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QUALITY OF SIDEWALKS IN A BRAZILIAN CITY: A BROAD VISION

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Abstract
The sidewalk is the structuring element of walking on foot in the urban environment. For this, it is necessary that the sidewalks offer moving conditions to all pedestrians. The movement of people on foot in urban space increases the quality of life in the cities. The aim of this paper is to evaluate the quality index of sidewalks in a medium-size Brazilian city, through the pedestrians' perception and technical evaluation. The methodology evaluated the Sidewalk Quality Index (SQI) in Passo Fundo, a medium-sized city in the South of Brazil. The results show that, like the great majority of Brazilian cities, the sidewalks in Passo Fundo have a performance index equivalent to 1.9 points which corresponds to the "G" classification - very bad - in the final evaluation. The improvement of the SQI in the study area should be made possible by the awareness of their importance for mobility, urban planning and the quality of life of people in the cities. Presenting a good SQI provides a number of benefits to cities, among which the following stand out: increased life quality and urban mobility, which, in turn, impacts positively on a number of other urban indicators.
Keywords:Sidewalk quality index; pedestrians; urban planning; cities.

1. INTRODUCTION

The role of the streets, as one of the most basic elements of society, allows people to move through cities and regions. Indeed, the road became synonymous of car use, while other users were squeezed out. Factors such as speed, convenience, design, comfort, and safety are reported to justify as the streets have been molded for the car driver, as shown by Agyeman (2013).

In this sense, planning and urban legislations should consider sidewalks as first element of urban space. The sidewalks enable pedestrians to travel around the city, a factor that has a positive impact on people's quality of life, urban planning, air quality and urban mobility (Wey and Chiu, 2013; Tsiompras and Photis, 2016; Sousa, 2017).

In this context, many studies about the relation between walkability and quality of life have been carried out with the aim of developing indices and information related to the importance of sidewalks in the urban environment (Mõri and Tsukaguchi, 1987; Gallin, 2001; Alfonso, 2005; Ferreira and Sanches, 2007; O'Brien, 2008; Agrawal, Schlossberg and Irvin, 2008; Ewing and Handy, 2009; Rogers et al., 2011; Leyden et al. 2011; Talavera-Garcia and Soria-Lara, 2015; Kang, 2018).

In terms of Brazil, the sidewalks of most Brazilian cities are precarious, representing discomfort and lack of safety for pedestrians in general and, in particular, for disabled people. Many times, the sidewalks present obstacles that difficult the proper circulation and are done with unsuitability materials (Ferreira and Sanches, 2007).

There are many propositions and indices related to walkability, as well researches about sidewalk quality. However, most of these studies were developed in big cities even though smaller ones already show problems as intense as the ones found in bigger cities (Conte, 2013). In this case, the study has been conducted in Passo Fundo, a medium-sized city. According Brandli, Prietto and Neckel (2014), an important part of the Brazilian population lives in similar cities with similar socioeconomic characteristics of Passo Fundo, assuring its relevance as a case study in a developing country.

Many studies have been focusing on the quality of urban spaces, urban sustainability and the importance of assessing stakeholders' opinions (Kaur and Garg, 2018; Macke et al., 2018; Xue et al., 2019; Yu et al., 2019), but less is discussed within the specific topic of sidewalks, which is totally connected to urban sustainability, and their quality and perception of users. Therefore, the aim of this paper is to evaluate the Sidewalk Quality Index in a medium-size Brazilian city, through pedestrians' perception and technical evaluation. Although this is a specific case study with its own particularities, the results presented in this paper are expected to be useful to municipal authorities, urban planners and researchers when discussing

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about the quality of sidewalks. In addition, it reveals the importance given by the population in relation to walkability, revealing future possibilities to improve it.

2. REVIEW ON WALKABILITY INDEX AND SIDEWALK QUALITY

The sidewalks should be planned and executed according to a range of quality indices, ensuring that all people have access to the urban space in an inclusive, safe and attractive way (Bradshaw, 1997; Speck, 2013; Kamel, 2013). Thus, it is necessary to be able to measure the indices of walkability and quality of the infrastructure for pedestrians - sidewalks (Grasser et al. 2013; Sousa 2017; Kang, 2018).

Bradshaw (1997) was one of the first authors to develop an index of walkability and to discuss the importance of measuring how the neighborhoods have been accessed by foot. A neighborhood could improve its rating by changing its physical form and amenities, range of businesses, local services, and collective programs. According to this author, walkability has four basic characteristics: a foot-friendly environment, useful destinations within walking distance, a friendly natural environment that moderates weather and vibrant local street life.

