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Urban shape and pedestrian traffic in southern Chile. The Valdivia case study

Forma urbana y peatonalidad en el sur de Chile. Estudio de caso de Valdivia

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ABSTRACT/ There is a growing demand for pedestrian traffic in middle-sized cities to counteract the increasing use of the automobile. In Valdivia, vehicle dependence is mainly due to the expansion of urban soil to peripheries, increasing distances and complicating access to everyday needs. The article explores elements of urban form that impact on pedestrian traffic and discusses two neighborhoods in the city of Valdivia, Chile. The methods used include a quantitative analysis to measure the accessibility and scale of the built surroundings; and a qualitative analysis to assess spatial quality and route selection. The outcomes show no lineal relationship between pedestrian accessibility and block size, suggesting that the distance that a person is willing to walk depends on the purpose: transportation or recreation. Finally, this study makes recommendations to improve local planning in order to guide urban development towards a human scale. **RESUMEN/** En las ciudades intermedias, la demanda para promover la peatonalidad como una medida en contra del creciente uso del automóvil va en aumento. En Valdivia, la dependencia en el uso del automóvil se debe principalmente a la expansión del suelo urbano hacia las periferias, lo que genera un aumento en las distancias y dificulta el acceso a las necesidades diarias básicas. El artículo explora elementos de la forma urbana que inciden en la peatonalidad y analiza dos barrios en la ciudad de Valdivia, Chile. Los métodos utilizados son de análisis cuantitativo para medir la accesibilidad y la escala del entorno construido, y de análisis cualitativo para evaluar la calidad espacial y la elección de rutas. Los resultados muestran que la relación entre accesibilidad peatonal y los tamaños de las manzanas no es lineal, lo que sugiere que la distancia que una persona está dispuesta a caminar depende del propósito: transporte o recreación. Finalmente, este estudio hace recomendaciones para mejorar la planificación local con el fin de orientar el desarrollo urbano hacia una escala humana..

INTRODUCTION

The past decade has seen a surge of interest in walkable neighborhoods as a counter measure against car-based urbanism, moving towards pedestrian-oriented cities in response to fossil-fuel-related environmental degradation (Atkinson 2007; Wu et al. 2018). Cities for a sustainable future are viewed in a way that can reduce car dependence and fossil fuel combustion by promoting walking environments. Walkability is associated to the concerns that car-dependent cities will not be sustainable in the future due to energy costs, fuel availability, congestion, pollution, and other environmental impacts (O'Hare 2014; Jirón 2013). Walkable neighborhoods have urban form characteristics that encourage pedestrian activity, thereby improving community health. Many scholars suggest that promoting walkability as a prime measure to bring people into public spaces, reduce congestion, and boost local economy and interactions will have beneficial effects not only to help reduce automobile reliance, but also to add an incredible amount of vibrancy to city life (Talen and Koschinsky 2013; UN-Habitat 2014).

The process of urbanized transformation in Chile has been modifying and increasing the scale of urban environment and functional relationships within the city (UN-Habitat 2011). In the case of Valdivia, an intermediate city in southern Chile, urban expansion and sprawling began in the sixties –post-earthquake– when people looked for safer areas in the peripheries (Villagra et al. 2014). Its current urban policies and planning

instruments have pursued market-oriented development through the hand of privates to shape urban growth by means of new expansive and low-density developments towards the peripheries, leading to profound changes and exacerbated socio-spatial segregation (Espinoza and Zumelzu 2016). In other words, this urban change scale missed integrating all of the daily functions of urban life (dwelling, work, and entertainment) in a defined territory in function of the commodity of walking persons—neighborhood levels (Zumelzu 2015).
In the debate of walkable neighborhoods, the quality of urban form at the block level plays a key role in terms of how the built environment supports pedestrian activities. These considerations would be a basis for this study to examine built environmental factors that appear to affect walkability in urban neighborhoods. This research explores urban form elements that appear to affect the built environment for walking. Built environmental elements could be defined as sidewalks, pedestrian paths, and facilities like parks and playgrounds, as well as their qualities to generate one's perception towards walking environments. The case study are the neighborhoods of Huachocopihue and El Bosque in Valdivia. This study will use mixed approaches of quantitative and qualitative analysis. The quantitative analysis was used for assessing access to neighborhood-level facilities and scalar patterns, while the qualitative analysis evaluated the quality of the built environment for walking. The article concludes with recommendations for the urban design of neighborhoods with a greater walkable orientation, and their impact to address a positive transformation of the city towards a more sustainable future.

