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Spatial quality assessment of the pedestrian's environment using online digital tools: application in the Tourist City of Barra Bonita (SP)

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ABSTRACT

Tourist cities, in addition to offering places of attraction, must have quality spaces, with pedestrian-oriented infrastructure to ensure comfort, safety, accessibility, among other aspects that contribute to increasing local attractiveness. However, for this to happen, it is necessary that these cities know the reality of the pedestrian-oriented infrastructure available, through accurate surveys, which can be done on site and/or through online digital tools. In this context, this paper shows results from a study on the quality of pedestrian infrastructure on an important avenue in the tourist city of Barra Bonita, a city in the Midwest of São Paulo. The methodology incorporated the use of the spatial quality index of the pedestrian environment (IQEAP), developed by TONON (2019), and the virtual tools of Google Earth and Street View. The analysis of the results showed that the evaluated area has "Regular" IQEAP and, therefore, needs improvements in aspects involving the three pedestrian environment plans aimed at the pedestrian scale. The results also show negative aspects in relation to the virtual form of data survey (technical audit), which is not very accurate due to the dates of the images, absence of precision tools, and low image resolution. However, significant positive aspects can be highlighted, such as the reduction of survey time on site (in situ), and the use of fewer financial resources. Thus, this method can facilitate the survey of data in places of difficult geographical access, dispersed, large or distant areas, and thus become an innovative and practical option.

Keywords: Tourist Cities. Pedestrians. Google Earth. Google Street View.

INTRODUCTION

In recent decades, cities in Brazil and abroad have experienced high growth rates in the tourism sector (UNWTO, 2014). This scenario becomes challenging for urban planners, as they need to offer urban infrastructure that meets both the needs of its residents and its visitors (GORRINI; BERTINI, 2018). However, for the planning of cities of tourist interest to meet these issues and be sustainable, it is necessary to incorporate the principles of sustainable development, such as the adoption of mobility strategies which aims to offer residents and tourists infrastructure focused on public transport modes, such as public transport, and non-motorized individual modes - bicycle and on foot (GORRINI; BERTINI, 2018; UNWTO, 2017).

Regarding pedestrians, quality infrastructure contributes to the health, well-being and quality of life of citizens, as it enhances physical activity and social inclusion (GRIEW et al., 2013; GORRINI; BERTINI, 2018). Aspects related to comfort and safety must also be incorporated, as they are essential for people with reduced mobility or mobility difficulties, such as the elderly and people with disabilities, to enjoy places considered points of attraction, which is essential for increasing the tourism sector of these cities.

Accessibility is another factor that contributes to providing security to tourists and directly influences the choice of leisure and entertainment destinations (CHAGAS, 2010). The presence of architectural and urban barriers in cities has a negative effect, since they exclude the possibility of visiting people who have some type of disability or reduced mobility in some tourist routes. On the other hand, the elimination of barriers, such as those found in access to transport terminals (roads, airports, metropolitan bus terminals), in transport vehicles, access to tourist establishments, in signage, when moving around the city, and in leisure and cultural activities (UNWTO, 2014), it makes tourism accessible.

To assist in the planning of accessible tourism, in relation to the quality of the walking space, it is essential to assess the quality of the pedestrian space. For this, national and international specific literature offers a theoretical and methodological diversity that can contribute to this issue (FERREIRA; SANCHES, 2001; EWING; CLEMENTE, 2013; NYC, 2013; FANTINI, 2014; JACOBS, 2014; MEDEIROS, 2016; MAGAGNIN; RIBEIRO; PIRES, 2016; CALDEIRA;

NEUZA; NUNES, 2017; PIRES, 2018; SILVEIRA; GOES, 2018; STEINMETZ-WOOD et al., 2019; TONON, 2019).

Most methods use pedestrian infrastructure assessment with data collection carried out exclusively through field research. Few researches use computational tools or virtual environments to perform this analysis partially or completely (CLARKE et al., 2010; RUNDLE et al., 2011; GRIEW et al., 2013; BETHLEHEM et al., 2014; BADER et al., 2015; LI et al., 2015; YIN; WANG, 2016; HE; PÁEZ; LIU, 2017; CAMPBELL; BOTH; SUN, 2019).

Among these tools, Google Earth stands out, which offers static images of streets from all over the world, can be accessed through Google Maps and provides street images from various places in the world (GOOGLE, 2019).

Google Street View, free software, has been standing out for viewing images in 3D, has millions of high-resolution panoramic images (captures at a field of view of 180 degrees vertically and 360 degrees horizontally composed of a linear montage of images cameras) from all over the world, and are associated with geolocation from GPS positioning (BETHLEHEM et al., 2014).

This feature has been used and defended by many researchers, as it presents information agreement by the application with the real environment. Street View stores images and allows the user/researcher to access it whenever necessary. It makes it possible to assess changes that have occurred in the same place over time, as it contains images from various periods. It saves time and resources, as it can be accessed anytime, anywhere, to carry out audits in large-scale neighborhoods and reduces travel costs and risks for researchers when visiting unsafe environments (HE; PÁEZ; LIU, 2017).

