Methodologies for measuring the quality of urban infrastructure for pedestrian mobility: A systematic literature review

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ABSTRACT

The spatial quality of urban infrastructure for pedestrian mobility, influenced by the physical aspects of space and the elements perceived by pedestrians, can induce the behavior of people in order to encourage or inhibit the use of some routes. Therefore, identifying methods and techniques to evaluate this infrastructure's quality is important to contribute to the analysis and diagnosis, which are fundamental for urban management. Given this context, this article aims to identify, through a systematic literature review , the main methods and techniques for evaluating the spatial quality of sidewalks from the micro, meso and macro scales. The Scopus platform database was used and the search delimited the period from 2016 to 2020 for scientific articles. The analysis of 42 articles allowed us to identify: (1) their main characteristics (most relevant authors evaluating this theme, countries where the study was carried out, year of the research´s development and journals with the highest number of publications on this theme, among other general aspects), (2) the main methodologies and techniques for the evaluation of spatial quality, and (3) the importance of the scale of analysis to evaluate urban infrastructure for pedestrian mobility and its influence on the analyses of the results.

KEYWORDS: Urban infrastructure for walking mobility. Methodology. Systematic Review.

1 INTRODUCTION

The spatial quality of sidewalks, the main urban infrastructure for pedestrian movement, can influence people's behavior by stimulating or inhibiting active means of transportation such as walking in the city, route choices, and contribute to sustainability as well.

Several authors (KOHLSDORF, 1996; CERVERO; KOCKELMAN, 1997; MAGAGNIN, 1999; FERREIRA; SANCHES, 2001; EWING et al, 2006; ZAMPIERI, 2006; BARROS, 2014) have studied this issue, whether concerning the physical factors associated with this urban infrastructure as type and condition of the floor, total width, presence of adequate and safe crossings, longitudinal and transversal slope, absence of urban barriers, public lighting; others incorporate aspects such as block size (EWING; CLEMENTE, 2013), pedestrian flow (ZAMPIERI, 2006; BARROS, 2014), diverse land uses, street connectivity (CERVERO; KOCKELMAN, 1997), urban form, imageability, legibility, and topoceptive aspects (KOHLSDORF, 1996; MAGAGNIN, 1999; EWING et al., 2006; BARROS, 2014; TONON, 2019).

According to Park (2008), the quality of the walking space perceived by its users can be measured by urban design elements, which link physical aspects to perception. Thus, methodologies to analyze this infrastructure employ objective and/or subjective forms. Objective methods can be employed in studies at local, regional or inter-regional scales (LITMAN, 2009) and make it possible to evaluate factors associated with the urban form (population density, land use diversity, and street connectivity), the street level (scale and proportion of streets, the design and construction condition of buildings and street furniture) at different study scales (KOO; GUHATHAKURTA; BOTCHWEY, 2021).

In studies that address accessibility, the analysis can occur at three scales, defined by microscale (analysis of the street, or sector), regional scale (of the neighborhood, mesoscale), and the interregional scale (of the city, macroscale) (LITMAN, 2009), allowing the analyzation of different elements of space. By being closer to the observer, the microscale reveals perceptible elements during pedestrian travel; at the mesoscale, neighborhood elements are identified; meanwhile, the macroscale analyzes different types of displacements, which use various modes of transport in the city (TONON, 2019).

Other authors adopt a two-level evaluation scale through the concepts of macro-

accessibility and micro-accessibility, like the research of Vasconcellos (2001). According to the author, micro-accessibility comprises people's free access to means of locomotion and final destinations, and macro-accessibility is understood as accessibility itself, i.e., the individual's ability to access city activities and services through means of transportation (on foot, bicycle, public or private transportation).

According to Pires (2018), the quality of walkability is directly linked to how pedestrians perceive the environment. When analyzed through the microscale, it uses elements of urban design perceptible to them (sidewalks, intersections, and bus stops) and should be evaluated in a more detailed way, and can be measured from physical characteristics (BRADSHAW, 1993; KHISTY, 1994; LANDIS et al, 2001), elements associated with road intersections (MURALEETHARAN et al., 2004) or by both parameters (SARKAR, 1995; DIXON, 1996; FERREIRA; SANCHES, 2001; ASADI-SHEKARI; MOEINADDINI; SHAH, 2015). Recently, characteristics associated with bus stops have also been included in the research (CERNA, 2014; PRADO, 2016).

