ARTICLE

Spatial Accessibility of Bakeries and Supermarkets in Belo Horizonte, Brazil

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ABSTRACT

The recent events and constant global changes show the importance of rethinking city planning. In this context, the 15-Minute City concept got important as it brings people closer to activities and services, through short trips by active modes, being the key to a sustainable city. Based on this concept, this paper analysed the spatial accessibility of residents of Belo Horizonte (Brazil) to two establishments essential to the quality of life: bakeries and supermarkets. The analyses were made through the influence areas, spatial clusters, and the Local Indicators of Spatial Association. The results showed that bakeries are more accessible than supermarkets, which are not accessible to the entire population, especially in low-density and low-income regions. In addition, areas with potential for new projects were identified by the relationship between existing facilities (supermarkets or bakeries) and population density/income. Finally, the results highlight the challenges for developing sustainable cities considering the 15-Minute City concept throughout the territory of Belo Horizonte.

1. Introduction

The COVID-19 pandemic has changed people's way of living and, consequently, their consumer behaviour [1]. Additionally, the increase in extreme weather events shows the need to rethink city planning towards more sustainable and resilient urban areas [2]. As a result, new concepts

rethinking the city have emerged, mainly in Europe and Asia, based on accessibility, walkability, density, mixed land use, and design diversity [2]. One form was translated into the 15-Minute City concept by Carlos Moreno, which advocates that geographic proximity between people, services, and activities is the key to a sustainable city.

The 15-Minute city is the motivation for this work. The

concept is composed of four pillars: density, digitalization, diversity, and proximity [3]. These pillars support the development of sustainable communities with spaces for living, working, commerce, healthcare, education, and leisure [3]. Also, within 15 minutes by bicycle or on foot displacements, people should be able to access such services or a public transport station that enables them to reach all services in the city [3].

Moreover, the concept of accessibility is the core of this paper and is understood as the easiness of reaching goods, services, activities, and destinations, hereby called opportunities [4]. Accessibility is directly related to the availability of opportunities for a specific activity when compared to another and varies according to socio-economic characteristics [5]. Accessibility to groceries is important to citizens [6] as it is closely related to people's life quality.

In Brazil, the neighbourhood design was historically oriented towards car use, and people depend on private vehicles for their daily activities, including accessing essential and basic opportunities [7]. As a result, access to essential retailing is designed for automobiles, even if the travel distance is little, makes it possible the usage of active modes. Retailing establishments with no parking areas are frequently not accessed by private car users, and consequently have a reduction in their potential consumer demand. It is worth mentioning the reasons that motivate essential goods purchases are not obvious or are impulsive [8]. In this way, providing a retail network of essential goods is vital for the population's quality of life, and access to these establishments through active modes can contribute to more sustainable urban transport.

Based on these issues, it was hypothesized that the adequate location of retail establishments increases the accessibility of the consumers by reducing the travel distance, contributing to the improvement of the quality of life of communities and making the environment more conducive to implementing the concept of a 15-Minute City. The 15-Minutes City creates accessible mixed communities, reducing inequality and meeting the 11th sustainable development goals. In addition (i) they promote the use of clean and affordable energy (goal 7) by encouraging the use of active modes, electric vehicles, and public transport; (ii) promote decent growth and economic development (goal 8), as the concept is based on of the community economic development; and (iii) combating climate change (goal 13) by reducing travel and the use of fossil fuels.

This paper focuses on the accessibility of supermarkets and bakeries, which offer essential services and kept running during the COVID-19 outbreak in Brazil. The accessibility to these commercial establishments was more critical during the pandemic time, with a restricted movements in the cities. In addition, most Brazilian cities had a reduction in public transport services, demonstrating the importance of having a nearby bakery and/or supermarket to access essential products during the lockdown. the population that depends on public transport for shopping was the most harmed during the pandemic, restricting their access to shop options. Those who did not have commercial establishments close to their home had to purchase the products in other ways, including e-commerce and peer-to-peer application services.

Based on the above, this paper aims to evaluate the accessibility of supermarkets and bakeries by active modes, using spatial analysis. The research question is "Are bakeries and supermarkets accessible for all?". Answer this question was identified the accessibility by buffer analysis. The spatial concentration of these establishments were analysed using the Local Indicator of Spatial Association based on the bivariate Moran Index. Findings showed that bakeries are more accessible than supermarkets by active modes. Moreover, few clusters were identified in Belo Horizonte, indicating potential regions for new supermarket and bakery businesses to contribute to a sustainable city, based on spatial distribution and accessibility (without considering other variables e.g., consumer behaviour, product quality, or others).

The contribution of this paper is twofold. First, the accessibility to supermarkets and bakeries was measured. Second, this research identified neighbourhoods with potential for new shop opportunities, more precisely, supermarkets and bakeries contributing to transforming Belo Horizonte into a 15-Minute city. Findings were based on public data and open-source software, allowing replication to other territories.

2. Importance of the Accessibility for Sustainable Trips in Urban Areas

Accessibility to urban services is a crucial component of quality of life [9] and a primary role of the transportation system [10]. In this matter, accessibility to urban services can be related to their use [11]. Neighbourhoods with a high level of accessibility can stimulate sustainable trips more efficiently [12,13]. Following the new urbanism principles, residential and retail areas need to be closer, enhancing a mix of complementary land uses to support the Transit-Oriented Development [14] and focusing on accessibility. Rethinking accessibility strategies are the basis of the sustainable paradigm [15]. The sustainable accessibility concept is based on the combined analysis of densification, mixed land uses, integration, and non-motorized transportation modes [15]. The combination of accessibility and sustainable concepts has become central to urban

planning [16] and the development of Sustainable Urban Mobility Plans (SUMP).