Given the need for social isolation, in Brazil and around the world, due to the Pandemic caused by the COVID-19 virus, field surveys had to be suspended in order to contribute to reducing the transmission of the virus. Therefore, the use of a tool such as Google Street View can help researches that involve assessment at micro or macro scales in cities. This paper shows a contribution of using this tool to analyzes the spatial quality of the pedestrian environment, based on a case study in an important avenue of the Tourist City of Barra Bonita (SP), using the methodology proposed by Tonon (2019).

OBJECTIVE

To analyze the feasibility of using online digital tools to assess the spatial quality of the pedestrian environment, through a case study in a tourist city.

CASE STUDY

The case study was carried out in the city of Barra Bonita (Lat. 22° 29′ 58″ South Long. 48° 33′ 8″ West), an important tourist city in the state of São Paulo. The city's main tourist activity is the boat ride through the Tietê River lock. The area selected for the study, Rosa Zanela Petri Avenue (Figure 1), is located in the central area of the city, located on one of the banks of the River Tietê, and includes the main attractions of the city: river navigation of the middle of Tietê, Mayor Luiz Fernando Ortigossa Exhibition Pavilion, Deputy Waldemar Lopes Ferraz Square, Almirante Barroso Square, Francisco Almeida Square, Namorado Square, Luiz Saffi Municipal Historical Museum, Tatinho Square, Youth Square and Barra Bonita Shopping.

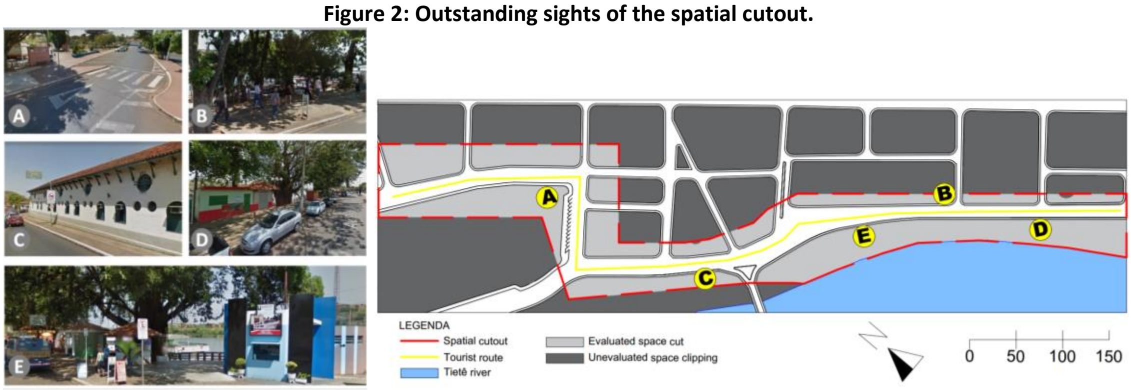
The location was chosen due to the large flow of people, especially on weekends or holidays, proximity to the tourist attractions, as it facilitates walking on foot, and being delimited by streets with a large flow of vehicles.

Figure 1: Rosa Zanela Petri Avenue – Area analyzed in Barra Bonita – SP.

Source: The authors, based on data from Google Maps, 2021.

The spatial cutout is approximately 900 linear meters, 14 blocks (represented by the yellow line in Figure 1). The urban grid is predominantly orthogonal, with blocks ranging from 60 to 180 meters, except near the banks of the Tietê River, whose region is characterized by its visual range, due to the large sides of the banks measuring about 400 linear meters. Figure 2 shows some locations of this area.

Figure 2: Outstanding sights of the spatial cutout.



Source: The authors, 2020.

METODHOLOGY

To measure the spatial quality of the selected clippings, the tool called the Pedestrian Environment Spatial Quality Index - IQEAP (TONON, 2019) was used. The IQEAP makes it possible to assess the physical and topoceptive aspects of elements related to the pedestrian scale involving the four two-dimensional planes (sidewalk, façade, roof and street), beyond the street's intersections.

The instrument consists of 41 indicators that assess aspects related to Comfort, Safety, Security, Attractiveness, Accessibility, Spatial Diversity and Readability, which can positively and negatively impact the pedestrian environment.

The application of the IQEAP is structured in five stages: (i) definition and delimitation of the evaluated area; (ii) identification of the analysis unit; (iii) definition of the hierarchical structure of the index components and respective form of evaluation; (iv) data collection; and (v) calculation of the index. In this article, steps 3 and 4 of the IQEAP index are discussed due to the use of online tools for data collection.

Area definition and delimitation - the instrument was developed to assess the spatial quality of the pedestrian space. In this step, the area to be evaluated must be defined.

Analysis unit - each analysis segment is composed of a square face and the consecutive intersection. The numbering of each block follows the x, y axis (North/East orientation), where: the numbering of blocks (Q) and street intersections (I) is performed from left to right (adding one unit on the X axis, and a hundred on the Y axis). Quad faces are named by capital alphabetical letters (A, B, C, ... n), clockwise starting from the top (north) or right side (east) face when there is no top face.

Hierarchical structure of indicators - In total, Tonon (2019) proposes the use of 41 indicators grouped into 5 units of analysis: Sidewalk Plan (18 indicators); Facade Plan (9 indicators); Coverage Plan (4 indicators); Street Plan (6 indicators); and Street's intersections (4 indicators), Table 1.