Studies using the macroscale evaluate the built environment through elements such as density, diversity, urban design, distance from the transportation system, and accessible destinations (PIRES, 2018).

According to Gehl (2015), urban planning, when done based on mesoscale (neighborhood) and/or macroscale (city), neglects the pedestrian because it is in the microscale (street scale) that contains the main elements and aspects that directly influence people´s life and movement. Still, according to the author, to evaluate the spatial quality of the environment, it is necessary to approach one of the scales and choose a method that obtains information about the place. Authors such as Krambeck (2006), Park (2008) and Cain et al. (2014) corroborate with Gehl (2015) and mention that interventions in the microscale space enable changes that involve less cost and time.

Given the diversity of methodologies and evaluation scales (microscale, mesoscale and macroscale) of urban mobility infrastructure for walking mode, this paper proposes to investigate the methods and techniques most used by researchers from different countries.

2 OBJECTIVE

This paper presents the main methods and scales for assessing the quality of pavements from a systematic literature review.

3 METHODOLOGY

The methodology used for the systematic review of the main methodologies and scales for sidewalk evaluation was divided into three steps: (1) planning, (2) data collection and triage, and (3) definition of data analysis parameters (KITCHENHAM, 2004; GOUGH; THOMAS; OLIVER, 2012).

The first stage (Planning) corresponded to the definition of the SCOPUS platform (Elsevier) for selection of the articles, with the temporal clipping of five years (2016-2020) and the keywords "pedestrian" and "sidewalk quality" in the fields: title, abstract and keywords.

The second step (data collection and results triage) was carried out in the SCOPUS platform (Elsevier) in May 2021. By adopting the terms "pedestrian" and "sidewalk", there was an identification of 1028 documents. A second triage was conducted, changing the search terms to "pedestrian" and "sidewalk quality" in the following fields: Title, Abstract, and Keywords. The publication period was maintained: last five years (2016 to 2020); the publication type was "article". In this query, a total of 56 articles were obtained. The query incorporated research conducted in different areas (Engineering, Social Sciences, Sustainable Environment, Materials Science, Medicine, Energy, Psychology), with any type of traveling and scale of analysis (micro, meso, and macro).

The 56 articles underwent an initial validation process (Table 1) through the availability of free access and adherence with the research objective were verified; for this purpose, the article's title, keywords and abstracts were evaluated. Out of the total, 2 articles were not available for download and other 12 articles did not adequate to the analysis proposal because they addressed other themes (air quality, emission of polluting particles, other means of transportation, public lighting, facades, government plans, and disparity).

Table 1: Systematization of the article search

Platform		Filtros		N° documents
SCOPUS (Elsevier)	Input data	Words in the title, abstract, and keywords	**Pedestrian** **Sidewalk quality**	163
	Triage (1)	Publication year	**2016-2020**	90
		Document type	**Articles**	56
	Triage (2)	Unavailable articles		2
		Non-Adherent articles		12
		Total		**42**

Source: Authors, 2022.

The third step (Definition of parameters and data analysis) made it possible to systematize data from the selected articles into two groups: (i) general characterization of the studies, which consists of the identification of general data from the articles; and (ii) characterization of the methodology used, based on three scales of analysis of the quality of sidewalks proposed by Litman (2009): microscale (street or sectorial scale), mesoscale (neighborhood or regional scale) and macroscale (city or interregional scale). The results were analyzed and presented adopting the following parameters: publication journals and their relevance (Brazilian classification), objectives of the studies, study sites, analyzed groups (sociodemographic factors, scale of analysis of the studies - micro, meso, and macro), land use of each study linked to the scale of analysis and methodologies used in the case studies according to the analysis scale of the study.

4 RESULTS AND DISCUSSIONS OF THE SYSTEMATIC REVIEW

The results of this systematic literature review are presented in two parts: The first one shows a general characterization of the 42 selected papers, and then the analysis based on the methods and techniques for evaluating the quality of sidewalks.

Of the 42 articles, 34 (80.95%) were published in journals and 8 (19.05%) are not classified because they are articles from international conferences. Of the 34 articles in journals, 8 (23.53%) are inserted in the A1[1] stratum, 11 (32.35%) in the A2 stratum, 8 (23.53%) in the B1 stratum and another 7 (20.58%) in the B2 and B3 strata.

