Methodologies to evaluate the quality of pedestrian infrastructure on the University campus: Systematic Review

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ABSTRACT

Walking is understood as a sustainable and economical means of transport, it promotes benefits such as improving people's health, but this option is chosen especially when adequate conditions are offered. As it contributes to the adoption of a sustainable urban mobility policy, walking should be encouraged in internal displacements carried out by users of higher education institutions. To support the analysis of mobility in this type of institution, this paper sought to identify the main methods and techniques that can be used to evaluate the quality of walking spaces, internal and external, to University campuses, through a systematic review of literature. For this, Scopus, MDPI, ScienceDirect and Sage Journals platforms were adopted to screen articles published between 2005 and 2021, with the following keywords "walkability, campuses, university" and "pedestrian, "campuses, university". The analysis of 26 papers, which were part of the sample size, made it possible to identify: i) objective, ii) methodology and iii) technique used among the researchers, and showed that predominantly the research carried out in these environments incorporates not only the spaces within the campus, but its surroundings, or users' access to the campus. Thus, several aspects associated with walkability are evaluated, such as the existing infrastructure itself, the most used mode of transport in displacements within the campus, in addition to some scenario in a certain route carried out by the user.

KEYWORDS: Pedestrian infrastructure. Methodology. Systematic review.

INTRODUCTION

Several characteristics related to urban space can influence pedestrians in choosing a particular route. Research carried out in Brazil and abroad highlights that some of these elements are associated with the type of floor, conditions of the flooring material, width of sidewalks/paths, presence of adequate crossings, safety in crossings, longitudinal and transversal slopes, presence of obstacles on the floor, steps, among other elements (FERREIRA; SANCHES, 2001; ITDP, 2016); size of blocks, presence of people in urban space (JACOBS, 2014; ITDP, 2016); human scale, greater dynamics and presence of public buildings on the ground floor, aesthetics of buildings (GEHL, 2015; KARSSENBERG et al., 2015); quality in public lighting, cleanliness of spaces, lack of vacant lots and abandoned buildings, low level of noise, visual and air pollution (ITDP, 2015), among other aspects.

Walking is a sustainable mean of transport, which promotes benefits such as improving people's health and travel savings, but this option is chosen especially when adequate infrastructure conditions are offered (SILVA et al., 2019). Characteristics related to the individual (gender, age, income, etc.), to the mode of transport, to travel (availability, cost, time, reason, etc.), and to those related to urban space (land use, density, etc.), also interfere in the choice of walking mode (AMÂNCIO, 2005).

Physical aspects related to pedestrian infrastructure have been evaluated by some authors based on the definition of walkability, among which Ferreira and Sanches (2001) and ITDP (2015) stand out.

In university environments, the same problems identified in other urban areas are observed, that is, sidewalks do not always have continuity, there are accessibility problems, crossings do not include universal accessibility, there are problems in the implementation of urban furniture, among other aspects (SABINO, 2017).

Walking could be prioritized by higher education institutions, both as a choice for arrival at the campus and for access to the internal spaces of the campus, to contribute to sustainable urban mobility (SILVA et al., 2019).

In general, among the works that deal with this issue, there are few that evaluate the quality of pedestrian paths in Universities (GILSON et al., 2009; ZHANG et al., 2013; ASADI-SHEKARI; MOEINADDINI; ZALY SHAH, 2014; AFSAR; YUNOS; YUSOF, 2015; KEAT; YAACOB;

HASHIM, 2016; MURWADI; DEWANCKER, 2017; RAHMANDARI; GUNAWAN; MUGNISJAH, 2018; ADI PRASETYA; PURWANTO; MARYONO, 2020; ALYASARI; AUDA; ATTYA, 2020; HACAR; GÜLGEN; BILGI, 2020; KING et al., 2020; LEE; SHEPLEY, 2020; RASWOL, 2020; ZHANG; MU, 2020; ZHANG, FISHER; FENG, 2020; ALHAJAJ; DAGHISTANI, 2021). Among them, most evaluate spatial accessibility, through performance indicators, such as: floor conditions, sidewalk width, existence of obstacles, protection against the weather, urban furniture, night lighting, border use, crossing, safety, among other aspects (GILSON et al., 2009; ZHANG et al., 2013; ASADI-SHEKARI, 2014; AFSAR; YUNOS; YUSOF, 2015; KEAT; YAACOB; HASHIM, 2016; MURWADI; DEWANCKER, 2017; RAHMANDARI; GUNAWAN; MUGNISJAH, 2018; ALYASARI; AUDA; ATTYA, 2020; HACAR; GÜLGEN; BILGI, 2020; KING et al., 2020; LEE; SHEPLEY, 2020; RASWOL, 2020; ZHANG, MU, 2020; ZHANG, FISHER; FENG, 2020; ALHAJAJ; DAGHISTANI, 2021).