On the other hand, some studies (Ferreira and Sanches, 2007; Kelly, Tight and Page, 2011; Talavera-Garcia and Soria-Lara, 2015; Kang, 2018) focus more specifically on aspects related to the physical conditions of the sidewalks, the surroundings and the safety of the pedestrians, as a possibility to encourage the walks. Previously developed index of walkability was operationalized in an Australian context, using available spatial data, as described by Leslie et al. (2007). The walkability index is calculated using the data sets with 1–10 score for each measure (dwelling density, intersection density, land use and net retail area) is summed to each Census Collection District (CCD), resulting in a possible score of 4–40. The final walkability indices are mapped using GIS to visually identify areas in the Adelaide Statistical Division that are conducive or not to walking activities.

A systematic review of English publications conducted by Grasser et al. (2012) suggests GIS-based walkability measures are relevant indicators that should be considered for monitoring environmental determinants of public health. Gross population density, intersection density and walkability indices were consistently correlated with walking for transport and can be considered as the best available GIS-based measures of walkability regarding walking for transport.

In another study, Grasser (2016) measured walkability in Graz, Austria, using geographic information system. Walkability was measured as gross population density, household unit density, entropy index, proportion of mixed land use, three-way intersection density, four-way intersection density and IPEN walkability index and the Graz walkability index. The study aimed to examine the direction and strength

of the association between objective measures of residential walkability and neighborhood satisfaction, as well as the differences by sex.

TABLE 1 - WALKABILITY INDEX AND SIDEWALK QUALITY STUDIES IN DIFFERENT CITIES.

Initials	Denomination	Categories analyzed/ Indicators	Scores	Authors/ source	City/ Country
Saqi	Sidewalk Quality	Street network density and the availability/quality of sidewalks within the buffer area.	B, G, M	Woldeamanvel and Kent (2016)	
Walk Score	Walk Score	Walking routes to nearby amenities. Pedestrian friendliness, population density and road metrics, such as block length and intersection density.	0 (least walkable) to 100 (most walkable)	Front Seat (2011)	USA, CAN and others countries
News	Neighborhood Environment Walkability Scale	(1) residential density; (2) land use mix – diversity; (3) land use mix – access; (4) street connectivity; (5) infrastructure and safety for walking; (6) aesthetics; (7) traffic safety; (8) safety from crime; (9) streets not having many cul-de-sacs; (10) physical barriers to walking; (11) parking difficult in local shopping areas; and (12) hilly streets in the neighborhood	Generally use a 5-point scale (1 = none; 2 = a few; 3 = some; 4 = most; 5 = all) with variation in	Cerin et al. (2013)	AUS, BEL, BRZ, COL, CZR, DEN, HKG, MEX, NZL, SPA, USA
URBAN	Understanding the Relationship Between Activity and Neighborhood	Street connectivity, dwelling density, mixed land use and mixed land use	4 to 40.	Badland et al. (2009)	NZL
PEI	Pedestrian environment index	Land-use diversity, population density, commercial density, and intersection density		Peiravian et al. (2014)	
SWI	Sydney Walkability Index	Residential dwelling density, intersection density, land use mix and retail floor area ratio	1 (lowest) to 10 (highest) and total walkability index score.	Mayne et al. (2013)	Sidney, AUS
SP	Sidewalk performance	Width, pavement suitability, conservation status, accessibilities, safety from traffic, lighting, obstacle density, walking environment and pedestrian density	Scale 0-4	Sousa et al. (2017)	PT
NWI	Neighborhood walkability index	Residential dwelling density, street connectivity and land use mix	1 to 10	Stockton et al. (2016)	London, UK
WRA	Environmental walkability in residential areas	Traffic safety, diverse destinations, crime safety, accessibility and pleasurability	Five point Likert scale (1-5)	Choi, Seo and Oh (2016)	KR
Q-PLOS	Quality of Pedestrian Level of Service	Accessibility, safety, comfort and attractiveness	Five point Likert scale (1-5)	Talavera-Garcia and Soria-Lara (2015)	Granada,Spain
SQI	Sidewalk Quality Index	Security, maintenance, effective width, security, visual attractiveness, permeability and accessibility	Five point Likert scale (1-5)	Ferreira and Sanches (2001)	São Carlos – SP, Brazil

Source: Elaborated by the authors.

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According with Woldeamanuel and Kent (2016), the pedestrian environment index (PEI) was developed by Peiravian et al. (2014). The index was defined as the product of four components representing land-use diversity, population density, commercial density, and intersection density. The authors said that these measures are contributing to the pedestrian infrastructure planning, but included little about the quality of the actual sidewalk at the ground level.

The literature about the lack and the poor quality of pavement in sidewalks is limited (Ferreira and Sanches, 2007). Woldeamanuel and Kent (2016) mentioned studies that analyze the factors that can limit or promote the accessibility of pedestrians to the transport (Schroeder and Wilbur, 2013; Handy et al. 1998; 1000 Friends of Oregon, 1993; Evan-Cowley and Conroy, 2006). Table 1 describes studies that focused in sidewalks and their walkability in different cities.