Table 1: Hierarchical structure of the IQEAP.

Categories/Plan	Indicators	
Sidewalk Plan	Presence of sidewalk. Full width of the sidewalk. Floor material. Floor maintenance condition. Permanent obstructions. Temporary Obstructions. Unevenness. Conflicts between pedestrians and vehicles. Accessible crossing.	Longitudinal slope. Cross slope. Shading. Presence of people. Presence of homeless people. Presence of street vendors. Street lighting. Urban furniture. Maintenance condition of urban furniture.
Facade Plan	Size of the blocks. Mixed and residential use. Day and night public use. Physical permeability. Visual permeability.	Abandonment aspects. Architectural diversity. Front setback. Scale and proportion.
Coverage Plan	Human scale. Visual pollution. Aerial obstructions. Visual landmarks.	
Street plan	Street classification. Street width. Visibility around corners.	Side safety presence. Traffic signage. Orientation and identification.
Street intersections	Traffic lights. Type of street intersection. Presence of crosswalk. Maintenance condition of the crosswalk.	

Source: Tonon, 2019.

The criteria for evaluating the indicators corresponds to a numerical range from 0 to 1 point, in each indicator can be a different numerical scale for evaluation. Values can be subdivided into: (i) 0.00 or 1.00; (ii) 0; 0.50; or 1.00; (iii) 0.00; 0.33; 0.66; or 1.00; or (iv) 0.00; 0.25; 0.50; 0.75; or 1.00.

Data collection - must be carried out through a technical audit, which according to Tonon (2019) must be carried out exclusively from an in loco survey. For most indicators, the assessment is carried out directly with the data collected in the field. However, for 18 indicators, highlighted below, it is necessary to perform some additional calculations to obtain the final grade: Presence of sidewalk, Floor material, Condition of maintenance of the sidewalk surface, Permanent obstructions, Temporary obstructions, Unevenness, Conflicts between pedestrians and vehicles, Cross slope, Shading, Public lighting, Mixed and residential use, Day and night public use, Visual permeability, Abandonment aspects, Architectural detailing, Frontal setback, Human scale, Aerial obstructions and Presence of a buffer zone. For them Tonon (2019) describes the corresponding calculation form.

In this paper, data collection was carried out with the adoption of software, based on the association of street images and online geographic maps, taken from the *Google Maps*, *Google Street View and Google Earth Pro software*. The Google Earth Pro application allows obtaining of two-dimensional and three-dimensional measurements, while other tools such as Google Maps and Street View, allow the collection of information through two-dimensional and three-dimensional images, respectively.

Index calculation - The procedures for calculating the walkability index are defined in 2 steps: i) calculation of the IQEAP with scores obtained in the field and ii) calculation of the IQEAP with maximum score of the indicators (Figure 3). Initially, the scores for each indicator are calculated, then the calculation of the scores for the two-dimensional planes and for the street intersections is performed, and finally, the IQEAP score assigned to the square face is obtained. In parallel, the calculations for the maximum marks in each stage must be carried out (Figure 3). The result between the maximum score obtained for each stage and the score obtained in the field, “results in the percentage of actual score attainment and can be compared with the spatial quality classification levels” (Tonon, 2019 p. 65), see Table 2.

