Systematic Review

Assessment of Citizens' Perception of the Built Environment throughout Digital Platforms: A Scoping Review

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Abstract: (1) Background: To assess the quality of the built environment, it is necessary to study both the physical components and the inhabitants' perceptions. However, since objective indicators are easily measurable, most studies have centered only on analyzing the physical dimensions of cities. Currently, the massification of information technology and the emergence of digital platforms are offering new participatory channels for studying citizens' perceptions of the built environment. (2) Objective: considering the scarcity of the theoretical and methodological approaches supporting this new research, the main objective of this article is centered on contributing to the field by developing a scoping review of the publications assessing the perception of the built environment through digital platforms and concluding with a conceptual framework to support future research. (3) Methods: to do so, 98 articles were reviewed and 21 of them were selected and studied in detail after applying a selection criteria identifying papers that analyzed the urban environment (Criteria 1), used participatory processes (Criteria 2), were developed with the support of digital platforms (Criteria 3), and were centered on the study urban places, therefore excluding mobility (Criteria 4), which was done in order to identify the main theoretical and methodological approaches used for studying perception in the built environment. (4) Results: The research identified Audit Tools and Perception Tools to study citizens' perceptions. Audit Tools are methodologically related to Systematic Social Observation (SSO). Perception Tools rely on transactional person–environment or Public Participation as the main theories, followed by Subjective Wellbeing (SWB), Physical Activity (PA), and Social Sustainability as fields where these studies are being applied. Participatory mapping is identified as a general methodology, considered the basic technical tool of Public Participation Geographic Information Systems (PPGIS). Place-based and Citizens Science are other methodologies supporting perception research. (5) Conclusions: Finally, the proposed framework for assessing the perception of the built environment supports the notion that, in order to study perception, both subjective and objective approaches are necessary. The subjective approach supports the study of the self-reported perceived environment while the objective approach is used to collect urban structure data so as to understand the socio-environmental context conditioning the experience.

Keywords: built environment; perception; subjective assessment; scoping review; PPGIS

1. Introduction

The quality of the built environment influences its inhabitants' perception, which conditions the capacity of cities to attract populations, generate richness, and support life [1]. Therefore, studying the relationships between the environmental features of the built environment, behavioral patterns, and human perception has been a constant challenge within urban sciences.

Historically, given that quantitative indicators are easily measurable, most methodological approaches have resorted to objective indicators to measure the quality of urban

environments [2]. In contrast, the specific ways in which the built environment contributes to citizens' experiences and wellbeing have rarely been studied [3–5].

However, with the emergence of information technology and social media, the link between citizens' perception and the quality of the urban environment has gained new research interest [6]. The appearance of digital platforms offering new participatory channels is enabling innovative methodologies for studying subjective indicators and assessing people's perceptions of their built environment [7].

Even though to date this type of research have been driven more by the explorations of potential and the opportunities of new technologies (applied research) than conceptual and theoretical research (basic research) [8], shaping a body of knowledge is still diverse in its concept and methods. As a consequence, the current bibliography evidences an absence of theoretical reviews, articulating different conceptual and methodological approaches to digital subjective assessment. On this context, reviewing the wide divergency of studies centered on assessing the subjective perception of citizens about their built environment is required in order to contribute to the building of a new theoretical field, which will help to fill in the gap between citizens' needs and planners' decisions [9].

1.1. Objective and Subjective Assessment of Quality in the Built Environment

Any discussion regarding the methodological approaches to studying the quality of the built environment must acknowledge that, by definition, quality is considered a subjective valuation, which depends on the opinion, background, and situation of the person consulted [10,11]. However, concurrently, it would be imprecise to assume that good quality is an entirely subjective concept. In fact, it has been proven that the quality of the built environment can also be measured objectively, through indicators regarding accessibility, urban design characteristics, urban maintenance, etc. [12].

One of the first review proposals analyzing quality in the built environment was performed by Smith et al. [13], who offered a list of physical form criteria and guided its development. The approach relating the built environment with quality criteria was later followed by Van Kamp, Leidelmeijer, Marsman, and De Hollande [11], and Dempsey [10].

From these studies, it has been revealed that the quality of the built environment is directly related to the wellbeing of people and communities. Residential areas with high densities, mixed uses, an accessible network, connectivity and permeability, legibility, attractiveness, character, inclusiveness, maintenance, and safety [10] have been found to be the main characteristics conditioning the quality of the built environment.

In the literature review developed by Van Kamp, Leidelmeijer, Marsman, and De Hollander [11], concepts such as human ecology, quality of life, city planning approaches, social indicators, satisfaction research, and transactional focus are mentioned. This suggests an evident relation between objective approximations (city planning approaches and social indicators) and subjective or perceptual considerations (quality of life, satisfaction research, and transactional focus). The interaction between environmental conditions and human responses is highlighted as a central theme [11].

Therefore, an appropriate methodological framework for analyzing the quality of the built environment must consider both objective and subjective appreciations. To do so, three categories have been identified to measure the quality and characteristics of the built environment [14]:

- Archival data sets—GIS (objective approach): GIS-based measurements of the built environment relate to existing data sets containing geographically referenced information. This information can cover indicators such as density, land use, or accessibility to different facilities. These are quantitative indicators.
- Audit Tools—observational measurements (objective approach): they consist of instruments and protocols to systematically assess the physical environment on site. Some indicators may consider street and building patterns, characteristics of public spaces, the quality of sidewalks, etc. These indicators are generally quantitative and they are measured by trained personnel.

- Perception Tools—perceived measurements (subjective approach): they involve self-reporting data on individuals' perceptions of their environment. Indicators in this category include safety, aesthetics, or regular destination venues. In this approach, the indicators are generally qualitative since they always try to measure a subjective fact in itself, such as people's perception or satisfaction.

Considering archival data sets (GIS) as a pure technical analysis, this article will focus on analyzing the last two types of approaches, considering their involvement in the interaction between urban environments and human responses (Criteria 1).

1.2. New Digital Platforms for Perceptual Assessment: From PPGIS to VGI

Traditional Public Participation methodologies are limited by the amount of people involved in each process, favoring active minorities and specific interest groups while marginalizing the opinion of the "silent majority" [8]. In this context, it has become necessary to create new bottom-up data production methods that support planning processes with better knowledge of citizens' preferences and behaviors and reach a potentially larger number of participants [1,8,15].

In this context, Public Participation Geographic Information Systems (PPGIS) have emerged as an alternative tool to support more representative Public Participation processes. PPGIS are considered to be a field within geographic information science where citizens can use geospatial technologies and generate data to support decision-making processes [16]. The term was created in 1996 during the meetings of the National Center for Geographic Information and Analysis (NCGIA) in the USA. The importance of PPGIS was again highlighted in the same meeting in 2006 [1]. Since then, Brown and Kytta [8] have identified the following literature reviews centered on a better understanding of the multiple dimensions of PPGIS: Craig, Harris, and Weiner (2002), Sawicki and Peterman (2002), Sieber (2006), Dunn (2007), and McLain et al. (2013) [8].

Later, the rise of web-based platforms and mapping applications facilitated generating geolocated spatial information provided by diverse groups of inhabitants, generally from online communities [17]. This phenomenon was initially defined by Goodchild [18] as Volunteer Geographic Information (VGI), where unqualified citizens use mobile and spatial technologies to generate a large amount of information.