The accessibility is based on the location perspective [17], i.e., "a location is accessible by people, whereas a person has access to locations" [18]. Therefore, increasing the accessibility to the shopping areas means growth in the diversity of goods offered by retailing in the same area.

Some studies analysed the spatial distribution of urban services as a measure of accessibility [9]. In the United States, the rural population has less accessibility to healthy food stores [19]. In Tehran (Iran), 98.3% of citizens have high access to local stores (less than 800 meters from their residence) [11]. The black race residents have less access to grocery stores, restaurants (not including fast-food stores), banks, liquor stores, and movie theatres in Atlanta (United States) [20]. The vulnerable groups have disadvantaged accessibility to shopping and supermarkets in Detroit (United States) [21]. The long travel distances and the obstacles from land-use influence pedestrian accessibility and the accessibility changes in the territory of Montreal [22]. Since shopping is the main reason the elderly make trips, the physical-spatial characteristics needed can make unsafe the way to food stores [22]. The accessibility of shopping malls in Nanjing (China) varies according to the transportation mode [23].

Moreover, the high accessibility level of retail is associated with high residential property values [14]. The trade-off between store accessibility and store size has a positive correlation between household income and store size in Atlanta (US) [6]. Nevertheless, the car is also the main transportation mode for shop travel motive by Americans [6].

Accessibility is also a social equity measure and a component of social sustainability [24]. Based on buffer analysis and evaluation of the 20-Minute City concept to Tempe (Arizona, US) transportation infrastructure system, [24] showed 88.8% of residential units have access to bicycle roads, and 69.1% of residential units have access to pedestrian sidewalks. The authors emphasise the importance to use spatial methods for the accessibility measure. The socio-spatial equity using a time-distance measure and a Spatial Separation Index was used to measure the accessibility of public services in Valencia (Spain) [25]. The pedestrian accessibility to neighbourhood facilities was evaluated in the Cittadella district in Parma (Italy), where 70% of inhabitants live within a 15-minute distance of kindergartens and 91% of inhabitants have shops within a 15-minute walking [13].

The analysis reported by the literature used the minimum distance method [11], grid analysis [23], accessibility measurement [20-22,] and service area analysis [13]. A similar approach proposed in this paper was used [24]. However, the goals and results are different. In general, the spatial tools are restricted to accessibility measurement. In this way, this paper innovates using a usual spatial technique and public data in the analysis. Urban planners can use the findings to improve the accessibility of retail and service functions [14]. Rethinking land use based on residence accessibility to services, activities, and trades [3], becomes essential to reduce travel distances and stimulate trips by active modes.

3. Study Area

The accessibility analysis at neighbourhood levels across the city requires data and geographic information systems [26]. This section describes the study area and the spatial data used in the geographic information systems to perform the accessibility analysis.

Belo Horizonte has 2.38 million inhabitants living in 487 neighbourhoods (Figure 1) [27]. Belo Horizonte is the sixth most populous municipality in Brazil. Despite the high population density (7,167/km^2, on average), there is almost no resident population in some parts of the municipality, where environmental preservation areas or urban facilities (e.g., universities and airports). The east region of the municipality is a residential area, and the most populous neighbourhoods have a population of over 12,768 inhabitants. Barreiro region has two districts with more than 12,768 inhabitants. Venda Nova is the most populous region in Belo Horizonte, and the most populous neighbourhood has more than 19,700 inhabitants. The Centre-South region of Belo Horizonte, which concentrates most of the commercial activities, has a population of over 8,501 inhabitants.

Figure 2 shows the income per neighbourhood in Belo Horizonte. The Centre-South region had the highest income, followed by the Pampulha region. On the other hand, Barreiro and Venda Nova regions have the lowest income, below BRL 2,408. In general, the income is heterogeneous among the neighbourhoods in Belo Horizonte.

The location of bakeries and supermarkets was obtained from Municipal Taxpayer Registry [28], based on the National Classification of Economic Activities (CNAE), with the following numbering: 4711301, 4711301, 1091102, and 4721102. Figure 3 shows the spatial pattern of these establishments. Belo Horizonte has more bakeries than supermarkets. Also, the Centre-South region concentrates more on bakeries, supermarkets, and residents and the average income is high in this region compared with others (Table 1). On the contrary, the North region concentrates fewer bakeries and supermarkets in Belo Horizonte. By region, the range of bakeries varies from 202 (North) to 348 (Centre South), while supermarkets range from 28 to 60 in the same regions.