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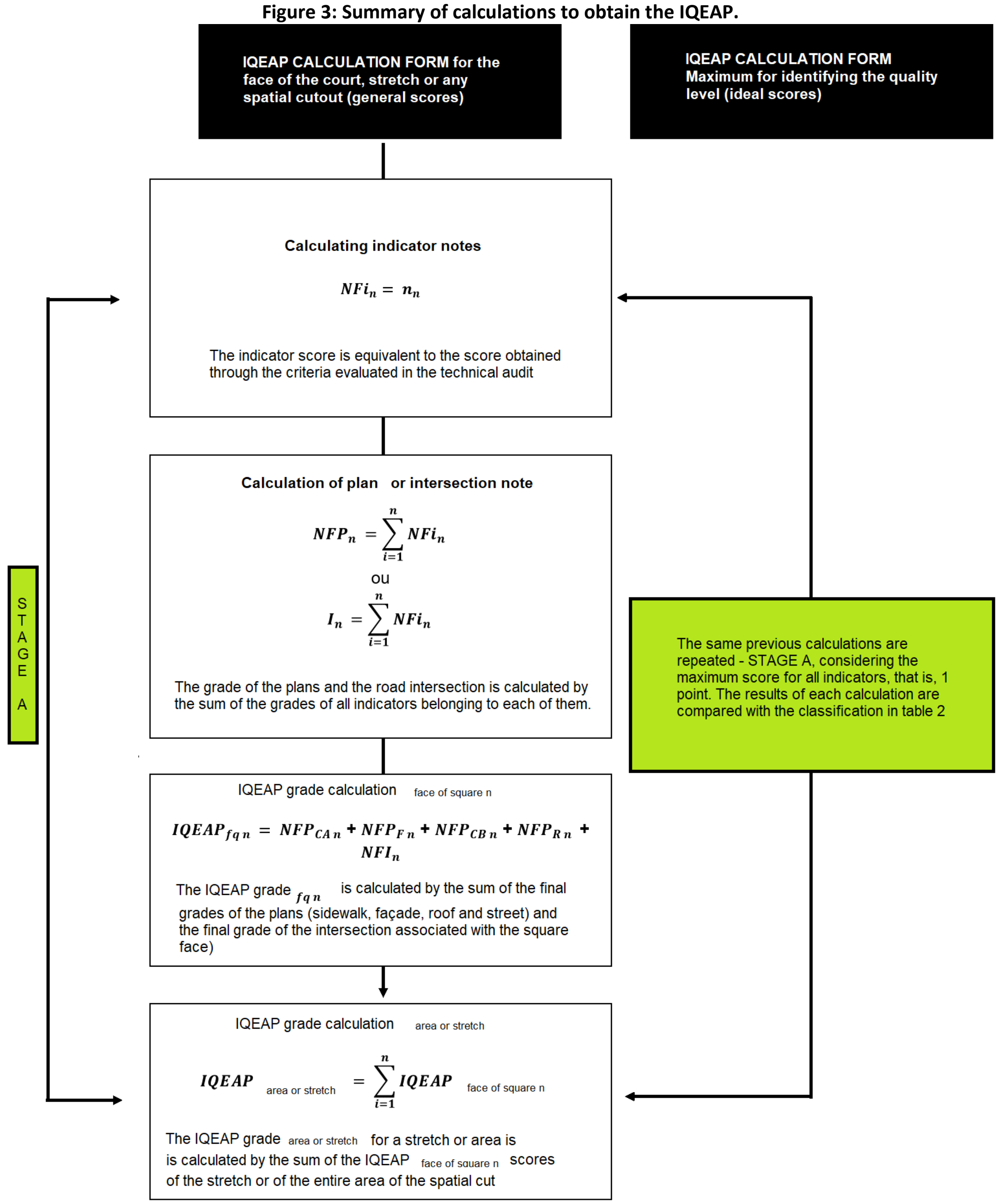
Figure 3: Summary of calculations to obtain the IQEAP.



Source: Tonon, 2019.

Table 2: IQEAP Quality Rating.

PERCENTAGE	LEVEL	DESCRIPTION OF THE PEDESTRIAN ENVIRONMENT
0% a 20%	VERY POOR	Spatial quality very unfavorable to the pedestrian environment
21% a 40%	POOR	Spatial quality unfavorable to the pedestrian environment
41% a 60%	FAIR	Spatial quality partially favorable to the pedestrian environment
61% a 80%	GOOD	Spatial quality favorable to the pedestrian environment
81% a 100%	EXCELLENT	Spatial quality very friendly to the pedestrian environment

Source: Tonon, 2019.

RESULTS AND DISCUSSIONS

The results are initially presented in relation to the use of online digital tools for data collection and then their application in the case study, and finally some considerations about the application of the instrument are presented.

Online digital tools for data collection

The first step in applying the IQEAP is related to the identification of indicators that could be evaluated exclusively using Google Maps and Google Street View software. Table 3 presents a summary of the evaluation of the digital tools used and the respective degree of accuracy in data collection. The highlighted cells show metrics that cannot be calibrated with Google Earth Pro digital tools.

Table 3: Evaluation of the use of digital tools for data collection of the IQEAP indicators.

Plans	Indicators	Definition (TONON, 2019)	Data collection method	Data accuracy (high/medium/low)
Sidewalk Plan	Sidewalk presence	It identifies the existence of a sidewalk in the block segment, defined by the space for pedestrians between two crossings.	Viewing the image directly in Google Earth Pro (Map and 3D).	High.
	Total width of the sidewalk	It assesses the total width of the sidewalk, that is, the sum of the three lanes: circulation, service and access.	2D map measurement (Google Earth Pro – ruler tool) and Street View (correlation measurements).	Low.
	Floor material	It evaluates the quality of the pavement material. Quality material is defined as that which is firm, non-slip and without vibrations, such as: concrete slabs, interlocking concrete, porous ceramics, among others.	Visual identification in Street View.	High (it depends on the date of the image).
	Floor maintenance condition	It evaluates the condition of pavement maintenance and sidewalk cleaning. Some problems that can reduce the quality of pedestrian movement may be associated with the presence of: potholes, irregularities, weeds, dirt, loose stones, among others.	Visual identification in Street View.	High (it depends on the date of the image).
	Permanent obstructions	It evaluates the presence of elements located in the lane destined for the free passage of pedestrians. For example: poles, garbage cans, trees, very tall roots, plant pots, among others.	Visual identification in Street View.	High (it depends on the date of the image).
	Temporary obstructions	It evaluates the presence of elements in the free traffic lane that temporarily interrupt the passage of pedestrians in the sidewalk segment. For example: parked vehicles, garbage bags, mobile advertising boards, sidewalks under repair, among others.	It does not allow evaluation by online digital tool.	It is not possible to evaluate.

