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Outlines for accessible routes on sidewalks: a big challenge for small Brazilian cities

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ABSTRACT

Sidewalks in Brazilian cities still have physical conditions that hamper pedestrians to move, especially those citizens with mobility impairments. Despite improvements on legal provisions, aiming to build more accessible cities, its fulfillment is still far from what is desired. The purpose of this paper is to present a method (virtual audit) to support local administrations, in particular of small cities, to define accessible routes on sidewalks. In order to illustrate the method application, it is shown an exploratory study in the Central Business District of Quitandinha municipality, located in Curitiba Metropolitan Area. The method allows a comprehensive knowledge of site problematic, and it is expected to stimulate local administrations to evaluate their sidewalks situation in order to include their suitability in their investment agendas; and regional and federal administrations to develop public policies towards urban environment qualification.

KEYWORDS: Sidewalk. Accessibility. Virtual Audit. Mobility Impairment. Urban Planning.

INTRODUCTION

Sidewalks of Brazilian cities have inadequate physical conditions that hamper or even prevent pedestrians from moving, especially those with mobility impairments. The 2010 Brazil Population Census indicated that 69.0% of urban households benefited from paved sidewalks in their surroundings, lower than the percentage of paved streets (81.7%). The worse situation was observed concerning curb ramps, available to only 4.7% of total urban households.

Brazilian legislation has advanced on setting up planning mechanisms aiming to build more accessible cities. In 2015, the federal law to protect the rights of people with mobility impairments modified the Statute of the City (urban planning federal law), inserting the request of accessible route plan to those municipalities that are required to enact Comprehensive Plans (BRASIL, 2015).

Therefore, the accessible route plan is mandatory for cities: i) with more than 20,000 inhabitants; ii) members of metropolitan areas or urban conglomerations; iii) where the municipal government will intend to use the instrument established in paragraph 4º of art. 182 of 1988 Federal Constitution; iv) members of particular tourist interest areas; v) inserted in the area of influence of developments or activities with significant environmental impact in the regional or national domain; vi) included in the national cadaster of municipalities located in areas susceptible to natural disasters.

The Statute of the City, 2001 Federal Law 10.257, now establishes that the accessible route plan must follow the Comprehensive Plan and that sidewalks must be executed to assure accessibility to pedestrians' attractors, either public or private, such as public offices, health care, educational, social assistance, sports or cultural facilities, post offices, commercial banks, or bus stops. Although improvements on legal provisions concerning accessibility, its fulfillment is still far from what is desired.

Among the states of the Brazilian federation, Parana has the highest number of municipalities with Comprehensive Plans approved by city councils: 383 out of 399 (IBGE, 2015). Even though most part of Parana municipalities have Comprehensive Plans, they do not have accessible route plan. In fact, most cities of the State of Parana are too small, and their municipal population are less than 20 thousand inhabitants. Besides that, local governments lack experience or technical capacity which restrict the elaboration or implementation of public policies towards urban development.

Within such an ongoing scenario, since 1989 the State of Parana Constitution established that cities with less than 20 thousand inhabitants (306) would receive technical assistance from a state urban development agency to define general rules relating to urban land use. Currently, the state agency with this mission is the Autonomous Social Service PARANACIDADE, linked to the State Department of Urban Development and Public Works (*Secretaria de Estado do Desenvolvimento Urbano e Obras Públicas – SEDU*) under a management contract.

Most recently in 2018, the State Public Prosecution has settled that local governments are responsible for sidewalk works and maintenance which conflicts with a common understanding that it is adjacent properties owners' responsibility: sidewalks, as part of public space, are public property. Those municipalities required to have Comprehensive Plans ought to provide their adaptation following

accessibility standards; otherwise, it can result in local authority's liability (MINISTÉRIO PÚBLICO DO PARANÁ, 2018).

Therefore, the purpose of this paper is to present a technical method to support, most of Parana municipalities, in accessible routes' definition in downtown sidewalks. The whole method consists of two stages. The first one, explored in this paper, employs a virtual street audit, using secondary information available from official sources and Google Street View - GSV. The second stage involves field visits to survey and analyze the data that complement the site diagnosis, accomplished in the first stage, to develop an accessible route project.

Initially, it is described the 5 steps that take place during the first stage: i) delineation of the Central Business District - CBD; ii) location of both public or existing private facilities as pedestrian attractors within CBD area; iii) development of a pedestrian network draft that assures access to attractors; iv) remote survey of sidewalks physical conditions; and v) preliminary physical works proposal to guarantee universal accessibility, with estimate costs.

