University Populations: A Tale of 3 Colleges. Presented at 14th TRB National Transportation Planning Applications Conference, Columbus, Ohio, May 5–9, 2013.

Khattak, A., Wang, X., Son, S., Agnello, P., 2011. Travel by University Students in Virginia: Is This Travel

Different from Travel by the General Population? In Transportation Research Record: Journal of the Transportation Research Board, No. 2255, Transportation Research Board of the National Academies, Washington, D.C., 2011, pp. 137–145.

Wang, X., Khattak, A.J., Son, S., 2012. What can be learned from analyzing university student travel demand?

In Transportation Research Record: Journal of the Transportation Research Board, No. 2319, Transportation Research Board of the National Academies, Washington, D.C., 2322, pp. 129–137.

ID 1499 | COLLECTIVE TRANSPORT. A SPATIAL ANALYSIS IN THE CITY OF RECIFE, BRAZIL

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ABSTRACT: Developed countries have related the lack of access to public transport to disadvantage and social exclusion, and many methods have been developed for the spatial measurement of the public transport supply aimed at equity in relation to socially disadvantaged groups, and for improvements in transport systems. These methods are still incipient in Latin America, although interventions to improve transport quality are an essential political requirement in urban governance. This paper is part of a PhD thesis, aiming the methodological development for the identification and evaluation of spatial gaps in the supply and demand of public transport causing social disadvantage in the Brazilian city of Recife. It is based on methodologies such as Needs-gap (Currie, 2010), PTAL (Transport for London, 2010), PTAI (Saghapour et al, 2016), and other methods analyzed. The objective of the paper is the critical analysis of the approaches that deal with these aspects, both in terms of social disadvantages due to the difficulty in accessing or even having public transport, as well as in the part related to the detection and analysis of spatial gaps in the supply and demand for public transport in urban areas of large cities. Based on the review carried out, it is possible to base the methodological development intended for the thesis study area, which can also be used for other cities in the world.

KEYWORDS: Public transport. Needs-gap. Social exclusion.

1 INTRODUCTION

Social inequality has been interpreted in several ways. It is most commonly explained as being the effect of income concentration and disparities in quality of life. In a study published in 2015, the OECD shows that the gap between rich and poor has widened in developed countries over the past 30 years, consolidating disparities between classes and affecting gross domestic product. What, then, can be said of the countries of Latin America that have reduced poverty, but in absolute numbers have millions of people in this situation in urban areas and high levels of unemployment strengthening informality? Considered the most urbanized region in the world, its cities are spatially and socially segregated (UN-Habitat, 2012). In Brazil, the appropriation of the urban space by private interests with the support of the State has been well-known and thus the challenge of overcoming the unequal conditions of citizenship is constant. The socially disadvantaged population moves away from the main centers of cities and the difficulty of access to public transport in carrying out basic activities such as work, school and health, compromises freedom and social progression. In view of the importance of the theme, several methods have been developed for the spatial measurement of the public transport supplied, aimed at identifying lack of equity in relation to socially disadvantaged groups.

This article focuses on the bibliographical review aimed at framing and sustaining the methodological development to be proposed for the current PhD thesis. The critical analysis of the approaches prepares the mainstay of the methodology for the study area of the thesis, the Brazilian city of Recife, and that can be used mainly for other cities of Latin America and also of the world, with adaptations to each reality.

Thus, the paper is formed by this section, containing the objetives and showing an overview of the framing for this work; section 2, which deals with the social needs and social exclusion that is due to the disadvantages in public transport; section 3, which presents the main and most recent methods for investigating spatial failures in the provision of public transport, and section 4, which presents the analysis and discussion of results concerning the content reviewed in the paper. Finally, in section 5, are the conclusions and the methodological proposal to be used in the thesis.

2 DISADVANTAGES IN TRANSPORT AND SOCIAL EXCLUSION

Social exclusion has a broad and multi-pronged concept, sometimes being addressed in a general context as a synonym for poverty, which is not real. For Kenyon at al. (2002), poverty mainly incorporates recognition of material and social deprivation, while social exclusion perceives unequal access and need for inclusion and participation of the individual in society (Levitas, 2007).

In the face of the concepts that translate social exclusion, when referring to transport in the face of a perspective on how its scarcity in diverse bias can bring losses to the lives of individuals in various social strata, one begins to perceive what the disadvantage in transport is. If social exclusion is encompassing in its structure, with factors such as poverty, ethnicity, gender, disability, age, employment status, among others, it is natural to understand that people who do not have or have difficulty accessing to achieve the normal activities of life such as education and employment, health, food and leisure shopping, do not have the same opportunities as others who have access to public transport and are thus disadvantaged. The disadvantage in transport is one of the causes of social exclusion.

Latin America and the Caribbean are mainly characterized by urban public transport, walking and cycling, while private motorized transport is composed by cars or motorcycles. It is important to note that for those who live in peripheral areas, transportation costs are higher, which is natural because of the greater mileage traveled and this corresponds to a considerable portion of their salaries. This picture portrays the great Brazilian cities, including the city of Recife, which also suffer from the inadequate supply of public transport, which made the use of private motorized transport attractive (IPEA, 2011). There is still a lack of adequate infrastructure for the so-called active means of transport, besides being sustainable, such as cycling and walking (Malatesta, 2007, UFRJ, 2016). Thus, having a motorized vehicle has become an important element for the level of accessibility and not owning it has become a factor of social exclusion (Rodrigue et al., 2006).