Plans	Indicators	Definition (TONON, 2019)	Data collection method	Data accuracy (high/medium/low)
	Unevenness	It identifies the presence of unevenness, usually transversal, along the sidewalk segment and measures its height.	It does not allow evaluation by online digital tool.	It is not possible to evaluate.
	Conflicts between pedestrians and vehicles	It identifies the number of lowered guides for vehicle access to buildings along the entire sidewalk segment.	Visual identification in Street View.	High (it depends on the date of the image).
	Accessible crossing	It assesses the presence of accessibility ramps at the beginning and end of the crossing, or the presence of elevated crossings at the sidewalk level, both with dimensions and characteristics defined by NBR 9050.	Visual identification in Street View.	High (it depends on the date of the image).
	Longitudinal slope	Measures the longitudinal slope along the sidewalk segment.	It does not allow evaluation by online digital tool.	It is not possible to evaluate.
	Cross slope	Measures the inclination between the guide and the access to the buildings, that is, transversal to the length of the sidewalk.	It does not allow evaluation by online digital tool.	It is not possible to evaluate.
	Shading	It evaluates the proportion of the sidewalk segment that is shaded by trees and/or other elements such as awnings, canopies, arches, among others.	Viewing the image directly in Google Earth Pro (Map and 3D).	High (it depends on the date of the image).
	Presence of people	It identifies the presence of people who walk or remain on the sidewalks. Flow can be continuous, occasional, or absent	It does not allow evaluation by online digital tool.	It is not possible to evaluate.
	Presence of homeless people	It identifies the presence of homeless people who can inhibit the movement of pedestrians in certain places.	It does not allow evaluation by online digital tool.	It is not possible to evaluate.
	Presence of street vendors	It identifies the presence of permanent street vendors or street vendors, such as: newsstands, churros, ice cream, paçoca vendors, among others.	It does not allow evaluation by online digital tool.	It is not possible to evaluate.
	Street lighting	It evaluates the proportion of the sidewalk segment that is illuminated by public lighting posts aimed at vehicles and/or pedestrians.	Viewing the image directly in Google Earth Pro (Map and 3D).	High.
	Street furniture	It evaluates the presence of urban furniture. They can be: traditional (and found in most cities), such as poles, signs, traffic lights, or those that provide greater convenience and contribute to the aesthetics and comfort of the urban public space, such as benches, trash cans, tables, flower boxes, among others.	Visual identification in Street View.	High (it depends on the date of the image).
	Maintenance condition of urban furniture	It evaluates the state of maintenance and conservation of urban furniture.	Visual identification in Street View.	High (it depends on the date of the image).
Facade Plan	Block size	It evaluates the length of the blocks, represented by the dimension of the sum of all the facades of the buildings implemented in the block.	2D map measurement (Google Earth Pro – ruler tool).	High.
	Mixed and residential use	It assesses the proportion of mixed uses (residential, commercial and service) and underutilized lots for pedestrian activities.	Visual identification in Street View.	High (it depends on the date of the image).
	Day and night public use	It evaluates the proportion of public use of buildings on the block face with	Visual identification in Street View.	Low (it depends on image date) and

Plans	Indicators	Definition (TONON, 2019)	Data collection method	Data accuracy (high/medium/low)
		operation for more than 10 hours a day (the schedule covers the day and night).		inaccuracy of operating hours.
	Physical permeability	It evaluates the amount of access for pedestrians in buildings or open public spaces (parks, squares, among others).	Visual identification in Street View.	High (it depends on the date of the image).
	Visual permeability	It evaluates the proportion of the area of the facades that have visual permeability in relation to the urban space.	Visual identification in Street View.	High (it depends on the date of the image).
	Abandonment Aspects	It evaluates the percentage of degraded buildings or facades, without maintenance, graffiti, with broken glass or unused lots (unused land).	Visual identification in Street View.	High (it depends on the date of the image).
	Architectural diversity	It assesses the characteristics of buildings that contribute to diversity in urban space, such as: presence of historic buildings, different colors (basic and accentuated), textures, materials, adornments, among other characteristics.	Visual identification in Street View.	High (it depends on the date of the image).
	Front setback	It identifies whether the buildings are aligned with the sidewalks or the presence of different setbacks.	Visual identification on 2D (Google Earth Pro) and 3D (Street View) map.	High (it depends on the date of the image).
	Scale and proportion	It evaluates the relationship between the average height of the buildings on the block face and the width between the axes of the sidewalk segments, parallel to each other.	Visual identification in Street View.	High (it depends on the date of the image).
Coverage Plan	Human scale	It assesses the presence of elements that contribute to the perception of comfort and proportion to the pedestrian's scale. Some of these elements are: marquees, balconies, eaves, trees, among others.	Visual identification in Street View.	High (it depends on the date of the image).
	Visual pollution	It evaluates the excessive presence of elements in the coverage plan that can discourage or hinder pedestrians in their movements. Some of these elements are: excess overhead wiring; advertising boards, billboards, among others.	Visual identification in Street View.	High (it depends on the date of the image).
	Aerial obstructions	It evaluates the presence of aerial elements with low heights. Some of these elements can be tree branches, awnings, signage, among others.	Visual identification in Street View.	High (it depends on the date of the image).
	Visual landmarks	It assesses the presence of reference points defined by their simple or contrasting form in relation to buildings, architectural or natural elements in the coverage plan. Often the use of land has the function of "marking" the place and contributing to the reading of the space by pedestrians.	Visual identification in Street View.	High (it depends on the date of the image).
Street Plan	Street classification	It identifies the characteristics of the street in terms of its role in the street system (local, collector or arterial), together with the speed and flow of vehicles.	Visual identification on 2D map (Google Earth Pro).	High.
	Width of the street	It evaluates the width of the street destined for vehicles, dimensioned by the distance between the guides on both sides	2D map measurement (Google Earth Pro –	Medium.