Previously, however, a brief quantitative evaluation of sidewalks situation in Parana municipalities is presented, considering available data.

SIDEWALKS IN PARANA MUNICIPALITIES: A GENERAL QUANTITATIVE OVERVIEW

Parana, located in the Southern region of Brazil, is the sixth most populated state. It entered 2016 with an estimated population of 11.2 million inhabitants (IPARDES, 2018). The state has a high degree of urbanization, since its cities offer greater job opportunities and better essential infrastructure services, putting pressure on local administrations to increase supply. Between 1990 and 2000, the annual urban population growth rate has reached 2.3% due to rural-urban migration. This urbanization process has increased the proportion of people in urban areas - from 73.4% to the current 85.3%. In addition to institutional weakness and insufficient financial resources availability, designed to attend the needs of the expanding urban population, urban infrastructure and primary services deficits became significant.

Aiming to support urban planning and management, in 2010, the institution in charge of the statistics in Brazil (*Instituto Brasileiro de Geografia e Estatística - IBGE*) produced information about the occurrence (or not) of 10 distinctive urban characteristics of household surroundings. The selected urban characteristics are: i) street name sign; ii) street lightning; iii) street pavement; iv) street tree; v) storm drain; vi) waste accumulation; vii) open sewer; viii) curb and gutter; ix) sidewalk; and x) curb ramp (IBGE, 2010a).

Table 1 shows that, in 2010, the percentage of Parana urban households with sidewalks in their surroundings was 58.6%, lower than the national level (69.0%). Besides that, only 9.7% of households in Parana had, in their surroundings, curb ramps. Although its level compared to that of Brazilian municipalities (4.7%) was higher, it was still deficient.

Table 1: Percentage of households with two urban characteristics in the State of Parana

RANGE	POPULATION (n. of inhabitants)	MUNICIPATILITIES	URBAN CHARACTERISTIC	
			Sidewalks (%)	Curb ramps (%)
1	Less than 5,000	98	56	11.1
2	5,001 - 10,000	105	48	8.3
3	10,001 - 20,000	109	48	8.1
4	20,001 - 50,000	55	51	9
5	50,001 - 100,000	14	57	8.5
6	More than 100,000	18	64	11
	PARANA	**399**	**59**	**9.7**
	BRAZIL	**5,570**	**69**	**4.7**

Source: IBGE, 2010a.

Municipalities with a population between 5,001 and 20,000 inhabitants presented the lowest proportion of urban households with sidewalks in their surroundings: no more than 48%. Moreover, only those municipalities with a population above 100,000 inhabitants, and therefore, with the largest numbers of urban households, had the most significant percentage of households with sidewalks (64%), exceeding state average (59%), but still lower than national mean level (69%).

The data collected by IBGE concerning sidewalks were only related to quantitative aspects restricted only to the existence (or not) of the sidewalk, that is, "…paved path, designed for pedestrians, usually in a higher level than travel lanes" (IBGE, 2010a), and the results in Parana are bad. If qualitative aspects were also considered, probably the state situation would be even more dramatic, especially because of restrictions imposed on people with mobility impairments.

Table 1 also shows that the percentage of Parana's urban households with curb ramps in their surroundings was higher than Brazilian average level, although both were very low (9.7% and 4.7%, respectively). In Parana, the municipalities with a population less than 5,000 inhabitants and more than 100,000 inhabitants presented the highest percentage (11.1% and 10.6%, respectively).

Although the data here considered were as of 2010, it can be assumed that current deficits of sidewalks and curb ramps are still very significant in Parana. Therefore, public policies, that ought to contribute to their considerable decrease, are becoming not only necessary but urgent.

A METHOD TO DEFINE ACCESSIBLE ROUTES ON SIDEWALKS

Theoretical references highlight walkability in urban design debate, aiming to make our cities more walkable (LO, 2009; SPECK, 2012; FORSYTH, 2015). People with mobility impairments perceive disability when urban space, or other environments of social life, are inaccessible (EISENBERG; HEIDER; GOULD; JONES, 2020). According to these authors, improvements in public space for pedestrian accessibility in United States, such as sidewalks and streets, can help to remove environmental barriers for people with impairments and, hence, to promote social inclusion.

Although increases in sidewalks' accessibility are directly associated with the implementation of tools, such as Tactile Ground Surface Indicators (TGSI), which

contribute to autonomy of people with visual impairments in urban travels; if this type of tool is poorly installed, it becomes ineffective or dangerous for pedestrians, such in the case of sidewalks in Yogyakarta City, Indonesia (PEMBUAIN; PRIYANTO; SUPARMA, 2020).