Investments in urban roads in order to improve their capacity have been only temporary in Brazil (Ministério das Cidades, 2007), increasing the additional capacity of the roads without privileging urban public transport and the active means of transportation. Transport, while not taking into account criteria for urban development in harmony with demand to improve urban mobility, is totally counterproductive, aggravates congestion and privileges individuals that can own a car (Vasconcellos, 2010).

According to Jaramillo et al. (2012), in the most traditional line of planning methods for urban transport systems, the demand has been the main object of study, not taking into account the spatial or socioeconomic equity (Banister, 2005). It should be noted here that spatial equity in focus is embedded in vertical equity because, according to Litman (2016), "transportation policies are equitable if they favor economically and socially disadvantaged groups, thus compensating for inequalities."

It is in this context that some of the methodologies developed for the identification and evaluation of the spatial gaps in the provision of public transport are presented and that they bring in their structure the problem of the disadvantages in transport relative to the disadvantaged social groups, trying to find the proper methodological support for the case study of the current thesis, as already mentioned.

3 METHODS FOR THE GAP ASSESSMENT IN PUBLIC TRANSPORT

Methods that associate the measure of supply to disadvantage in transport using geographic information systems (GIS) have been developed for a long time in Australia (Currie and Wallis, 1992; Currie et al., 2003; Currie, 2004; Currie, 2010; Delbosc and Currie, 2011). In the studies for Hobart (Currie, 2004), which is in the Australian state of Tasmania, the already refined approach has been called 'needs-gap'. The designation of this approach is due to the fact that needs-gaps are the spatial failures between transport and social deprivation, after comparing measures of supply and demand. Currie (2010) used the methodological development needs-gap in Melbourne, which is in the State of Victoria, Australia, for all 5,839 census collection districts (CCDs) -which will be called 'bairros' (neighborhoods) in our study - in order to test how this approach would respond to the case of larger localities within the Australian context. Greater Melbourne already had a population of 4,530,000 inhabitants in 2015, to the detriment of the population of Greater Hobart, which in the same year (2015) had 221,000 inhabitants (Australian Bureau of Statisticians, 2016).

Delbosc and Currie (2011) also presented a new approach to the metropolitan Melbourne region, with a visual representation of the shortcomings in the provision of public transport in relation to population and employment.

Also aimed at Greater Melbourne, in a differentiated bias, the methodological development of Saghapour et al. (2016) considered the frequency of public transport services, with the incorporation of population density, an innovation considering previous studies.

Also in the context of the quality of public transport provision, the work of Wu and Hine (2003) studies the supply and the disadvantage in transport, in the city of Belfast, Northern Ireland. It uses the geographic information system and the Public Transport Access Level (PTAL) method (Transport for London, 2015).

The revisions of the aforementioned methodologies regarding supply and demand measures are shown below, observing the social needs due to the transportation disadvantage.

3.1 MEASURE OF SUPPLY

In the treatment of supply, Currie's study (2010) considered a combination of the level of service provided by public transport in metropolitan Melbourne and the conditions to access it through the existence of buffers in the neighborhoods of the study area. The frequency was evaluated by the number of arrivals per week in each neighborhood and the measurements of typical walk catchments (Currie, 2010) were used for public transport modes. For the calculation of the supply index, a combined measure of the above parameters was used, as shown in the equation below. GIS software was also used.

$$SIbairro = \sum N\left(\frac{Area_{B_n}}{Area_{bairro}} * SL_{Bn}\right) \quad (1)$$

Where: bairro is the neighborhood under analysis; SIbairro is the index of the supply corresponding to each neighborhood; N is the number of walk access buffers for the stops/stations in each neighborhood; Bn is the buffer n for each stop/station in each neighborhood; Areabairro is neighborhood area in square kilometers (km²); SLBn is the measure of the level of service (number of arrivals per week of buses, trams and metro in buffer n). The approach then considered the territory of the neighborhood taking into account its coverage by walk catchments to access public transport beyond its relative service levels.

Delbosc and Currie (2011) used the same index for the supply developed by Currie (2010), corresponding to equation (1), in each census tract (CCD) or 'bairro' for metropolitan Melbourne. The main focus was on the distribution of supply in relation to population and employment. The approach consisted in the use of Lorenz curves as a measure of the relative supply of transport to the population, as well as the Gini coefficients for the representation of the equity measure, allowing a visual representation of the gaps in the public transportation supply relative to the population and employment. They reported in their research that service levels were calculated based on the walk catchment overlap of the stop and not based specifically on the catchment centroid, where the stop is located, noting that the public transport stop does not have to actually be within the neighborhood so your service contributes to the supply of this neighborhood.

In the studies of Wu and Hine (2003) the PTAL-Public Transport Access Level method (Transport for London, 2015) was used to determine the quality of the Citybus network's supply in Belfast, Northern Ireland. The purpose was to assess the spatial impacts that would be caused on the population under the influence of that network in the case of hypothetical networks, by comparing relatively the access to the localities in Belfast, as well as verifying the relative effects on access with the introduction of new schedules or levels of service. Among the main parameters of the research were the age structure of the population, the possession of the car and the fact of belonging to the Roman Catholic religion or the Protestant religion. The PTAL translates into a scale of levels that show the amount of service provided, including measures such as frequency, reliability and walking time to access public transport.