The surveys have as main objectives: investigate pedestrian's perception of the characteristics of the built environment and how it influences their choice of paths and/or stay on public roads (30.65%); analyze the level of pedestrian satisfaction (14.51%); to examine physical characteristics of the pedestrian infrastructure from certain themes such as accessibility, quality of the infrastructure, attractiveness, and connectivity of sidewalks (27.42%); to develop models of analysis and evaluation of the quality of the sidewalk from objective and/or subjective variables (17.74%); to complement existing models (4.84%) and to conduct a systematic review of the literature (4.84%). Some studies unite more than one of these aforementioned objectives, depending on the methodology used and the focus of the research.

Sociodemographic factors are essential for the studies and evaluation of urban spaces and to understand the influence on pedestrian traffic; for that, specific procedures are used for data collection and analysis, adherent to what one wants to investigate together with the characteristics of the population studied. The 42 selected articles present studies in the following countries: the United States of America with 14 publications, followed by Colombia and Italy with 4 publications each; China and Indonesia with 3 publications each; Korea, India and Turkey with 2 publications each; Bangladesh, Brazil, Chile, Singapore, Iran, Iraq, Lebanon and Poland with 1 publication each. By analyzing studies from different locations it is possible to identify the adaptability and reproducibility of methods and techniques and what factors influence pedestrians, as well as serving as a means of method validation.

Most publications, (38 articles, 90.47%) assess sidewalk quality from the perspective of the pedestrian, who are adult men and women (18-50 years old on average) with no mobility restrictions. Other studies (4 articles, 9.52%) incorporate the accessibility theme as a central point to evaluate the pedestrian space and include in this analysis the elderly, people with disabilities, and children. Of these studies, those conducted in early childhood education schools, by Ozbil; Argin; Yesiltepe (2016) and Corazza et al. (2020), analyze the paths chosen by children on their way to school, and the respective factors that contribute to the safety of it. The article by CAO and DUNCAN (2019) evaluates the environmental factors that influence the behavior of elderly people in a high-density neighborhood. Ai and Tsai (2016) present an automated model to evaluate sidewalks based on the North American accessibility legislation (Americans with Disabilities Act- ADA). Pinna and Murrau (2017) investigate the differentiation of pedestrian travel, alone or in groups. The articles by Lowe (2016) and Conway and Thornton (2016) evaluate the characteristics of the built environment in neighborhoods of different socioeconomic backgrounds based on racial/ethnic composition.

Table 2 presents the systematization of the 42 articles based on the 3 scales of analysis

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[1] In Brazil, the quality of articles is determined by the classification system of the Coordination for the Improvement of Higher Education Personnel (CAPES, acronym in Portuguese), QUALIS, whose current classification refers to the evaluation Quadrennial 2013-2016. The strata A1 and A2 are journals of international excellence and those classified B1 and B2 have national excellence.

of sidewalk quality proposed by Litman (2009): microscale (street scale), mesoscale (neighborhood scale) and macroscale (city scale).

