_Digital exclusion	6	74	12,33	4
Social exclusion	149	1879	12,61	21
OA_Social exclusion	62	434	7	11
Spatial exclusion	151	1548	10,25	19
OA_Spatial exclusion	60	383	6,38	10

Furthermore, 129 articles are available from open access repositories. The total number of citations, calculated for this sub-set, is equal to 916, the average number of citation per item to 7.1, and the H-index to 15. The number of publications and of citations per year, reveals the increasing relevance and impact of the topics of accessibility and exclusion.

Table 4. Results of the comparative analysis of the articles retrieved from the WoS database

Paper	Sum of total citations	Average citations per year	Dim. of access	Indicators (Independent variable)	Indicator dependent variable
[35]	47	5.88	Digital	Urban/ Rural Classification (URC); Indicator of Multiple Deprivation (IMD)	Average Download Speed (ADS); Distance to nearest node (DNN)
[36]	36	5.14	Spatial/Social	Educational Level (EDU); Activity Status (JOB); Political Status (CIT); Residential Stability (RES); Build Density (BD); Green/Pedestrian Areas Accessed [Density/Area] Indicator (APGS); Cultural, Leisure, Public Facilities Density Indicator (DPOI); Diversity of LU (DVLU); Density of Transport Nodes (DTRANS); Frequency of Social Disorder (ASOC); F of Signs of Neglect (PDIS); F of Violent Crimes (VCRM); F of Vandalism (VAND)	Consumption of Anti-depressants (CADEP)
[37]	33	5.5	Social/ Spatial	Social and Material Deprivation Ind (SMDI); Population Density (DPOP); Age (AGE); Gender (GND);	Distance to PGS (PPGS); PGS Area (APGS); Distance to PGS U Sport Facilities (PPGSPORT); PGS Dist to Transport Nodes (PGS_TRAN)
[38]	21	2.63	Spatial	Relative Proportion of Abandoned Lands (R-PDL); Env. Deprivation (MEDIX); Social and Material Deprivation Ind (SMDI/ TAIND); Educational Level (EDU); Activity Status (JOB); Ethnical Composition (ETCOMP); Residential Tenure (RES); Car Tenure (CAR)	Standardised Morbidity Ratio (SMR); Standardised Premature Mortality Ratio (SPMR)

(*continued*)

Table 4. (*continued*)

Paper	Sum of total citations	Average citations per year	Dim. of access	Indicators (Independent variable)	Indicator dependent variable
[39]	19	4.75	Spatial	Miles Traveled Car (VMT); Average Body Mass ind (BMI), F of Violent Crimes (VCRM); Air Quality Ind (AQUAL); Smoking (SBEV); Population Density (DPOP); Age (AGE); Gender (GND); Social and Material Deprivation Ind (SMDI); Ethnical Composition (ETCOMP); County Compact Ind (CCI)	Standardised Premature Mortality Ratio (SPMR)
[22]	15	5	Social/Spatial/Social	SES Ind (SECIN) f [Activity Status [Inverse] Unemployment Rate (UR); Log of median after-tax HH Income (LN_MHI); L income measure (LIM); L income cut-off (LICO)]	Location i access to employment by Transit (ALT); Location i access to employment by Driving (ALD); Access to labour force from employment location (LJ);
[40]	15	3.75	Social/Spatial	Street Tree Density (STRED); Green Areas Accessed Indicator (APGS); PGS Quality (PGSQ)	Social Deprivation (HHD); Ethnical Composition/ Concentration of Minorities (ETCOMP/AS); Ethnical Composition/ Concentration of W Residents (ETCOMP/WH);
[41]	13	4.33	Spatial/Social	Ratio of Res under 14 (AGE_14); ratio of Res Over 65 (AGE_65); Ethnical Composition/ Concentration of Minorities (ETCOMP/AS); Educational Level (EDU); L Income Measure (LIM); Street Density Ind (RDI)	Ecosystem Services Ind (ESERV) f [Air Purification Ind (AIR); Run-off Mitigation Ind (WAT); Urban Temperature Regulation Ind (TEMP)]; UGI Coverage (NDVI)