Lack of accessibility in sidewalks is also significant in South America urban context, as pointed out by Márquez, Poveda and Vega (2019). The authors state that places in Tunja City – Colombia, where there is no sidewalk continuity, wheelchair users cannot access the transportation system.

In Brazil, it is remarkable the lack of urban planning concerning sidewalks to guarantee the existence of accessible routes, as defined in the Brazilian technical standard NBR9050 (ABNT, 2020). It can still be said that, even nowadays in Brazil, among sidewalk's functions, adequate pedestrian's movement is one of the less considered. It is common the presence of obstacles on clear paths, such as inadequate vehicles access to properties, street lighting poles, street furniture and trees.

To implement accessible routes in Brazil, sidewalk design must consider NBR9050 width standards for each of the three sidewalk zones: street furniture zone, clear path, and frontage zone.

The street furniture zone is defined as the sidewalk section between the curb and the clear path, where street furniture and sidewalk amenities should be implemented, such as lighting, benches, traffic signs and green infrastructure elements. The minimum width recommended to accommodate all these elements is 0.70 meter. Nevertheless, this specification is not, in practice, considered, and besides that, those elements use to be in the clear path.

A clear path, where accessible routes should be implemented, is the pedestrian through zone that ensures a safe and adequate place to walk. It must be free of any obstacle, with gentle cross slope (less than 3%), minimum width of 1.20 meter and free from a 2.10 meters height.

According to NBR9050, the minimum clear path width of 1.20m is required to comfortably absorb a flow of 25 pedestrians per minute, in both directions. The clear path width must be increased due to sidewalk impedance factors, such as i) shop windows or façade stores at the building line (+0.45m); ii) urban furniture (+0.25m); and iii) building entrance at the building line (+0.25m). It can be said that, in Brazil, compliance with these normative provisions is not the rule, but the exception.

The frontage zone defines the section of the sidewalk that functions as an extension of the building. According to NBR9050, the existence of this space is only possible on sidewalks width larger than 2.00m, allowing room for vehicle access to properties, without interference in clear path specifications. As in the case of the street furniture zone, it is common in Brazilian sidewalks, due to their small widths, that the function of the clear path is affected by the coexistence of the function designed to the frontage zone.

Besides the minimum standards specified to accessible sidewalks, it is essential to point out additional relevant aspects that can contribute to improve walkability, such as continuity of pedestrian routes; accessibility of facilities to people with different impairments; connections to street network and transit services; safety of crossings; visual interest; and perceived security (LO, 2009).

The virtual street audit to define accessible routes was selected considering the inadequate urban planning capacity of local government staffs, particularly in small municipalities, where it may be even nonexistent. Virtual street audits, using secondary data, including Google Street View, were considered viable to understand the diversity of built environment aspects (KELLY et al., 2013; LEE and TALEN, 2014; HARA et al., 2015; HARA and FROEHLICH, 2015; SAHA, 2019).

Most of the aspects related to the physical conditions of a preliminary proposal are shown in Table 2. The secondary information sources used in this method were: i) urban digital cartography; ii) urban digital orthophotos; and iii) GSV.

Table 2: Aspects considered to evaluate walkability conditions

ASPECT	ZONE	ATRIBUTTE	VIRTUAL AUDIT	INFORMATION SOURCE
Topography	Clear Path	• Longitudinal Slope	Yes	1
		• Transverse Slope	No	--
Size	Clear Path	• Width	Yes	1 / 2/ 3
		• Length (block)	Yes	1 / 2 /3
Obstacle	Clear Path	• Street Tree	Yes	3
		• Urban Furniture (traffic light, light pole, public telephone, fountain, trash can, awning, bench)	Yes	3
		• Pavement (material, irregularity)	Yes	3
		• Light Pole	Yes	3
		• Vehicle Access Ramp	Yes	3
Equipment	Travel Lane / Street Furniture	• Crosswalk	Yes	2 / 3
		• Curb Ramp	Yes	2 / 3
		• Traffic Light	Yes	3
		• Elevated Crosswalk	Yes	2 / 3
Thermal Comfort	Street Furniture	• Street Tree and Shading	Yes	1 / 2 / 3
Convenience	Street Furniture	• Bench	Yes	2 / 3
Safety	Street Furniture	• Street Lighting	No	--

Source: The Authors, 2019.