3. METHODOLOGY

Passo Fundo is a medium-sized city with approximately 200,000 inhabitants, located in the South region of Brazil, according to Fig. 1. It is a reference for neighboring municipalities, with emphasis on providing services in health and higher education areas. For these reasons, Passo Fundo receives daily around 6,000 people (floating population) who come to the city for the purpose of studying and/or performing health-related activities (IBGE, 2010).

FIGURE 1 - LOCATION OF THE STUDY AREA

The index methodology proposes that the service level should be determined according to the technical evaluation of the infrastructure (through quality indicators of the sidewalks) and the importance attributed by the individuals residing in the study area. In order to define the sidewalks quality index, seven indicators (safety, maintenance, effective width, security, visual attractiveness, permeability and accessibility) were

analyzed, weighting them according to the importance attributed to each indicator, made by the interviewees' perception.The sample size determination was based on the definition and characterization of the study population in the urban area of Passo Fundo. For that, a counting of the existing blocks in the urban area was performed, based on a city official map overlapped with satellite image - totaling 2,718 blocks. Two samples were then generated: one for blocks and another for number of pedestrians to be interviewed. Table 2 summarizes the data used to sample size calculation.

TABLE 2 - DETAILS USED FOR SAMPLE SIZE CALCULATION.

Sample of blocks	Description	Sample of pedestrians	Description
Equation	$n = \left(\frac{z_{\alpha/2} \cdot \sigma}{E} \right)^2$ (1) Were: n = sample size $z_{\alpha/2}$ = trust rate σ = standard deviation E = margin of error	Equation	$n = \left(\frac{z_{\alpha/2}}{E} \right)^2 \times 0,25$ (2) Were: n = sample size $z_{\alpha/2}$ = trust rate E = margin of error
Parameter of interest	Averages	Parameter of interest	Proportions
2,718 blocks	Population size	179,588 inhabitants	Population size
α= 0.05	Significance level	α= 0.05	Significance level
E/α= 0.50	Desired accuracy	E = 0.05	Desired accuracy
zα/2= 1.960	Sample size	zα/2= 1.960	Sample size
n = 15.4		***n = 384***	

Source: Prepared by the authors based on Malhotra and Girald (2012).

Thus, it was identified that it would be necessary to evaluate at least 16 blocks and randomly interview 384 pedestrians residing in the blocks selected for analysis (however, after the fieldwork, the total number of interviews conducted in the sixteen sectors was 370, which corresponds to a 96.3% utilization of the proposed applications, as some respondents refused to complete the questionnaire or to participate in the survey). Therefore, the city was divided into 16 sectors (Figure 2).

Figure 2 shows the 16 sectors under study (in each one, a block was randomly selected for analysis); and Figure 3 illustrates the three methodological steps for assessing the quality of sidewalks.

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Legend:

01 José Alexandre Zachia
02 Nenê Greaff
03 Vila Jerônimo Coelho
04 Vila Donária
05 Boqueirão
06 Vila Luiza
07 Vila Lucas Araújo
08 Vila Planaltina
09 São Cristóvão
10 Vila Rodrigues
11 São Luiz Gonzaga
12 São José
13 Vila Petrópolis
14 Centro
15 Vila Victor Issler
16 Vila Vera Cruz

FIGURE 2 - STUDIED SECTORS IN THE URBAN AREA OF PASSO FUNDO

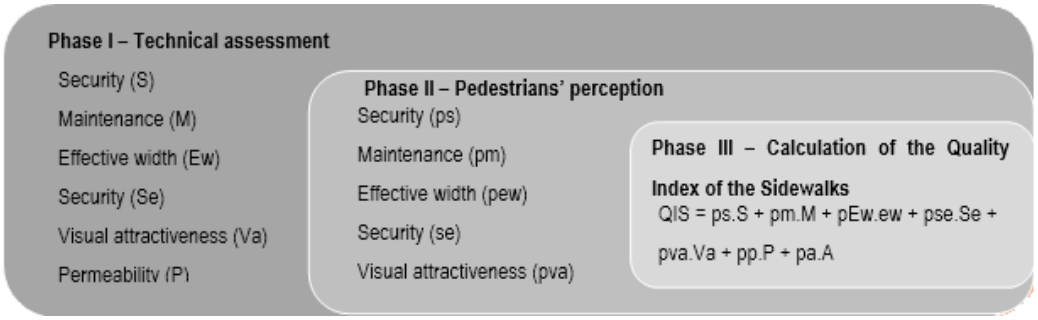

FIGURE 3 - METHODOLOGICAL PHASES

3.1. Phase I: Technical Assessment

The first step is the technical evaluation of pedestrian spaces, based on quality indicators, with the corresponding score being assigned. It varies from 7 to 0 according to the characteristics of the infrastructure, as shown in the Table 3.