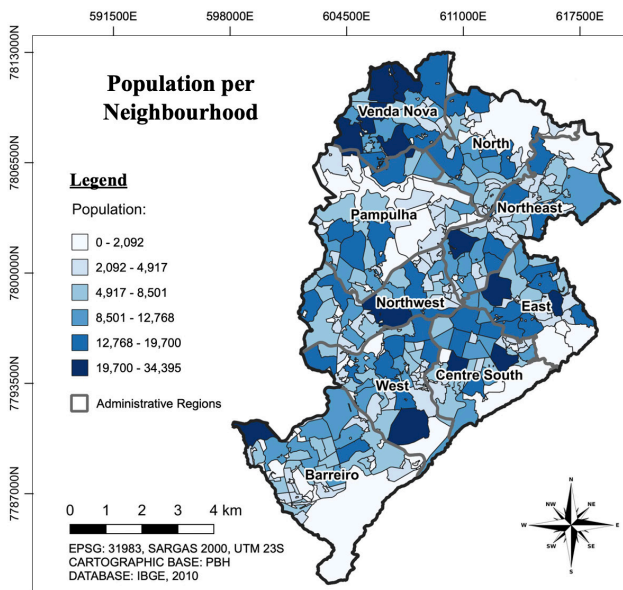On average, each neighbourhood has 7.7 bakeries
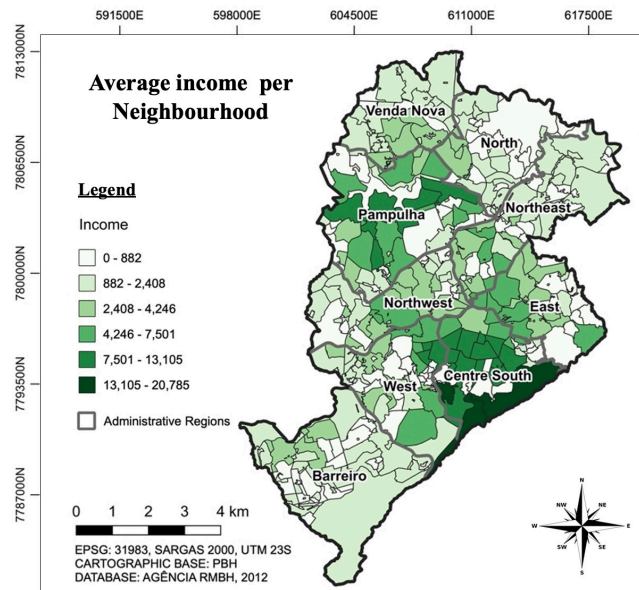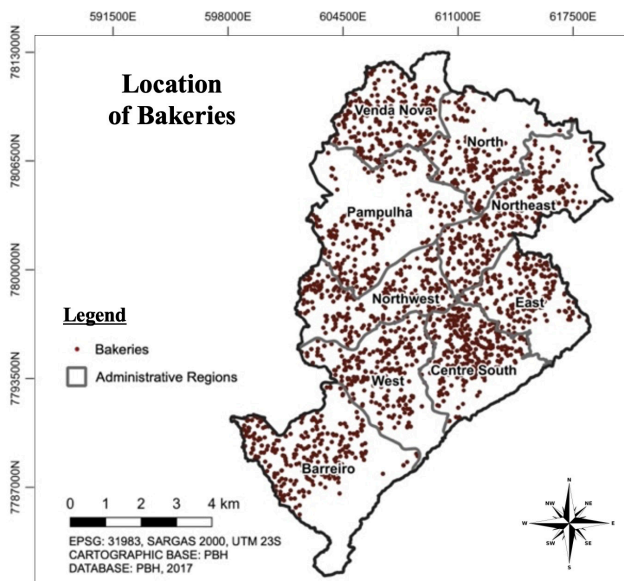
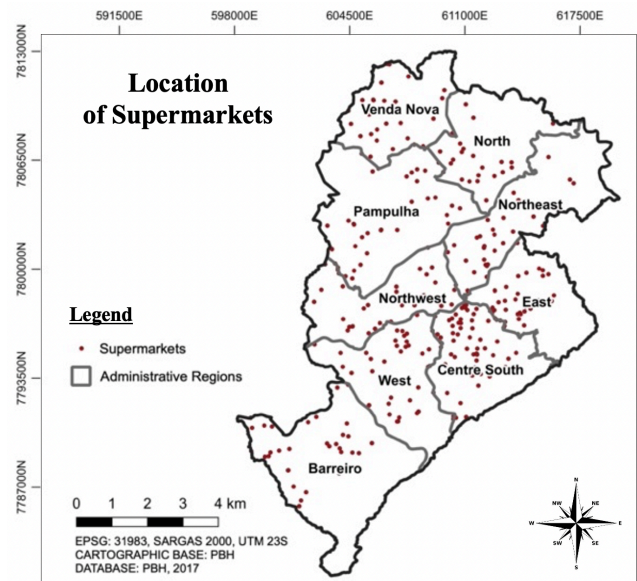**Figure 1.** Population per Neighbourhood.

Figure 2. The average income per neighbourhood (in BRL, 1US$ ~ 5.3BRL, in July/2022)

a)

b)

Figure 3. a) Location of Bakeries; b) Location of Supermarkets

and 1.9 supermarkets in the Centre South. On the other hand, each neighbourhood of Barreiro and Pampulha has 4.1 bakeries and 0.7 supermarkets (the lowest values by neighbourhood). The centre-South region has the lowest bakery density, 811.93 residents/bakery, while the North-ern region has the highest value, 1,398.77 residents/bak-ery. Supermarkets have a similar pattern in these regions: 4,709.20 residents/supermarkets in the Centre-South region and 10,001.14 residents/supermarkets in the North region. These data give preliminary evidence about the accessibility of residents to these establishments.

Data described in this section were used to assess

Table 1. Belo Horizonte regions characteristic.

Administrative regions	Number of neighbourhoods	Area (km^2)	Bakeries	Supermarkets	Population	Average income (BRL)
Barreiro	74	53.48	303	37	282,552	1,890
Centre South	45	31.74	348	60	272,285	8,097
East	47	27.86	254	36	249,273	3,343
North	44	32.56	202	28	212,953	1,928
Northeast	62	39.32	304	36	291,110	2,663
Northwest	47	30.07	284	41	331,362	2,787
Pampulha	62	51.03	255	37	187,315	3,983
Venda Nova	43	29.17	265	40	262,183	1,915
West	63	35.93	292	44	286,118	3,549

the accessibility of supermarkets and bakeries by active modes in Belo Horizonte. The research approach is described in the hereafter section.

