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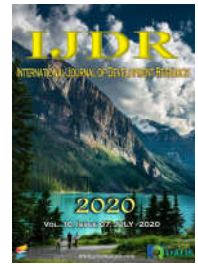
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RESEARCH ARTICLE

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## MEASURING URBAN (IM) MOBILITY AS DEPRIVATION

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### ABSTRACT

The purpose of the paper is to compute a multidimensional index to measure well-being through several dimensions (including mobility) for the São Paulo Metropolitan Area. The low accessibility can affect well-being and quality of life, thus according to the Capabilities approach, it could be a deprivation. The paper developed two strategies to answer these questions. The first strategy was to create an index to measure the different levels of accessibility to better represent the deprivation associated with the mobility dimension. The second strategy was to include the accessibility index into a multidimensional index of well-being and to analyze its consequences. The findings of this study showed that 20 of 39 municipalities from the São Paulo Metropolitan Area lowered their positions in the well-being ranking when the mobility dimension is incorporated into the multidimensional index. This study lights on the importance of urban mobility to the measurement of well-being and quality of life.

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## INTRODUCTION

The purpose of the paper is to compute a multidimensional index to measure well-being through several dimensions (including mobility) for the São Paulo Metropolitan Area (SPMA), Brazil. Historically and due to several restrictions, the most underprivileged population has often predominated in the peripheral regions far from the main employment and labor markets. Public policies on goods and services have not followed the population densification at the peripheries aggravating deprivation in its different dimensions, including urban mobility. Socio-economic development processes have several effects on space and time with different intensities as far as well-being is concerned. Since neighborhoods and municipalities in the same metropolitan area are quite unequal in terms of living conditions, mobility, utilities, public services, and urban infrastructure provision, the question posed here is the relevance of computing a spatially disaggregated ranking for a multidimensional well-being index. This research makes use of the Capabilities and Urban Economics theoretical frameworks involving several attributes to compare a multidimensional index to an expanded multidimensional

index which takes into account mobility and how the well-being ranking is affected by it. The assumption is that a low degree of accessibility can be regarded as a form of deprivation affecting well-being and quality of life, and also that the role of public policies is to reduce social inequalities and increase the quality of life. In the Brazilian case, with its remarkable inequalities, to develop an improved right diagnosis to point out adequate proposals to reduce inequalities is still a difficult but important issue. According to Robeyns (2005:94), the capabilities approach can be regarded as a broad normative framework for the calculation and evaluation of individual well-being, social arrangements, design of public policies, and proposals of social change. For Sen (2001:79), the "assertion is that the functionings are constitutive of a person's "state", and an evaluation of well-being has to take the form of an assessment of these constituting elements." As capabilities represent several combinations of functionings, including beings and doings, it evidenced the relevance of the approach to the proposition and analysis of social development policies. If the functionings achieved are well-being, then the capability to achieve functionings will be the person's freedom, which can be seen as real (or substantive) opportunities to achieve well-being. The achieved well-being

depends on the capabilities to achieve functionings, that is, functionings accessible to a person regardless of how well-being is characterized (Sen, 2001:80-81). Capabilities are the manifestation of each individual's opportunities to achieve functionings inherently associated with freedom of choice among possible lives to achieve well-being. The expansion of freedom is a means to an end for development since people's capabilities depend on economic, social, and political provisions from the several and interrelated components of freedom. The state has to provide programs to strengthen and protect human capabilities as well (Sen, 2000; Nussbaum and Sen, 1996). Therefore, the development of a country is a process of elimination of deprivation of freedom since the developed freedom and rights will also contribute to economic progress. The relation between well-being and freedom of choice is not very clear though. If among a limited set of alternatives, there is a choice for A, there is freedom. However, if in the set of alternatives there is not a possibility wanted by the individual, will there be any freedom to choose or to achieve well-being?