As a case study, it is presented a preliminary proposal of a sidewalk accessible route within CBD of Quitandinha, located in Curitiba Metropolitan Area, to illustrate the application of the suggested method.

DEFINITION OF AN ACCESSIBLE ROUTE IN THE CENTRAL BUSINESS DISTRICT OF QUITANDINHA: A CASE STUDY

The municipality of Quitandinha, with around 5,000 urban inhabitants, belongs to the third-class interval of Table 1, with the worst percentages of sidewalks and curb ramps supply in the surroundings of households.

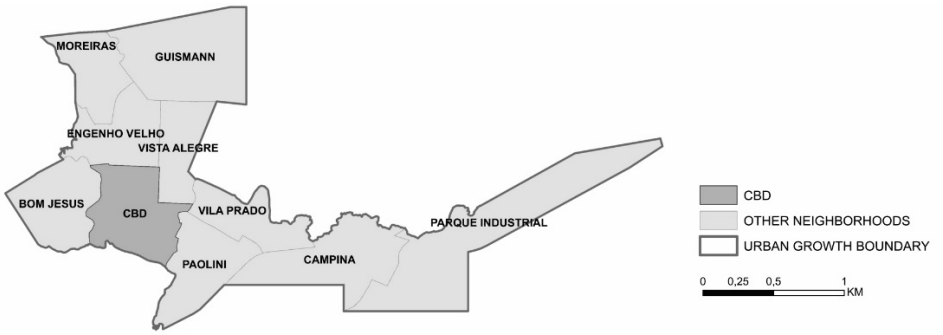
Around 24% of Quitandinha municipality inhabitants declared themselves as disabled people (IPARDES, 2018). This large contingent of people, added with those with reduced mobility, makes the lack of accessibility a priority issue in urban local agenda.

The first step of the proposed method consists in CBD delineation. According to Speck (2012), starting to improve the CBD physical conditions can help to

improve all other parts of the city. If the CBD does not look good, the same also happens with the rest of the city. In Parana, only 10% of its municipalities have neighborhoods officially defined, mostly the large ones (IBGE, 2010b).

Autonomous Social Service Paranacidade, based on Quintandinha Comprehensive Plan (historical evolution of urban land use and zoning law) and on urban cadaster, has conducted a study that outlined 10 neighborhoods, including CBD. The latter's limits took as reference the spatial concentration of, public or private service and commercial activities, comprising an area of 55.35 hectares (9.5% of urban growth boundary), and a set of 17 streets with a total extension of 5,638.80m (12.4% of the urban street network).

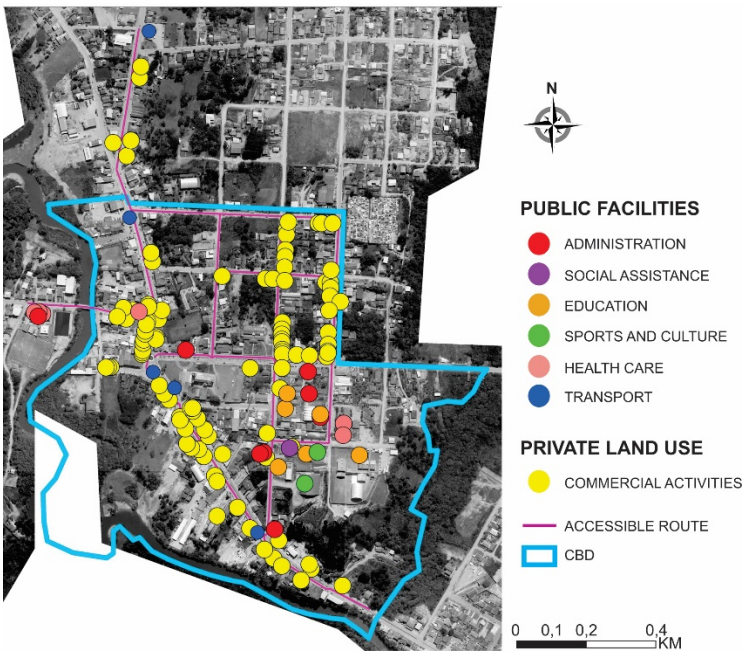
Figure 1: Location of CBD area within Quitandinha Urban Growth Boundary



Source: SEDU/PARANACIDADE INTERATIVO, 2019.