LITERATURE REVIEW

The Importance of Walkability in Urban Sustainability

As urbanization rate increases, there is a pressing need to improve community living in today's neighborhoods as "neighborhood is seen as the most important urban element that establishes the social and economic sustainability of the area, providing the community ties which hold it together" (Neal 2003). The main mode of transportation even in the neighborhood area are private cars because using motorized vehicles rather than walking is the norm of urbanites. This car reliance is also caused by sprawling and unsustainable lifestyles, which disconnect pedestrians to the neighborhood cores by creating housing beyond the residential walking zone (McNally 2010). The transformation of the cities' built environments towards increasing urban sprawling is one of the major factors impacting declining walkability due to a notable increase in car travels and vehicle transportation (Rafiemanzelat, et al. 2017).
In a similar sense, intermediate-sized cities have gained their competitiveness and attractiveness as places to live. Urbanization requires an advancement for intermediate cities because they are strongly associated to regional and surrounding dynamics (Concha *et al.* 2013). Advances in the provision of access to transportation, settlement, commerce, and other services have increased these cities' attractiveness, suggesting a better balance in national urban systems. Some mid-sized cities undergo accelerated growth due to large-scale industrial investments which are also linked to large urban centers that act as magnets for human and financial capital. The increase in the supply of sufficiently qualified labor to fulfil industrial requirements, coupled with lower land prices and relatively less complicated atmospheres, and in some cases, infrastructure and connectivity improvements, helped decentralize companies to these secondary conglomerations (UN-Habitat 2012). Intermediate cities, hence, offer possibilities for providing a suitable environment to boost metropolitan cities achieving economic equilibrium in the urban network and a multiplication of the beneficial effects of urbanization.
Some intermediate cities, however, are reproducing the environmental and social processes triggered by globalization in large cities (Henríquez et al. 2006; Espinoza and Zumelzu 2016). Mid-sized cities play a role in providing suburban settlements for people who work in large cities, making the progressively scattering the populations into these settlements. The heart of the matter is the strong relationship between people and automobiles, even making the suburban lifestyle to simply follow their social self-expression of car ownerships (Atkinson 2007). Living with cars will turn the scale of suburban environments into a car-oriented development that deflects our vision away from a sustainable future, in the absence of efforts to arrange daily activities within walking distances.
In the line of sustainable future, promoting walkable environments stands as the foundation of sustainable cities, creating a compact city in which people and their activities within a defined territory are well-connected. Burden (2010) defines walkability as the extent to which the built environment is friendly to the presence of people walking, living, shopping, visiting, enjoying, or spending time in an area. Frank et al. (2006) argue that walkability also depends on the human behavior of neighborhood residents. In this sense, many scholars have advocated the importance of walkability in approaching the concept of urban sustainability because walking is a 'green' mode of transportation that not only reduces congestion, but also has low environmental impact, preserving energy without air and noise pollution.
Forsyth and Southworth (2008) stated that walkability can be more than a purely utilitarian mode of travel for trips to work, school, or shopping, but it can have both social and recreational value. It is also a socially-equitable mode of transport that is available to a majority of populations, across classes, including children and the elderly. Additionally, while walking around, residents might have more chances to interact with