TABLE 3 - SCORING SYSTEM OF EACH INDICATOR

	Scenario Feature	
Safety	No predicted conflict between pedestrian and vehicles. Exclusive area for pedestrians with restrictions on vehicular traffic.	7
	No predicted conflict between pedestrian and vehicles. Pedestrian area protected from the flow of vehicles by flowerbeds, with guides of 15 cm in height.	6
	No predicted conflict between pedestrian and vehicles. Pedestrian area protected by a small vegetation barrier.	5
	No predicted conflict between pedestrian and vehicles. Pedestrian zone totally separated from the flow of vehicles by guides with 15 cm in height.	4
	Possibility of conflict. Separate pedestrian area of vehicle flow by lowered guides, for vehicle access, at various points.	3
	Possibility of conflict. Separate pedestrian area of vehicle flow by lowered guides, for vehicle access, over large tracts.	2
	Possibility of conflict. Pedestrian area without vehicle flow separation, with constant vehicular access along the sidewalk.	1
	Great possibility of conflict between pedestrians and vehicles. There is no area reserved for pedestrians who dispute the area of movement with the vehicles.	0
Maintenance	Flooring in excellent condition, use of appropriate material and appearance of constant maintenance.	7
	Floor pavement in good condition, irregularities and defects recovered.	6
	Sidewalk pavement in acceptable conditions and regular maintenance.	5
	Sidewalk pavement in acceptable conditions, material unsuitable for surface because it becomes slippery when wet.	4
	Pavement in bad conditions, surface presenting cracks, gaps and lack of maintenance.	3
	Unpaved sidewalk, surface in grass that hinders walking, especially in rainy weather conditions.	2
	Unpaved sidewalk, ground surface that hinders walking, especially in rainy weather conditions.	1
	Non-existent sidewalk. Although demarcated, the sidewalk does not present any condition of use, because it is covered by bush and construction waste.	0
Effective width	Range of free pedestrian circulation with a width greater than 2.0 m, without any visual obstructions throughout its implantation.	7
	Range of pedestrian circulation free of obstacles, with width around 2.0 m, suitable to accommodate pedestrian flow.	6
	Range of pedestrian circulation with small obstruction due to the installation of urban equipment, but with free width of 1.2m.	5
	Range of pedestrian circulation with small obstruction due to the installation of urban equipment, but wide enough to accommodate the flow.	4
	Range of pedestrian circulation reduced, width less than 1.2 m due to the presence of sidings, bar tables, posters etc...	3
	Range of pedestrian circulation quite reduced, width less than 0.70 m, due to occupation by other uses, such as newsstands, street vendors etc...	2
	Range of pedestrian circulation very reduced, width less than 0.50 m, due to inadequate landscaping.	1
	Pedestrian range totally obstructed. Pedestrians are required to walk outside the pedestrian walking range.	0

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Security	Safety is guaranteed by the good configuration of the urban landscape, by the usual presence of other pedestrians and by constant policing.	7
	Safety is guaranteed by the configuration of the urban landscape, by the presence of other pedestrians and by eventual policing.	6
	Safety is guaranteed by good lighting	5
	Safety is guaranteed more by the presence of other pedestrians than by the regular configuration of the urban landscape.	4
	Safety is hampered by the inadequate configuration of the urban landscape. Parked vehicles, high vegetation and poor lighting weigh negatively	3
	Safety is bad due to the great density of pedestrians and street vendors, facts that favor the harassment and the action of malicious people.	2
	Security is very bad without pedestrian flow and with walls in the lot divisions, a fact that favors insecurity.	1
	Security is totally undermined by the terrible configuration of the urban landscape. Open places (vacant lots) poorly lit and without policing.	0
Visual attractiveness	Environment designed with living space, pleasant and well maintained. Sidewalks next to parks, squares, woods etc.	7
	Pleasant environment, with outdoor space configuration composed of residences with low walls, gardens and shops with attractive shop windows.	6
	Pleasant environment, with vegetation insertion along the sidewalk.	5
	Environment with configuration of outer space composed of residential buildings with high walls and commercial premises without shop windows and without attractions.	4
	Unattractive environment, with configuration of outer space composed of constructions of large commercial use (wholesaler).	3
	Environment with configuration of outer space without any concern with visual and aesthetic aspects. Buildings without access to the sidewalk.	2
	Environment without the presence of any type of vegetation.	1
	Inhospitable environment for pedestrians. Configuration of unpleasant outside space, with the presence of rubbish and rubble accumulated on the sidewalk.	0
Permeability	Flooring in excellent condition, use of appropriate material - permeable, with constant maintenance and landscaping work.	7
	Flooring in excellent condition, use of appropriate material - permeable, with regular maintenance and landscaping work.	6
	Flooring in very good condition, use of suitable material - permeable, with temporary maintenance and little landscaping work.	5
	Flooring in good condition, use of suitable material - permeable, with temporary maintenance and no landscaping work.	4
	Flooring in regular condition, use of waterproofing material, with temporary maintenance and no landscaping work.	3
	Flooring in regular condition, use of appropriate material - permeable, with no maintenance.	2
	Pavement in irregular conditions (unevenness), use of waterproofing material and without landscaping work.	1
	Pavement in irregular conditions (unevenness), use of waterproofing material, without landscaping work and with the accumulation of water.	0
Accessibility	Pavement in excellent conditions, use of appropriate material, constant maintenance, presence of directional paving inserted near the alignment of lots with the presence of ramps.	7
	Pavement in very good conditions, use of appropriate material, constant maintenance, presence of directional paving inserted in the central axis of the sidewalk with the presence of ramps.	6
	Pavement in good conditions, use of appropriate material, temporary maintenance, presence of directional paving inserted near the alignment of the sidewalk with the street, with the presence of ramps.	5