Understood as a special case of the web phenomenon of user-generated content, the most important value of VGI may lie in the opportunities of evidencing data from locations that go unnoticed by the world's media [18]; therefore, it transforms information typically released in a top-down manner under institutional structures into a diversity of data generated spontaneously from the local level following bottom-up patterns [18,19].

In this context, smartphones have become the key tool for activating a new people-focused sensor-networking paradigm, allowing citizens to become part of the urban sensing infrastructure [8] and effectively "instrumenting" the entire planet [19]. This technology, supported by GPS, microphones, or cameras, is probably the most efficient sensing device today based on its mobility and possibility to collect data directly from the field [5,7], which enables gathering a huge amount of information at a very low cost; therefore, smartphones are offering new platforms to overcome traditional constraints of participatory research, improving recruitment and opportunities for collecting and analyzing data [20,21].

Thus, PPGIS and specially VGI, through smartphones and mobile apps, have enabled a diversity of digital platforms (Criteria 2) and have enhanced a new era of citizens' involvement within the urban planning field. By employing ICT, citizens are able to get widely involved in the participation process to voluntary assess their built environment (Criteria 3).

However, despite the emergence of these new digital platforms, many researchers have coincided that investigations, developed mainly in North America, Europe, and Oceania, still require a more robust methodological framework to analyze the quality of the built environment, if coherent and comparable results are expected [22–25].

Therefore, this research is centered on contributing to the field by developing a scoping review [26] to map the evidence of the research assessing the perception of the built environment through digital platforms, identifying the main concepts and theories, and concluding with a conceptual framework to support future research in this field.

Based on this scope, the research questions are:

1. Which are the theoretical approaches supporting studies assessing the perception of the built environment?
2. Which methods are being used to collect perceptual data through digital platforms?
3. Which fields of urban planning are studying citizens' perception of the built environment using digital platforms?
4. Is it possible to synthesize these theories and methods onto a conceptual framework to support studies on the perception of the built environment through digital platforms?

Therefore, the main aim of this research consists of systematizing the theoretical framework of the conceptual approaches for studying citizens' perception through digital platforms. Specifically, the aims are to:

1. Identify and describe the main approaches for studying citizens' perception;
2. Detect and explain the methods applied;
3. Classify urban planning study fields where citizens' perceptions are being used;
4. Design a conceptual framework to measure the perception of the built environment using digital platforms.

2. Materials and Methods

In order to search for pertinent articles, a protocol for the scoping review was conducted based on the PRISMA-ScR (the Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews) checklist (See Supplementary Materials) and explanation [26]. This method was selected based on the fact that scoping reviews are centered on addressing topics where different study designs might be used, demanding a comprehensive systematization of the available literature [27]. Such would be the case of assessing citizens' perceptions of the built environment throughout digital platforms.

To proceed, a search was conducted in WoS and Scopus based on 3 key terms: built environment, perception, and digital platforms. For each term, a diverse set of synonymous was selected (see Table 1). The search strings were structured to connect the terms with "AND" and the synonyms with "OR". The whole database was scanned, with no cutoff date for the earliest articles, until December 2021. The same search was executed in December 2021 and May 2022. The eligibility criteria excluded reviews, conference proceedings, and discussion articles as they lack the peer-review process. Books and book chapters were also excluded, bearing in mind the difficulty to access them. Complementarily, the search was limited to articles written in English, Spanish, or Italian to facilitate their interpretation.

This search delivered 62 articles in WoS and 68 articles in Scopus: 130 articles in total. A total of 31 articles were duplicated and removed. As a result, 30 articles from WoS, 37 articles from Scopus, and 31 articles from both databases were screened.

Each abstract was exhaustively screened, applying a selection criterion to identify those sources of evidence to be studied in detail for this scoping review. The conditions to be selected were defined as the following:

- Criteria 1: the selected papers should focus on studying the built environment at a pertinent urban scale, excluding articles centered on assessing specific buildings or rural areas.
- Criteria 2: the selected research should be based on applying PPGIS or VGIs, supported by digital platforms.
- Criteria 3: the selected articles should focus on developing a participatory process, considering a subjective approach for assessing the perception of inhabitants about their built environment.

- Criteria 4: articles centered on studying mobility issues were excluded, since their scope focuses on displacement.

Table 1. Search terminology in WoS and Scopus.

	Term 1 (Built Environment)	Term 2 (Perception)	Term 3 (Digital Platforms)
Sin 1	Urban Public Space	Perception	Shared geographic information
Sin 2	Urban space *	Citizens' assessment	Digital platforms
Sin 3	Urban environment *	Assess * perception	Participatory app
Sin 4	Built environment *	Subjective assessment	PPGIS
Sin 5	Urban design	Perceptual valuation	App
Sin 6	Public Realm	Assess *	VGIs
Sin 7	Urban public environment	Participatory indicator *	Volunteer Geographic Information
Sin 8	Urban landscape	Experimental indicator *	
Sin 9		Quality indicator	
Sin 10		Quality index	
Sin 11		Measure *	

* The asterisk is used as truncation or wildcard operator.

The selection process was registered on a flow diagram for new systematic reviews, based on PRISMA 2020 statements. As a result, from this process, 21 papers were finally selected (see Figure 1).
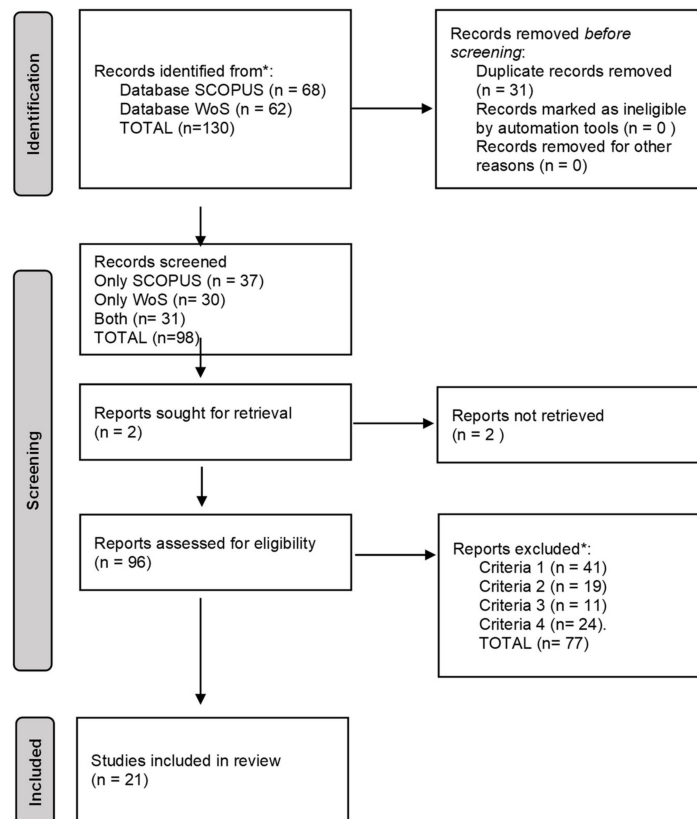
*More than one Criteria could be applied to the same article.

Figure 1. PRISMA 2020 flow diagram for new systematic reviews which included searches of databases and registers only.