In the methodological development of Saghapour et al. (2016) an index for classifying public transport access levels (PTAI) for metropolitan Melbourne's Statistical Areas Level 1 (SA1s) was formulated. In the elaboration of this index, two factors were calculated for each SA1 district and for each buffer, that is, the weighted equivalent frequency (doorstep frequency) and the proportion of population density. In the approach, Mesh Blocks were used to calculate the population density of SA1s and buffers. According to ABS, the Melbourne region contains 53,074 Mesh Blocks and 9,510 SA1s. The PTAI index for each SA1 in the service level part follows a similar approach to the London PTAL method (Transport for London, 2015). In this way, the buffer areas were overlapped on the SA1s, using ArcGIS, in order to calculate their population density. Figure 1 illustrates the overlapping areas of a SA1 selected with walking catchments of tram stops and mesh blocks. In this figure the authors assumed a homogeneous distribution of the population within the mesh blocks. The SA1 population is then obtained through the population in the mesh blocks that compose it. The population within buffer areas was calculated based on the proportion of these areas in relation to their overlap in the mesh blocks. Thus, the area or population of each SA1 corresponds to the sum of the areas and population of the respective mesh blocks.

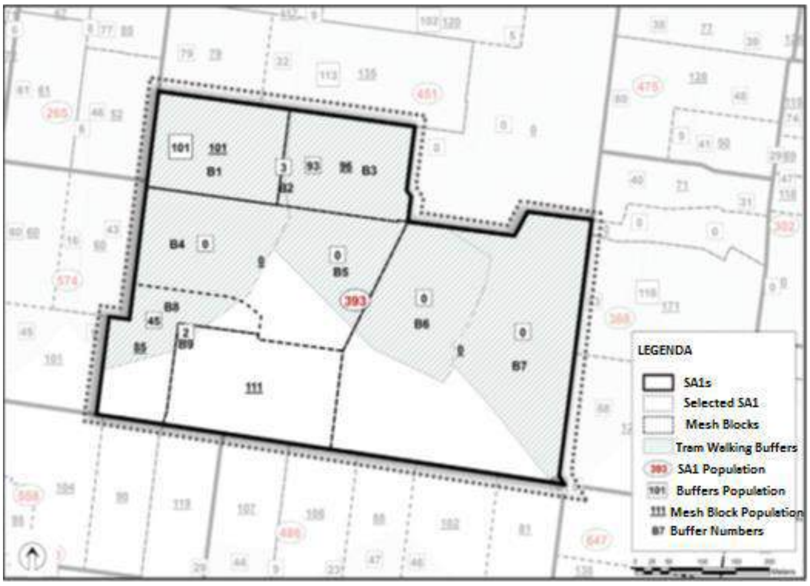

Fig. 1. Illustration of calculation of population density for buffer areas and SA1s.
(Adapted from Saghapour at al, 2016)

It is possible, therefore, to calculate the population density, for both study areas, that is, those of buffers and SA1s. Since the PTAI index is the composition of the combined measure of the weighted equivalent frequency of the SA1s and the incorporation of the population density ratio of the buffers' areas in relation to their respective SA1s, then,

$$\text{if } DB_{ij} = 0;\ PTAI\ SA1i = \sum_{j=1}^{3}\sum_{i=1}^{l}\left(1+\frac{DBij}{DSA1i}\right) * WEFSA1i$$

$$\text{if } DB_{ij} \neq 0;\ PTAI\ SA1i = \sum_{j=1}^{3}\sum_{i=1}^{l}\left(\frac{DBij}{DSA1i}\right) * WEFSA1i$$

Where: PTAI SA1i is the index of access to public transport for each SA1; DBij is the population density of buffer i for transport mode j; DSA1i is the population density of SA1i and WEFSA1i is the weighted equivalent frequency of the corresponding SA1.

Finally, a measure of the provision of public transport is obtained through the same evaluation technique of the London PTAL, that is, the PTAI is grouped into 6 bands with levels of quality of the offer ranging from very poor to excellent. The result equal to zero indicates that there is no accessibility or there is no population in an SA1.

3.2 THE MEASURE OF TRANSPORT NEEDS (DEMAND)

In the methodological development of Currie (2010) for Melbourne, two groups of indicators were presented for calculating the needs index in the socioeconomic context, and the analysis could be based on one group or another. The first group was composed of variables primarily of socioeconomic characteristics and weighting values according to the level of importance of each one in the social analysis of the study area. The second group concerns the more specific indicators of transport demand, and was based on an earlier 'need-gaps' approach developed by Currie & Wallis (1992); Travers Morgan (1992) and Currie (2004). These indicators are shown in table 1.