In the second step, 121 pedestrians' attractors were identified within CBD: 99 from private sector and 22 consist of public agencies (Figure 2). Public facilities are grouped in 2 blocks, whereas commercial activities are more equally distributed among the main street (Eleutério Fernandes de Andrade Avenue) and two other streets (Expedicionário Street and Padre Francisco Street).

Figure 2: CBD Quitandinha Accessible Route Final Proposal



Source: The Authors, 2021.

The first accessible route proposal was defined considering the connection of all the 121 pedestrians' attractors identified within CBD (third step). Nevertheless, the high longitudinal slope of the initial section (2 block frontages) of Estalisnau Socek Street and of the total extension of Abílio Alves Street compel to their exclusion. In both cases, the longitudinal slope was higher than the allowable standard for wheelchair users, as specified in NBR9050. So, the total length of accessible route first proposal was 7,828.54m (comprising 11 out of 17 Quitandinha CBD streets and 50 out of 67 central block frontages), which allowed the connection of 97% of all identified pedestrians' attractors (Table 3).

Table 3: Extension and number of block frontages of the CBD accessible route proposal

STREET	BLOCK FRONTAGE					
	CBD		CBD ACCESIBLE ROUTE			
			FIRST PROPOSAL		FINAL PROPOSAL	
	LENGTH (m)	Nº	LENGTH (m)	Nº	LENGTH (m)	Nº
Eleutério Fernandes de Andrade	1,919.90	08	2,658.73	13	2,658.73	13
Abílio Alves	356.66	02	356.66	02	------	-----
Acelino Ribas Pinto	781.85	06	210.89	02	781.85	06
Independência	209.40	02	209.40	02	209.40	02
Dias de Moraes	118.76	02	-----	-----	-----	-----
Expedicionário	1,251.18	08	1,251.18	08	1,251.18	08
Estanislau Socek	713.83	06	713.83	06	452.29	04
José de Sá Ribas	687.93	05	687.93	05	687.93	05
Marciano de Carvalho	544.20	04	333.22	02	544.20	04
Monsenhor Miguel Mickos	295.88	02	-----	-----	-----	-----
Padre Francisco Starzybski	1,208.89	08	983.56	06	983.56	06
Paraná	401.64	03	-----	-----	-----	-----
Pedro Zolner	196.79	02	196.79	02	196.79	02
José Eugênio Soczek	120.86	02	-----	-----	------	-----
01	104.09	01	-----	-----	-----	-----
02	181.83	03	-----	-----	-----	-----
03	87.40	02	-----	-----	-----	-----
Marinho de Almeida Prado	226.35	02	226.35	02	226.35	02
TOTAL	**9,407.44**	**67**	**7,828.54**	**50**	**7,992.28**	**52**

Source: The Authors, 2021.

Additionally, to make connections with other two near relevant public facilities, outside CBD, (bus station and public health unit), it was necessary to expand the first proposal of an accessible route, including 4 block frontages of Acelino Ribas Pinto Street 2 of Marciano de Carvalho Street, achieving the total length of 7,992.28m (comprising 10 streets and 52 block frontages). Figure 2 illustrates the street set of the accessible route final proposal.

In the fourth step, physical conditions of the accessible route sidewalks must be virtually audited. However, fully audit was only possible in the CBD main street (Eleutério Fernandes de Andrade Avenue) where information from GSV was available. Nevertheless, the analysis concerning the other streets was taken forward restricted to those aspects that could be evaluated considering the two other secondary information sources.

Sidewalks' width analysis pointed out the need to their enlargement: José de Sá Ribas Street, where City Hall is located, has the largest sidewalk width (1.90m); three other streets have sidewalk widths near the minimum required by NBR9050 in relation to clear path (1.20m); and the rest (6) has their sidewalks' width with less than 1.00m. To ensure full accessibility, total sidewalks widths should be increased - considering commercial land use - which directly implies travel's lanes width narrowing.

Only 4 out of the 52 central block frontages has length less than 100m; half of them, between 100m and 120m; and the rest, over 150m, reaching the largest block frontage length of 765m. The latter group corresponds to 60% of the accessible route total extension (7,922.28m), which possibly requires the implementation of midblock curb cuts, together with crosswalks, to assist people with mobility impairments.

Along Eleutério Fernandes de Andrade Avenue, different types of obstacles in the clear path were recognized, such as i) 6 trees out of 11; ii) 10 urban furniture elements out of 19 – 5 vertical signs, 3 awning's support, 1 bus shelter and 1 public trash; iii) improper materials for sidewalks pavement (73%), added to the irregularity of those deemed appropriate (27%), compromising accessibility in almost all sidewalks of the route; iv) 6 light poles out of 38 (the improper location makes them an obstacle to pedestrian flows); and, v) 21 vehicle access ramps out of 35 (affecting the clear path transversal slope).