Complementarily, while the abstracts from each of the 97 papers were being screened, their content was categorized under one of the following urban planning study fields:

- A_Technologies (information management and virtual space)
- B_Neighborhood character, place identity
- C_Urban environment, health, and wellbeing
- D_Vegetation, greenery, and wildlife
- E_Acoustic and thermal comfort
- F_Mobility, walkability, cycling, and transit
- G_Risk and resilience

These planning fields were defined and applied by the researchers as the most encompassing and yet illustrative set of categories to embrace the diversity of the research areas looking to study the perception of the built environment throughout digital platforms.

Finally, the validation of this scoping review was assessed throughout the enforcement of the PRISMA-ScR checklist [26].

The process for charting the data obtained from each of the selected papers was based on developing a database in M.S. Excel, considering the following data items: the theoretical approaches for the subjective assessment (as declared or identified in the article), the object of study, the research area, the methodological approach for collecting the perceptual data (as declared or identified in the article), the place studied, and the scale studied. Additionally, general information such as the country and cities involved were also considered.

While critically appraising the content of each article, insufficient theoretical information was identified to clarify certain key concepts. To cover this shortcoming, specific papers were used to complement the research based on the theoretical approach that needed to be reviewed. The selection criteria for these additional papers were based on the relevance of the research subject, as well as the amount of times they were cited in the selected articles. These complementarily papers are listed within the bibliography of this paper.

3. Results

Although the search did not have a lower threshold regarding the year of publication, the oldest article selected was quite recent, from 2013. In addition, there was a tendency for the amount of publications on the subject to increase in recent years, especially in 2018 (Figure 2).
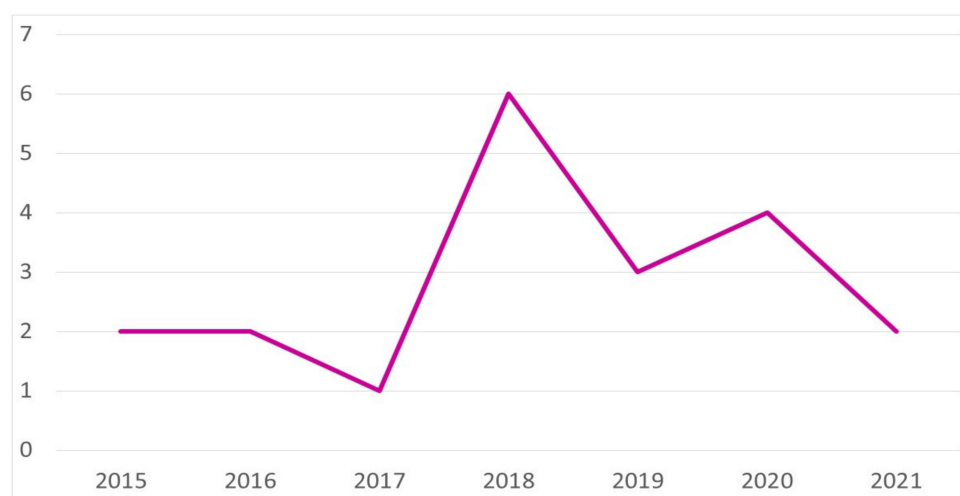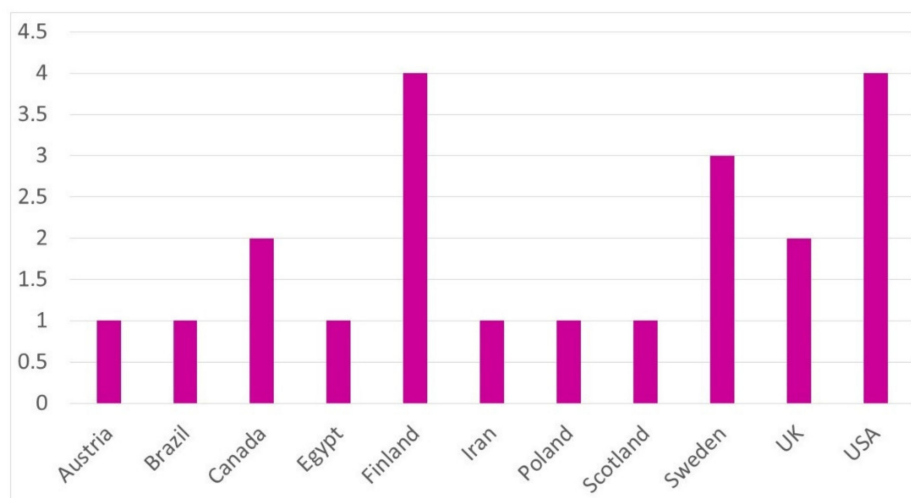

Figure 2. Years of publications of the selected articles.

Considering the countries from which the publications were generated, the USA and Finland topped the list with four publications each, followed by Sweden with three articles

and Canada and the UK with two publications. This highlights the dominance of the global north in this study field (Figure 3).

Figure 3. Countries where selected articles were published.

Out of the papers selected, only three journals appeared more than once as places to share the results of this type of research. The most popular journals in this study field were the International Journal of Health Geographic (cited three times), the International Journal of Environmental Research and Public Health (cited two times), and the Journal Health and Place (cited two times).

Out of all the authors associated with the selected papers, the names appearing more than once were essentially from Aalto University in Finland, followed by the University of Derby in the UK and Stanford University in the USA (See Table 2. It might be relevant to notice that all the authors were women.

Table 2. Most recurring authors assessing citizens' perception through digital platforms.

Author	Papers	Institution	Country
Kyttä, Marketta	3	Department of Real Estate, Planning and Geoinformatics, School of Engineering, Aalto University	Finland
Laatikainen, Tiina	3	Department of Built Environment, Aalto University	Finland
Broberg, Anna Katariina	2	Department of Real Estate, Planning and Geoinformatics, School of Engineering, Aalto University	Finland
Ferguson, Fiona	2	Human Sciences Research Centre, The University of Derby	UK
King, Abby C.	2	Department of Epidemiology and Population Health, Stanford University School of Medicine	USA

3.1. Theoretical Approaches for the Subjective Assessment of the Built Environment

The 21 selected papers were analyzed and seven theoretical approaches for assessing the perception of the built environment were identified (Figure 4). The first approach is related with the application of Audit Tools by diverse experts or trained personnel in order to assess the physical characteristics of their surroundings, which obtain generally objective indicators. The following two approaches are recognized as conceptual proposals for assessing the perceptions of citizens about their built environment: the transactional person–environment approach relates people's perceptions and experiences with the char-