Table 2: Characterization of the articles

General Characterization						Methodology
Author(s), Year	Country	Study location and sample	Scale of Study	Land use	Period Data collection	Technique – research instruments
Lee; Shepley (2020)	Korea	Campus			N/R	Interview; Questionnaire
Kim et al. (2020)	U.S.A.	Campus			1 month	Systematic Obs.; Questionnaire; Direct documentation (field research); Asystematic Obs.
Corazza et al. (2020)	Italy	School surroundings			N/R	Systematic Obs. (walkthrough)
Vallejo-Borda; Cantillo; Rodriguez-Valencia (2020)	Colombia	30 sidewalks			2 weeks.	Interviews; Testing
Woldeamanuel et al. (2020)	U.S.A.	10 parks			N/R	Systematic Obs. (walkthrough)
Jahan; Mazumdar; Hadiuzzaman (2020)	Bangladesh	31 sidewalks			1 month	Questionnaire; Testing; Systematic Obs. (walkthrough)
Rodriguez-Valencia et al. (2020)	Colombia	30 routes			1 week	Questionnaire; Systematic Obs. (walkthrough); Direct documentation (field research)
Arellana et al. (2020)	Colombia	Central region	N/R		1 year	Document collecting
Khabiri; Afshari; Afkhamy (2020)	Iran	Historical region			N/R	Systematic Obs. (walkthrough); Direct documentation (field research)
Mutiawati et al. (2020)	Indonesia	Central region			1 day	Questionnaire; Systematic Obs. (walkthrough)
Sovani e Mumbai (2020)	India	neighborhood			N/R	Questionnaire
Vallejo-Borda et al. (2020)	Colombia	30 sidewalks			1 month	Questionnaire; Systematic Obs. (walkthrough); Direct documentation (field research)
Zhao et al. (2020)	China	Sidewalks			N/R	Direct documentation (field research); Testing
Zumelzu; Barría; Barrientos-Trinanes (2020)	Chile	neighborhood			N/R	Direct documentation(field research); Asystematic Obs.
Cao; Duncan (2019)	U.S.A.	Sidewalks			1 month	Questionnaire
Yencha (2019)	U.S.A.	7 cities			1 year	Direct documentation(field research); Testing
Cao; Heng; Fung (2019)	Singapore	neighborhood			1 month	Interview; Systematic and Participant Obs (walkthrough)
Suminski Jr; Dominick; Saponaro (2019)	U.S.A	3 neighborhoods			2 days	Systematic Obs. (walkthrough)
Ozbil et al. (2019)	Turkey	30 sidewalks			2 days	Systematic Obs.
Rocha et al. (2019)	Brazil	City			N/R	Questionnaire; Systematic Obs. (walkthrough)
Markvica; Richter; Lenz (2019)	Italy	3 Routes			2 years	Questionnaire; Systematic Obs.
Dong et al. (2019)	China	5 neighborhoods			2 months	Questionnaire
Sun et al. (2019)	China	Sidewalks			N/R	Systematic Obs. (walkthrough)
Dakhil; Alobaidi; Shaheed (2019)	Iraq	4 neighborhood areas			N/R	Questionnaire; Systematic Obs.

General Characterization						Methodology
Author(s), Year	Country	Study location and sample	Scale of Study	Land use	Period Data collection	Technique – research instruments
Bivina; Parida (2019)	India	36 sidewalks	Micro-scale	Mixed	1 month	Questionnaire; Testing
Trzaskowska; Adamiec (2019)	Poland	sidewalks	Micro-scale	Mixed	N/R	Questionnaire; Systematic Obs.
Makarewicz et al. (2018)	U.S.A.	2 cities	Macro-scale	Mixed	N/R	Interview
Qin; Curtin; Rice (2018)	U.S.A.	City	Meso-scale	Mixed	N/R	Interview; Systematic Obs.
Nigro et al. (2018)	Italy	8 neighborhoods	Meso-scale	Mixed	1 month	Questionnaire; Direct documentation (field research); Systematic Obs.
Murwadi; Dewancker (2017)	Indonesia	Campus	Micro-scale	Educational	N/R	Document collecting
Pinna; Murrau (2017)	Italy	neighborhood	Meso-scale	Mixed	N/R	Systematic Obs.
Carlin et al. (2017)	U.S.A.	N/R	N/R	N/R	1 year	Document collecting
Said; Abou-Zeid; Kaysi (2017)	Lebanon	Campus	Micro-scale	Educational	1 month	Questionnaire; Testing
Jung et al. (2017)	Korea	neighborhood	Meso-scale	Mixed	2 years	Questionnaire; Systematic Obs.
Thornton et al. (2016)	U.S.A.	neighborhood	Micro-scale	Mixed	2 years	Systematic Obs. (walkthrough)
Lefrandt et al. (2016)	Indonesia	City	Macro-scale	Mixed	N/R	Systematic Obs.; Testing
Tilahun et a. (2016)	U.S.A.	City	Macro-scale	Mixed	N/R	Systematic Obs.
Rice et al. (2016)	U.S.A.	Crossings	Micro-scale	Mixed	1 month	Questionnaire; Systematic Obs.
Woldeamanuel; Kent (2016)	U.S.A.	sidewalks	Micro-scale	Access to Public Transportation	2 months	Systematic Obs. (walkthrough)
Ai; Tsai (2016)	U.S.A.	Campus	Micro-scale	Educational	N/R	Systematic Obs. (walkthrough); Testing
Ozbil; Argin; Yesiltepe (2016)	Turkey	School surroundings	Micro-scale	Educational	2 months	Questionnaire; Systematic Obs.
Lowe (2016)	U.S.A.	Bus stops	Micro-scale	Access to Public Transportation	N/R	Systematic Obs.