(*continued*)

Table 4. (*continued*)

Paper	Sum of total citations	Average citations per year	Dim. of access	Indicators (Independent variable)	Indicator dependent variable
[23]	13	2.17	Spatial	Green Areas Accessed [Ratio of PGS over Census Area] Indicator (APGS); Green Areas Available (Ratio of PGS per Resident in district] (AVPGS); Distance to HCF (DISTHCF); Medical Density (D_HCF); Environmental Negative Exposure [Ratio of Buildings in Area Buffer from Infrastructure] Indicator (ENVNEG); Social and Material Deprivation Ind (SMDI);	Neonatal mort Rate (NNMR); Infant Mortality Rate (IMR); R of Neonatal Mortality (RRNN); R of Infant Mortality (RRI)
[42]	12	4	Social/Spatial	Social and Material Deprivation Ind (SMDI);	Distance to PGS (PPGS); Green Areas Accessed Indicator (APGS); Population Density in Service Area (D_POP/GS); PGS Quality (PGSQ); Presence of Prov for Young People (YOUNG)

Within these collections of articles, spatial and social exclusion emerge as central topics. On the other hand, only 6 items focus on digital divide. Yet, the average number of citations per item, equal to 15.42, demonstrates the significant impact of studies on digital exclusion. The comparative analysis focuses on a sub-set of relevant articles selected depending on the pertinence to the discipline of transport and urban planning and on their impact. The first finding concerns the centrality of the access to green public spaces (PGS) and to urban green infrastructure (UGI) as an indicator of spatial and social inequality [36, 37, 40–45]. UGIs are considered, in fact, as a component of the built environment providing significant ecosystem services (see Table 4); Ecosystem services refer to conditions and processes through which natural ecosystems sustain and fulfil human life. [46, 47]. Consequently, equality in terms of access to the cultural, provisioning and regulatory services provided by urban green infrastructure emerges as a central component of the discourse on social and spatial justice in the contemporary city. In particular, a relevant part of the articles investigated (29%) investigates the co-relations between socio-economic status, deprivation, social marginalization and access to UGIs or PGS. Moreover, a clear negative co-relation between social and material deprivation and access to UGIs does not emerge. Nevertheless, a clearer negative

co-relation between social and material deprivation and access to ecosystem services provided by UGIs emerges when the quality, level of maintenance and equipment of green spaces are considered [37, 42]. Moreover, the issue of green gentrification identifies the relation between social marginalization and access to Urban green infrastructure and facilities as a process resulting from urban greening agendas and interventions [48, 49]. The WoS database contains 34 items, published in the 2017–2021 time-span, cited 311 times by 229 articles. A further condition of spatial inequality concerns the co-relation between social marginalization, defined in terms of occupational, education status and income, and access to transport systems, which in turn affects individuals' opportunities to access employment, basic services and to engage in sociality and cultural activities. Further aspects of spatial inequalities concern the positive co-relation between deprivation and proximity to brownfields [38] and large road infrastructures [23], the negative co-relation between deprivation and access to healthcare facilities and services, and the negative co-relations between urbanity and premature mortality [39] and digital marginalization, measured by Average Download Speed and Distance to nearest node [35]. Lastly, a relevant consideration concerns the relation between spatial access and exclusion and the cultural, socio-economic and technological dimensions of marginalization: spatial exclusion, defined as a condition of marginality determined by inequality in the distribution of urban facilities and infrastructures, emerges both as result and as a determinant of exclusion from decision-making, cultural activities, employment. Hence, spatial structures reflect and reproduce socio-cultural patterns [15, 50, 51]. A discussion of the findings from the literature review is presented in the following section.