The problem of mobility and accessibility in the São Paulo Metropolitan Area (SPMA) can be seen as deprivation of freedom which undermines well-being. It has emerged from a particular form of metropolitan dynamics, a pattern of territorial occupation, marked by a strong and fast internal migratory movement from the countryside to the city without the necessary urban infrastructure provisions thus causing vulnerability and deprivation. The difficulty to provide the necessary infrastructure to development contributes to the increase of precarious settlements with significant environmental and social impacts affecting the residents' well-being. This type of urbanization imposes restrictions on housing choices and ways of commuting which, in turn, deprives the population of their quality of life. In continent-sized countries such as Brazil, it seems conspicuous to establish patterns but, when there is certain regularity despite the differences, this characteristic may become symptomatic and its causes require further analysis. Following the arguments from Glaeser and Henderson (2017), three characteristics stand out over the urbanization process in Brazil: fast (time), concentrated (space), and intense and considerable (dimensions) movements.

According to Sinha and Labi (2007), two key goals of a transport system are to ensure mobility and accessibility. Mobility refers to the flow of movement of people and cargo between a point of origin and a destination. Performance measurements associated with mobility include, for example, journey time, level of service, speed, delay time, and traffic jam. On the other hand, accessibility means people's ease to commute to/from home and work, for shopping or recreation. Alternative indexes for measuring part of deprivation in urban centers, such as São Paulo, seem to account for insights and methodology on the social costs of uncontrolled growth. Regarding this concern, the paper suggested a multidimensional index that computes the accessibility and shapes changes on well-being ranking.

## MATERIAL AND METHODS

A multidimensional index of quality of life was chosen to express the ranking changes on well-being because of the inclusion of a mobility dimension. The Multidimensional Index of Quality of Life for Municipalities (MIQL-M) was

shaped to be sensitive to the inequality of their components. This index is composed of six dimensions: income, education, health care, household conditions, urban infrastructure, access to information, and it used the geometric mean for the final compilation (Piza; Kuwahara, 2009).

This procedure allows having the level of development expressed by the index which also meets the criterion of consistency of the subgroup. The consistency property in subgroups ensures that an increase in the average of a subgroup which is part of the index results in an increase in the average level of development as long as the average of the other subgroups remains constant. Accessibility is important to understand mobility and its effects on quality of life due to data availability and its compatibility with the quality of life index previously established. Thus, accessibility was measured from the information of the person's journey time from home to work using the same MIQL database: the 2010 Population Census microdata (IBGE, 2012). The question of the Census sample component was about "the usual journey time from home to work" (IBGE, 2012: Variable 0662). So, the index expresses the journey time from home to work, and, by definition, it is limited to people who have formal or informally paid labor. The potential answers to the question were categorical and not a figure so we could change them into minutes. The qualitative answer "up to 5 minutes" became the quantitative attribute 5. "From 5 to 30" became 15; "From 30 to 1 hour" became 45; "Between 1 and 2 hours" became 90, and "More than 2 hours" became 120. From this transformation, we created the accessibility index referred to the journeys from home to work similarly to the one Piza and Kuwahara (2009) elaborated indexes. The Transport Accessibility Index (TAI) is calculated as follows:

$$TAI = 1 - \left( \frac{\text{stated average time in minutes} - 5 \text{ minutes}}{120 \text{ minutes} - 5 \text{ minutes}} \right)$$

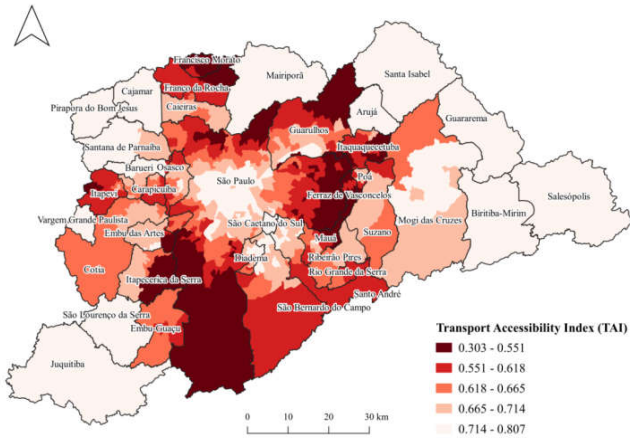
The TAI was calculated for each individual who answered the question about the usual journey time from home to work. It ranges from 0 (lack of accessibility) to 1 (full accessibility) and is related to the declared maximum and minimum journey time. It is a fuzzy index then.