Legend

Study of Scale — Micro-scale; Meso-scale; Macro-scale

Land use — Educational; Commercial; Mixed; Residential; Access to Public Transportation; Green Area

Abbreviations: Obs – Observation; N/R – No Record.

Source: Authors, 2022.

The articles present different scales for evaluating the quality of pavements. According to Table 2, 20 articles (47.62%) analyzed micro accessibility based on studies about the surroundings of a building, or specific routes (segments of pavements and road intersections), of which: 10 articles (50%) on areas of mixed-use, 7 articles (35%) on school areas, 2 articles (10%) on places of access to public transportation, and one article (5%) on residential areas. The mesoscale is assessed in 14 articles (33.33%), whose objects of investigation are associated with neighborhoods and parks, being: 10 articles (71.42%) on sites with mixed land use, 2 articles (14.28%) on residential areas, 1 article (7.14%) on a commercial site and 1 article (7.14%) on a green area. The macroscale assessment was identified in 6 articles (14.29%), which assessed the city as a whole; out of these articles 5 (83.33%) addressed mixed land use as a central research theme, and only one article (16.66%) analyzed residential neighborhoods in different cities. Two studies (4.76%) did not present an evaluation scale (CARLIN et al., 2017; ARELLANA et al., 2020) because they consisted of systematic reviews.

Table 2 shows that 13 articles (30.95%) analyzed more than one site (OZBIL; ARGIN;

YESILTEPE, 2016; THORNTON et al., 2016; NIGRO et al., 2018; DONG et al., 2019; MARKVICA; RICHTER; LENZ, 2019; OZBIL et al., 2019; SUMINSKI JR; DOMINICK; SAPONARO, 2019; YENCHA, 2019; CORAZZA et al, 2020; MUTIAWATI et al., 2020; RODRIGUEZ-VALENCIA et al., 2020; VALLEJO-BORDA et al., 2020; WOLDEAMANUEL et al., 2020), being them belonging to the same city (more than one neighborhood or institution) or in different cities. In this review, no studies were found comparing data from cities located in different countries.

As for the methodological approach, the articles are characterized by having descriptive-exploratory methodology (39 articles, 92.86%) and bibliographical methodology (3 articles, 7.14%). The main techniques used in the 42 articles are systematic observation (64.28%), questionnaire (42.85%), tests (19.04%), direct documentation (19.04%), and interview (11.90%); 27 articles use more than one methodology.

Among the 20 articles that use the microscale, the main techniques employed are systematic observation (11 articles, 55%) and questionnaire (9 articles, 45%). The systematic (structured, planned) observation is performed under controlled conditions and uses instruments to collect data (charts, notes, scales, cameras, etc.); in this technique the observer must analyze the pre-established items, eliminating from the observation their personal influence (MARCONI; LAKATOS, 2017). For this, the instrument "Walkthrough analysis" is used in 6 articles (30%) through a professional in the area, and that enables the identification of negative and positive aspects of the place, and how the physical aspects articulate the user's interactions with the environment (RHEINGANTZ et al., 2009).

The systematic observation, or unstructured observation, is used more in exploratory studies, to collect and register the facts of reality, whose researcher collects the data without special technical means (MARCONI; LAKATOS, 2017). In microscale studies, it is possible to apply it through the technique of Analysis of behavioral traces, which makes observations about the behavior and activities of users, and identifies the uses, flows, and spatial relationships; when represented graphically, it is called a behavioral map (RHEINGANTZ et al., 2009). This technique is present in 2 studies in this review (KIM et al., 2020; ZUMELZU; BARRÍA; BARRIENTOS-TRINANES, 2020).