Plans	Indicators	Definition (TONON, 2019)	Data collection method	Data accuracy (high/medium/low)
		of the street. For streets that have a central median, the width of the guideway to the refuge island is considered, as long as it has a safe space for pedestrians to remain.	ruler tool).	
	Visibility on corners	It evaluates the visibility of the traffic observed by pedestrians in both directions (parallel and perpendicular) and for the two crossings (beginning and end of the sidewalk segment).	Visual identification on 2D (Google Earth Pro) and 3D (Street View) map.	Medium.
	Side safety presence	It identifies elements between the sidewalk and the street that can dampen the invasion of a vehicle on the sidewalk. Elements are identified by length relative to the whole. These elements can be trees, poles, dumps, parked vehicles, cycle lanes, among others.	Visual identification on 2D (Google Earth Pro) and 3D (Street View) map.	High (it depends on the date of the image).
	Traffic signs	It evaluates the presence of horizontal (marked on the ground) and vertical (by means of signs) traffic signs, both for vehicles and for pedestrians.	3D visual identification (Street View).	High (it depends on the date of the image).
	Orientation and identification	It evaluates the presence of urban signage that aims to guide users in their movements. Some examples are: name of streets, indication of important places in the city or other region, among others.	3D visual identification (Street View).	High (it depends on the date of the image).
Street intersections	Traffic lights	It assesses the presence of traffic lights for vehicles and for pedestrians on arterial and/or collector roads, and whether they have a timer and/or pedestrian pushbutton.	3D visual identification (Street View).	High (it depends on the date of the image).
	Type of street intersection	It identifies the types of turns (left and right) at the street intersection and how much they can interfere with pedestrian safety. A streets intersection is where two or more streets intersect.	Visual identification on 2D (Google Earth Pro) and 3D (Street View) map.	High (it depends on the date of the image).
	Presence of crosswalk	It assesses the presence of crosswalks at crossings of street intersections.	Visual identification on 2D (Google Earth Pro) and 3D (Street View) map.	High (it depends on the date of the image).
	Maintenance condition of the crosswalk	It evaluates the state of conservation and maintenance of the crosswalk (painting, unevenness, holes, among others).	Visual identification on 2D (Google Earth Pro) and 3D (Street View) map.	High (it depends on the date of the image).

Source: The authors, 2021 and Google Earth Pro, 2020 e 2021.

Out of the 41 indicators proposed by Tonon (2019), 17% cannot be evaluated by online tools, as they involve observation of the use of space, such as the presence of people in the place, or the degree of precision of the elements to be measured, that make it impossible to evaluate by virtual means. In search of a more accurate result, these indicators were removed (Table 3). The results of the evaluated plans are presented below:

Sidewalk plan – in this plan, the evaluation showed that of the 18 indicators, 39% cannot be collected by virtual technical audit. In relation to the other indicators, 5% were considered of low precision (daytime and nighttime public use), as they needed to observe the functioning of the place for more than 10 hours a day, which is impossible through virtual means. The others were classified as high precision.

Facade plan – in this plan, the evaluation showed that of the 09 indicators evaluated, 9.9% were considered of low precision (day and night public use) because they needed to observe the functioning of the site, and the others were classified as high precision.

Coverage plan – in this plan, the evaluation showed that of the 04 indicators evaluated, 100% were considered to be highly accurate and, therefore, can be evaluated by digital online data collection tools.

Street plan – in this plan, the evaluation showed that of the 06 indicators evaluated, 33.3% were considered to be of medium precision due to the lack of precision in virtual mode, while 66.6% were considered to be of high precision.

Street's intersections – in this plan, the evaluation showed that of the 04 indicators evaluated, 100% were considered to be highly accurate.

Regarding the data collection tool through Google Street View, the following stand out: 1) For the indicators that were classified as highly accurate, this information, in some Brazilian cities, can be evaluated as of low precision due to the outdated date the images stored in this software's database; 2) The greatest difficulty was associated with indicators that required linear measurements. Examples of these indicators are the Total Sidewalk Width, Court Size and Street Width. These indicators did not present accurate data, as Google Earth does not offer precise tools for this purpose and the measurement results in a scale with map distortion; 3) Regarding the collection of data from other indicators, it is observed that the use of digital tools proved to be a viable alternative, provided that the images made available for viewing are recent and 4) Some indicators may be affected at certain points due to obstacles that impede the vision of the studied plans, such as large vehicles at the time of image registration by Google Street View.

Application of the IQEAP in Barra Bonita

Table 4 shows the results obtained for each of the plans evaluated on Rosa Zanela Petri Avenue.

Table 04: Results of the IQEAP on Rosa Zanela Petri Avenue.