## RESULTS

The spatial representation of the TAI average per weighting area is displayed in Map 1 giving the visual impression that there are spatial patterns. It makes sense intuitively as the TAI is an index constructed from the declared journey time from home to work. Therefore, some locations in the Metropolitan Area of São Paulo (RMSP) share the same commuting infrastructure and the same difficulties or facilities of access to the main locations where employment is concentrated. Employment is not evenly distributed in space but is rather concentrated in some areas, such as the expanded center of the municipality of São Paulo, the ABC Region<sup>1</sup>, the Barueri region, and whereabouts and the municipality of Guarulhos (See Map 2). This corroborates LaSage's (1999:3-4) statement that "location and distance are important driving forces in human geography and the market mechanism." The concentration is even higher if we consider the index of employment rates per kilometer in the area of each Origin-

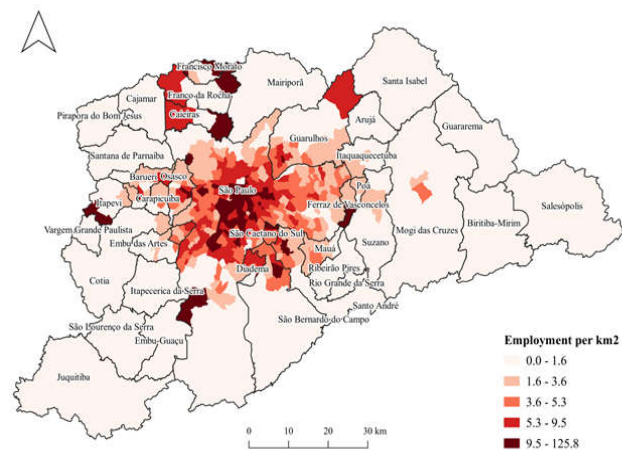
<sup>1</sup> It includes the municipalities of Santo André (A), São Bernardo do Campo (B) and São Caetano do Sul (C).

Destination (OD) Zone. As depicted in Map 2, job density in the SPMA is high in some ‘islands’ in the north and west but the central zones of the São Paulo city marshal most of the jobs evidencing the concentrated character of employment in the region.



Source: Based on the 2010 Population Census (IBGE, 2012)

Map 1. Quintiles of distribution of the average TAI per weighting area of the RMSP



Source: São Paulo Metropolitan Origin-Destination (OD) Survey (2017)

Map 2. Total employment numbers per Origin-Destination Zone in 2017

To complete the task of incorporating the dimension transport to the MIQL-M, we had to ‘raise one level’ in the aggregation scale calculating the TAI weighted mean per municipality (TAI-M), as follows:

$$(I_t) \equiv TAI - M = \sum_1^n \left(\frac{n}{N}\right) TAI_n$$

The average TAI-M for RMSP is 0.66505 and the standard deviation is 0.07532, meaning low dispersion in the TAI-M values. Despite the subjectivity inherent in an individual choice and all aspects related to it, the municipal average expressed by the TAI-M reflects the municipalities’ patterns of accessibility in their residents’ perspective, that is, how easy (or difficult) it is to commute from home to work daily. The result is the consequence of the process of the SPMA socioeconomic development and occupation. Once calculated, the TAI-M was incorporated into the new multidimensional index – the Multidimensional Index of Quality of Life for Municipalities and Transportation (MIQL-T) –, composed of seven dimensions: income, education, health care, household conditions, urban infrastructure, access to information, and