Faced with the diversity of activities and users who move around the university campus using different modes of transport, it can be observed that, often, the forms of displacement do not contribute to sustainability and local mobility. In this context, this article proposes to investigate which methods and techniques are most used by researchers from different countries to assess the quality of walkability (or infrastructure intended for active walking mode) in order to identify which parameters can effectively contribute to this assessment.

OBJECTIVE

This article aims to identify the main methods and techniques to assess the quality of pedestrian infrastructure in University campus, based on a systematic review of the literature.

METHODOLOGY

Based on the systematic review works developed by Gough, Thomas and Oliver (2012), Ruiz and Granja (2012), Perillo, Campos and Abreu-Harbich (2017) and Mendes, Fontes, Magagnin (2021), a protocol was developed to the selection and analysis of articles comprising three steps: i) identification of the database and definition of search criteria; ii) data collection and sorting; iii) definition of parameters for the analysis of articles.

The first step corresponded to the selection of the database, string formulation and the search protocol. The SCOPUS database (Elsevier) was chosen because it brings together important journals with themes that adhere to the theme "walkability on University campus".

The article search protocol involved the following definitions: i) Conceptual structure, aimed at identifying in the articles the methods and techniques most applied in the evaluation of pedestrian infrastructure in University campuses; ii) Context – corresponds to the definition of the period of publication of the articles, defined in 16 years (2005-2021); iii) Language - English and Portuguese; iv) Exclusion criteria - research applied outside University campuses; v) Inclusion criteria - researches related to the topic of assessing pedestrian walkability or environment on University campuses.

The second stage was carried out in the database of the SCOPUS Platform (Elsevier), in the months of May and June 2021, using the keywords "walkability", "campuses", "university". A total of 29 articles were obtained, of which 19 were excluded when reading the title and abstract.

Due to the low number of articles adhering to the theme, the following strategies were defined: i) expansion of databases and ii) alteration of keywords. The Scopus, MDPI, ScienceDirect, Sage Journals databases were selected, and the keywords: "walkability", "campuses", "university" and "pedestrian", "campuses", "university" connected by the Boolean component "AND". The period of publication between 2005 and 2021 and publications in journals were used (Table 1). In these queries, the following results were found, for the set of keywords, "walkability", "campuses", "university", 199 articles were obtained and for the keywords "pedestrian", "campuses", "university", 199 articles were obtained. 323 articles were identified, resulting in a total of 522 articles (Table 1).

With the application of the free access filter, adherence was verified for the purpose of this investigation. After reading the title and abstract of the articles, a total of 30 articles were obtained (Table 1). From the full reading of the articles, 26 articles adherent to the theme were selected, , one of which, despite not having free access, was made available by the author.

Table 1: Article screening

Platform	Filters			N. of Articles
SCOPUS MDPI SCIENCEDIRECT SAGE JOURNALS	Input data	Keywords 1	"walkability", "campuses", "university"	199
		Keywords 2	"pedestrian", "campuses", "university"	323
	Screening 1	criterion (a) - Period (year)	2005-2021	
		criterion (b) - Document Type	Only articles	522
	Screening 2	criterion (a) - Free access		30
		Reading titles and abstracts		26
			Result	**26**

Source: AUTHORS, 2021.