	Pavement in regular conditions, use of appropriate material, temporary maintenance, without directional paving with ramps inserted in the accesses to the sidewalk.	4
	Pavement without regular conditions, use of improper material, without temporary maintenance, without directional paving inserted in the sidewalk and with unevenness.	3
	Pavement in bad conditions, without temporary maintenance and without directional paving.	2
	Pavement in regular conditions, use of improper material, without temporary maintenance, without directional paving inserted in the sidewalk and with holes.	1
	Sidewalk without conditions of traffic, without maintenance, without directional paving and with garbage accumulation, fact that forces the crossing by the street.	0

Source: Prepared by the authors, based on Ferreira and Sanches (2001).

3.2. Phase II: Pedestrians' perception

The second stage refers to the weighting of these indicators according to the pedestrians' perception (degree of importance attributed to each indicator) according to their opinion of which is more important for the sidewalk quality. Table 4 shows how the respondents should evaluate the indicators, scoring from 1 to 7, with 1 being the most important value and 7 being the lowest/unimportant value.

TABLE 4 - DEFINITION OF EACH INDICATOR FOR USER PERCEPTION ANALYSIS

Indicator	Description
Safety	A sidewalk where there is no danger of being hit
Maintenance	A sidewalk that provides adequate and uniform paving
Effective width	A sidewalk free of obstacles.
Security	A sidewalk where there is no risk of being robbed
Visual attractiveness	A sidewalk in a nice, clean and green area
Permeability	A permeable sidewalk (which does not accumulate water)
Accessibility	An accessible sidewalk (with tactile floors and ramps)

Source: Prepared by the authors based on Ferreira and Sanches (2001).

3.3. Phase III: Sidewalk Quality Index (SQI)

The Sidewalk Quality Index (SQI) is obtained through equation (1), while Table 4 describes the service level corresponding to each quality index range.

$$SQI = psS + pmM + pewEw + pseSe + pvaVa + ppP + paA \quad (3)$$

Where:

S, M, Ew, Se, Va, P, A represent, respectively, the score obtained in the technical evaluation for the aspects of safety, maintenance, effective width, security, visual attractiveness, permeability and accessibility.

ps, pm, pew, pse, pva, pp, pa a represent, respectively, the weighting factors of safety, maintenance, effective width, security, visual attractiveness, permeability and accessibility.

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This index was calculated for each block studied, and finally, by averaging the observed values, an SQI was also found for the city of Passo Fundo. In this paper, we chose to present the results of only one block (located in Sector 07), as an example, and the overall analysis of the city.

TABLE 5 - QUALITY INDICES AND SERVICE LEVELS

Quality Index	Condition	Service level
7	Excellent	A
6 a 6.9	Great	B
5 a 5.9	Very good	C
4 a 4.9	Good	D
3 a 3.9	Regular	E
2 a 2.9	Bad	F
1 a 1.9	Very bad	G
0 a 0.9	Terrible	H

Source: Prepared by the authors, based on Ferreira and Sanches (2001).

4. RESULTS AND DISCUSSIONS

4.1. Phase I: Technical Assessment

Table 6 presents an example of the technical evaluation performed in a block of Sector 07, and Fig. 4 presents the general diagnosis of this block.