Plans	Total score	Maximum score	Results %
Sidewalk Plan	119,46	270,0	**44%**
Facade Plan	61,89	135,0	**46%**
Coverage Plan	37,0	60,0	**62%**
Street plan	48,25	90,0	**54%**
Street intersections	10,33	32,0	**32%**
IQEAP	**264,68**	**587,0**	**44%**

Source: Authors, 2021.

Data show that of the five plans evaluated, 60% were considered regular. The overall result of the analyzed stretch reached IQEAP of 44%, which is considered "regular" and, therefore, partially favorable to the pedestrian environment. In summary, the tourist area should receive improvements related to spatial quality to encourage its use by visitors and residents. Therefore, interventions are needed that take into account the present study so that the site has a positive evaluation and, consequently, better results in the IQEAP.

The individual analysis of the plans showed that in relation to the **Sidewalk Plan**, classified as "regular", the biggest problems refer to the following indicators: Accessible crossing and shading. In the **Facade Plan**, rated as regular, the main problems were: Physical Permeability, Visual Permeability and Architectural Detailing. The evaluation of the **Street Plan**, classified as "regular", the main problems are associated with the Width of the Street and Orientation and Identification. In the **Coverage Plan** rated as "good", the main problems are related to Human Scale. Regarding **Street's intersections**, classified as "bad", all indicators are considered "very bad": Traffic lights at the street intersection, Type of Street Intersection, Presence of Crosswalk and Condition of Maintenance of the Crosswalk.

The results of the evaluated area, with the "Regular" IQEAP, show the importance of improvements in aspects involving pedestrian-oriented plans. Regarding the type of virtual audit used, positive and negative points were observed that may vary according to the type of research applied. Among the negative points is the difficulty in collecting information from indicators that require long-term measurements or observations. Another issue found was the date of the Google Earth images that were last captured in 2011 in Barra Bonita touristic city. On the positive points is the optimization of time in relation to the trip to the evaluated city and the length of stay in the place.

Thus, this research, in addition to highlighting the importance of the quality of pedestrian infrastructure in tourist cities, especially for its residents, those who most use this area for daily activities, also highlights the importance of using online digital technologies. These technologies can assist in various aspects of the technical audit process in research and contribute to public managers being able to view the positive and negative aspects of the entire area simultaneously and, thus, being able to offer guidelines for improving urban spatial quality for the pedestrians.

CONCLUSION

The article analyzes the feasibility of using online digital tools to assess the spatial quality of the pedestrian environment, through a case study carried out in an important avenue of the Tourist City of Barra Bonita, in the state of São Paulo.

The results show that although some indicators can be collected through online digital tools, the technical audit in the virtual format is still not very accurate due to: i) Date of the images made available on these virtual platforms, especially the images from Street View, ii) Lack of precision tools, especially linear measurements, and iii) Available image resolution (viewpoint altitude) the larger the image scale, the lower the degree of visual accuracy. Regarding the advantages, the following stand out: i) Use of fewer financial resources for displacements; ii) Decrease in the survey time on site (in situ) and iii) Ease of data collection in areas of difficult geographic access, dispersed, large or distant areas by improving the geographic scope and the tabulation of results. Aspects also highlighted by Bader et al. (2017).

REFERENCES

BADER, M. D.; MOONEY, S. J.; LEE, Y. J.; Sheehan, D.; NECKERMAN, K. M.; RUNDLE, A. G.; TEITLER, J. O. Development and deployment of the computer assisted neighborhood visual assessment system (CANVAS) to measure health-related neighborhood conditions. **Health & Place**, 31, 163–172. 2015. Available in: <https://doi.org/10.1016/j.healthplace.2014.10.012>.

BETHLEHEM, J. R.; MACKENBACH, J. D.; BEN-REBAH, M.; COMPERNOLLE, S.; GLONTI, K.; BÁRDOS, H.; LAKERVELD, J. The SPOTLIGHT virtual audit tool: A valid and reliable tool to assess obesogenic characteristics of the built environment. **International Journal of Health Geographics**, 13(1), 52. 2014. Available in: <https://doi.org/10.1186/1476-072X-13-52>.

BRASIL. Lei Geral do Turismo. Available in: <http://www.turismo.gov.br/turismo/legislacao/legislacao_geral/11771_lei.html>. Accessed on March 23, 2012.

CALDEIRA, M.; NEUZA, S.; NUNES, F. Turismo Acessível em Guimarães. Oportunidades e desafios para uma cidade inclusiva. **Holos**, v.4. 2017, pp. 341-356.

CAMPBELL, A.; BOTH, A.; SUN, Q. Detecting and mapping traffic signs from Google Street view images using deep learning and GIS. **Computers, Environment and Urban Systems**, 77, 101350. 2019. Available in: <https://doi.org/10.1016/j.compenvurbsys.2019.101350>.

CHAGAS, M. M. das. **Análise da relação causal entre imagem de destinos, qualidade, satisfação e fidelidade: um estudo de acordo com a percepção do turista nacional no destino turístico Natal.** Dissertação (Mestrado em Turismo), Universidade Federal do Rio Grande do Norte, Natal. 2010.

CLARKE, P.; AILSHIRE, J.; MELENDEZ, R.; BADER, M.; MORENOFF, J. Using Google Earth to conduct a neighborhood audit: Reliability of a virtual audit instrument. **Health & Place**, 16(6), 1224–1229. 2010. Available in: <https://doi.org/10.1016/j.healthplace.2010.08.007>.