4. Research Approach

The research approach has two steps: accessibility of bakeries and supermarkets, analysis through the influence area, and the spatial pattern of these establishments through Local Indicators of Spatial Association.

4.1 Step 1: Accessibility Analysis

The influence area of the establishments identified the accessibility of the population to the bakeries and supermarkets. A buffer zone was defined around the location of the establishments centred on the distance, based on the distance definition of shopping travel time [29,30], and the 15-Minute City concept. Were analysed three different distance levels: 500 meters (5 minutes walking), 1,000 meters (15 minutes walking or 9 minutes cycling), 2,000 meters (25 minutes walking or 15 minutes cycling). The analysis was performed in QGis software using the spatial join tool.

In each buffer, the number of neighbourhoods, the maximum population served, and the number of bakeries and supermarkets inner were measured. Then, was analysed the accessibility based on the ease of reaching bakeries and supermarkets by walking or cycling.

4.2 Step 2: Spatial Pattern of Bakeries and Supermarkets

The Local Indicators of Spatial Association (LISA) approach, based on the Bivariate Moran Index, was used to identify the spatial pattern of bakeries and supermarkets. Cluster analysis is a technique to classify elements based on their similarity. The local index is a statistic that demonstrates the spatial dependence of each location in a neighbourhood, and they are analysed in terms of clusters [31]. The Moran Index measures the intensity of the spatial correlation by evaluating how much the observed value of an attribute in each region is dependent on the variable values in neighbouring locations, based on deviations from the mean [32].

The Bivariate Moran Index is defined as $I_i^B = cx_i \sum_j w_{ij} y_j$, where w_{ij} is the element of the spatial weights matrix, $\sum_j w_{ij} y_j$ is the lagged variable, x_i is the variable in the standardized form, and c is the constant scaling factor [32]. LISA is based on the relation of Ii = (zi×Wzi)/σ2 where Ii is the local index for the region i, zi is the deviate value in the same area i, Wzi is the average value of neighbourhood region of I, and σ2 is the variance of the deviate distribution.

Based on the Bivariate Moran Index, LISA identifies five types of clusters: High-high, high-low, low-high, low-low, and not significant. The first part of the denomination indicates the intensity of the index value observed in the analysed neighbourhood. The second part of the denomination indicates the intensity of the index value in the surroundings of the analysed neighbourhood. Typically, clusters identify hot and cold spots with high-high and low-low clusters, and high-low and low-high clusters are outliers. The outliers' clusters are considered opportunities for installing bakeries and supermarkets in this paper.

Finally, the spatial dependence of bakeries and supermarkets were verified, and grouped by neighbourhoods, measuring Moran's global autocorrelation index. The analysis of the Moran's Index was made based on the p-value (lower than 0.05), the comparison of the z-value in the module (if the z-value is in greater modulus and not very close in value to the expected value, it is considered

that there is spatial dependence), and signal of z-value (negative signal indicates the spatial dependence due to dissimilarities in space, and positive signal indicates spatial dependence due to similarities in space) [32]. This procedure identified places for the location of new bakeries and supermarkets based on accessibility, i.e., ease of reaching bakeries and supermarkets by foot or bicycle.

The bakeries' and supermarkets' location was geolocated using the ggmap package [33]. LISA was performed using the spdep package [34] in the R environment, with the queen contiguous spatial units, 95% significance level, and a p-value less than 0.05. The LISA analysis was based on the neighbourhood's unit spatial.

5. Results

5.1 Accessibility Analysis of Bakeries and Supermarkets

Figure 4 shows the influence area of bakeries and supermarkets. The influence area of bakeries covers 99.9% of the territory of Belo Horizonte with 500 meters buffer. On the other hand, the 500-meter buffer for supermarkets covers 93.8% of neighbourhoods. This result shows that Belo Horizonte is well-served by bakeries for a short walk, but some areas remain unserved by supermarkets. These areas are in the neighbourhood with lower income and lousy infrastructure conditions.

For the 1,000 meters buffer, 97.6% of the population of Belo Horizonte can reach a supermarket within a 15-minute walk. Increasing the walking time, we have an increase in the population covered by the supermarkets. However, this is not

the ideal scenario for a sustainable perspective. Usually, people go to supermarkets to buy groceries, which sometimes are heavy or voluminous. Therefore, if the walking distance is close to 15 minutes, the use of an active mode of transportation starts to be unappealing. Additionally, the topographic conditions were not evaluated in this paper, which could further influence the preference for travel in less active modes, depending on the distance.

For a radius of 2,000 meters, 99.3% of the population can reach a supermarket which means they can reach a supermarket with a 15-minute bike ride. This scenario also is not the ideal situation, especially in low-income neighbourhoods. Moreover, this scenario did not stimulate the use of bicycles depending on the purchase volume. Besides that, this situation could be acceptable if the supermarket had a free delivery service for the local community.

The data regarding the coverage area of bakeries and supermarkets are summarized in Table 2. Although the distribution of supermarkets is not ideal, especially in some neighbours with lower income, 93.8% of the municipality area is covered by a supermarket within a 5-minute walk and 99.9% by a bakery, so we consider this a potential scenario for a 15-Minute City, based on these establishments' location. It is worth mentioning that bakeries sell more than typical bakery products in Brazil, working as convenience stores. They also supply essential goods for the population and bakery products. On the other hand, supermarkets are usually bigger and sell various products. Thus, the supermarket location is more restricted because they demand more ground area.