The existing crosswalks (20) are only 25% of the overall estimated need (82), and, in 3 streets (out of 10) they do not even exist. The survey results revealed a worse situation for curb ramps: there are only 6% of the total number required (150). In addition, there is only one elevated crosswalk along Eleutério Fernandes de Andrade Avenue. This kind of element should also be available in other accessible route streets, as is the case for Expedicionário Street where several public facilities and educational establishments are concentrated.

Regarding the thermal comfort aspect, the existence of shading elements along the accessible route was evaluated. Of the 48 trees identified, only half of them provide shade over sidewalks. Based on the estimated need of 191 trees, the deficit is approximately 87%. Even in the Expedicionário Street, which has the greater contingent of afforestation (12), thermal comfort is far from desired (22), since distances between existing trees oblige pedestrians to walk extensive stretches under sun exposure.

Virtual audit, using GSV, allowed to identify 7 commercial awnings, of which 4 are continuous and contribute for 40 meters of shading along Eleutério Fernandes de Andrade Avenue. The 3 other remainder awnings provide 15 additional meters of shade, although not continuously. No other convenience elements, such as benches that could provide rest along the footpath, were identified in the furniture zone.

Once the accessible route within Quitandinha CBD was audited, the fifth and last step consisted in quantifying the required physical interventions as well as in estimating their costs, so that the municipality can anticipate the required financial resources for their works.

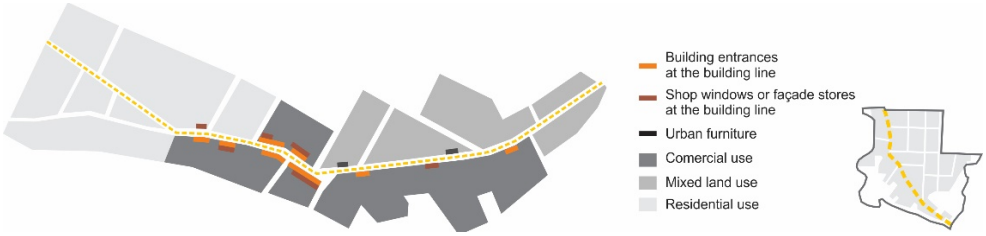
Public works required to implement the accessible routes proposed were estimated based on data collected of sidewalks' inadequacies, resulting from the virtual audit carried out. To facilitate the works and services measurement, data has already been collected using objective criteria such as area with inadequate pavement for pedestrians, number of additional curb ramps needed etc. Preliminary interventions cost was made using Paranacidade's model spreadsheet for budgeting works on urban streets, available for public access (PARANACIDADE, 2019).

Pavement materials that provide uniform and regular surfaces, such as asphalt and concrete were favored. Although it does not meet this criterion, it was also considered the paver block, due to its recent and wide dissemination in Parana cities' sidewalks.

Due to scarce information, the present analysis was grounded on the sidewalks' adaptation requirements of Eleutério Fernandes de Andrade Avenue central segments, to which GSV was available. So, the estimated total costs for the other streets were based on its average costs.

Initially, lot-by-lot land use, urban furniture in sidewalks, and zones' widths were audited to identify width sidewalk readjustment requirements (Figure 3). As a result, sidewalks widths needed to be increased, as follows: i) 2.60m in central blocks where commercial activities concentrate; ii) 2.40m in residential areas where frontage zones are needed; and iii) 2.15m where urban furniture is available.

Figure 3: Sidewalk impedance factors – Eleutério Fernandes de Andrade Ave.



Source: The Authors, 2021.

Figure 4 illustrates the shifts on sidewalks widths. It should be noted that the required narrowing of travel lane width does not compromise the street service capacity.

Figure 4: Sidewalks widths proposal - Eleutério Fernandes de Andrade Ave.

Source: The Authors, 2021.

Moreover, it was identified the needs to replace sidewalks pavement and execute additional physical interventions, such as tactile paving, car ramps in access zones, curb ramps at intersections, public lighting poles, and pedestrian crosswalks. Since in CBD pedestrian flows are most intense, no infiltration strips were proposed on the accessible route.

The estimate project cost for each of the 3 sidewalk pavement alternatives is presented in Table 4. The scope of the intervention area is 4,586.45m2 (corresponding to 70% of total area), due to pavement material inadequacy or poor conditions of maintenance.