The third step was responsible for defining the criteria for collecting data from articles for further analysis. The collected data were grouped into information that allowed (i) to characterize or identify aspects related to the authors, name of the journals, year of publication, identification of keywords, identification of a link with a university, public agency or institution; country of study; and (ii) analyze the methodology used for the analysis of pedestrian infrastructure on university campuses, by identifying the purpose of the article, method and techniques used, sample; sample profile; main results. It was defined by using the technical criterion of walkability analysis to analyze this second topic. The information collected from the articles was analyzed using graphs, tables and word clouds, which were generated in the application called Wordle.

RESULTS AND DISCUSSIONS OF THE SYSTEMATIC REVIEW

The results of this systematic review of the literature are presented in two parts, initially the general characterization of the 26 articles is carried out and, subsequently, the methods and techniques used to assess the pedestrian infrastructure on the University campus are analyzed.

The 26 articles were published between 2009 and 2021. In the years 2011 and 2012, no publications were found on pedestrian infrastructure in these databases. Most publications

occurred in 2020 (31%, 8 articles), and from 2021 to the date of data collection in the databases, 4 articles (15%) were obtained, followed by the years 2016 and 2014 with 3 publications (12% of articles) each year. In 2015 there were 2 publications (8% of articles). In the years 2009, 2013, 2017, 2018 and 2019, only 1 article (4%) was published per year.

The journals with the highest number of published articles are IOP Conference Series: Materials Science and Engineering (3 articles, 11%), classified as B3 by CAPES Qualis and impact factor 6.578; Sustainability (Switzerland) with 3 articles (11%), which has an impact factor of 2.576; Sustainable Cities and Society (2 articles, 7%), classified as B3 and impact factor 7.587; and Land Use Policy (2 articles, 7.6%), classified as A1 and impact factor 5.398. Another 16 journals (16 articles, 61.5%) had only one publication.

The main areas of knowledge of the publications are associated with urban and regional planning (7 articles, 26%), sustainability and transport, two articles (19%) in each theme. Other areas (multidisciplinary, geography, medicine, geography, environment and science and agriculture) present only one article (3%) each, totaling 15 articles (57%).

The analysis of the keywords reveals that the most used terms are Walkability (7 occurrences, 26%), Walking (4 occurrences, 15%), and Pedestrian facilities, University campus, Green campus and Sustainable campus (3 occurrences, 11%, each), Figure 1.

Figure 1: Word cloud containing the keywords used in the selected articles

Source: AUTHORS, 2021.

Most of the research is carried out on University campuses abroad (25 articles, 96%) and only one study is carried out in Brazil. Those carried out abroad, 12 articles (48%) are developed in the Asian continent (China, South Korea, Indonesia, Malaysia and Turkey), 4 articles (16%) are applied in Europe (Scotland, Spain, England, Northern Ireland and Malta) and 5 articles (20%) are carried out in the American continent (United States and Canada). No evaluations were found in countries on the African continent (Table 2).

Table 2: Characterization of the articles studied, with identification codes

Code	Author (year)	Country	University	Objective		Technique			
				1	2	A	B	C	D
01	KEAT; YAACOB; HASHIM (2016)	Malaysia	University Malaya	X			X		
02	RAMAKRESHNAN et al. (2020)	Malaysia	Tropical university	X			X		
03	ZHANG; MU (2020)	United States	University of Georgia		X		X		X
04	KING et al. (2020)	United States	-	X			X		
05	ALHAJAJ; DAGHISTANI (2021)	Saudi Arabia	King Abdulaziz University	X			X		
06	ATTARD; CAÑAS; MAAS (2021)	Malta	University of Malta	X				X	
07	RASWOL (2020)	Iraq	University of Duhok	X			X	X	
08	ZHANG; FISHER; FENG (2020)	China	Tianjin University		X		X		
09	ALYASARI; AUDA; ATTYA (2020)	Iraq	University of Kerbala		X		X		X
10	SILVA et al. (2019)	Brazil	UFSCar, USP I and USP II		X			X	
11	MURWADI; DEWANCKER (2017)	Indonesia	University of Lampung		X		X	X	
12	ASADI-SHEKARI; MOEINADDINI; ZALY SHAH (2014)	Malaysia	University Tektology Malaysia		X		X		
13	RAHMANDARI; GUNAWAN; MUGNISJAH (2018)	Indonesia	Bogor Agricultural University	X			X		
14	AFSAR; YUNOS; YUSOF (2015)	Malaysia	University Putra Malaysia	X			X		
15	ADI PRASETYA; PURWANTO; MARYONO (2020)	Indonesia	Diponegoro University	X			X		
16	HACAR; GÜLGEN; BILGI (2020)	Turkey	Yildiz Technical University	X					X
17	LEE; SHEPLEY (2020)	South Korea	Daejeon University	X			X		
18	SUO; ZHANG (2016)	China	Universidade Sudoeste em Chongqing	X			X		
19	ALHASSAN; MASHROS (2016)	Nigeria	Universidade Bayero, Kano	X				X	
20	SULTAN; KATAR; AL-ATROUSH (2021)	Saudi Arabia	Prince Sultan University	X			X		
21	SUN et al. (2015)	China	Chinese university of Hong Kong	X			X		
22	GÖÇER et al. (2019)	Turkey	University Özyeğin, Çekmeköy campus	X				X	
23	RYBARCZYK; GALLAGHER (2014)	United States	University of Michigan-Flint	X				X	X
24	GILSON et al. (2009)	Australia, Canada, England, Northern Ireland, Scotland,	10 campuses[1]	X		X			