accessibility to work. Accessibility to the workplace represents the incorporation of mobility and becomes the seventh dimension of the MIQL-T. The index is calculated for each municipality by the geometric mean of the seven indexes:

$$MIQL - T = \sqrt[7]{I(y) * I(e) * I(s) * I(h) * I(ie) * I(in) * I(t)}$$

The incorporation of the transport dimension affected the quality of life (well-being) index very much. Only three of 39 municipalities kept the same position in the ‘well-being ordering’ and 20 municipalities (more than a half) of the remaining 39 municipalities worsened their position in quality of living ranking, as shown in Figure 1.

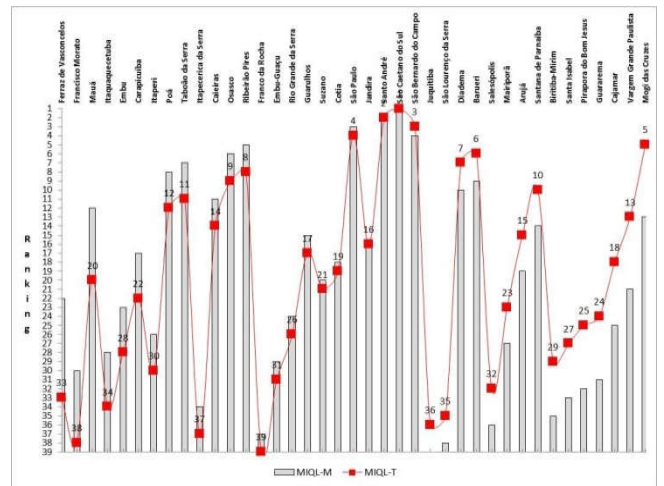
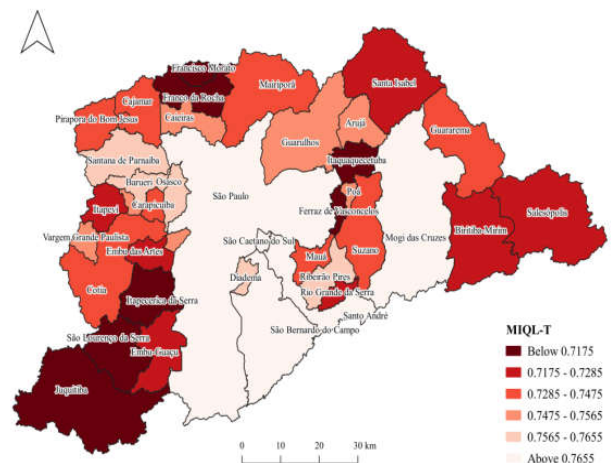


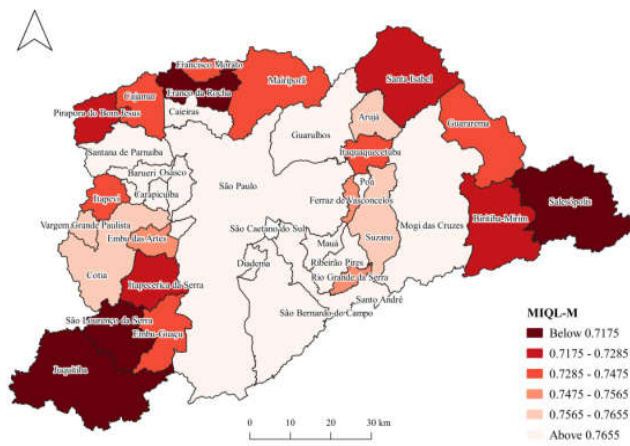
Figure 1. Ordering of the RMSP municipalities by the quality of life (with and without the transport)

Therefore, it seems evident that the effect of measuring the quality of life taking into account the mobility dimension underpins the assumption that accessibility matters for the quality of life. The dimensions of the quality of life in the municipalities of the SPMA have huge internal disparities with relevant variations among their weighting zones. The effects are unequally the citizen's life. Moreover, most of the municipalities which lost relative position in the quality of life index border São Paulo, the great concentration-oriented municipality of economic activities and employment opportunities, showing that commuting problems from/to the capital affect directly and negatively commuting to/from its neighboring cities (See Map 3 and Map 4).