Table 4: Total and average costs estimate of sidewalks in Eleutério Fernandes de Andrade Ave. according to pavement alternative

SIDEWALK PAVEMENT ALTERNATIVE	TOTAL COST (R$ 1.00)	AVERAGE COST (R$ 1.00)
Asphalt	399,525.93	87.11
Concrete (in-situ)	452,092.59	98.57
Paver block (precast)	531,870.30	115.97

Source: The Authors, 2019.

The total project cost of supplying and adapting urban elements that guarantee universal accessibility and adequate comfort conditions for Eleutério Fernandes de Andrade Ave. was estimated in R$ 388,682.25 corresponding to the average cost of R$ 84.75. The item that most impacted final budget was light poles installment (85%).

Based on estimate average costs and on accessible route final proposal total area (19,927.97 m²), the budgets for the 3 sidewalks pavement alternatives were appraised as follows: R$ 2,515,868.64 for asphalt; R$ 2,683,639.47, for concrete (in situ); and R$ 2,938,334.51, for paver block.

These amounts accounted from 36 to 42% of the potential indebtedness capacity of Quitandinha municipality to borrow money to finance investments in 2019 (16% of its net current revenue) or from 52 to 61% of the average value of its investment expenditure for the two-year period 2017-2018 (TESOURO NACIONAL, 2019).

CONCLUSIONS

The requirement, in the federal sphere, for cities already obliged to elaborate Comprehensive Plan, to plan accessible routes, demands, in the state and municipal spheres, a wide building capacity effort concerning the content and methods related to this plan. Even though this legal requirement has already been in existence since 2015, there is no city in the State of Parana with an accessible route plan.

To develop an accessible route plan for Quitandinha, a small city obliged to elaborate an accessible route plan, proved to be a challenge from its very beginning due to scarce and limited available data concerning physical aspects of its streets. Nevertheless, the efforts made so far are much smaller than those required to redesign and rebuild a lot of Brazilian urban streets, such as Eleutério Fernandes de Andrade Ave. of Quitandinha, aiming to guarantee sidewalks universal accessibility.

Virtual audit contributed, despite limits of GSV coverages, to get a preliminary broad site comprehension by compiling several types of spatializable data (pedestrian attractors, topography, street features, obstacles, equipment, thermal comfort, convenience, and safety physical elements) from different information sources of public access. Besides that, this method enables to propose a set of physical interventions and gives support to estimate its investment costs.

It is expected that this feasible method encourages: i) local administrations to audit sidewalks situation to include in their investment agendas aiming urban walkability improvement; and ii) regional or national governments to define public policies towards urban environment qualification.

REFERENCES

ABNT – Associação Brasileira de Normas Técnicas. **NBR 9050**: Accessibility to buildings, equipament and the urban environment. 2020. Available from: <https://www.abntcatalogo.com.br/norma.aspx?ID=447312> Access: November 2020.

BRASIL. Lei nº 13.146, de 6 de julho de 2015. Institui a Lei Brasileira de Inclusão da Pessoa com Deficiência (Estatuto da Pessoa com Deficiência). Available from: <http://www.planalto.gov.br/ccivil_03/_ato2015-2018/2015/lei/L13146.htm> Access: November 2020.

EISENBERG, Y.; HEIDER, A., GOULD, R.; JONES, R. Are communities in the united states planning for pedestrians with disabilities? findings from a systematic evaluation of local government barrier removal plans. **Cities**, 102, 2020, 102720. Available from: <https://doi.org/10.1016/j.cities.2020.102720> Access: November 2020.

FORSYTH, A. What is a walkable place? The walkability debate in urban design. **Urban Design International**, vol. 20, no. 4, 2015, pp. 274-292. Available from: <https://dash.harvard.edu/handle/1/29663388> Access: November 2020.

HARA, K.; AZENKOT, S.; CAMPBELL, M.; BENNETT, C. L.; Le, V.; PANNELLA, S.; MOORE, R.; MINCKLER, K.; NG, R. H.; FROEHLICH, J. E. Improving public transit accessibility for blind riders by crowdsourcing bus stop landmark locations with Google Street View: An extended analysis. **ACM Transactions on Accessible Computing**, vol. 6, no. 2, 2015, pp. 1-8. Available from: <https://dl.acm.org/citation.cfm?id=2717513> Access: November 2020.