Need indicator	Source	Weight
Adults without cars	Census 2001[a]	0.19
Accessibility	Distance from Melbourne - CBD[b]	0.15
Persons aged over 60 years	Census 2001	0.14
Persons on a disability pension	Centrelink[c]	0.12
Low income households	Census 2001[d]	0.10
Adults not in the labour force	Census 1996 [e]	0.09
Students	Census 2001[f]	0.09
Persons 5–9 years	Census 2001	0.12

Table 1 Transport need indicators and weights applied. (Adapted from Currie, 2010)

a. Based on the number of cars per household and the number of persons aged 18 and over (Census 2001).
b. Based on the straight line distance to Melbourne central business district (GPO) from the CCD centroid.
c. Based on the number of persons on a disability pension in a postcode grouping (Centrelink 2006). This was then spread across CCDs based on number of persons in each CCD within that postcode (Census 2001).
d. Based on the number of households with a weekly household income of $499 or less (Census 2001).
e. Based on persons over 15 not in labour force in 2001 (Census 2001).
f. Based on persons enrolled in an educational institution – including primary and secondary school, university and technical and advanced further education.

Currie used the group listed in table 1 to elaborate the measure of social needs due to transportation disadvantages. For the measure of accessibility, the direct distance from the center of each neighborhood to the central business district (CBD) in Melbourne was considered. Thus, for calculating the transport needs index, the following equation was used, highlighting the fact that the values of the indicators should be standardized beforehand, since a single need score will be produced for each neighborhood.

$$\boldsymbol{NIbairro}=\Sigma(\boldsymbol{SI1bairro}*\boldsymbol{W1})+(\boldsymbol{SI2bairro}*\boldsymbol{W2})+\cdots+(\boldsymbol{SInbairro}*\boldsymbol{Wn}) \quad (2)$$

Where: $\boldsymbol{NIbairro}$ is the index of need for the neighborhood; $\boldsymbol{bairro}$ is the neighborhood under analysis; $\boldsymbol{SIi}bairro$ is the standardized indicator of each indicator of need, where $\boldsymbol{i}=\boldsymbol{1}\ldots\ldots\boldsymbol{n}$ and $\boldsymbol{Wi}$ is the assigned weight for each indicator of need.

In order to calculate the measure of transportation disadvantages, Currie and Delbosc (2011) developed their research in the perspective of an equity analysis in relation to public transport, both horizontal and vertical, using, for this, the Gini coefficients, calculated using the following equation:

$$G1 = 1 - \sum_{k=1}^{n}(X_k - X_{k-1})(Y_k + Y_{k-1}) \quad (3)$$

Where: X_k is the cumulative proportion of the population variable, for k = 0, . . . , n, with X_0 = 0, X_n = 1; Y_k is the cumulative proportion of the public transport service variable, for k = 0, . . . , n, com Y_0 = 0,

Y_n = 1.

In order to evaluate the horizontal equity, the index of the public transport supply was compared to the population and also later compared to the employment. Data from Australian census of Melbourne 2006, at the district level, were used. Demographic data from that census were obtained for the evaluation of vertical equity.

Wu and Hine (2003), on the other hand, used the multiple deprivation index of Northern Ireland, the so-called Noble Index, to measure transport disadvantages in the approach developed for Belfast in that country. This index was based on the demographic census of 1991, allowing an understanding in the spatial analysis of the most distinct aspects, whether of deprivation or disadvantage. Among the deprivation indicators considered by the Noble Index were income, employment, health and physical or mental incapacity, education, social environment, housing and geographical access to health services, postal services, among others.

3.3 THE NEED-GAPS

As explained above, the methodological development of the thesis is based on the identification of spatial gaps in the provision of public transport for people who are socially disadvantaged.

Before the measurement of the supply and of the one referring to the disadvantage in transport, the two are compared using the geographic information system and in this way the need-gaps are obtained, according to the method of Currie (2010). Following this approach to Greater Melbourne, he calculated the supply index by arranging it into seven groups, one in the zero supply category and the other categorized as three above average (above average, high, very high) and three below average (below average, low, very low). The groups that are below the average, are those that suffer of greater social necessity. In this context, we found the results shown in figure 2, which presents the spatial distribution of supply in the categories mentioned.

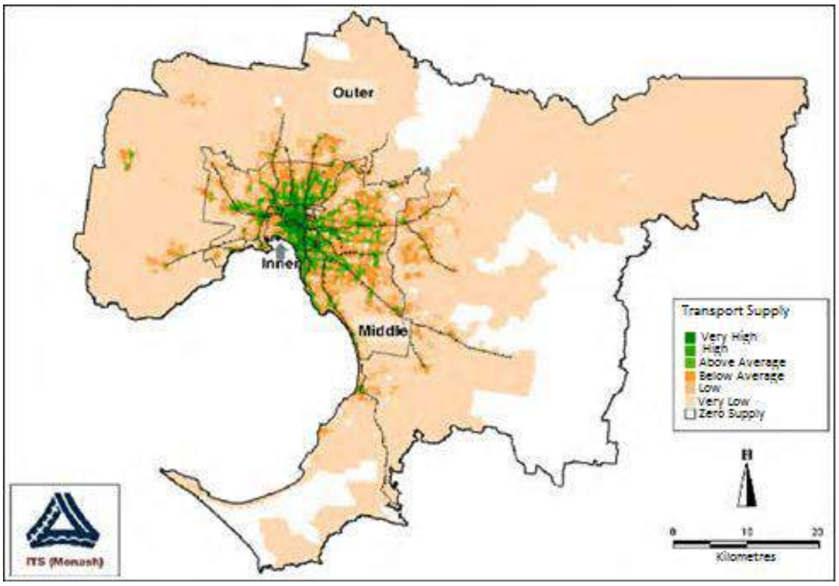

Fig. 2. Distribution of supply measure scores – Metropolitan Melbourne. (adapted from Currie, 2010)

With regard to the index of disadvantages in transport, it is seen in figure 3 below, the spatial distribution of social needs due to disadvantage in public transport. Groups were separated into a needs scale with scores ranging from low need to high need, in the context of three levels below average (below average, low and very low) and three levels above average (above average, high and very high).