acteristics of their environment, considering the importance of both parties, while Public Participation focuses on the active involvement of individuals in their communities and decision-making processes. The last three approaches are theories related with general research fields in which the perception of citizens about their built environment is being studied: Social Sustainability considers the relation between urban accessibility to services and opportunities (social equity) and the experiential outcomes of inhabitants (such as local attachment, social interactions, safety, perceived quality, etc.); Subjective Wellbeing (SWB) focuses on measuring wellbeing based on people's self-reports in different spots within the city; and Physical Activity (PA) is centered on studying how the built environment could promote Physical Activity practices within inhabitants. In the category of others, one biological response to the built environment was identified and excluded from this review due to its mismatch with the objectives of the investigation.
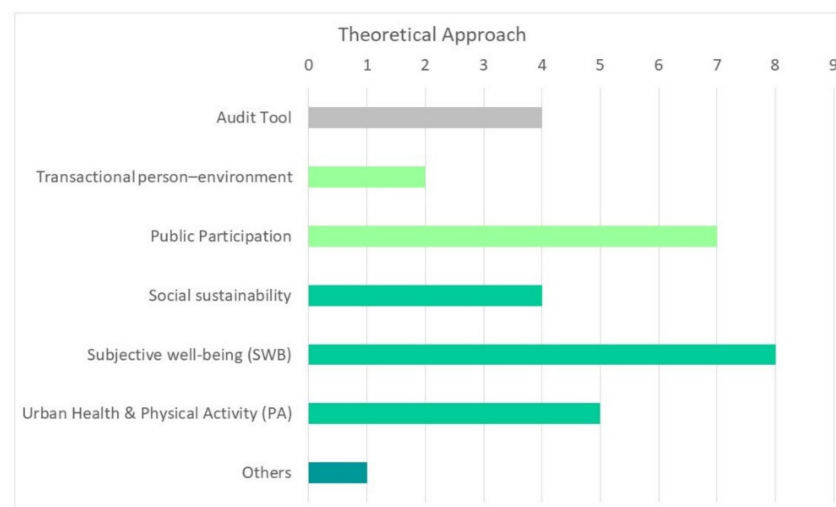
Figure 4. Theoretical approaches for the subjective assessment of the built environment.

3.1.1. Audit Tools

The application of Audit Tools can be found in four articles within this review: Besenyi et al. [28], Osborne et al. [29], Remigio et al. [30], and Kijewski-Correa et al. [19].

Audit tools are instruments and protocols used by researchers for studying the physical environmental conditions that are best assessed through direct observation at the community level [14]. These tools are generally applied by personnel trained in the field, i.e., people with the ability to rate, code, or score information based on instruments such as surveys, checklists, or standardized forms [30]. Therefore, Audit Tools typically require in-person observations for collecting data [14] and assessing the characteristics of the built environment, which enables diverse community stakeholders with a basic formation to evaluate their environment.

Audit Tools can be used for diverse objectives. Osborne et al. [29] and Kijewski-Correa et al. [19] applied them to assess environmental hazards on the built environment, while Besenyi et al. [28] and Remigio et al. [30] used them to assess the quality of urban parks and informal neighborhoods, respectively.

3.1.2. Transactional Person–Environment Approach

In general, all the articles focusing on the subjective paradigm could be classified under the transactional person–environment theory since this conceptual approach considers a dynamic and interactive relation between the person and the environment, where both parties (the built environment and experiences) are equally emphasized [16]. Furthermore, authors such as Brown and Kytta [8] and Laatikainen et al. [16] have stated that the transactional person–environment approach offers the basis for participatory mapping

methodologies. However, only two articles, Laatikainen et al. [16] and Samuelsson et al. [31], explicitly mentioned the conceptual aspects directly related to the transactional approach.

The transactional approach to person–environment relationships has been related to Gibson's (1979) ecological approach to perception or Zube's (1987) transactional model of landscape perception [8]. Complementarily, other authors have rescued this idea and related the concept to the environmental psychology field [16]. This idea is coherent with the theoretical framework presented by the Department of Social Psychology and Quantitative Psychology at the University of Barcelona, based on Holahan's (1982) and Bechtel's (1997) work categorizing James Gibson as one of the main thinkers in the field of Environmental Psychology.

3.1.3. Public Participation

Public Participation comprised a total of seven articles associated with these ideas explicitly, Saadallah [1], Szarek-iwaniuk [32], Jose and Wade [33], and Besenyi et al. [28], or implicitly, Jelokhani-Niaraki et al. [34], Orrù [35], and Wannemacher et al. [9].

Social Participation requires citizens to be actively involved in collective actions as well as in decision-making processes. It favors contributions by members of the community in the management processes associated with urban planning and urban life [32]. The emergence of networked societies has led to the development of new communication platforms. These platforms have empowered the role of citizenship and have thereby enhanced bottom-up planning processes in the urban environment field [1,36]. Therefore, some articles using Public Participation Geographic Information Systems (PPGIS) have supported their theory on Public Participation processes.

Researchers have used this approach to assess the quality of green open spaces [9,28], to identify the cultural ecosystem services associated with sustainable urban drainage systems [33], and to locate existing and potential places for growing food [35]. It has also been used in more complex tasks, such as assessing the sense of community [1] or the age-friendliness of cities [34]. Finally, Szarek-iwaniuk [32] highlighted the importance of e-Public Participation as part of the smart city movement, enabling governments to reach more people than traditional Social Participation methods while allowing citizens to be actively involved in the consultation process via digital platforms.

In general, Public Participation has been related with studies involving the direct participation of citizens by engaging people in decision-making processes, incorporating local knowledge, and integrating spatial information from a user's point of view [1].

3.1.4. Subjective Wellbeing (SWB) and Urban Happiness

Eight articles within this literature review were associated with the concept of Subjective Wellbeing: Chrisinger and King [37]; Mackerron and Mourato [6]; Kyttä et al. [3]; McEwan et al. [38]; Katapally et al. [20]; Samuelsson et al. [31]; and Fuller et al. [5].

Subjective Wellbeing (SWB) has been related to people's self-report responses regarding their level of happiness and personal fulfillment [6], with experience as a mediator between the environment and wellbeing [31]. Kytta et al. [3] applied this approach of operationalizing wellbeing as a compound of perceived happiness, quality of life, and health. A similar approach was presented by Fuller et al. [5]. Complementarily, McEwan et al. [38] and Mackerron and Mourato [6] related the level of wellbeing with the degree of connectivity with nature, while Samuelsson et al. [31], Kytta et al. [3], and Chrisinger and King (2018) directly studied SWB in relation with urban environmental features. Finally, Katapally et al. [24] tried to encourage it by promoting active living surveillance platforms.

SWB offers an interesting approach to research by allowing it to relate people's impressions on their level of happiness with the physical characteristics of their surroundings, representing the wider theoretical group in this scoping review.

3.1.5. Social Sustainability

Out of the selected articles, four papers appeared related to the Social Sustainability concept: Kyttä et al. [3]; Laatikainen, Hasanzadeh, and Kyttä [39]; Kajosaari and Laatikainen [21]; and Samuelsson et al. [31], although only Kyttä et al. [3] stated this relation explicitly. The other three articles recured to Social Sustainability principles to analyze the urban environment around citizens' declared experiences.

In general, the Social Sustainability approach requires an understanding of the physical configuration of the built environment through analyzing accessibility patterns [31]. In particular, Social Sustainability is presented as a link between accessibility (social equity) and experiential outcomes (or the sustainability of the community) where experiential outcomes are characterized by pride and attachment to the neighborhood, social interactions, safety or security, perceived quality of the local environment, satisfaction with the home, stability, and participation in civic activities [3,40].

Kyttä et al. [3] goes beyond this definition and proposes a new model of Social Sustainability based on context-aware Social Sustainability, where the structural urban characteristics that condition accessibility patterns end up generating different experiential outcomes and influencing the inhabitants' wellbeing [3]. Social Sustainability offers a perspective where accessibility to personally meaningful places and daily services (defined by urban form) conditions activity spaces and the quality of the community's experiential outcomes [39].