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[1] University of Queensland, University of Toronto, Leeds Metropolitan University, Loughborough University, University of Bath, University of Ulster, Heriot-Watt University, Universität de Vic, Arizona State University, University of Alabama.

Code	Author (year)	Country	University	Objective		Technique			
				1	2	A	B	C	D
		Spain and Unite States		■		■			
25	ZHANG et al. (2013)	China	Tianjin University	■		■			
26	ZHANG et al. (2020)	United States	University of south Florida, campus Tampa	■				■	

Note:

1 - Assess the pedestrian infrastructure; 2 - Propose a methodology.

A - Indicator and/or index; B - Questionnaire or Interview; C - Image registration (photos or videos); D - Other GIS.

Source: AUTHORS, 2021.

Of the 26 articles analyzed, only one article does not inform the place of study, two studies include more than one university campus and the others evaluate only one. Silva et al. (2020) evaluates three university campuses (UFSCar, USP I and USP II) in two public universities located in the same city in Brazil – São Carlos. While Gilson et al. (2009) study 10 university campuses belonging to 7 countries.

Most of the articles 20 articles (77%) aim to analyze the pedestrian infrastructure from the physical space aimed at campus users (students, teachers and technical-administrative staff) and those that aim to propose some methodology correspond to 6 articles (23%), as shown in Table 2.

As for the technique used to assess pedestrian infrastructure, 16 articles (62%) use performance indicators. The other articles involve the application of questionnaires and interviews (18 articles, 69%) and image registration (6 articles, 23%). Four articles (15%) involve the application of other techniques such as GIS, which is always associated with some other tool (RYBARCZYK; GALLAGHER, 2014; ALYASARI; AUDA; ATTYA, 2020; HACAR; GÜLGEN; BILGI, 2020, ZHANG; MU, 2020). Twelve publications (46%) involve more than one technique (ZHANG et al., 2013; KEAT; YAACOB; HASHIM, 2016; MURWADI; DEWANCKER, 2017; RAHMANDARI; GUNAWAN; MUGNISJAH, 2018; ALYASARI; AUDA; ATTYA, 2020; HACAR, GÜLGEN; BILGI, 2020; KING et al., 2020; RASWOL, 2020; ZHANG; MU, 2020; ZHAN; FISHER; FENG, 2020; ALHAJAJ; DAGHISTANI, 2021; ATTARD; CAÑA; MAAS, 2021).

Sixteen articles (61%) evaluate the pedestrian infrastructure inside the university campus through indices and performance indicators (GILSON et al., 2009; ZHANG et al., 2013; ASADI-SHEKARI; MOEINADDINI; ZALY SHAH, 2014; AFSAR; YUNOS; YUSOF, 2015; KEAT; YAACOB; HASHIM, 2016; MURWADI; DEWANCKER, 2017; RAHMANDARI; GUNAWAN; MUGNISJAH, 2018; ADI PRASETYA; PURWANTO; MARYONO, 2020; ALYASARI; AUDA; ATTYA, 2020; HACAR; GÜLGEN; BILGI, 2020; KING et al., 2020; LEE; SHEPLEY, 2020; RASWOL, 2020; ZHANG; MU, 2020; ZHANG, FISHER; FENG, 2020; ALHAJAJ; DAGHISTANI, 2021).