HARA, K.; FROEHLICH, J. E. Characterizing and visualizing physical world accessibility at scale using crowdsourcing, computer vision, and machine learning. **ACM SIGACCESS Accessibility and Computing**, vol. 113, no. 15, 2015, pp. 13-21. Available from: <https://dl.acm.org/citation.cfm?id=2850442> Access: November 2020.

IBGE - INSTITUTO BRASILEIRO DE GEOGRAFIA E ESTATÍSTICA. Características urbanísticas. 2010a. Available from: <https://biblioteca.ibge.gov.br/visualizacao/periodicos/96/cd_2010_entorno_domicilios.pdf> Access: November 2020.

_____. Censo Demográfico. 2010b. Available from: <https://ww2.ibge.gov.br/home/estatistica/populacao/censo2010> Access: November 2020

_____. Perfil dos municípios brasileiros. 2015. Available from: <https://biblioteca.ibge.gov.br/index.php/biblioteca-catalogo?id=295942&view=detalhes > Access: November 2020.

IPARDES - INSTITUTO PARANAENSE DE DESENVOLVIMENTO ECONÔMICO E SOCIAL. Paraná em números. 2018. Available from: <http://www.ipardes.pr.gov.br/Pagina/Parana-em-Numeros > Access: November 2020.

KELLY, C. M.; WILSON, J. S.; BAKER, E. A.; MILLER, D. K.; SCHOOTMAN, M. Using Google Street View to audit the built environment: inter-rater reliability results. **Annals of Behavioral Medicine**, vol. 45, no. 1, 2012, pp. 108-112. Available from: <https://academic.oup.com/abm/article-abstract/45/suppl_1/S108/4563959?redirectedFrom=fulltext > Access: November 2020.

LEE, S.; TALEN, E. Measuring Walkability: A Note on Auditing Methods. **Journal of Urban Design**, vol. 19, no. 3, 2014, pp. 368-388. Available from: <https://www.tandfonline.com/doi/abs/10.1080/13574809.2014.890040> Access: November 2020.

LO, R. H. Walkability: what is it? **Journal of Urbanism**, 2(2), 2009, pp. 145-166. Available from: <https://doi.org/10.1080/17549170903092867> Access: November 2020.

MÁRQUEZ, L.; POVEDA, J. C.; VEGA, L. A. Factors affecting personal autonomy and perceived accessibility of people with mobility impairments in an urban transportation choice context. **Journal of Transport & Health**, 14, 2019, 100583. Available from: <https://doi.org/10.1016/j.jth.2019.100583> Access: November 2020.

MINISTÉRIO PÚBLICO DO PARANÁ. Nota Técnica Conjunta (No 1). 2018. Available from: <http://www.urbanismo.mppr.mp.br/arquivos/File/NTC01_2018CALCADAS.pdf> Access: November 2020.

PARANACIDADE – AUTONOMOUS SOCIAL SERVICE. Standard documentation to be submitted by municipalities. Available from: < http://www.paranacidade.org.br/modules/conteudo/conteudo.php?conteudo=172> Access: November 2020.

PEMBUAIN, A.; PRIYANTO, S.; SUPARMA, L. B. The evaluation of tactile ground surface indicator condition and effectiveness on the sidewalk in Yogyakarta City,

Indonesia. **IATSS Research**, Volume 44, Issue 1, 2020, pp. 1-7. Available from: <https://doi.org/10.1016/j.iatssr.2019.04.002> Access: November 2020.

SAHA, M.; SAUGSTAD, M.; MADDALI, H. T.; ZENG, A.; HOLLAND, R.; BOWER, S.; DASH, A.; CHEN, S.; LI, A.; HARA, K.; FROEHLICH, J. Project Sidewalk: A Web-based crowdsourcing tool for collecting sidewalk accessibility data at scale. **Conference on Human Factors in Computing Systems**, vol. 62, 2019. Available from: <https://dl.acm.org/citation.cfm?doid=3290605.3300292> Access: November 2020.

SEDU/PARANACIDADE INTERATIVO. Priority accessible routes. Available from: <https://paranainterativo.pr.gov.br/portal/apps/MapSeries/index.html?appid=513efb6ce40f4017b57e37722395f790> Access: November 2020.

SPECK, J. **Walkable city: how downtown can save America, one step at a time**. New York: Farrar, Straus and Giroux, 2012.

TESOURO NACIONAL. Summary report on simplified budget execution – last two months. 2019. Available from: <https://siconfi.tesouro.gov.br/siconfi/pages/public/declaracao/declaracao_list.jsf> Access: November 2020.

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