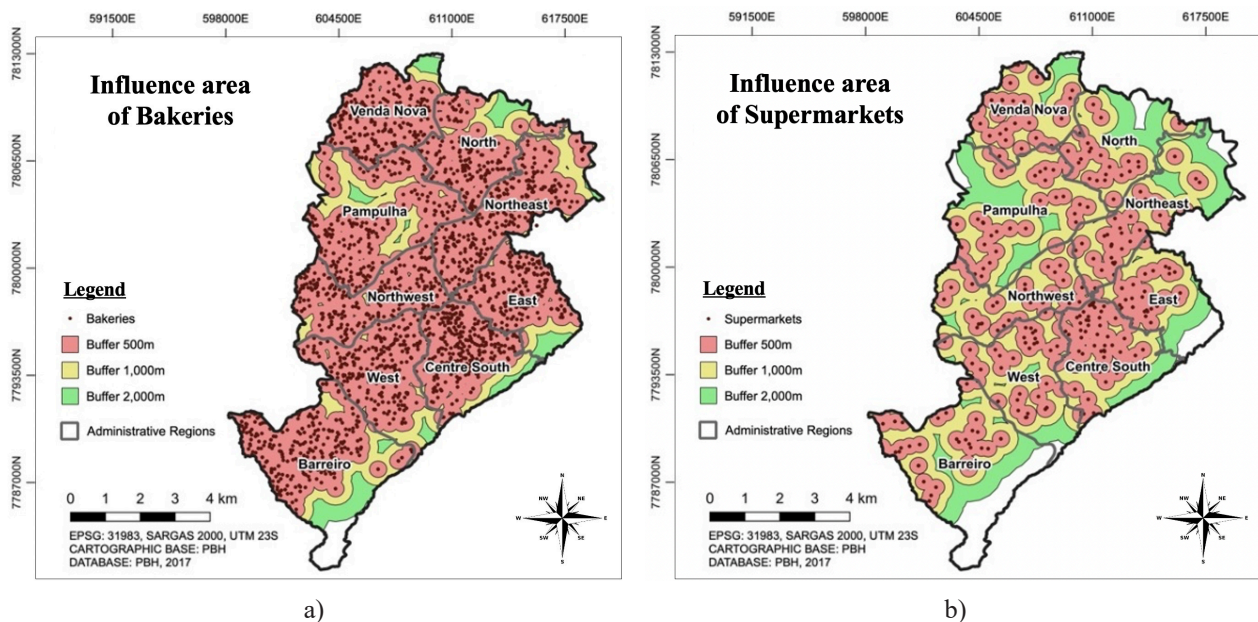Although apparently, the territory of Belo Horizonte

Figure 4. a) Influence Area of Bakeries; b) Influence Area of Supermarkets

Table 2. Summary of Influence Area.

Radius	Supermarkets		Bakeries	
	Neighbourhoods Served	Maximum Population Served	Neighbourhoods Served	Maximum Population Served
500 meters	370	2,228,210 93.8%	478	2,372,217 99.9%
1,000 meters	431	2,317,671 97.6%	484	2,373,029 99.9%
2,000 meters	456	2,357,632 99.3%	487	2,375,151 100.0%

is all served by bakeries and almost all served by supermarkets, many neighbourhoods have low options for the residents. The comparison of 500 meters service area buffers with the population (Figure 5) and income (Figure 6) shows a concentration of bakeries in the Centre-South region, the same region with population and high-income concentration. Figure 6 shows the same comparison with the population (a) and income (b) for the supermarkets, concentrated in the neighbourhoods with population concentration, such as the Centre-South region, the west of the East region and the west of the Venda Nova region. The Centre-South and the west of East regions also have high-income concentration. These findings show that almost every citizen of Belo Horizonte would have a nearby establishment to go by an active transportation mode for essential needs. However, there are not many options in low-income neighbourhoods. Thus, the products may be overpriced with the low supply of establishments and high demand, or the residents may not find the desired products.

5.2 Spatial Pattern of Bakeries and Supermarkets

Figure 7 shows the LISA map with the spatial pattern concerning the lagged population. The high-high clusters indicate the places well served by bakeries or supermarkets and with a high concentration of population. These establishments are in the same neighbourhoods, with 19 clusters of bakeries (a) and 18 supermarkets (b). The lack of high-high clusters indicates the overall need for bakeries and supermarkets related to the mean population in each neighbourhood. Concerning income, Figure 8 shows the high-high clusters are like the population, with 26 clusters to bakeries (a) and 24 to supermarkets (b). These results mean that supermarkets or bakeries and their surroundings serve the high-high neighbourhood well.

Furthermore, the high-income or high population attracts these facilities and influences the geographic environment. On the contrary, the low-low cluster indicates that bakeries or supermarkets poorly assist places with lower income or population. Supermarkets have more low-low clusters scattered by the Belo Horizonte territory. The neighbourhoods with the low-low relation indicate how the capacity to attract businesses, either because of lack of population or because of low resident income. Independent of the reason, this should not be a motive for these neighbourhoods to be unattended, and they should be a focus of public policies to increase the density population, mix uses and business attraction.

The outliers' clusters (high-low and low-high) indicate the potential to install new bakeries and/or supermarkets in the neighbourhoods. The low-high cluster displays potential neighbourhoods for bakery or supermarket investments, while the high-low clusters indicate areas whose surroundings are poorly assisted by bakeries or supermarkets. Moreover, findings show that the clusters of bakeries and supermarkets are similar and concentrated in neighbourhoods with high income and populations.