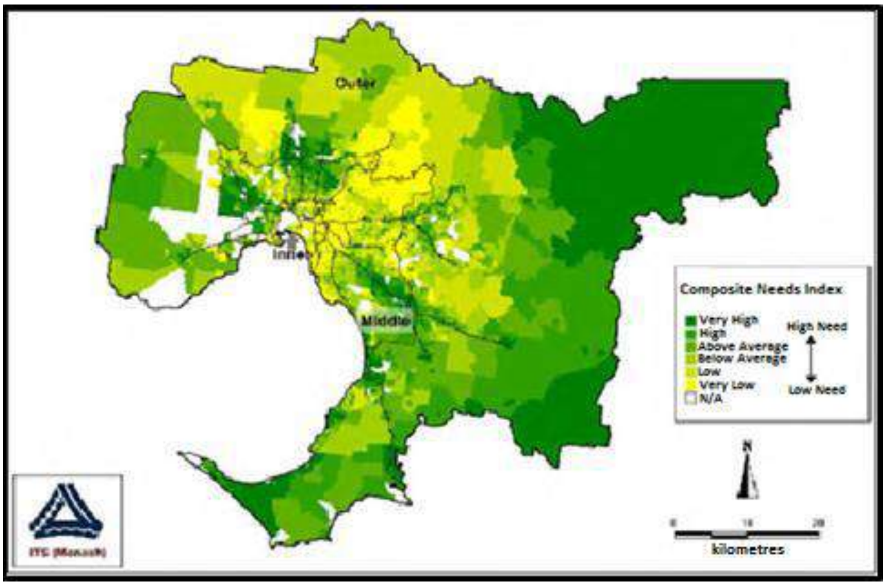

Fig. 3. Distribution of categories of composite social need index scores.
(Adapted from Currie, 2010)

In Currie's methodology, as mentioned previously, need-gaps are obtained through the comparison between the measure of supply and the measure of social needs (or demand). As an example, figure 4 below presents spatial gaps due to the disadvantage in transport (need-gaps) in the category of very low supply or zero supply and in the category of social disadvantage by transport, very high.

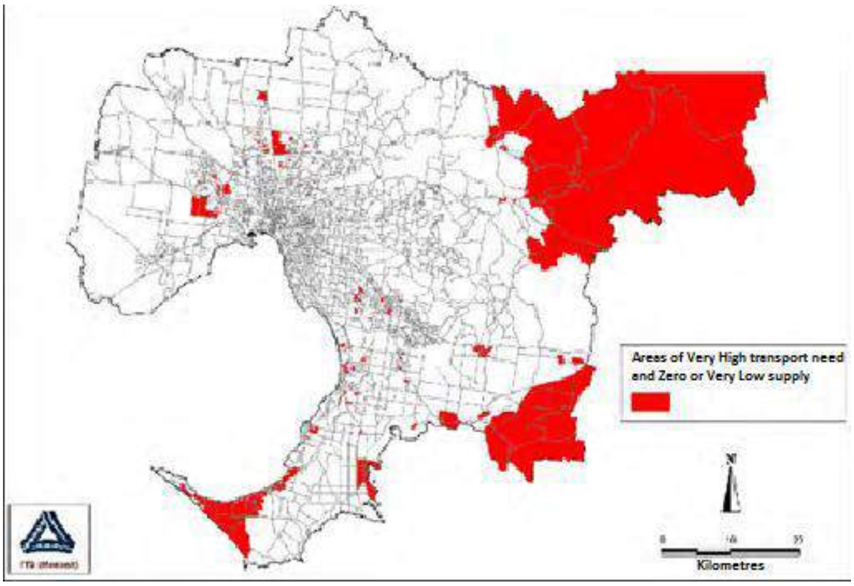

Fig. 4. Melbourne needs-gap – very high transport need areas with
zero or very low public transport supply. (Adapted from Currie, 2010)

In the study of Delbosc and Currie (2011), as already discussed in section 3.1, the approach was developed in a perspective of horizontal and vertical equity. Using the Lorenz curves for the measure of supply and the Gini coefficient for the measure of equity, it is possible to graphically represent the results of the relationship between transport supply and population and employment, since, according to the authors, “while the Lorenz curve is a visual interpretation of equality, the Gini coefficient is a singular measure of the representation of the degree of inequality”. Figure 5 below shows that 70% of the population of Melbourne shares only 19% of public transport, while 30% of this population shares the remaining 81% of the public transport service. In this case, the Gini coefficient obtained was 0.68, which suggested relatively low horizontal equity, since services are only available for a small proportion of the population. In order to map the gaps for horizontal equity, the differences between the supply and the population are detected, and the inequalities of the service are identified.