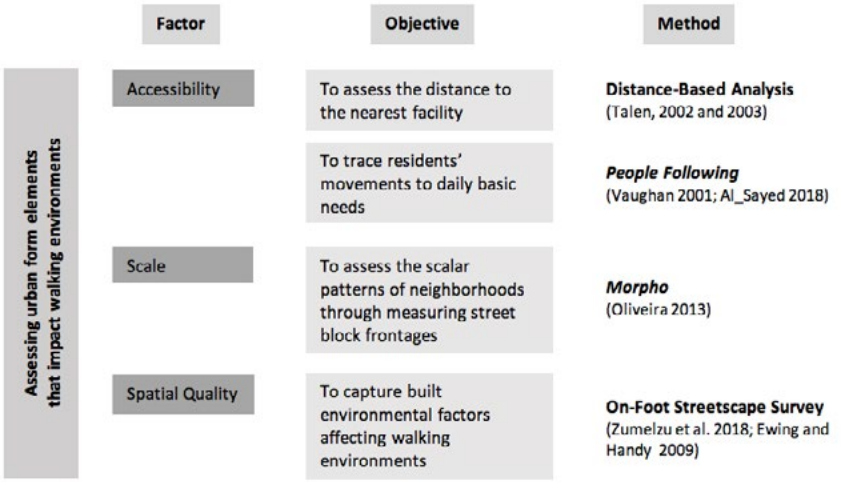

Figure 1. *Methodological structure (source: Authors, 2018).*

their surroundings more regularly and thus, to feel more connected to their neighbors, creating "sustainable communities" which are described as places where people are sensitive to their environment and contribute to a high quality of life, including collective aspects of social life such as activity, inclusiveness, and safety (Dempsey et al. 2009).

Built environmental factors that affect walkability of neighborhoods

Most studies that address the built environment to walk have focused on the amount of walking as the outcome variable. For many people walking in the urban environment, especially urban designers, the success of increased walking should not simply be measured by the number or duration of walking trips, but also by the quality of those trips in terms of user experience. As the literature makes clear, the quality of walking environments is one of several broad factors influencing walking behavior, along with demographic characteristics, attitudes, and the presence of desirable destinations, such as local shops/retails, parks, playgrounds, green open spaces, schools, etc. Therefore, better understanding of how built environment characteristics influence user perceptions of quality, could potentially lead to both improved user experience and more walking. This because the walkable neighborhood is also associated with specific urban design features (Talen and Konschinsky 2013). A physical environment where residents live acknowledges a socio-spatial interpretation of neighborhood and community closely related to the built-environment since it is claimed that such feelings can be affected by the perceived quality of a place (Talen 1999). Forrest and Kearns (2001), therefore, argue that the importance of the urban form (or features of the built-environment) should not be underestimated in relation to one's sense of relating to a place. It can be discerned that pedestrian friendly designs include features that make active travel pleasant and safe, such as tree-shaded streets, well-connected streets with sidewalks, or other pleasantly-aesthetic features.

MATERIAL AND METHODS

Methodology

In terms of assessing walkability, human experiences to the features of the built-environment have the centrality of contributory factors that affect the way people relate and use the pedestrian access to local amenities. Perceptions of the built environment's quality have been found to be important in studies linking neighborhood form to walking behavior since a quantitative research alone tends to miss qualitative factors of the built-environment's features that appear to affect walking.