Finally, the Global Moran Index was calculated to confirm the spatial pattern of bakeries and supermarkets. For supermarkets, Moran's I was 0.067 (p-value=0.012). Compared with the expected value of –0.002, there is positive spatial dependence for supermarkets, indicating supermarkets are distributed throughout the territory due to their similarities. On the other hand, the p-value is not statistically valid (0.378) for bakeries, making it impossible to analyse the z-value. Thus, there is no spatial pattern in the spatial distribution of bakeries in Belo Horizonte. It is worth mentioning that the overall number of bakeries is considerably higher than the supermarkets', justifying further spatial econometric models for the bakeries' location distribution. Thus, it was concluded that bakeries are more accessible to the population of Belo Horizonte, regardless of income and population concentration. To improve the accessibility of supermarkets, it is necessary for new establishments in peripheral areas where there is less concentration of income and high population density.
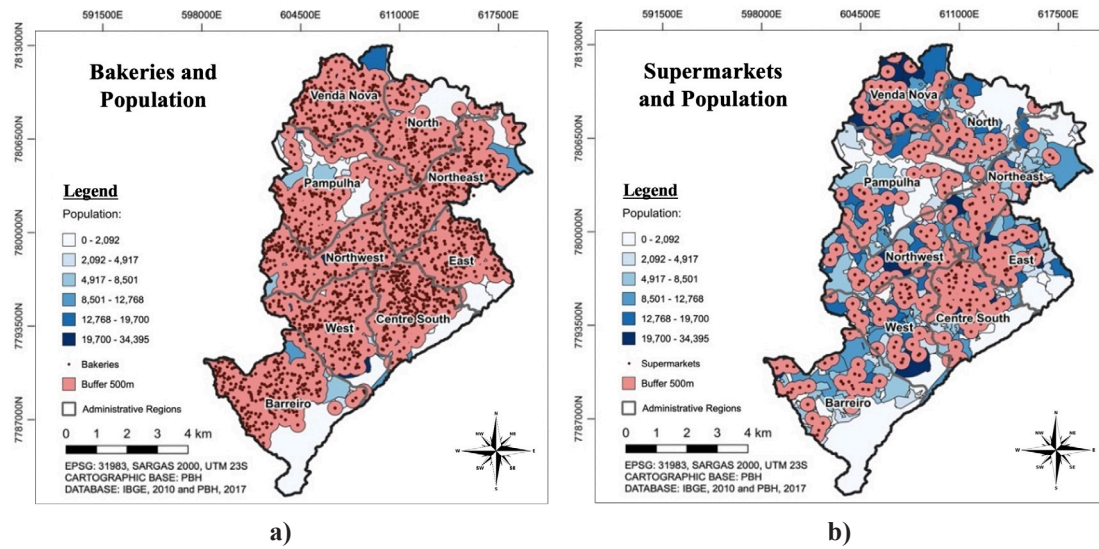
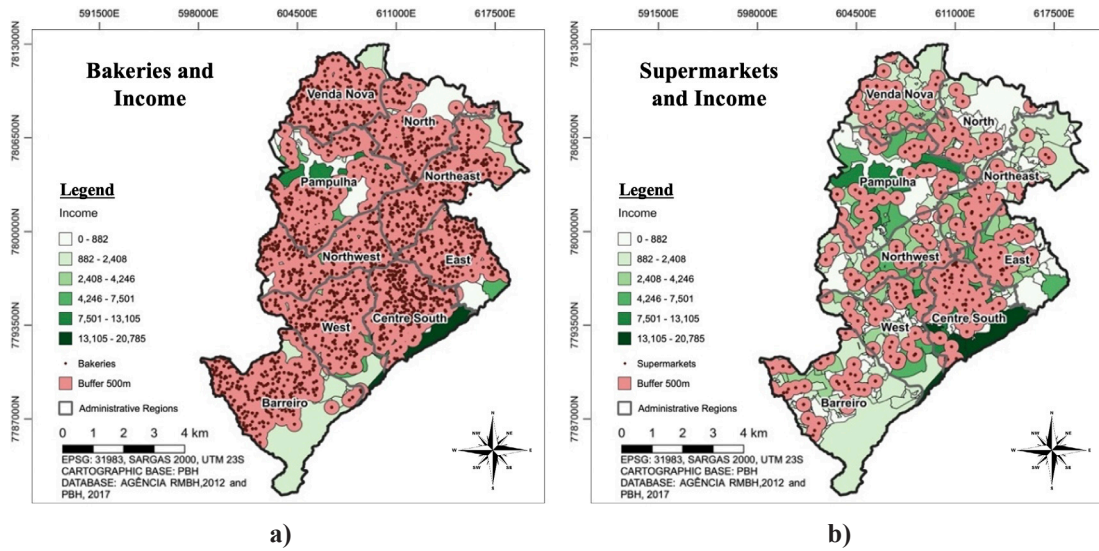**Figure 5. a)** Bakeries and Population; b) Supermarkets and Population