3.1.6. Urban Health and Physical Activity (PA)

Five articles within this literature review were associated with the concept of Urban Health and Physical Activity (PA): Katapally et al. [20], Besenyi et al. [28], Fuller et al. [5], Rydenstam et al. [4], and Kajosaari and Laatikainen [21].

In general, the framework for Urban Health states that the health of urban citizens is related to urban living conditions [29]. In particular, active living research (ALR) considers that the Physical Activity (PA) of inhabitants goes beyond exercise and includes any movement accomplished in any urban environment [20]. These interpretations have increased research interest towards studying the possible correlations between PA and a neighborhood's built environment [21].

Within the identified studies, Katapally et al. [20] proposed to promote PA throughout surveillance methodologies, while Besenyi et al. [28] and Rydenstam et al. [4] researched the same objective involving youth on the assessment of urban parks. Fuller et al. [5] studied the impact of new greenway projects on citizens' PA and Kajosaari and Laatikainen [21] demonstrated that PA in neighborhoods is also conditioned by the socioeconomics of the inhabitants and not only by environmental features.

3.2. Methodological Approaches for the Subjective Assessment of the Built Environment

By reviewing the selected articles, four main methodological approaches were identified: the Systematic Social Observation method (SSO), used mainly in association with the appliance of Audit Tools; participatory mapping, which is the basic technical tool of Public Participation Geographic Information Systems (PPGIS); place-based methodologies, which are related with the transactional person–environment approach centered on locating people's experiences on a map; and Citizens Science, where people provide information based on their experiences regarding a situation or place (Figure 5).

Other methodologies, such as interviews, positive psychology interventions, or Quantified Self, also appear in the reviewed bibliography, although they do not rely on GIS or mapping techniques.
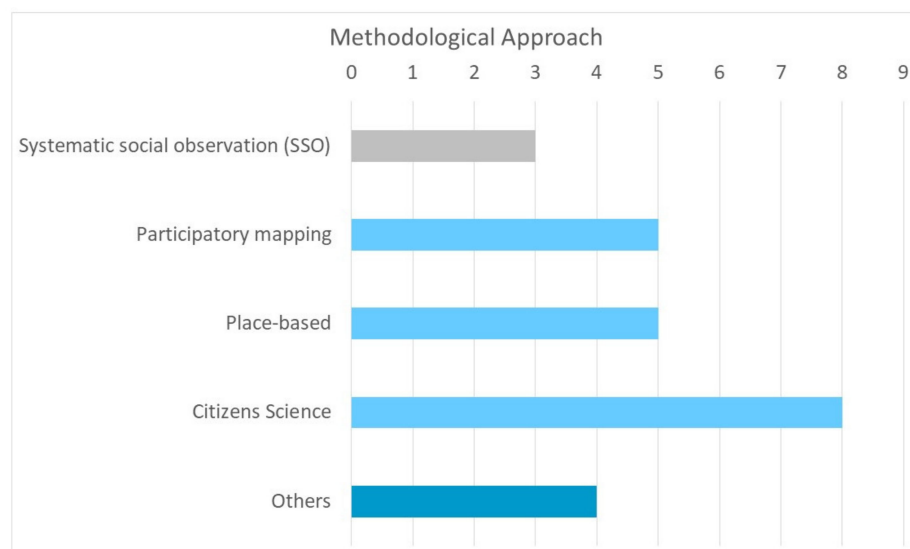
Figure 5. Methodological approaches for collecting perceptual data.

3.2.1. Systematic Social Observation (SSO)

Four of the selected articles applied Systematic Social Observation (SSO) methods: Besenyi et al. [28], Osborne et al. [29], Remigio et al. [30], and Kijewski-Correa et al. [19]

SSO is the basic technical tool used by Audit Tools and is based on protocols and criteria to guide the appliance of standardized instruments and forms, which allows the collection of information in the field. SSO is used to collect data on sample locations, such as streets, public spaces, or neighborhoods.

While Osborne et al. [29], Remigio et al. [30], and Kijewski-Correa et al. [19] up-skilled a selected group of citizens in order to rely on trained personnel to assess the characteristics of the built environment, Besenyi et al. [28] applied this method by relying on general citizens, based on Observational Environmental Data Collection Tools.

3.2.2. Participatory Mapping

Participatory mapping is the basic technical tool of Public Participation Geographic Information Systems (PPGIS), providing empowered citizens with new platforms to generate data and inform decision-making processes [8,29,32]. It has also been associated with the practice of critical geography [35]. Actually, as this article centers on analyzing the subjective assessment of places within the built environment throughout digital platforms such as PPGIS, all the papers reviewed could be related to the participatory mapping technique. However, only four manifested an explicit connection with this concept: Jose and Wade [33] mapped participants' preferences regarding green spaces over an aerial photo and followed a traffic light methodology; Orrù [35] digitally located existing and potential places for growing food; Kajosaari and Laatikainen [21] identified the spatial distribution of moderate-to-vigorous leisure-time physical activities (LTPA); and Saadallah [1] combined participatory mapping with place-based methodologies to locate community activities over a map in order to assess the sense of community of Alexandria, Egypt.

Participatory mapping can also be used as a basic tool by other methodological approaches, such as place-based and Citizens Science. From the place-based perspective, participatory mapping relies on the ability of individuals to locate their person–environment experiences on a map, assuming Gibson's (1979) ecological approach or Zube's (1987) transactional model of landscape perception [19]. From a Citizen Science perspective, participatory mapping does not require professional expertise. It is developed by members of a community, relying on their personal local knowledge to characterize particular places or situations on a map, allowing community knowledge to be collected [29].

3.2.3. Place-Based

The place-based methodology is centered on locating people's experiences on a map, allowing them to be studied in a contextually sensitive manner, assuming Gibson's (1979) ecological approach or Zube's (1987) transactional model of landscape perception [19]. Such an interpretation was recognized by five articles among the literature reviewed: Kytta et al. [3], Samuelsson et al. [31], Laatikainen et al. [16], Laatikainen et al. [39], and Saadallah [1].

Being related with the transactional person–environment approach, place-based research has been understood as both a methodological and theoretical proposal [16].

Almost all the papers explicitly adopting the place-based methodology are related to Aalto University in Finland, connecting this method with PPGIS tools in a context-sensitive way [3,16,31]. Dina Saadallah [1], from Alexandria University in Egypt, also used this methodology. Samuelsson et al. [31] implicitly related their research to the place-based approach by citing Gibson and Zube and locating people's positive and negative experiences on a map.

3.2.4. Citizens Science

The term Citizen Science is related to recognizing citizens' expertise in their local knowledge, and it is considered a basic component of the Citizens as Sensors paradigm [41]. This term is often used to refer to a network of citizens acting as observers in some domain of science [18]. Following this idea, articles related with the Citizens Science methodology are: Mackerron and Mourato [6], Chrisinger and King [37], Katapally et al. [20], Osborne et al. [29], Jelokhani-Niaraki et al. [34], Fuller et al. [5], Rydenstam et al. [4], and Wannemacher et al. [9].