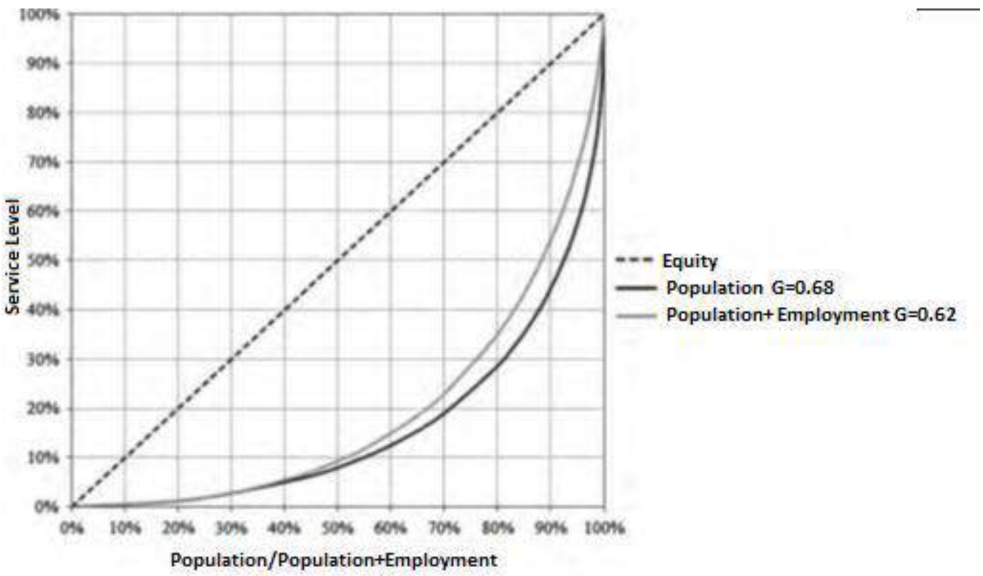

Fig. 5. Lorenz curves of population and employment (Adapted from Delbosc and Currie, 2011)

The approach of Wu and Hine (2003) using the PTAL method (Transport for London, 2015) focused on the analysis of the existing Citybus Network and the assessment of the spatial impacts that would be caused in the population under the influence of the network, in the case of Implementation of hypothetical networks by comparing the access to localities in Belfast, as well as by checking the relative effects on this access with the introduction of new schedules or levels of service. The PTAL levels were calculated for different periods of time, so that it was possible to examine the relative access in different locations, as well as the relative effects on access to public transport in view of the proposed changes. In this way, the gaps were identified when comparing the variations of the local PTAL index and the spatial distribution of the deprivation indexes.

4 ANALYSIS AND DISCUSSION OF RESULTS

The methodological development of this work follows a research line similar to Currie's Need-Gaps method (2010); however, in the perspective of an innovative bias, adaptations will be carried out in search of consolidated results, in addition to being a study focused on Recife, in northeastern Brazil, while Currie's studies were primarily in developed countries.

Considering the documents analyzed, it is observed that in Currie's approach (2010) the analysis was able to detect significant gaps for the metropolitan area of Melbourne. Considerable differences have been found between the service levels of the public transport supply in Inner and Middle Melbourne with space areas covered by walk catchments at a much greater advantage than Outer Melbourne. It was observed that in addition to having much lower levels of service, the suburbs of this part of the outskirts of Melbourne have characteristics of sparse population of low density, and thus, the overlap of walk catchments is also limited when compared to the more central region and surrounding (Inner and Middle). In the analysis of the social needs index for transport disadvantages, it has been found that there are large spatial concentrations in Outer Melbourne with high levels of transport necessity and even in Inner and Middle Melbourne, despite the better conditions in relation to the urban periphery, yet they have sectors with high and very high social needs. When comparing needs/spatial gaps, the analysis identified that 1.1% of residents were in locations with no public transport provision, and were included in the group with needs scores rated very high. Overall, 8.2% of the population of Melbourne, according to the Need-Gaps methodology, were included in the group with very high needs score and with public transportation in the zero, low and very low supply categories.

In a different context, Saghapour et al. (2016) in the development of the PTAI included the population density as an indicator of the spatial distribution of the population in the neighborhoods and in the walk catchments areas and for this it was introduced the ‘mesh blocks’. The mesh blocks represent a closer estimate of the reality, because being smaller measures, make possible a calculation of the population in

SA1s (neighborhoods) or buffers, more accurate. A homogeneous distribution of the population within the mesh blocks was assumed, which allowed a better analysis of the spatial distribution, which was not done in Currie (2010), since it was considered a uniform population distribution throughout the study area.

Wu and Hine (2003), using the PTAL (Transport for London, 2015) method, with the benefits of GIS and transport networks, strategically analyzed the spatial impacts caused in the population with the hypothetical networks in Belfast, in view of changes in the original Citybus network. PTAL levels were produced at different time periods, so relative access could be examined at different sites. In all the hypothetical options a strong impact was observed on the age groups, mainly harmful to the elderly. Families without cars would be more disadvantaged, as they would have more difficulty accessing the network especially at the peak of the morning. The users of each religious group, Catholics and Protestants, would have many problems in the periods between peaks and off-peak. A contextualized research on vertical equity was observed in Wu and Hine. The PTAL methodology is pertinent in the approach of the authors, as it develops a measure that reflects the connectivity between the different modes of public transportation and thus, the availability of access to them.