Source: Based on the 2010 Population Census (IBGE, 2012)

Map 3. MIQL-T 2010

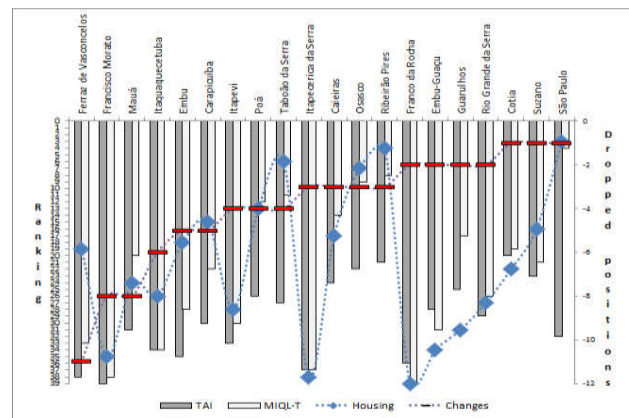


Source: Based on the 2010 Population Census (IBGE, 2012)

Map 4. MIQL-M 2010

**DISCUSSION**

By comparing the MIQL-T and the original MIQL-M, two characteristics stand out regarding these municipalities: a) the average of population density where transport conditions deteriorated the quality of life (3,809 inhabitants per square kilometer) is higher than the average of the total set of municipalities (2,856 inhabitants per square kilometer), a characteristic which is maintained even excluding the capital; and b) on average, the set of municipalities negatively affected by the transport dimension has also worse housing conditions than the average of the total set of the municipalities when comparing their respective MIQL-T subindexes, especially the Housing subindex (see Figure 2).



Source: Based on the 2010 Population Census (IBGE, 2012)

Figure 2. Largest relative position changes (red line) after accessibility index inclusion

A half part from the municipalities (Figure 2) that have dropped positions is worse-ranked according to the Housing index. The accessibility conditions in Ferraz de Vasconcelos and Francisco Morato are the worst. The first one is hard enough to raise 11 positions from the MIQL-M ranking. On the other hand, São Paulo, the biggest municipality studied, is the 9th worst (32nd) according to the TAI index. Because of the other dimensions, in the Housing ranking it is the 3rd, p.e., São Paulo dropped just one position.

**Final remarks**

This paper claimed that difficult accessibility is a kind of deprivation which undermines human well-being and quality

of life under a theoretical perspective, and also that commuting is a key aspect of mobility. The Transport Accessibility Index for Municipalities (TAI-M) was generated. The new index contributed to shed light on measuring the results of fostering municipal transport policies. The accessibility index identified the weighting areas of the municipalities of SPMA with the lowest degrees of accessibility. When the accessibility dimension was incorporated into the synthetic and multidimensional quality of life index, the created Multidimensional Index of Quality of Life for Municipalities - Transportation (MIQL-T) revealed the municipalities most affected when it takes into account the urban mobility dimension. Twenty municipalities of the SPMA dropped positions in the ranking of quality of life. These results suggest the relevance of incorporating mobility to measure the quality of life. The two indexes generated contribute to the knowledge of the metropolitan areas' dynamics. Because of how the MIQL-T was built, it can marshal more dimensions than HDI as well as it can express the inequality within dimensions. The MIQL-T and TAI data allow calculating the index for disaggregated areas. In conclusion, the advantages of the strategy characteristics are not only the multidimensionality, or the ability to light on disaggregated areas, or even the inequality sensitive of the dimensions. The contribution of the indexes lies in being an alternative to understand the limits of living and moving well in big cities.

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