Another methodology employed in the microscale studies (6 articles, 30%) is Testing, "instruments used with the purpose of obtaining data that allow measuring the performance, frequency, ability or conduct of individuals in a quantitative way" (MARCONI; LAKATOS, 2017, p. 258). The articles used the Statistical Method, a technique to quantify the data obtained during the investigations and analysis of the studies and, through the extraction of numerical information arising from an observation (sample), the identification of characteristics and aspects of the whole (total population of the sample). The studies that employed SEM (Structural Equation Modeling) made use of photographic images of the sites to process information and obtain data about the quality, characteristics, and conditions of the analyzed space. This methodology also appears in an article that covers the macroscale (LEFRANDT et al., 2016).

Other methodologies used in the microscale studies were Direct documentation (4 articles, 20%), Interview (2 articles, 10%), and Documentary collection (1 article, 5%). In 13 studies that evaluate micro-accessibility, the authors use more than one technique, most of them uniting the systematic observation to the use of questionnaires, or the questionnaire with

direct documentation and/or with the tests; this enables the main user of the place, the pedestrian, to participate in the evaluation of the environment, giving greater veracity to the study.

Data collection in the field in microscale studies occurs, mostly (7 articles, 35%), for a period of one month; 9 papers did not present information about the development period of this stage of the research, the others were carried out in 2 weeks (1 article, 5%), 2 months (2 articles, 10%) and over 2 years (1 article, 5%), Table 2.

The meso accessibility, addressed in 14 articles (33.33%), also employs the methodologies of systematic observation (12 articles, 85.71%) and the use of questionnaires (7 articles, 50%). In this scale, the analyses use the obtaining and analyzing images and data; this technique makes it possible to identify values, meanings, preferences, and cultural aspects of a particular group and its relationship with the built environment, besides showing the impacts caused by spatial elements (RHEINGANTZ et al., 2009). The obtaining of images and data occurs in the field with the use of cameras, schematic maps, and others.

In this scale, it was used Participant Observation in one of the articles (CAO and DUNCAN, 2019); this methodology consists of the participation of the researcher within the community or group, experiencing the activities as users of the space (MARCONI; LAKATOS, 2017), which allows a deep analysis of the built environment.

Also according to Table 2, studies associated with mesoscale correspond to 8 articles (57.14%) and use more than one methodology; they combine systematic observation with the use of questionnaires and interviews, and 6 articles (42.85%) use only one methodology. In this scale, only two articles (14.28%) used Direct documentation (field research) (KHABIRI; AFSHARI; AFKHAMY, 2020; NIGRO et al., 2018). This technique consists of the observation of facts and phenomena, and the recording of relevant variables for the analysis, being quantitative-descriptive (MARCONI; LAKATOS, 2017). Here, occurs the measuring of the flow of people and dimensioning of the roads and public spaces, with instruments such as field notebook, photographs, schematic plans and specific equipment.

Regarding the development time of the works, a great variation is observed; due to the methodology employed, 3 articles (21.42%) analyzed data collected in 1 or 2 days, 3 studies (21.42%) were carried out in the period between 1 and 2 months and 2 articles (14.28%) had a longer time of information collection - two years, the other analyses, in 6 articles (42.85%), did not inform about the period of study.

Authors who evaluated the macroscale infrastructure (6 articles, 14.28%) used the same methodologies adopted for the previous scales, with an emphasis on systematic observation, which uses images and data obtained in the field to evaluate the space. Despite analyzing the city as a whole, the authors Rodriguez-Valencia et al. (2020), Rocha et al. (2019) and Makarewicz et al. (2018) managed to apply questionnaires and interviews with the population. The application of the questionnaire occured at the study site or virtually. The analysis of the results obtained makes it possible to identify the user's profiles and verify their opinion about the aspects of the built environment. The studies present variations regarding the number of sampling due to the scale differences of the evaluated sites.

Unlike the questionnaires, the interview occurs in the presence of the researcher. According to Rheingantz et al. (2009), the interview allows one to ascertain facts and feelings,

know the current or past situation and the reasons that lead to these factors; the interview completes the information raised in the field when searching for data that were hidden and fills gaps in information, being used in 5 articles (MAKAREWICZ et al., 2018; QIN; CURTIN; RICE, 2018; CAO and DUNCAN., 2019; LEE; SHEPLEY, 2020; VALLEJO-BORDA et al., 2020).

Out of the 6 articles that used the macroscale, 4 did not present information regarding the period of performance, the other two were performed over a year (YENCHA, 2019) and in one week (RODRIGUEZ-VALENCIA et al., 2020).