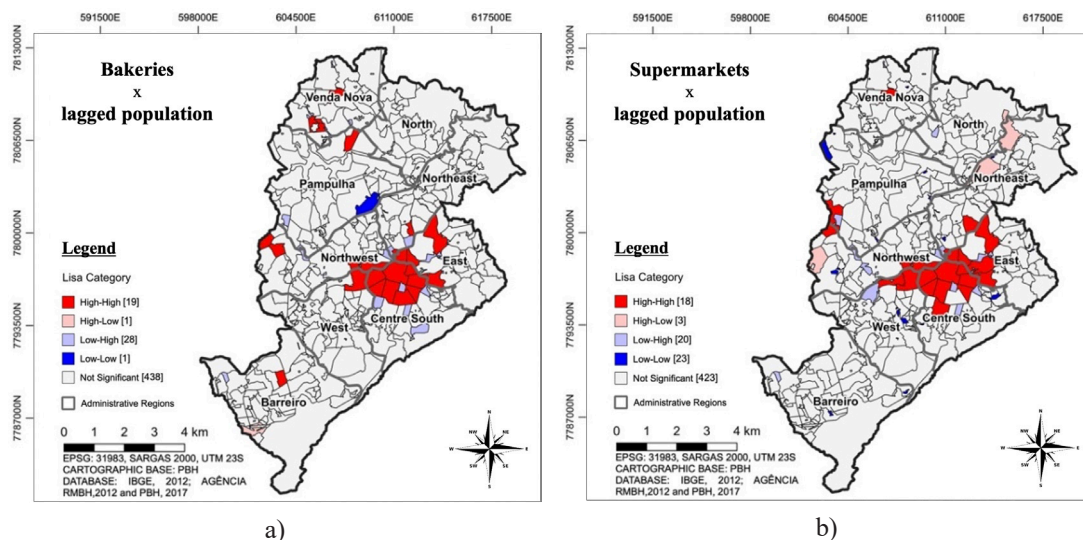
Figure 6. a) Bakeries and Income; b) Supermarkets and Income

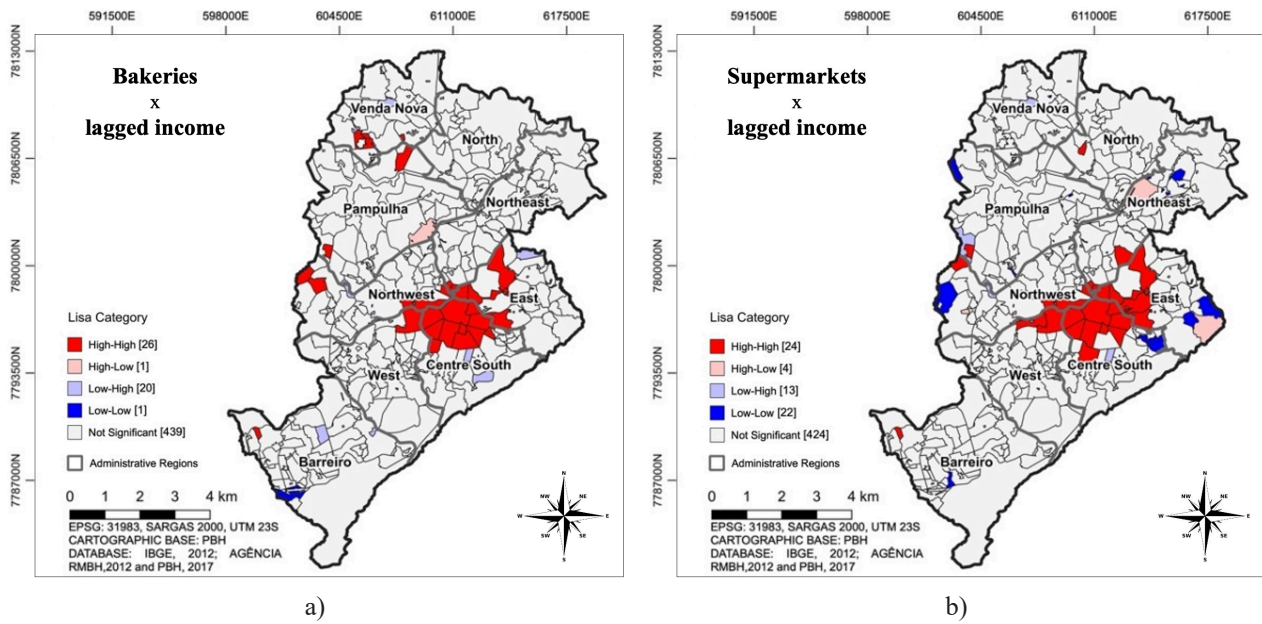**Figure 7.** a) LISA map: bakeries vs lagged population; b) LISA map: supermarkets vs lagged population LISA map: supermarkets vs lagged population

Figure 8. a) LISA map: bakeries vs lagged income; b) LISA map: supermarkets vs lagged income

6. Discussion

Bakeries and supermarkets were vital establishments during the COVID-19 outbreak. For many days they were the only establishments allowed to keep open in Belo Horizonte; it was where people bought essential products. Therefore, during the COVID-19 outbreak, having a bakery or a supermarket close to your residence means having a place to shop. But unfortunately, not all residents of Belo Horizonte can reach these establishments by active modes, which generated some social exclusion and loss of quality of life, especially for those dependent on public transportation, which had its frequency reduced at that period.

The development of a 15-Minute City has the potential to provide accessibility to all residents and reduces socio-spatial inequalities. From the perspective of access to essential services, the 15-Minute displacement by active modes is more critical for such inequalities. However, our findings showed socio-spatial inequalities in Belo Horizonte, based on the location of bakeries and supermarkets. The high-income neighbourhoods have more supermarkets, and the residents can reach within a 2 km radius. On the other hand, low-income communities have fewer options, which may lead to higher product prices for a lower-income population. This uneven spatial distribution of supermarkets reinforces social inequalities.

Another result highlighting social-spatial inequalities was the small number of high-high clusters for both bakeries and supermarkets. The neighbourhoods well-served by these establishments are in the centre-south region,

with high-income and high-density populations. Thus, we concluded that less densely populated areas with lower income have less diversity of opportunities. The lack of opportunity diversity represents an increase in prices and a reduction in local job offers, an essential part of a 15-Minute City.