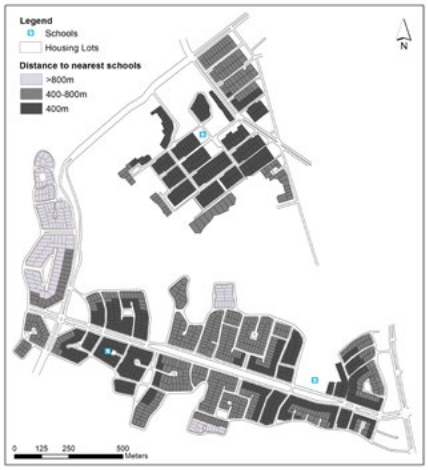

Figure 2a. *Distance to Schools (source: Authors, 2019).*

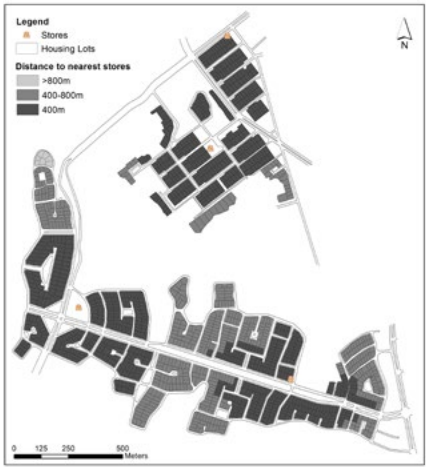

Figure 2b. *Distance to Stores (source: Authors, 2019).*

Ewing and Handy (2009) dismantled that perceptions produce awareness or understanding of sensory information. Moreover, perceptions can be assessed with a degree of objectivity by outside observers, while individual reactions cannot. As such, the author here was the outside observer to assess the spatial qualities based on the appearance of built environmental factors. To assess the effects of urban form elements on walkability of neighborhood, the methods applied here were as follows:

- Accessibility is defined here as the ease with which residents can reach a given destination. In this research, accessibility was calculated through two major stages. First, an analysis of neighborhood in terms of pedestrian access to services, using the "distance-based analysis" by Emily Talen (2002; 2003). Access is measured based on spatial proximities between residents and the neighborhood-level facilities, such as schools, stores, and parks. Secondly, an analysis for tracking and mapping the walking movement of neighborhood residents to access daily needs. The method of this second stage is known as *People Following* to trace the routes taken by people by following them. With regards to numbers, Vaughan (2001) suggested that it is best to follow around 25 – 50 people on site.
- Scale poses as evaluating static morphological elements to determine the human scale of pedestrian movement. To analyze the scalar patterns of the built-environment and its influence on pedestrian access, dimensions of street block frontages were employed. The evaluation of scalar patterns of the neighborhoods used the *Morpho* method created by Oliveira (2013) to assess the scale dimension of a built form.
- Spatial quality is measured by the evaluation of the quality of built form. This will be qualitatively assessed based on the current data and information from fieldwork analysis. The analysis of spatial qualities lies on three criterions: Quality of public spaces, infrastructure for local businesses and basic services, and green areas (Zumelzu et al. 2018). The three spatial quality criteria will be discussed by means of specific parameters of the built-environment settings that have contributory factors influencing pedestrian experiences (Ewing and Handy 2009).

Figure 1 exhibits the analytical structure of the research methodology.

Case study

The El Bosque and Huachocopihue neighborhoods were selected to carry out the observational site studies. Both neighborhoods are located in Valdivia's peripheries, which began to be urbanized post-earthquake, during the sixties. Huachocopihue was developed with a western Garden City concept that prevailed during the post-earthquake period, when the Chilean state intended to solve the housing gap. There was a huge social housing development on Valdivia's peripheries, which were deemed as low-risk areas from potential earthquake and tsunami impacts. Under the Housing Bureau state program *(Corporación de la Vivienda, CORVI)*, the idea was to connect inhabitants with their natural environment in the form of parks, private or communal gardens, and other surrounding green areas. On the other hand, El Bosque is a social housing development built by a private stakeholder in the eighties, during the dictatorship era. During that decade, the housing development was the result of the land market liberalization. This economic-driven development tends to segregate uses (housing and non-housing) eventually increasing transportation demand to access services and jobs. All in all, both neighborhoods are residential areas with many of the right urban elements to understand how people use and relate to spaces.

RESULTS

How access is measured should be based on how the indicator is to be used. Figure 2 shows the intra-neighborhood variation of access to schools and stores.