Another methodology present in the analyzed articles was the Systematic Review of the literature, which consists of the process of searching, analyzing, and describing material about a topic, seeking to answer a specific question. In the systematic review, the works are investigated, critically evaluated and their results are synthesized. The information is collected from books, journal articles, newspaper articles, historical records, reports, theses, and dissertations among other documents. This methodology is present in 3 articles (ARELLANA et al., 2020; MURWADI; DEWANCKER, 2017; CARLIN et al., 2017).

The articles present in their results the most relevant characteristics for determining the quality of sidewalks. As this review addresses studies from different locations, it presents significant differences in the results; for example, in studies carried out in developing countries; before evaluating any characteristic of the sidewalk, the authors need to verify the availability of this infrastructure. Next, the most relevant physical elements of this infrastructure are evaluated, such as the pavement´s width and length, condition/maintenance of the paving, and accessibility of the sidewalk. Other physical variables assessed are the connectivity between the pavements and the intersections.

As for the perceived variables, the feeling of safety proves to be the most relevant, being it a conditioning factor of the route choice and time of permanence in the roads; the safety of a road is associated with the level of crime and traffic accidents (BIVINA; PARIDA, 2018; DONG et al., 2019; ROCHA et al., 2019; JAHAN; MAZUMDAR; HADIUZZAMAN, 2020). Distance is another variable that is found to be relevant in path choices and determinant of the quality of pavements. Articles address this issue in two ways: the distance between the starting point and final destination, and the distance between urban and service facilities (commerce, schools, hospitals, etc.). Pedestrians tend to choose the shortest route, but can be influenced to change their route to a longer one according to their interests; the presence of diversified land use activities influences this choice, and serves as an incentive to walk (SAID; ABOU-ZEID; KAYSI, 2016; CORAZZA et al., 2020; ZUMELZU; BARRÍA; BARRIENTOS-TRINANES, 2020).

After reading and analyzing the articles, summarized in Table 2, the following gaps were identified: omission of information about the study period, technical information about the analyzed place and data about sampling. In warm climatic countries, it was identified that pedestrians did not want to answer the questionnaires in public open space, new evaluation models have initial limitations for requiring an application/evaluation with a large number of pedestrians; items to be evaluated are not described.

5 CONCLUSIONS

This systematic literature review aimed to survey and analyze academic research on the quality of pedestrian infrastructure published in the last five years (2016 to 2020) in the Scopus database in order to identify the main methods and techniques used in pedestrian space evaluations. Linked to the proposed identification of the methodologies, the articles were divided according to their scale of analysis (micro, meso, and macro); this division allows the identification of the types of studies, the applicability of the methods, and relevance of the results.

Studies carried out from the micro-accessibility scale are more focused on elements of space perceptible to pedestrians, providing a more detailed evaluation of segments of pavements, short paths or areas adjacent to a device. Studies that use the mesoscale analyze neighborhoods or several areas of a neighborhood, which enable the evaluation of both of the elements more perceptible to the user and more general elements of the study area. Meanwhile, those who approached the macroscale present broader results, as they investigate the city as a whole, or several neighborhoods, from analyses of elements such as density, diversity, urban design, distance, and destinations.

The choice of the scale of analysis and the methodology to be employed in the research must be made based on the objective to be achieved and the time available. This review showed that the methodologies are applicable to all scales of analysis and that the use of more than one method collaborates to understand the space in a broader and more detailed way. As to assess the spatial quality of environments for pedestrians, it is necessary to measure quantitative and qualitative elements of the physical space and the perception of users.

The review of 42 articles from the Scopus database, from 2016 to 2020, of national and international scope, allowed the identification and exemplification of the applicability of different evaluation methods in different scales of analysis; besides presenting problems, potentialities and gaps for future research, it is possible to find studies with similar objectives, methods, and evaluation techniques and results; highlighting that the quality of sidewalks is directly related to the physical variables of infrastructure (width, length, condition of the pavement and accessibility) and the variables of safety and attractiveness of the place (diversified land use).

This study and the analyses presented in it do not exhaust the debate on the subject. Other systematic reviews should be carried out using other temporal clippings, research bases and keywords. It is emphasized that the evaluation of the quality of sidewalks contributes beyond scientific means since it is on the sidewalks that the city comes to life.

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