Citizen Science projects are related to initiatives where measurements are delivered by volunteer members of local communities, providing evidence-based data to inform local action or decision-making processes [6]. Participatory sensing is considered a specific area of Citizen Science, relying on the use of smartphones provided with internal sensors (such as GPS location, cameras, microphones, or specific apps) to collect and share measurements of citizens' everyday environment and experiences and thus increasing their knowledge about specific local areas [6,41].

Among the literature reviewed, Mackerron and Mourato [6] and Chrisinger and King [37] studied wellbeing in relation with urban environmental features by registering SWB data over an app. Katapally et al. [20] and Fuller et al. [5] explored a relation between wellbeing and Physical Activity by assessing neighborhood surveillance with citizens' help [20] and assessing the impact of a new urban project on citizens' PA [5]. Rydenstam et al. [4] directly tried to identify the environmental features promoting PA among youth. Jelokhani-Niaraki et al. [34] and Wannemacher et al. [9] directed their efforts to monitor the age-friendliness of a city or urban landscape changes with the help of citizens. A special case was observed in Osborne et al. [29], who relied on Audit Tools to identify environmental hazards in watersheds throughout a community-based participatory process [29].

3.2.5. Others

Other methodological approaches not related to participatory mapping have also been identified among the reviewed articles, such as interviews [32] or a positive psychology intervention [38]. However, the most recurrent and significant is Quantified Self [5,37].

The Quantified Self methodology is related with a movement based on the idea of developing self-knowledge through self-observation. Under this approach, individuals can register their bio data digitally, recording and assessing their information in order to understand their physical and psychological process better and to improve their quality of life [7].

3.3. Urban Planning Study Fields Assessing Citizens' Perception of the Built Environment

Within the 98 articles screened, 31% were centered on studying the relationship between the urban environment, health and wellbeing, followed by 24% that were focused on reviewing urban mobility. This distribution acutely changed after applying the selection criterion to identify the final papers for assessment. Considering only the 21 selected papers, it is evident that the main study field in which most of the research regarding the subjective assessment of the built environment is being conducted is urban environment, health and wellbeing, with sixteen articles, which is equivalent to 76%. Complementarily, two articles were centered on studying the neighborhood character and place identity. The remaining papers were associated with divergent approaches (see Table 3).

Table 3. Urban planning study fields of the review and selected papers.

CATEGORIES	TOTAL	SELECTED PAPERS
A_Techs (inf management and virtual space)	12 (12%)	1 (5%)
B_Neighborhood character and place identity	11 (11%)	2 (10%)
C_Urban environment, health and wellbeing	30 (31%)	16 (76%)
D_Vegetation, greenery, and wildlife	4 (4%)	1 (5%)
E_Acoustic and thermal comfort	6 (6%)	0
F_Mobility, walkability, cycling, and transit	24 (24%)	0
G_Risk and resilience	11 (11%)	1 (5%)
TOTAL ABSTRACTS REVIEWED/PAPERS SELECTED	98	21

Urban environment, health and wellbeing studies state that the health of urban populations is a function of urban living conditions [29,30]; therefore, they explore the relationship between the built environment and health, which leads to the identification of environmental challenges and opportunities to improve citizens' quality of life. These types of studies are focused on reviewing happiness and wellbeing [3,6,37,38], active living and physical activity (PA) [4,5,20,21,28], and positive/negative experiences within the city [9,16,31], among some others.

Neighborhood character and place identity studies investigate the interplay between physical, social, and psychological factors on the neighborhood scale. The main objective of this type of research is to identify how the formal spatial structure and urban morphology (such as the density or urban typology) influences residents' experiences in the place and their socio-cultural interpretation [2]. Research on the 'sense of community', which relates a neighborhood's physical attributes with the quality of the community interactions and place attachment [1], needs particular attention.

3.4. Framework to Assess Citizens' Perception of the Built Environment

This proposed framework is structured based on the two main conceptual approaches identified within the reviewed theory: Public Participation and the transactional person–environment, considering that both approaches state a relation between people's experiences and their environment. While Public Participation focuses this relation on the political implications of supporting decision-making process on people's perception of their surroundings, the transactional person–environment approach states that every experience is expressed and defined by the environmental context in which it occurs. In this respect, experience is understood to be the perceived environment influenced by a diverse range of socio-environmental conditions, such as physical, social, and psychological factors [2,31], following Gibson's affordance theory [31,42]. Complementarily, the environmental context in urban studies can be interpreted as a relationship between urban structure and accessibility [3,40].

Therefore, on the individual scale, experience is compounded by impressions (the perceived environment) and personal circumstances (the socio-environmental conditions). Simultaneously, at the urban scale, the environmental context conditioning the experience

is related to the city's physical form (the urban structure) and the opportunities to access the diversity of the activities that the urban environment offers (accessibility).

The subjective assessment of the built environment is centered on studying people's perception of places, which is related to a subjective approach [14]. However, the study was conditioned by socio-environmental conditions [2], which were assessed through an objective approach, in order to measure the sociodemographic factors or particular characteristics related with the perceived experience. The environmental context, compounded by the urban structure and its accessibility patterns, is also generally studied through an objective approach based on archival data sets (GIS tools) or Audit tools in order to assess the physical patterns that condition the experience [14]. Based on these considerations, a gradient between the subjective and objective approaches was included in the proposed framework.

With these considerations, a conceptual framework is proposed to measure the perception of the built environment using digital platforms (Figure 6).
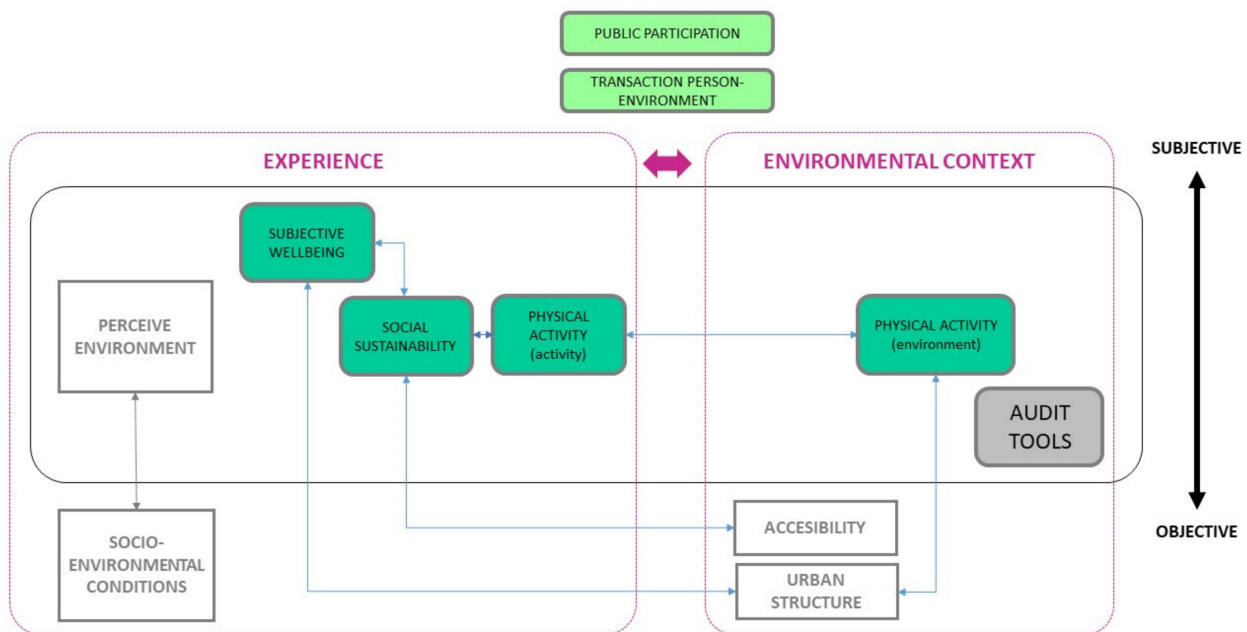
Figure 6. Conceptual framework to assess citizens' perception of the built environment throughout digital platforms.