5 Discussion and Conclusions

The findings presented in the previous section led to different for the development of the research on accessibility and usability. In particular, the analysis of the different forms of marginalization, reveals that the inequalities in the distribution of cultural, social and financial capital manifest in specific spatial patterns; these are, hence, both a result and a co-determinant of exclusion and poverty. Within this perspective, the analysis of the configurational properties of the urban environment emerges as a central aspect for the understanding of exclusion [52, 53]. Configuration, in fact, is the aspect of space where the spatial implications of social and cultural patterns can be observed. Configuration refers to the set of topological relations and interdependencies among components comprising a spatial system. Thus, the concept of configuration focuses on the inner formal logic of space: the potential of space to form patterns constitutes, in turn, the means through which social logic and meanings can be expressed [13, 50, 51, 54, 55]. In particular, patterns of segregation, integration and centrality can be described in quantitative, objective terms through the analysis of configurational properties based on space syntax techniques and theories. As a consequence, the marginal consideration of configurational properties as a central aspect of processes of marginalization represents a significant gap in the existing literature [56]. The Web of Science database contains, in fact, only seven articles, published in the 2012–2021 time-span, pertinent to the topics "space syntax" "social exclusion" and "inequality". On the other hand, the analysis of factors of usability focuses on intrinsic material, geometric, and perceptual properties of spaces, and on the

structure of decision-making processes, with respect to the mobilization of information related to intrinsic physical qualities of spaces. Hence, the existing literature on usability focuses on the environmental factors that determine opportunities and constraints for individuals' activities. Yet, the emotional and social aspects of individuals' engagement with the public space are only marginally considered. The Web of Science database returns 27 results, related to the disciplines of urban and transport planning and to the 2012–2021 time-span, which refer to the topics of "usability" or "universal design" or "disability" and "social" or "emotional" opportunities. Consequently, the concept of affordance emerges as a central aspect of a comprehensive theoretical framework for the understanding of the relationship between built environment factors and usability.

Affordances, in fact, refer to the functional, social and emotional opportunities and constraints embodied in a setting and resulting from the set of relations – situated in space and time – between environmental factors and individual abilities, needs and interests [57–60]. Furthermore, the concept of usability could be expanded in order to consider both the inner qualities and the extrinsic properties of a space. Extrinsic properties refer to the qualities determined by contextual factors, including land use patterns, configuration of the transport system, and configuration and morphology of the built fabric.

Finally, both dimensions of equality in the urban context, encompassed by accessibility and usability, can be comprehensively analysed through the concept of capability. In Sen's words [61] capability is defined as the ability of an individual to achieve a specific condition or "functioning" considered as meaningful. Capabilities depend both on specific abilities of the person and on opportunities embodied in the spatial and social environment. This opportunity dimension, which is more comprehensively understood through the concept of affordance, thus constitutes a relevant object of studies on equality in the built environment: in this context, equality can be reframed as the potential of the built environment to provide all individual with the opportunities for the achievement and exercise of central capabilities. This study presents three limits: first, the comparison among studies that adopt different conceptualizations of usability and accessibility results in the heterogeneity of perspectives in the analysis of factors related to disability and exclusion; Second, the context-specificity of cultural aspects related to disability and exclusion and the diversity of methodological frameworks can result in the incommensurability of built environmental factors considered as determinants of marginalization. A further limit concerns the scarceness of statistical analyses measuring the co-relation among built-environment factors and patterns of independent activities of impaired individuals. The aspects affect the understanding of the relative importance of intrinsic compositional and of extrinsic configurational-functional qualities of spaces in determining patterns of exclusion of impaired individuals. As a result, the findings from the literature review, are relevant to the definition of a theoretical and methodological framework for describing the urban environment in terms of equality. Yet, the future development of the research should address three issues: first, the investigation of the effects of configurational properties of the urban structure on marginalization of vulnerable individuals; the investigation of the effect of extrinsic qualities of urban spaces on patterns of independent activities of people affected by different forms of disability; and, lastly, the formulation of a method that integrates spatial analysis, space syntax techniques and qualitative assessment for individuating patterns of spatial exclusion,

and for evaluating the potential of the urban environment to equally assist all individuals in achieving and exercising their central capabilities.

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