Having performed the 'distance-based'

Figure 3a. *Movement traces to access daily needs in Huachocopihue (source: Authors, 2019).*

Figure 3b. *Movement traces to access daily needs in El Bosque (source: Authors, 2019).*

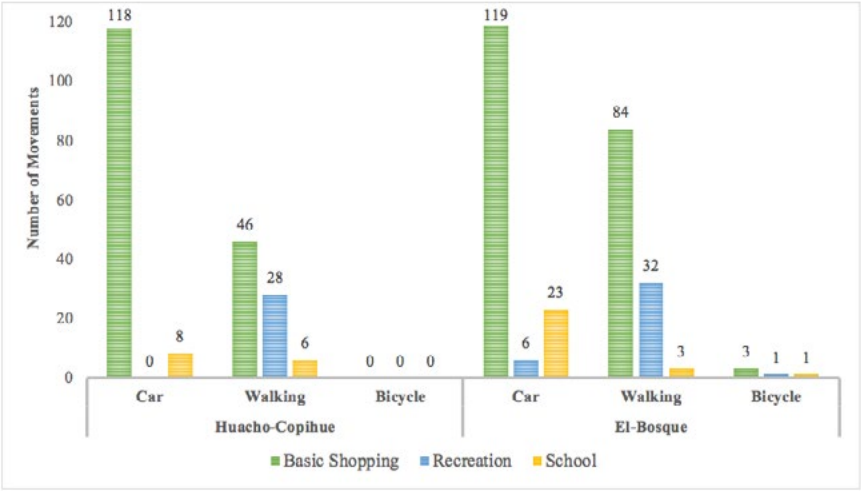

Figure 4. *Modes of transportation taken by residents to their daily activities (source: Authors, 2019).*

Figure 5. *Block performance for pedestrians (source: Authors, 2019).*

application, the next level of application lies on the *People Following* method. To conduct this method, a total of 37 and 43 participants took part in Huachocopihue and El Bosque, respectively. The traced movement pattern in Figure 3a and 3b depicts pattern movements in Huachocopihue and El Bosque to perform daily activities such as basic shopping, recreation, and going to school. These were conducted in several ways, either at facilities within the neighborhood or to sectors beyond the neighborhoods' boundaries to satisfy basic daily needs. The figures show the routes taken by the respondents to access daily needs in each neighborhood. Each map is a collection of many thin lines indicating the routes and since there are so many overlapping lines, they look like a single thick line. Each line indicates each route from an origin (home) to a destination point (either store, school, or park), differentiated by colors.

With regards to the result of traced movements, both neighborhoods are suffering from walkability decline since most daily needs are covered by car trips (refer to figure 4). Empirically speaking, neighborhood residents will not resort to the businesses and services provided locally if they fail to match the residents' preferences, especially if the choice of grocery stores is poor and there are no preferential education institutions where residents are more likely to send their children.

To assess human-built dimensions in a neighborhood, conducting a scalar assessment is crucial to identify the convenience of the neighborhood's built

CRITERIA	HUACHOCOPIHUE		EL BOSQUE	
	Quality	Observation	Quality	Observation
Public spaces	3 (fair)	Some grocery stores with signs were found. They will draw attention and act as identifiers of the street where they are located.	2 (poor)	Lack of features that serve as identifiers and memorable elements may negatively impact the uniqueness or human experiences for pedestrians.
Infrastructure to facilities	2 (poor)	Street frontages on most avenues approach to 'dead' building uses and be worse with some blank walls along public streets. Also, a rigid fence in front of every home is a solid barrier for public and private interfaces.	2 (poor)	The absence of diverse building uses and, in contrast, the monotonous presence of single-family houses makes 'dead' building uses. As a consequence, the vibrancy of street life is taken over by vehicular traffic.
Green areas	4 (good)	The Reserva Huachopihue nature reserve and other smaller parks are located just beside sidewalks and can be accessed easily while walking.	4 (good)	The El Bosque urban park and many cluster parks play a role as recreational destinations for residents, who mostly walk to them.