The four remaining theoretical approaches, Subjective Wellbeing, Social Sustainability, Physical Activity, and Audit Tools were distributed inside this framework according to their different strategies to assess citizens' perception of their built environment. In general, Subjective Wellbeing (SWB) research is centered on upraising information regarding inhabitants' self-reported wellbeing [3,37,38] or happiness [6], contrasting these impressions with the characteristics of urban structure measures through the use of archival data sets. The Physical Activity (PA) theoretical approach is based on assessing the type or level of Physical Activity [5,20] and/or the perceived environmental quality to perform Physical Activity [4,21,28], studying its relationship with the urban structure based on archival data sets. Social sustainability generally appears in relation with SWB or PA as a complementarily theoretical approach used to identify personally meaningful places [3,31,39], assessing accessibility to these locations based on GIS data sets. Finally, Audit Tools rely on personnel trained in the field to directly assess the characteristics of the built environment.

According to this framework, the assessment of the perception of the built environment is compounded by both types of approaches, subjective and objective. The subjective approach is related to the different types of perceptions of the environment that individuals can generate vis-à-vis, while the objective approach is associated with the social, physical,

and psychological elements conditioning the perception. The objective approach is also related to the urban characteristics of the environmental context in which the perception is generated.

Finally, a summary diagram is presented, relating these six theoretical approaches with the four methodological approaches identified, displaying the different strategies adopted by the reviewed papers to structure their research (Figure 7).
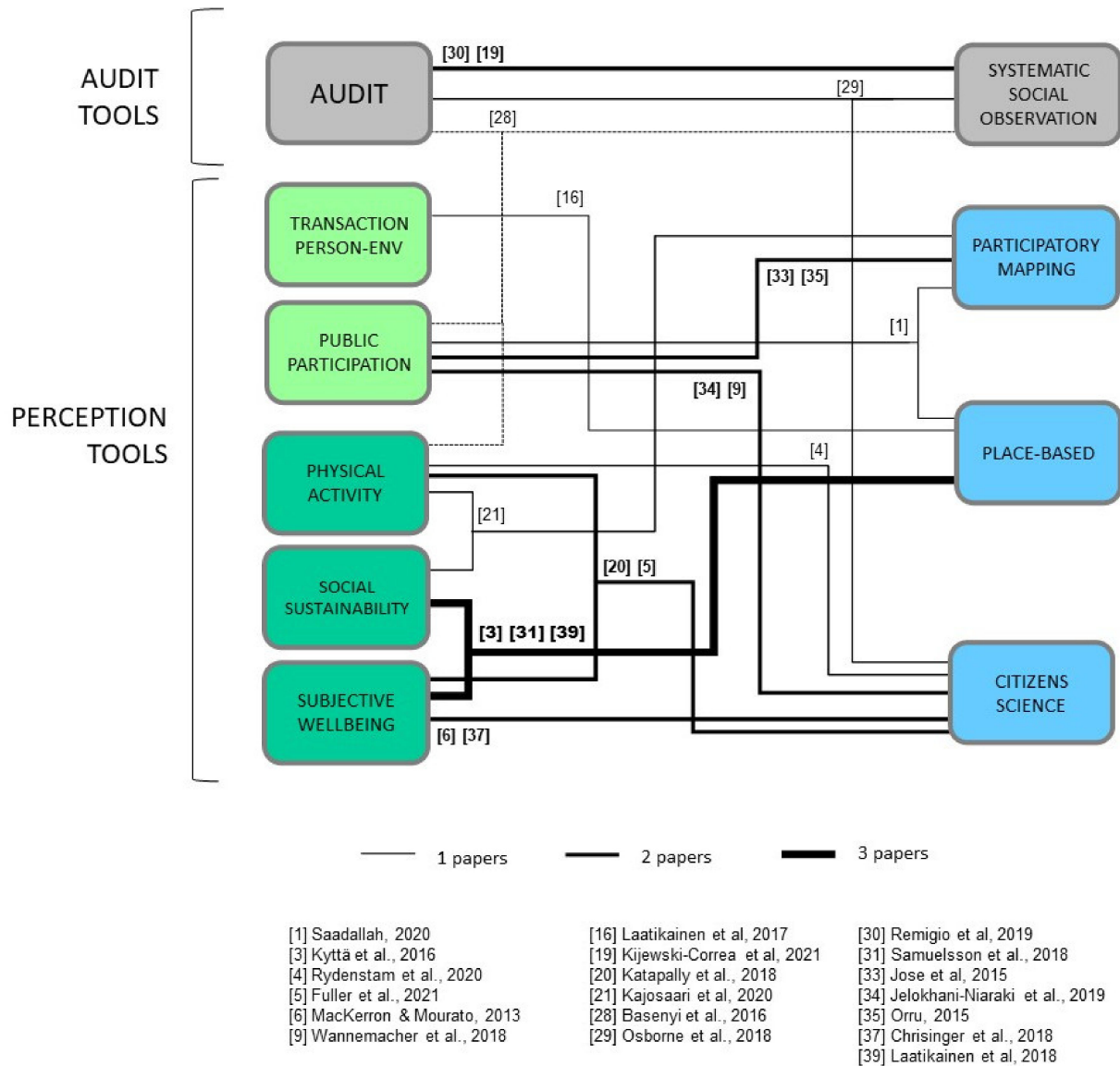
Figure 7. Summary diagram relating theoretical with methodological approaches.

4. Discussion

The emergences of ICT and social media have risen the willingness of people to participate in decision-making processes, evidencing a crucial need to develop new tools and methods to canalize citizens' impressions regarding their surroundings [1]. Public Participation Geographic Information Systems (PPGIS) in digital platforms are offering new tools within the planning processes, making it possible to reach larger and more diverse numbers of participants than traditional participatory methods [8]. On this context, this scoping review was centered on identifying and analyzing articles relying on PPGIS to assess the perception of inhabitants about their urban environments, thereby developing new participation processes. Therefore, the main scope of the research focused on identi-

fying key theories and methodologies in the digital assessment of urban perception and concluding with a conceptual framework to support future research in this field.

As a general result, it is possible to identify that, despite the fast growth of PPGIS, the field researching the perception of the built environment throughout digital platforms has proven to still be small. The search in Web of Science (WoS) and Scopus, the main databases for urban research, only resulted in 98 articles. Regarding the urban planning study field associated with these studies, 31% of the screened articles were centered on studying the urban environment, health and wellbeing, followed by 24% of the papers focused on reviewing urban mobility. Strategies to expand this research could be adopted in order to screen other databases and verify this observation.