Six articles (23%) aim to present a methodology to assess pedestrian infrastructure. They utilize more than one technique: indicator associated with image registration or GIS (ALYASARI; AUDA; ATTYA, 2020; ZHANG; MU, 2020), indicator associated with a questionnaire or interview (MURWADI; DEWANCKER, 2017; ZHANG; SILVA et al., 2019; FISHER; FENG, 2020), or only the use of indicators and an index (ASADI-SHEKARI, 2014).

The works developed by Afsar, Yunos and Yusof (2015), Murwadi and Dewancker (2017), Rahmandari, Gunawan and Mugnisjah (2018), Lee and Shepley (2020), Raswol (2020), Alhajaj and Daghistani (2021) and Attard, Cañas and Maas (2021) apply different techniques to

assess walkability on university campuses. These articles aim to determine the quality of the sidewalk, for different purposes. The research by Afsar, Yunos and Yusof (2015) evaluate the walkability of university campuses and the use of bicycles through questionnaires. Murwadi and Dewancker (2017) evaluate the walkability on the campus of the University of Lampung to identify the effects that the quality of the space can affect the student's walking and, for this, they used questionnaires and indicators. Authors Rahmandari, Gunawan and Mugnisjah (2018) use questionnaires and indicators to assess aesthetics and how they impact students on the Bogor Agricultural University campus. Lee and Shepley (2020) evaluate the walkability of university campuses and the impact of smartphone use using indicators and questionnaires.

The article by Raswol (2020) assess walkability on the Duhok University campus using questionnaires and indicators. Alhajaj and Daghistani (2021) use questionnaires to understand how students observe the quality of walking on campus. Attard, Cañas and Mass (2020) carry out the research with focus groups, so that they can show, through photographic records, the problems encountered along the way.
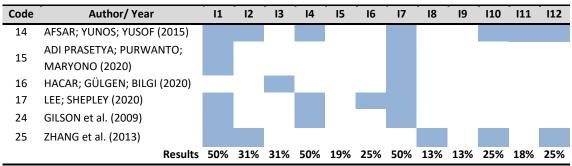
Other techniques used for campus evaluation refer to the application of spatial syntax, which makes it possible to analyze the connectivity of axial lines represented by the road system or sidewalk system (ALYASARI; AUDA; ATTYA, 2020; ZHANG; MU, 2020). There are also articles that use GIS tools associated with the application of performance indicators to assess walkability.

Among the studies that use performance indicators, we seek to identify some of the most common parameters among the authors to assess the infrastructure of sidewalks and sidewalks on university campuses. From the analysis of 16 articles, it is identified that the main parameters are: crossing (pedestrian lane), infrastructure, accessibility and quality of the sidewalk (GILSON et al., 2009; ZHANG et al., 2013; ASADI-SHEKARI; MOEINADDINI; ZALY SHAH, 2014; AFSAR; YUNOS; YUSOF, 2015; KEAT; YAACOB; HASHIM, 2016; MURWADI; DEWANCKER, 2017; RAHMANDARI; GUNAWAN; MUGNISJAH, 2018; ADI PRASETYA; PURWANTO; MARYONO, 2020; ALYASARI; AUDA; ATTYA, 2020; HACAR; GÜLGEN; BILGI, 2020; KING et al., 2020; LEE; SHEPLEY, 2020; RASWOL, 2020; ZHANG; MU, 2020; ZHANG, FISHER; FENG, 2020; ALHAJAJ; DAGHISTANI, 2021). In the evaluation of the sidewalks around the campus, only one article presents indicators that allow this evaluation (ADI PRASETYA; PURWANTO; MARYONO, 2020), as shown in Table 3.