Table 1. *Spatial quality assessment (source: Authors, 2019).*

Image 1. *Built environmental factors in Huachocopihue: a). Blank walls; b). Parked cars on pedestrian paths; c). A street along 'dead' uses on both street sides (source: Authors, 2019).*

environment for pedestrians. Based on the Morpho method, street block frontages were measured as an element deemed to impact the pedestrians' convenience and resulting in circulation patterns at block levels (see figure 5). The block frontages were then applied to conditions which represent the best trade-off between pedestrian and vehicular requirements in the circulation mesh. It must be emphasized that the performance assessments of block dimensions are comparative and relative, rather than absolute connotations.

Table 1 provides the results of spatial quality assessment, while images 1 and 2 present a selection of representative images of the built-environment's features in Huachocopihue and El Bosque, respectively. As the result, this study reveals the built environmental factors which could be improved to stimulate on-foot activities. See table 2.

Image 2. *Built environmental factors in El Bosque: a) Lack of tree canopies; b) Green belt; c) Curbsides and sidewalks; and d) Rigid house fences to interrupt public/private interfaces (source: Authors, 2019).*

DISCUSSION

According to the movement patterns that have been assessed, there are two motivations for walking: Recreation and transportation. Recreation refers to travel for pleasure or picnic by going to a park, plaza, or playground; while transportation relates to a non-motorized mode of transport to reach a destination, such as a store or a school. The results suggest that the different modes of transportation that residents take depend on their reason for walking. They are more willing to walk for recreation than for transportation purposes. If someone is walking to reach a destination (transportation), it is important for them to have access to short routes (less than 400 meters or equal to a 5-minute walk), and that the origin and destination are in close proximity. Surprisingly, while both neighborhoods have their own school and stores, residents prefer to go beyond the neighborhood's borders or take their private cars to reach the services, even when they are within the neighborhood's limits.

With regard to walking for transportation, there are at least three possible explanations of why car usage remains considerably demanded. Firstly, the predominant single-family typology in the neighborhood housing may result in low population density, thereby creating longer routes and resulting in less people on the streets. Comparing the density calculation for both neighborhoods and a recent study by UN-Habitat (2014), population densities in Huachocopihue (57 people/ha) and El Bosque (51 people/ha) are far below from

NEIGHBORHOOD	ELEMENTS	IMPROVEMENTS NEEDED
Huachocopihue	The centrality of local shops	By providing more local shops that offer a large variety of household daily needs in the neighborhood's central area, residents are encouraged to satisfy their routine life needs on foot.
	Street frontages	Microscale features of walking environments that might make pedestrians feel attracted to and pleased by walking could be accounted for, such as tree-shaded streets, parks, glass-fronted shop displays, open outdoor dining, or other pleasantly-aesthetic features.
	Pedestrian routes with "dead uses"	Availability of children's playgrounds, street furnishing, small food and beverage locales, other amenities and venues will help add diversity to street life and result in a vibrant surrounding.
	Public open spaces	Public open spaces, such as children's playgrounds, squares, fountain landmarks; or indoor areas, such as cafés, community centers, liquor stores, and so on, are some examples that can be taken into account for bringing opportunities to keep in touch with others.
El Bosque	Linear settlement pattern	Providing more dispersed local amenities in order to reduce the distance to businesses and services. A number of relatively small neighborhood-level facilities are preferred instead of a single large facility (like the El-Trebol supermarket), thereby improving the chances to simply walk and to meet the residents.
	Cluster parks	Cluster parks serve as complementary features to the urban park or the green corridor on the main collector street. Cluster parks provide different qualities of public spaces and bring social interaction closer compared to the urban park. For that reason, keeping existing parks and establishing new ones would be supportive measures to attain a walkable neighborhood.
	Homogenous housing	Introducing diverse and mixed-use developments (land uses and building uses) by combining land uses between housing and commercial buildings, could be used as a countermeasure to limit the housing's single-function.
	Street frontages	The absence of active street frontages in most of the streets' ambiences becomes a major concern towards spatial quality assessment. The same treatment proposed for Huachocopihue is considered for this neighborhood.
	Barriers that thwart public/ private interfaces.	In order to link the house with the neighborhood, the municipality can introduce semiprivate transit areas, which are areas between the private space (home) and the public areas (streets, sidewalks). Semiprivate areas include front yards (with furnishing), porches, and semi-private forecourts.