EWING, R.; CLEMENTE, O. **Measuring urban design – metrics for livable places**. Washington, DC: Island Press, 2013.

FANTINI, F. **Acessibilidade espacial para idosos em zonas turísticas balneares costeiras: Estudo de caso em Balneário Camboriú/SC**. Dissertação (Mestrado em Arquitetura e Urbanismo), da Universidade Federal de Santa Catarina. Florianópolis, 2014.

FERREIRA, M.; SANCHES, S. Índice de Qualidade das Calçadas – IQC. **Revista dos Transportes Públicos**. Ano 23. n. 91. p. 47-60. 2001.

GOOGLE. Google Earth website. Available in: <http://earth.google.com/, 2019>.

GORRINI, A.; BERTINI, V. Avaliação de Walkability and tourism cities: the case of Venice. **International Journal of Tourism Cities**. vol. 4 No. 3, pp. 355-368. 2018.

GRIEW, P.; HILLSDON, M.; FOSTER, C.; COOMBES, E.; JONES, A.; WILKINSON, P. Developing and testing a street audit tool using Google street view to measure environmental supportiveness for physical activity. International **Journal of Behavioral Nutrition and Physical Activity**. 10(1), 103. 2013. Available in: <https://doi.org/10.1186/1479-5868-10-103>.

HE, L.; PÁEZ, A.; LIU, D. Built environment and violent crime: An environmental audit approach using Google street view. **Computers, Environment and Urban Systems**, 66, 83–95. 2017. Available in: <https://doi.org/10.1016/j.compenvurbsys.2017.08.001>.

JACOBS, J. Morte e vida de grandes cidades. 3 ed. São Paulo: Martins Fontes, 2014.

LI, X.; ZHANG, C.; LI, W.; RICARD, R.; MENG, Q.; ZHANG, W. Assessing street-level urban greenery using Google street view and a modified green view index. **Urban Forestry & Urban Greening**, 14(3), 675–685. 2015. Available in: <https://doi.org/10.1016/j.ufug.2015.06.006>.

MAGAGNIN, R. C.; RIBEIRO, C. C. R.; PIRES, I. B. As diferentes percepções sobre os problemas de mobilidade urbana em uma cidade brasileira de médio porte: a visão dos especialistas e da população de Jundiaí (SP - Brasil). **Anais...** do

7º Congresso Luso Brasileiro para o Planejamento Urbano, Regional, Integrado e Sustentável, PLURIS, Maceió - AL. 2016.

MEDEIROS, H. L. V. de. Resgatando a habitabilidade local: inserção de rota acessível no centro histórico de João Pessoa – PB", In: **Anais....** Encontro Nacional De Tecnologia Do Ambiente Construído, 16., Maceió: Antac, 2016. p. 1 – 08.

NYC – NEW YORK CITY. **Active Design: Shaping the sidewalk experience**. New York, 2013. Available in: <https://nacto.org/docs/usdg/active_design_shaping_the_sidewalk_experience_nycdot.pdf>. Accessed on 22 Aug. 2018.

PIRES, I. B. **Índice para avaliação da caminhabilidade no entorno de estações de transporte público**. 2018. 151 p. Dissertação (Mestrado em Arquitetura e Urbanismo) - Faculdade de Arquitetura, Artes e Comunicação, Universidade Estadual Paulista, Bauru, 2018.

RUNDLE, A. G.; BADER, M. D.; RICHARDS, C. A.; NECKERMAN, K. M.; TEITLER, J. O. Using Google street view to audit neighborhood environments. **American Journal of Preventive Medicine**, 40(1), 94–100. 2011. Available in: <https://doi.org/10.1016/j.amepre.2010.09.034>.

SILVEIRA, P. R. G. da; GOES, G. V. Acessibilidade e caminhabilidade no roteiro da fé em Juazeiro do Norte-CE. p. 339-350. In: **Anais...** VII Encontro Nacional de Ergonomia do Ambiente Construído / VIII Seminário Brasileiro de Acessibilidade Integral. São Paulo: Blucher, 2018.

STEINMETZ-WOOD, M.; VELAUTHAPILLAI, K.; O'BRIEN, G.; ROSS, N. Avaliando o ambiente em microescala usando o Google Street View: a ferramenta virtual sistemática para avaliar paisagens de pedestres (Virtual-STEPS). **BMC Public Health** 19, 1246. 2019.

TONON, B. F. **Instrumento para avaliação da qualidade espacial do ambiente de pedestres**. 231 p. Dissertação (Mestrado em Arquitetura e Urbanismo) - Faculdade de Arquitetura, Artes e Comunicação, Universidade Estadual Paulista, Bauru, 2019.

UNWTO - Organização Mundial do Turismo. **Annual Report 2016.** UNWTO, Madrid, 2017. DOI: <https://doi.org/10.18111/9789284418725>.

YIN, L.; WANG, Z. Measuring visual enclosure for street walkability: Using machine learning algorithms and Google Street view imagery. **Applied Geography**, 76, 147–153. 2016. Available in: <https://doi.org/10.1016/j.apgeog.2016.09.024>.