Table 3: Identification of articles that use performance indicators to evaluate pedestrian infrastructure

Code	Author/ Year	I1	I2	I3	I4	I5	I6	I7	I8	I9	I10	I11	I12
01	KEAT; YAACOB; HASHIM (2016)	■		■						■			
03	ZHANG; MU (2020)			■									
04	KING et al. (2020)				■								
05	ALHAJAJ; DAGHISTANI (2021)					■		■					
07	RASWOL (2020)							■		■			
08	ZHANG; FISHER; FENG (2020)			■									
09	ALYASARI; AUDA; ATTYA (2020)						■						
11	MURWADI; DEWANCKER (2017)			■									
12	ASADI-SHEKARI; MOEINADDINI; ZALY SHAH (2014)	■		■		■					■		
13	RAHMANDARI; GUNAWAN; MUGNISJAH (2018)	■		■		■					■		

Code	Author/ Year	I1	I2	I3	I4	I5	I6	I7	I8	I9	I10	I11	I12
14	AFSAR; YUNOS; YUSOF (2015)	▪			▪			▪			▪	▪	▪
15	ADI PRASETYA; PURWANTO; MARYONO (2020)	▪	▪										
16	HACAR; GÜLGEN; BILGI (2020)			▪									
17	LEE; SHEPLEY (2020)	▪			▪		▪	▪					
24	GILSON et al. (2009)	▪	▪	▪									
25	ZHANG et al. (2013)	▪							▪		▪		▪
	Results	**50%**	**31%**	**31%**	**50%**	**19%**	**25%**	**50%**	**13%**	**13%**	**25%**	**18%**	**25%**

Note:

I1 - Crossing; I2 - Street furniture, I3 - Connectivity, I4 - Sidewalk quality I5 - Safety, I6 - Aesthetics, I7 - Accessibility, I8 - Comfort, I9 - Attractiveness, I10 - Barriers/obstructions on the sidewalk, I11 - Bus stop, I12 - Slope

Source: AUTHORS, 2021.

Of these 12 parameters identified for the evaluation of pedestrian infrastructure, it is observed that the indicators crossing (I1), sidewalk quality (I4) and accessibility (I7) are used in 8 articles (50%), in a research aimed at analyzing the crossing between blocks, the crosswalk, the state of conservation of the sidewalk, and the infrastructure for the movement of people with disabilities on the campus sidewalks. Street furniture (I2) and connectivity (I3) of sidewalks are analyzed in 5 articles (31%), followed by aesthetic indicators (I6), barriers and obstacles (I10) and slope (I12), which appear in 4 articles (25 %) of the total. The safety (I5) and bus stop (I11) indicators are identified in 3 articles (19%) and the other parameters, comfort (I8) and attractiveness (I9) appear only in two articles (13%), as shown in the Table 3.

The main problems identified in the evaluation in the internal area of the campus are related to safety and comfort. These problems interfere with the quality of pedestrian movements and can reduce the number of people who use the walking mode. In the articles that evaluate the sidewalks around the campus, problems associated with the quality of the infrastructure contribute negatively to users being able to access the campus by foot (ADI PRASETYA; PURWANTO; MARYONO, 2020; LEE; SHEPLEY, 2020).
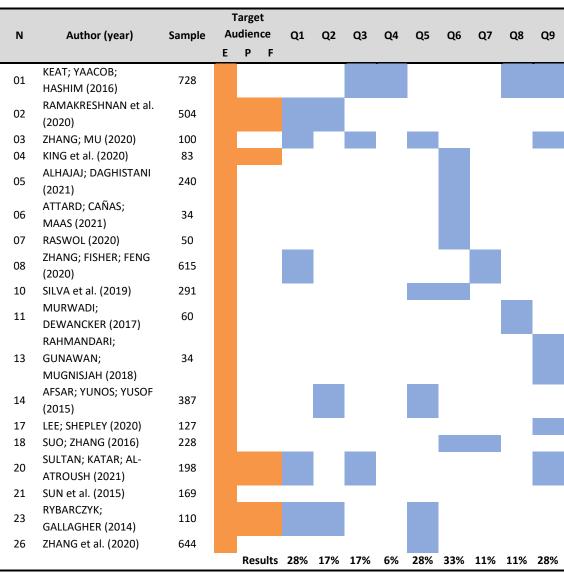
Other articles evaluate accessibility and safety, such as the research carried out by Alhajaj and Daghistani (2021) within a campus, whose main mode of transport used by users is the car. For this evaluation, performance indicators and an index are used, in addition to questionnaires.