TABLE 6 - TECHNICAL EVALUATION OF A BLOCK IN SECTOR 07 – LUCAS ARAÚJO NEIGHBORHOOD

Indicators	Order number of the block: 07			
	Sidewalk I	Sidewalk II	Sidewalk III	Sidewalk IV
Safety	3	3	3	3
Maintenance	2	4	1	2
Effective width	3	4	2	3
Security	2	3	2	2
Visual attractiveness	3	4	2	3
Permeability	1	2	1	2
Accessibility	2	2	0	1

The technical assessment considered all the seven indicators, in each one of the sidewalks in the randomly selected block (in this example, block seven). It is noted that safety (indicator related to not having accidents between people and vehicles) in the studied sidewalks is regular. That is because these sidewalks present only basic infrastructure to separate the vehicles and pedestrians flows - high sidewalk curbs.

As for the maintenance indicator, technical assessment in sidewalks I, III and IV classified the indicator with a very poor performance and this is evident in Fig. 6. There is a lack of maintenance of the quality of the infrastructure in 75% of the blocks analysed in this sector.

Next, the technical assessment considered the effective width. In sidewalk III, the performance was poor and this result is mainly due to the narrowing of the sidewalk width, its obstruction with street signs, rubble and inappropriate vegetation.

Almost all sidewalks of this block scored "bad" for the security indicator. This is due to the fact that there is no pedestrian lighting (in most cases public lighting bulbs were located on the opposite side of the street) and there is large vegetation on the sidewalks. It results in poor lighting and in the impossibility of safely using the sidewalk during the night.

The visual attractiveness was the indicator that had a better overall evaluation, considering the four studied sidewalks, owing to the presence of vegetation around the block. On the other hand, permeability and accessibility were the indicators with worst performance. The sidewalks were made of basalt stone and closed with concrete joints, and there are no access ramps, parking floors or minimum circulation conditions for the elderly, pregnant women and other people with some type of reduced mobility.

The results of the technical evaluation show that in all blocks of analysis, in sector seven, the points attributed to the performance of the infrastructure of the sidewalks (indicator) represent values with low performance, in general.

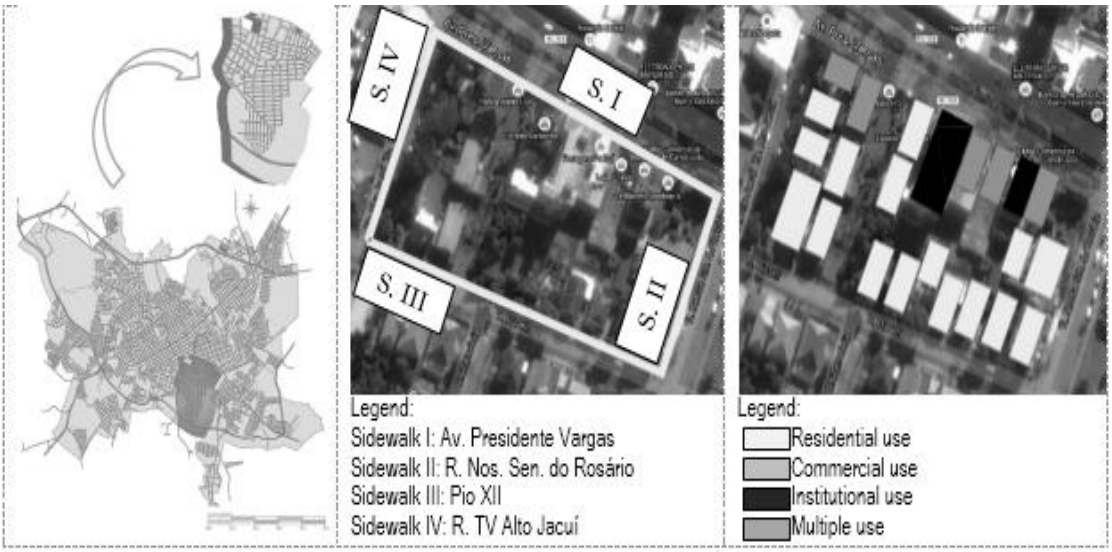

FIGURE 4 - BLOCK DIAGNOSIS IN SECTOR 07 (LUCAS ARAÚJO)

4.2. Step 2: Pedestrians' perception

The pedestrians' perception of the sidewalks (370 questionnaires) in the study area was tabulated and submitted to simple statistical procedures, thus generating the weight of importance assigned to each indicator. The scale was reversed (since the value 1 assigned by respondents indicates greater

importance, and therefore should earn higher scores). Thus, for each indication of 1st place in order of importance, the indicator receives 7 points; for the second place, 6 points; and so on. The results can be seen in Table 7.

TABLE 7 - DISTRIBUTION OF THE IMPORTANCE WEIGHT ATTRIBUTED TO THE QUALITY INDICATORS OF THE SIDEWALKS (%).