With the purpose of identifying the final papers to be reviewed, a selection criteria was applied, selecting articles that were centered on studying the urban environment (Criteria 1), applied participatory processes (Criteria 2), developed with the support of digital platforms (Criteria 3), and centered on studying urban places, therefore excluding mobility (Criteria 4); as a result, only 21 papers were identified, almost all of them centered on studying the urban environment, health and wellbeing. This evidences an increase in research looking to clarify the linkage between the built environment and wellbeing outcomes, with special attention to Physical Activity patterns (PA), where a scarcity of data has been reported [4,5].

Regarding articles associated with the assessment of citizens' perception of the built environment thorough digital platforms, a peak of publications was identified in 2018, with the prevalence of Finland, the USA, and the UK as countries with the most research published. These characteristics could be shedding light onto an emerging research field or evidencing amateurishness or difficulties between global researchers in developing digital platforms to support these types of studies.

Even though scattered information on conceptual frameworks for the subjective assessment of the built environment has effectively been found [8], this scoping review is proposing a systematization of the current theories and methodologies identified on the diversity of the articles selected in order to finally contribute to the proposal of a conceptual framework for the perceptual assessment of the built environment.

Regarding the main theories for the study of citizens' perceptions, this research has identified six different approaches. Audit Tools offer a diversity of instruments and protocols applied by trained personnel to assess the characteristics of the built environment [19,28–30], and transactional person–environment and Public Participation approaches can be used as the main conceptual proposals to relate people's experiences with their surroundings. The first one is associated with environmental psychology and is supported by Gibson's ecological approach to perception [21,31] and the second one emphasizes the political implications of citizens' involvement in decision-making processes [1,9,28,32–35]. Subjective Wellbeing (SWB) and Physical Activity (PA) are general research fields in which the perception of citizens about their built environment is being studied. SWB is generally centered on measuring perceived wellbeing and happiness [3,6,31,37,38] but is also related with identifying activity spaces or active living practices [5,20,39]. Additionally, PA assesses the self-reported type or level of physical activities and environmental preferences to perform exercise within the urban environment [4,5,20,21,28]. Finally, Social Sustainability appears as a complementarily theoretical approach used to identify the accessibility to personally meaningful places [3,31,39].

Complementarily, four main methodological approaches have been identified. Systematic Social Observation (SSO) is the main methodology related with the appliance of Audit Tools [19,28–30]. Participatory mapping, as a general methodology, is considered the basic technical tool of Public Participation Geographic Information Systems (PPGIS) [8,29,32] and is also related with the practice of critical geography [35]. The place-based methodological approach appears strongly related with the transactional person–environment theory [1,3,16,31,39], which can be understood as both a theory and a methodology [16]. Additionally, the Citizens Science methodological approach is related with the Citizens

as Sensors paradigm where citizens generate data to inform planning processes [18]. It is pertinent to underline that both approaches, place-based and Citizens Science, could be recognized as part of the participatory mapping technique [8,32].

Even though this research has acknowledged an increase in publications during recent years, it has been noticed that there is a scarcity of research centering on studying citizens' perception of the built environment through the use of digital platforms. This scarcity of publications might be due to the absence, to date, of literature reviews regarding concepts and methodologies for measuring the perception of the built environment [8,22–25], which are conceptual constraints that might be limiting the possibility of constructing a theoretical framework to fully comprehend citizens' perception of their built environment.

To ease this situation, the final efforts of this research have centered on proposing a conceptual framework to guide the subjective assessment of the built environment, based on the theoretical and methodological outlines identified in the reviewed literature. The proposed framework is based on Public Participation and the transactional experience–environment approach, the only two theories explicitly relating human experience and environmental context [31,42]. For analyzing the environmental context, Gibson's affordance theory [15,20] and Bramley's approach to Social Sustainability [3,31] were considered, while factors conditioning the experience were organized according to Sabri et al.'s [2] interpretation of the relationship between the perceived environment and socio-environmental conditions. These factors have finally been arranged according to the subjective and objective approach for studying the quality of the built environment [14], recognizing the need to incorporate both subjective and objective factors in the assessment of citizens' perception of the built environment. The former includes individuals' perceptions of their immediate surroundings, while the latter brings together all those elements that condition the perception of those individuals such as social, physical, and psychological elements and the environmental context itself. As a result, the proposed framework (see Figure 4) considers both the subjective and objective approaches as necessary for assessing the perception of the built environment throughout digital platforms.

As a general conclusion, the categories presented by Brownson et al. [14] have proven to be certain and are related to the framework to assess citizens' perception of their built environment. Audit Tools related with the SSO methodology appear as an objective approach to assess the quality of the urban environment through citizens' perceptions. While SWB, PA, and Social Sustainability are presented as subjective approaches based on the self-reported perceptions of citizens, these subjective data are complemented with archival data sets and GIS analysis (the objective approach) to study the socio-environmental conditions (such as the sociodemographic profile of the participants) or the urban structure pattern (such as urban form or accessibility) (Figure 6).

In particular, a summary diagram relating theoretical with methodological approaches is also presented (Figure 7), where Audit Tools and SSO methodology have been separated from the Perception Tools associated with the other theories and methodologies identified in this scoping review. This research categorized Audit Tools as an objective approach, where people with the ability to rate or code information record field-generating data with instruments such as surveys, checklists, or standardized forms [30]. Therefore, Audit Tools typically require in-person observations for collecting data [14] and assessing the characteristics of the built environment; therefore, they rarely admit responses from a large group of people. Additionally, Perception Tools such as maps, questionnaires, or sensors are used to collect data regarding the impressions, reactions, and behavior of the people in their surroundings and thereby measure or map the inhabitants' perception of their built environment. The main contribution of this research states that this perception methodology is generally mixed, measuring the inhabitant's perception (the subjective approach) and contrasting it with a technical analysis of the characteristics of the urban environment where the measurement was made (the objective approach).

A consensus had been identified regarding the importance of promoting participation channels to improve the quality of the built environment. Social Participation, with the

involvement of ICT, is a prerequisite for the creation and development of Smart Cities [32], recognizing the need of cooperation between local authorities and users of urban spaces. A similar scope was identified for sustainable, inclusive, and resilient cities [1,9]. Participatory mapping empowers the role of citizenship enhancing the planning process [1,28,29,35]. Under the Citizens as Sensors paradigm [18,41], smartphones emerge as an efficient and effective device [7], allowing participatory sensing to expand the consulted universe beyond the community limits or assembly capacity and facilitating that the public provide direct feedback on the conditions of their environment, thus strengthening bottom-up participation processes [36].

Therefore, Public Participation Geographic Information Systems (PPGIS), Volunteer Geographic Information Systems (VGIS), and methodological approaches such as participatory mapping, collective sensing, or Citizens Science are offering new alternatives for studying the perceptions and preferences of inhabitants within their urban surroundings. In this new technological scenery, there is a chance that traditional deductive planning starts to be complemented by inductive planning approaches, such as those centered on studying subjective preferences and bottom-up crowdsourcing processes [7].

Finally, it has also been noticed that most of the publications reviewed are of Anglo-Saxon origin, with other significant contributions from Europe and the Middle East. The foregoing shows the dominance of western culture and the global north within this field of study, as well as the need to extend the research to the study of Latin American and Eastern cities, which concentrate the highest current and projected rates of growth in urbanization areas.

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