Table 2. *Key elements of the built environment for promoting walkability in neighborhoods (source: Authors, 2019).*

sufficient to promote vibrant street life and walkability based on the UN's standard of minimum 150 people/ha. Secondly, the variety of facilities also plays an important role in determining the results. In this case, the centrality is made up of several retail shops arranged in a row. As could be seen from the People Following result, residents only benefit from the presence of this retail center to buy bread. Other basic needs, such as groceries, fruits, vegetables, and meat, are almost entirely met outside the neighborhood. In sum, there is a huge imbalance between what people want and what is currently offered.

Given the suburban locations of the two cases, this thesis poses a proponent towards Atkinson's study in his second trilogy (2007). The author stated that the growing dependency on car usage is a nemesis of modern civilization and the heart of the suburban lifestyle problem. The progressive dispersion of populations into suburban settlements favors a closer relationship between people and automobiles. Individual houses cannot be understood except in connection with automobiles that connect them to work places, schools, businesses, and recreational facilities, which are often located downtown. Therefore, walkability is degraded by a priority use of automobiles to connect the sprawled development outside of the resident's walking zone.

Comparing the results between the traced movements of both neighborhoods (figure 3) and block performance based on street block frontages (figure 5) reveals that the relationship between pedestrian accessibility and block lengths is non-linear, suggesting that whether smaller or larger blocks would improve pedestrian accessibility depends on one's purpose for walking: transportation or recreation. The size of the block and plot dimensions do not affect walking behavior; this behavior is impacted only for transportation purposes if the starting point to reach a destination is over a walking distance and/or if residents simply choose their own preferred mode of transportation early in their trips. Similarly, in the certain case of walking for recreation, there is no significant association between block lengths and pedestrian accessibility. People still prefer to walk when they go for recreational activities, regardless of the length of the block from where they begin. This is important since a number of

urbanists inter alia Targa and Cliffon (2005), Ewing and Cervero (2010), and Talen and Koschinsky (2013), have stipulated that walkability should increase with smaller blocks because they believe typically smaller blocks do indeed tend to generate higher pedestrian accessibility than larger blocks.

CONCLUSIONS

Walkability is a multifaceted concept that requires several elements of the built environment. Walkability studies, hence, emerge to look for the elements in the environment that might influence walking experiences and to promote them wherever feasible. Promoting walkability is a key measure to bring people into public spaces, reduce car dependency, and boost the vibrancy of city life. Walkability helps enhance the vitality and livability of a city. The impacts of expanding the urban form towards peripheral areas are not only reducing the ability of citizens to reach urban opportunities, but are also degrading the built environment for pedestrian accessibility to be less walkable. Consequently, this study suggests that urban form should be taken into consideration in city planning instruments, to better guide its growth and promote the use of its citizens' attitudes towards urban space. Efforts to promote walkability should not be discerned as merely normative and physical-metric approaches; qualitative measures ought to be involved to assess the extent to which walking environments capture pedestrian's perception that might arise while walking. The lack of active street frontages is considered the major contributory factor in the declining walkability of neighborhoods. As a catalyst, the built environment is recommended to be improved by enhancing diverse building uses, refurbishing "dead uses" along pedestrian routes and taking pedestrian-friendly designs into consideration for the sake of adding vibrancy to street life. Lastly, future studies could explore downtown neighborhoods and use "walk to work" as an aspect of further study. Another suggestion is for the quality of the built environment assessment to involve the residents' own perception in order to provide comparisons with the researcher's perception and with outside observer.

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