Indicator	Order of importance for interviewees							Total number of points	Weight of importance %
	7th	6th	5th	4th	3rd	2nd	1st		
Safety	60	59	74	67	56	33	21	1.667	0,16
Maintenance	33	33	32	44	62	72	94	1.189	0,11
Effective width	14	36	47	61	55	90	67	1.205	0,12
Security	47	58	71	49	65	44	36	1.547	0,15
Visual attractiveness	39	64	57	46	50	51	63	1.441	0,14
Permeability	35	45	47	63	55	61	64	1.353	0,13
Accessibility	140	80	42	38	25	21	24	1.936	0,19

Figure 5 shows the position of each indicator according to the weight obtained. Based on the sample from Passo Fundo and the pedestrians' perception, the accessibility indicator is relatively more important than the others. In an intermediate position appear security, safety, visual attractiveness and permeability. In a position significantly less important than the others, there are effective width and maintenance. The justification given by the interviewees for the maintenance being the last factor indicated by them made reference to the following: in most cases, if the infrastructure presents the other indicators in good conditions, the maintenance of the sidewalk could become an automatic process and made possible with greater emphasis, both by public management and by civil society.

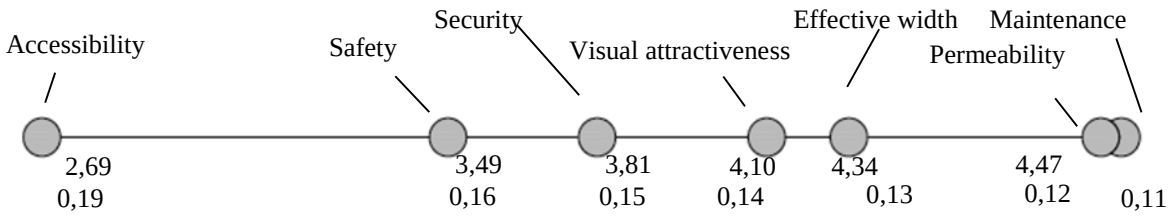

FIGURE 5 - INDICATORS' POSITION IN THE SCALE

4.3. Phase III: Sidewalk Quality Index (SQI)

Table 8 shows the calculation of the Sidewalk Quality Index for the sidewalks of the block in Sector 07, as an example. It is observed that two sidewalks have a "Bad" level of service, another sidewalk has a "Regular" level, and another one "Very Bad", according to the ranges of values of the SQI presented in Table 10. These results can also be observed graphically in Fig. 6, which details the diagnosis made.

TABLE 8 - SIDEWALK QUALITY INDEX DIAGNOSIS IN SECTOR 07.

	Sidewalk Quality Score	Service level
S. I:	SQI= (0,16x3)+(0,11x2)+(0,12x3)+(0,15x2)+(0,14x3)+(0,13x1)+(0,19x2)= 2,29	Bad (F)
S. II:	SQI= (0,16x3)+(0,11x4)+(0,12x4)+(0,15x3)+(0,14x4)+(0,13x2)+(0,19x2)= 3,05	Regular (E)
S. III:	SQI= (0,16x3)+(0,11x1)+(012x2)+(0,15x2)+(0,14x2)+(0,13x1)+(0,19x0)= 1,54	Very bad (G)
S. IV:	SQI= (0,16x3)+(0,11x2)+(0,12x3)+(0,15x2)+(0,14x3)+(0,13x2)+(0,19x1)= 2,23	Bad (F)

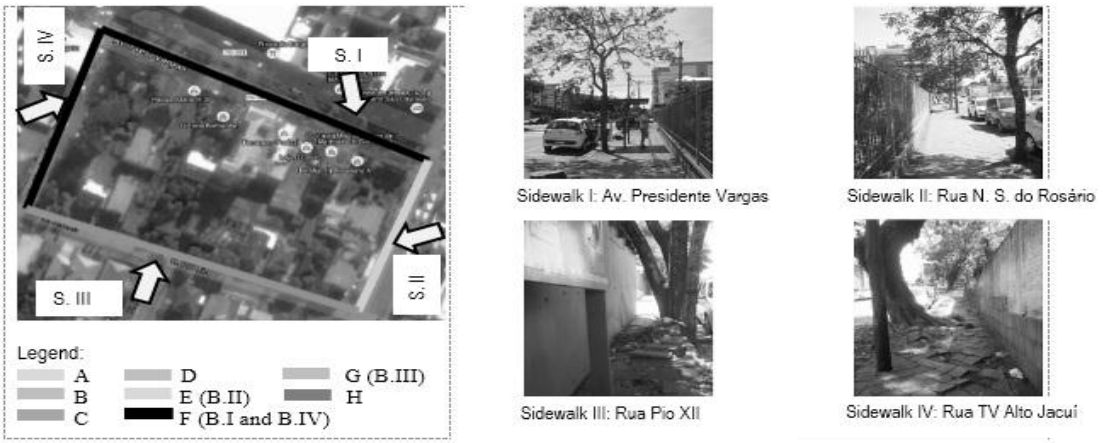

FIGURE 6 - SIDEWALK QUALITY INDEX DIAGNOSIS IN SECTOR 07

TABLE 9 - SQI CALCULATED FOR EACH BLOCK, SECTOR AND FOR PASSO FUNDO.