Asadi-Shekari, Moeinaddini and Zaly Shah (2013) evaluate the sidewalk level of service from 27 performance indicators that can interfere with the movement of pedestrian users on campus. Among the topics evaluated are: 1) traffic speed; 2) damping barriers; 3) reduction of traffic lanes; 4) mid-court crossing; 5) landscape and afforestation; 6) moisturizers; 7) trash can; 8) sidewalk pavement; 9) crosswalk; 10) islands of refuge for pedestrians; 11) paved on both sides; 12) vehicle stopping area before the crosswalk; 13) width of the sidewalk; 14) driveway; 15) lighting; 16) signage; 17) traffic limiting posts; 18) slope; 19) access ramp to the sidewalk; 20) accessible drinking fountain for wheelchair users; 21) directional tactile floor; 22) tactile alert floor; 23) ramp; 24) step; 25) traffic light; 26) rest area; 27) drinking fountains.

Articles that use questionnaires or interviews with users to assess some aspects related to pedestrian infrastructure on the campus correspond to 18 articles (Tables 2 and 4).

Table 4: Characterization of articles that use questionnaires or interviews to assess pedestrian infrastructure

N	Author (year)	Sample	Target Audience E	P	F	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9
01	KEAT; YAACOB; HASHIM (2016)	728	■						■				■	
02	RAMAKRESHNAN et al. (2020)	504	■			■								
03	ZHANG; MU (2020)	100	■			■		■		■				■
04	KING et al. (2020)	83	■	■	■						■			
05	ALHAJAJ; DAGHISTANI (2021)	240	■											
06	ATTARD; CAÑAS; MAAS (2021)	34	■											
07	RASWOL (2020)	50	■											
08	ZHANG; FISHER; FENG (2020)	615	■			■						■		
10	SILVA et al. (2019)	291	■	■	■						■			
11	MURWADI; DEWANCKER (2017)	60	■										■	
13	RAHMANDARI; GUNAWAN; MUGNISJAH (2018)	34	■											■
14	AFSAR; YUNOS; YUSOF (2015)	387	■				■			■				
17	LEE; SHEPLEY (2020)	127	■											■
18	SUO; ZHANG (2016)	228	■									■		
20	SULTAN; KATAR; AL-ATROUSH (2021)	198	■	■	■		■	■						■
21	SUN et al. (2015)	169	■											
23	RYBARCZYK; GALLAGHER (2014)	110	■	■	■		■				■			
26	ZHANG et al. (2020)	644	■			■								
	Results					**28%**	**17%**	**17%**	**6%**	**28%**	**33%**	**11%**	**11%**	**28%**

Note:

E - Students; P - Teachers; F – Employees.

Q1 - User profile; Q2 - Motivations for walking; Q3 - Quality scale; Q4 - Perceptions of walking;

Q5 - Sociodemographic issues; Q6 - Frequency and time of walking; Q7 - Landscape; Q8 - Infrastructure quality;

Q9 – Others.

Source: AUTHORS, 2021.

As for the profile of users for application the questionnaires, all apply to students. Professors and administrative technicians only participate in 4 surveys (22%), which involved the 3 segments of users, to identify the quality of sidewalks (RYBARCZYK; GALLAGHER, 2014; SILVA et al., 2019; KING et al., 2020; SULTAN; KATAR; AL-ATROUSH, 2021). The questions most present in the analyzed articles are related to the frequency and time (Q6) that the user spends walking (6 articles, 33%), then the users' profile (Q1), sociodemographic issues (Q5%) and other aspects (Q9) are present in 5 articles (28%). Motivations to walk (Q2) and quality scales (Q3) are identified in 3 articles (17%), and issues related to landscaping (Q7) and sidewalk infrastructure (Q8) are present in 2 articles (11%). Only one article (5%) involved the evaluation of the user's perception during the walk.