Delbosc and Currie, verified the practicality of their method, with the use of the Gini coefficient to obtain a simplified value of the equity of the system as a whole. When the (population + employment) curve was also taken into account in relation to supply, the situation was not very different from the (supply x population) curve, mentioned in section 3 (because 70% of jobs and population share only 23% of the service (Gini = 0.62). For the authors, “perfect horizontal equity is not attainable or even desired, but the fact that 77% of public transport is concentrated for only 30% of the population and employment in the city, seems quite unfair”. With respect to vertical equity, there are features of it in Inner Melbourne, where young people and low-income groups have much higher transport supply than other groups and in Outer Melbourne, where older people have a slightly larger offer. However, in Middle Melbourne there is little difference in supply between groups. In the three areas of Melbourne, households that do not own cars are located in places with much higher rates than those with one or more cars.

5 CONCLUSIONS AND METHODOLOGICAL PROPOSAL TO BE USED IN THESIS

Some failures were detected during the review of the analyzed methods, as well as positive and value aspects.

In the case of the Need-Gaps methodology, Currie (2010) pointed out as fragility of this approach, the fact that supply allocation has been assumed to be uniformly distributed spatially within the neighborhoods. This issue could present more consistent results with the incorporation of population density to the method, as Saghapour et al. (2016) in the methodological development PTAI. In this case, the population density served as an indicator of the spatial distribution of the population in the neighborhoods and in the walking catchment areas, and for this purpose ‘mesh blocks’ were used. The population of the neighborhood was obtained through the existing population in the mesh blocks that composed them and the population in the buffer areas was calculated based on the proportion of their areas in relation to the overlap in the mesh blocks. Thus, the area or population of each neighborhood corresponded to the sum of the areas and the population of the respective mesh blocks and the homogeneous distribution of the population was assumed to be within these neighborhoods instead of being throughout the study area as was done in Currie (2010). In this way a closer analysis of reality in terms of spatial distribution is possible.

The method of calculating the Currie supply index (2010), pointed out by Delbosc and Currie (2011), presents deficiencies, one of which is that the frequency of the service does not have a measure of access to specific destinations. This same failure in relation to the PTAL methodology itself is identified by Transport for London (2015) because the PTAL does not take into account the destinations to which the individual can travel. PTAI, on the other hand, is limited in terms of connectivity between modes, which certainly has a great influence on access, the object of its approach, especially in areas where it is inappropriate.

The other methodological deficiency in the measure of Currie's supply (2010) perceived by Delbosc and Currie (2011) is in relation to walk catchments. They pointed out that most of the important points that are in larger neighborhoods than those around them are sometimes identified as being of low supply. What happens is that sometimes the point shares its catchment with the neighborhoods bordering it, thus reducing its level of service.

In view of the above, given the positive aspects and the detected failures, it is expected that the methodology of this thesis will cover the following directions: the use of a methodology similar to Currie, considering the index of the public transport supply and the index of the social needs (demand) due to the disadvantage in transportation, for the identification and analysis of spatial/need gaps, according to the standard of the Need-Gaps method, but considering, however, the system of Saghapour et al. (2016) when the population density was included in his PTAI, in order to distribute more properly the population in the walk catchments and in the neighborhoods, making the results closer to reality. In this case, due to the fact that Brazil does not have the 'mesh block' measure unit, the Brazilian Institute of Geography and Statistics (IBGE), the so-called 'census sector', would be used as the smallest measure. Another adaptation in Currie's methodology (2010) that this thesis can add is the incorporation in the index of the supply of a measure of access to specific destinations, that in the case of Recife study would be the hospital of the 'Restauração' and the hospital 'Santa Joana', and that in the framework of this study was already foreseen the redistribution of the frequencies for these equipments.

BIBLIOGRAPHIC REFERENCES

Australian Bureau of Statistics. (2016). Victoria Total Population. Retrieved April 19, 2017 from http://www.abs.gov.au/AUSSTATS/abs@.nsf/Latestproducts/3235.0Main%20Features202015?opendocument&tabname=Summary&prodno=3235.0&issue=2015&num=&view=.

Australian Bureau of Statistics. (2016). Tasmania Total Population. Retrieved April 19, 2017 from http://www.abs.gov.au/AUSSTATS/abs@.nsf/Latestproducts/3235.0Main%20Features402015?opendocument&tabname=Summary&prodno=3235.0&issue=2015&num=&view=.

Banister, D. (2005). Unsustainable transport: city transport in the new century. Routledge, London.

Currie, G., Wallis, I. (1992). Determining priorities for passenger transport funding: the needs assessment approach. Australasian Transport Research Forum, Canberra.

Currie, G., Enright, D., Hoey, C., Paterson, D. (2003). Quantitative approaches to needs based assessment of public transport services: the Hobart transport needs gap study. Australasian Transport Research Forum. Wellington, New Zealand.

Currie, G. (2004). Gap analysis of public transport needs: measuring spatial distribution of public transport needs and identifying gaps in the quality of public transport provision. Transportation Research Record: Journal of the Transportation Research Board. 1895, 137-146.

Currie, G. (2010). Quantifying spatial gaps in public transport supply based on social needs. Journal of Transport Geography 18, 31-41.