The 15-Minute City concept can effectively promote sustainable transportation since the active modes are at the core of the 15-Minute City network planning. This paper showed that Belo Horizonte has the potential to become a 15-Minute City when analysing the access to essential services, bakeries, and supermarkets. For that, urban planning must focus on locating new establishments in neighbourhoods, and there is no need to find a high number of new ones. New establishments could provide more accessibility to the residents by active modes and reduce socio-spatial inequalities. Also, urban planning should integrate these incentives for establishments' location with adequate transport infrastructures, such as adequate sidewalks and bike lanes. Thus, urban planning must contemplate the reduction of socio-spatial inequalities, not only for the establishments analysed in this article but for the public, health, and education services.

This paper did not consider the quality of the sidewalks and bike paths in Belo Horizonte. The infrastructure attributes are the next stage of analysis, as it has the same importance as the existence of opportunity and influence in the displacement comfort of the citizens. For example, older people were concerned about the sidewalk quality in Belo Horizonte [35]. The quality of sidewalks is also cru-

cial for the owner of commercial establishments [36], as the more people walk, the more people are attracted to such establishments. In this way, sidewalk quality and security safety improvements increase walkability in lower-income neighbourhoods [37], consequently, improving life quality and reducing social inequalities due to the lack of accessibility. In other words, the quality of the sidewalk is a critical factor in developing sustainable cities.

Similarly, benefits associated with sidewalks could be achieved with bike paths. However, Belo Horizonte has only 118 km of the 400 km planned by the municipality since 2017. The planned routes are still far from serving the entire population of Belo Horizonte because they lack connectivity. Moreover, most parts of the city have bike path projects.

We recognise that as far as our effort to identify the location of bakeries and supermarkets as a first step to creating a 15-Minute City, it cannot come isolated. Besides policies incentivising access to groceries and job opportunities with integrated planning with the retail sector, Belo Horizonte Municipality needs to change its urban planning process. Nonetheless, a recent Master Plan was approved in 2019 and is innovative for environmental preservation. Moreover, it has direct guidelines that can contribute to the construction of a SUMP [38]. The new SUMP should follow the master plan guidelines and prioritize active modes and public transport. The most important factor of this new SUMP should be the revitalization of pathways and the adequate planning of connected bike paths. Besides that, the municipality needs to materialize the planning since the last two SUMPs from 1996 [39], and 2013 [40] did not come out of paper. Thus, the municipality must include the concept of a 15-Minute City in the new SUMP. In addition, the SUMP must incentivise land use diversification and increase population density accompanied by a mix of income in each community.

Answering our research question, "Are bakeries and supermarkets accessible for all?", findings showed that bakeries are more accessible than supermarkets. Furthermore, supermarkets are not accessible to the entire population, especially in low-density and low-income regions. The adoption of the 15-Minute City planning concept is a way to increase this accessibility, and the municipality has the crucial role to approve projects aligned with such guidelines and sustainable development. In addition, the municipality may encourage the development of new bakeries and supermarkets in line with the accessibility municipality regulation (Law 8616/03 and Law 9725/09) [41,42], improving sidewalks and creating bike paths as a counterpart to the installation of these projects. The counterpart is already a pioneering initiative in Belo Horizonte

in the authorization of projects that are characterized as trips generating hubs. This initiative can be extended to small establishments, encouraging the improvement of sidewalks and/or creating a monetary fund to implement bike paths. Simple measures, in line with the installation of new projects, make it possible to reduce socio-spatial inequalities in the city and develop sustainable cities.

7. Conclusions

The COVID-19 pandemic evidenced the importance to rethink how activities should be distributed in cities. People need alternatives to reach essential services by means other than motorized ones. In this context, the urban planning concept based on the 15-Minute City emerges as an alternative to reduce car or public transport dependence and valuing trips by active modes (foot or bicycle). The mix of the residential area and job opportunities, the variety of trade and services could contribute to this concept.

This paper analysed the spatial accessibility of supermarkets and bakeries in Belo Horizonte (Brazil). These establishments play a central role in people's daily lives and were crucial during the COVID-19 outbreak, providing essential goods for the residents. Giving people accessibility to bakeries and supermarkets increase the equity to access gross products, essential to better life quality.

Findings showed there are many more bakeries than supermarkets in the city, and they are more dispersed in the municipality territory. It was not possible to identify a spatial dependency for the bakeries' spatial distribution: it was found that almost all citizens of Belo Horizonte can reach a bakery within 5 minutes of walking and a supermarket within 15 minutes of es cycling. The two hypotheses were proved: (i) the bakeries are more accessible than the supermarkets, and (ii) the clusters of bakeries and supermarkets regarding the population and income are similar. Therefore, supermarkets are not accessible to the entire population, especially flow-population and income-concentration regions. Also, some neighbourhoods have opportunities for new bakeries or supermarkets, given the relationship between the actual installations and population concentration or income.

Analysing the spatial dispersion of the facilities is extremely important to increase trips by active mode. The accessibility of urban services also contributes to the security and attractiveness of urban areas [43]. Analysing this part of the supply chain, we concluded that Belo Horizonte could become a 15-Minute City. However, the authors recognize that this is just a tiny of the bigger chain that could be further studied.

This paper instigates the analysis of the accessibility to basic services as and education and health services. More-

over, we suggest exploring how the low accessibility of commercial establishments could impact the development of 15-Minute City.

Author Contributions

João Guilherme C. B. França was responsible for the primary data collection. João Guilherme C. B. França and Isabela K. Oliveira were responsible for the analysis. Leise Kelli de Oliveira was responsible for the academic research of this study. All authors read and approved the submitted version of the manuscript

Conflict of Interest

The authors declare no conflict of interest.

Funding

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