Due to the diversity of objectives, the sample of interviews or questionnaires is different (34 to 728 forms). This definition is often associated with the total number of enrollments or users on the campus. For Rheingantz et. al (2009) there is no absolute number to determine the number of respondents, the sample must have a sufficient number of people to identify what is to be evaluated.

Some questionnaires use a five-point scale to assess issues related to pedestrian-friendly infrastructure such as accessibility and safety. Some of the issues are associated with parking access to the sidewalk; surface quality and obstacles; the use of stairs in external areas. Others make it possible to assess the student's perception of a particular topic. Indicators are associated with parking access to sidewalks, barriers, sidewalk surface, continuity, stairs, sidewalk safety, and safety at crossing between parking and sidewalk, and these assessments are performed using a three-point scale.

Articles that use image registration (photographs and/or filming) as the main methodology are identified in the works developed by Zhang et al. (2013), Alhassan and Mashros (2016), Murwadi and Dewancker (2017), Göçer et al. (2019), Raswol (2020) and Attard, Cañas and Maas (2021), Table 5.

Table 5: Characterization of articles that use image registration to assess pedestrian infrastructure

Code	Author (Year)	Pedestrian flow	Image analysis	Pedestrian detection by image
06	ATTARD, CAÑAS, MAAS (2021)			
07	RASWOL (2020)			
11	MURWADI, DEWANCKER (2017)			
19	ALHASSAN, MASHROS (2016)			
22	GÖÇER et al. (2019)			
26	ZHANG et al. (2013)			
	Results	17%	83%	17%

Source: AUTHORS, 2021.

Zhang et al. (2013), Alhassan and Mashros (2016), Murwadi and Dewancker (2017), Göçer et al. (2019), Raswol (2020) and Attard, Cañas and Maas (2021) use image, photography or footage to analyze the walking environment on campus. The elements observed in the images refer to obstacles, sidewalk maintenance, safety and user direction.

The study carried out by Attard, Cañas and Maas (2020) involve the holding of a workshop on active mobility, to analyze, through photographic recording, the problems found by 34 participants distributed in two groups - outside and inside the campus, using both on foot and by bicycle. These images were shared on social networks, and through hashtags, users could express how they felt walking in these spaces. The security theme was the most used among the participants, demonstrating the lack of it, followed by comfort.

To assess the flow of pedestrians around the campus and a hospital, Alhassan and Mashros (2016) use image analysis to compare the quality of both routes. Göçer et al. (2019) identifies from footage at strategic points on the campus the number of pedestrians passing through a given location. The footage in this article aim to identify the number of users who pass through certain stretches, how much time they spend at the site, and determine which stretches users walk with greater speed compared to other stretches of the campus.

CONCLUSIONS

This systematic literature review aimed to carry out the survey and analysis of articles that address the space for walking on university campuses, published in the last 16 years (2005 to 2021), in the Scopus, MDPI, ScienceDirect and Sage Journals databases with the objective of to identify the main methods and techniques used in the evaluation of the pedestrian space.

The evaluation of the 26 articles showed that predominantly research carried out on university campuses incorporate the surroundings of the campus in their analysis, or the users' access to the campus and various aspects associated with walkability, such as the evaluation of the existing infrastructure itself. They aim to identify which mode of transport is most used on campus for internal displacements or to evaluate some scenario in a given route carried out by the user.

Regarding the methodology used, all use the case study to carry out the analysis of walkability, but in relation to the central objective of these articles, it is observed that they can be grouped into articles that evaluate walkability on university campuses and those that propose a methodology for assessing walkability, both have as their central point the investigation of the quality of sidewalks.

As for the technique used, it is observed that most analyze the surroundings of the campus or its interior, predominantly from performance indicators and/or questionnaires. For those who use indicators, the main evaluation topics are related to the quality of the sidewalk, accessibility, crossing (crosswalks), comfort and safety.

The most frequent questions identified in these articles refer to the motivations for walking, quality and safety. In both methods, the items negatively evaluated were also quality and safety in walking.

In summary, this article allowed us to identify the methods and techniques most used by researchers from different countries to assess the infrastructure intended for pedestrians on university campuses. These data gathered in this article can support similar studies, improve methods and understand what has been evaluated in these different spaces.

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