Currie, G., Delbosc, A. (2011). Using Lorenz curves to assess public transport equity. Journal of Transport Geography 19, 1252-1259.

Instituto Brasileiro de Geografia Estatística (IBGE), Brasil. (2015). Estimativas da população dos municípios brasileiros e unidades da federação com data de referência em 1º julho 2015. Retrieved January 13, 2016 from http://www.ibge.gov.br/home/presidencia/noticias/imprensa/ppts/00000023130408172015040928872 32.pdf.

Instituto de Pesquisa Econômica Aplicada (IPEA), Brasil. (2011). Revista desafios do desenvolvimento do IPEA. Mobilidade Urbana: o automóvel ainda é prioridade – a mobilidade urbana e a supremacia do transporte individual. Ano 8. Edição 67. (2011, September 20).

Jaramillo, C., Lizárraga, C. e Grindlay, A. (2012). "Spatial disparity in transport social needs and public transport provision in Santiago de Cali (Colômbia)". Journal of Transport Geography 24, 340-357.

Kenyon, S.; Lyons, G.; Rafferty, J. (2002). Transport and social exclusion: Investigating the possibility of promoting inclusion through virtual mobility. Journal of Transport Geography, 10 (3). pp. 207-219. ISSN 0966-6923. Retrieved May 22, 2017, from http://eprints.uwe.ac.uk/8903

Levitas, R.; Pantazis, C.; Fahmy, E.; Gordon, D.; Lloyd, E., Patsios, D. (2007). The multi-dimensional analysis of social exclusion. Retrieved May 19, 2017 from http://webarchive.nationalarchives.gov.uk/+/http:/www.cabinetoffice.gov.uk/ media/cabinetoffice/social_exclusion_task_force/assets/research/multidimensional.pdf.

Litman, T. (2016). Evaluating transportation equity: guidance for incorporating distributional impacts in transportation planning. Victoria Transport Policy Institute, Australia. Retrieved July 2 2016 from http://www.vtpi.org/equity.pdf.

Loader, C.; Stanley, J. (2009). Growing bus patronage and addressing transport disadvantage – the Melbourne experience. Transport Policy 16, 106–114.

Malatesta, M. E. B. (2007). Andar a pé: uma forma de transporte para a cidade de São Paulo. Master thesis. Faculdade de Arquitetura da Universidade de São Paulo (FAUUSP). São Paulo.

Ministério das Cidades, Brasil. (2007). PlanMob Construindo a Cidade Sustentável. Retrieved December 20, 2015, from http://www.cidades.gov.br/images/stories/ArquivosSEMOB/Biblioteca/LivroPlanoMobilidade.pdf.

Organisation for Economic Co-operation and Development, OECD (2015). In It Together: Why Less Inequality Benefits All. OECD Publishing: Paris. Retrieved January 15, 2017 from http://dx.doi.org/10.1787/9789264235120-en.

ONU-Habitat. (2012). Estado de las ciudades de America Latina y el Caribe 2012: rumbo a una nueva transición urbana.Programa de las Naciones Unidas para los Asentamientos Humanos, ONU-Habitat.

Rodrigue, J. P., Comtois, C. e Slack, B. (2006). The Geography of Transport Systems. Routledge, New York.

Saghapour, at al. (2016). “Public transport accessibility in metropolitan areas: A new approach incorporating population density”. Journal of Transport Geography. 54, 273-285.

Transport for London, UK. (2015). Assessing transport connectivity in London. Retrieved March 22, 2017 from http://data.london.gov.uk/dataset/public-transport-accessibility-levels/resource/86bbffe1-8af1-49ba-ac9b-b3eacaf68137/proxy.

Travers Morgan. (1992). Strategies to overcome transport disadvantage. Department of the Prime Minister and Cabinet, Canberra.

Universidade Federal do Rio de Janeiro (2016). Mobilidade por bicicleta no Brasil. Rio de Janeiro : PROURB/UFRJ. ISBN: 978-85-88027-32-9.

Vasconcellos, E. A. (2010). El futuro de la movilidad urbana en America Latina. Corporación Andina de Fomento, México.

Wu, B., Hine, J. (2003). A PTAL approach to measuring changes in bus service accessibility. Transport Policy, Volume 10, Issue 4, p. 307-320.

ID 1508 | A HEURISTIC FRAMEWORK FOR EXPLORING UNCERTAINTIES IN TRANSPORT PLANNING

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1 INTRODUCTION

In recent decades, the effectiveness of positivistic approaches in transport planning has been growly contested by academics and practitioners (Innes and Booher, 2010). The idea of planning for a single model of reality is becoming obsolete when considering the fast and radical changes that society is experiencing at present and in the near future (e.g. ICT advances, environmental concerns, social inequalities, changes in mobility behaviour, etc.) (Batty et al., 2012; Lyons and Davidson, 2016; Marsden et al., 2014). The

discussed crisis of the rational-planning model has generated a great deal of interest in those rationalities pursuing “alternative realities” of planning, rooted in critical realism, constructivism and pragmatism (Khisty and Arslan, 2005). However, practitioners and policy-makers are still comfortable with the idea of planning as “enlightening the future”, also reinforced by traditional planning cultures, legal frameworks, and political institutions (Lyons and Davidson, 2016). Placed in a crossroad of approaches, motivations and