Sector	Sidewalks of each studied block				SQI
	I	II	III	IV	
1	1.4	1.9	1.8	1.7	1.7
2	1.6	2.4	1.3	1.9	1.8
3	1.3	1.0	0.8	1.2	1.1
4	2.7	3.6	2.0	2.0	2.6
5	3.4	2.7	3.3	2.7	3.0
6	2.5	1.7	1.2	1.5	1.7
7	2.3	3.1	1.5	2.2	2.3
8	0.4	0.5	0.7	0.8	0.6
9	3.9	4.1	3.1	2.2	3.3
10	1.5	1.2	3.4	2.0	2.0
11	1.8	1.8	1.7	1.1	1.6
12	1.4	1.3	1.9	1.1	1.4
13	2.0	1.2	1.6	2.6	1.9
14	2.8	2.2	1.9	2.0	2.2
15	1.1	1.2	1.7	1.1	1.3
16	3.0	2.8	1.7	2.0	2.4
SQI Passo Fundo			1,9		

The same methodological procedure was developed for the sixteen blocks under study. The SQI average of all randomly selected blocks allowed identifying the current SQI for the urban area of Passo Fundo, which is equivalent to 1.9, corresponding to a “Very Bad” (G) condition. These results are shown in Table 9.

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TABLE 10 - RANGES OF QUALITY INDICES AND SERVICE LEVELS

Quality Index	Condition	Service Level
4 a 4.9	Good	D
3 a 3.9	Regular	E
2 a 2.9	Bad	F
1 a 1.9	Very bad	G
0 a 0.9	Terrible	H

The Sector 08 (Neighborhood Planaltina) was among all the sectors which presented the worst SQI (Poor - H) corresponding to 0.6. The main reason for this result was the condition diagnosed in the infrastructure, since the quality of the sidewalks is precarious (vicinal roads). On the other hand, Sector 09 (Neighborhood São Cristóvão) was among all the evaluated sectors, which presented the best SQI (Regular - E) corresponding to 3.3, the only one with blocks having a Good SQI.

5. CONCLUSIONS

The methodology used was adequate and relatively simple to apply. Also, it should be emphasized that the SQI analysis considers both the technical evaluation and the pedestrians' perception, reaching a final result (service range) that integrates different perspectives of the urban space. It is worth highlighting the contribution of this paper towards the possibility of replicating this methodology that combines different visions, being representative of the local reality studied.

The results identified by the survey were as expected since the sidewalks, in the great majority of Brazilian cities, are treated superficially by public management and private initiative. The poor performance of the quality of the sidewalks' infrastructure diagnosed in Passo Fundo, in relation to the studied indices, reflects that regardless of the location of the neighborhood (either in the central area of the city or in the more peripheral areas), the sidewalks do not present good conditions that make feasible and / or invite to walk around the city. However, the greater the distance of the neighborhood from the central area, the more the precariousness of the infrastructure tends to worsen.

Thus, it is suggested that awareness-raising work should be developed by public management for society, in order to mobilize pedestrians on the importance of sidewalks for urban planning, mobility and the quality of life of people in the cities. In addition, booklets with detailed projects on the infrastructure sidewalk should be developed with the aim of guiding the execution of the sidewalks in order to ensure accessibility, safety, visual attractiveness, effective width, permeability and maintenance.

Lastly, municipal public management also needs to expand inspections on sidewalks and also suggest alternative ways for the entire community to be able to execute its sidewalks in accordance with local municipal legislation. Thus, a strategy would be for the municipal government to execute the sidewalk

and the costs of this process would be passed on to the lot owner in feasible installments, according to his/her financial conditions.

The limitations of this paper are related to its focused research area, since it was an experience developed according to the characteristics of a Brazilian city and the local perception. On the other hand, the methodology can certainly be the basis for future studies in other cities. The pedestrians' perception and the sidewalk quality index are expected to vary according to the studied area, posing better or worse results than those found in this research.

Finally, the work contributes to global science since it describes a case study with a simple methodological process and emphasizes the importance of sidewalks to the context of cities. Thus, it is suggested that other works to be carried out with the same approach and to consider the environmental perception of the interviewees in the context of the city.

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