

Transport accessibility and urban development: a case study of the city of Rio de Janeiro, Brazil

D. S. C. P. Lemos, M. P. S. Santos & L. S. Silva
*Transport Engineering Programme - PET/COPPE,
Federal University of Rio de Janeiro (UFRJ), Brazil*

Abstract

The understanding of the relationship between transport and urban development has been an important research objective for many years. In this paper, a case study carried out in the city of Rio de Janeiro, Brazil, is presented. Transport accessibility is represented through the use of a set of transport infrastructure indicators related not only to the urban road and traffic systems, but also to urban public transport supply characteristics. Urban development is expressed in the form of human development indicators, which are directly linked with the social and economic aspects of Rio de Janeiro city. The analysis of the relationship between urban development and transport accessibility is carried out considering the municipal area of Rio de Janeiro, which is divided into 32 administrative regions. The data basis used in the analysis consisted of information regarding these 32 administrative regions that was assumed to be the spatial analysis unit. The results of the statistical analysis have shown that, for the city of Rio de Janeiro, there is no clear evidence to assume the relationship between the indicators of transport accessibility and indicators of urban development. On the other hand, the results of the analysis have also shown that, under certain peculiar characteristics of both socio-economic and transport infrastructure conditions, the relationship might be considered as a valid one. In this last case, only a partial sample of administrative regions has been used.

Keywords: accessibility, urban development, Rio de Janeiro, Brazil.

1 Introduction

The lack of equilibrium in urban development for large metropolitan regions in developing countries is well documented. In this context, particularly in the case



of countries which present high urban population concentration, like Brazil, the transport system assumes an essential function. It is an instrument for expanding and organizing the territory as a local where economic and social activities take place. The objective of this paper is to present an analysis of the relationship between transport accessibility and urban development, considering the case of the city of Rio de Janeiro, Brazil.

The relevance of this work is to contribute to the understanding of the complex relationship between the urban transport system characteristics and urban development conditions; mainly in social exclusion is an important aspect to be taken into account.

2 Methodology

The methodology of analysis involved three steps: first, the definition and characterization of the study area, following its institutional division in "administrative areas" (RA) according to the Rio de Janeiro City Municipal Institute of Urbanism (IPP [11]).

The second step consisted upon the definition and determination of a set of indicators for representing both the accessibility provided by the urban transport system and also the levels of urban socio-economic development regarding each one of the administrative zones considered.

In the case of transport accessibility, two indicators were selected: (i) the first accessibility indicator was the aggregate sum of all the distances between one administrative zone (RA) and all the others, considering the minimum road path between them (Fernandes [4]); the second accessibility indicator represents the magnitude of public transport supply through the number of bus frequencies which attend each one of the administrative zones. It is convenient to mention that more than 85% of all trips observed in the study area are made by bus.

In order to measure the level of urban socio-economic development, two indicators were adopted: an income distribution indicator and the human development index, which includes a set of factors such as education, housing, income and longevity. The geographic unit used, as said above, was the institutional administrative zones (RA) of the city of Rio de Janeiro (FJP/IPEA/PNUD [3]). After collecting and treating the data based composed by the described indicators for the entire city administrative regions, they have been normalized for allowing carrying on to the comparative statistical analysis. For simplifying reasons, the normalized indicators have been classified into three distinct categories: low, medium and high.

The third and last step of the methodological procedure consisted on the elaboration of a number of maps using appropriate graphic software for allowing the comparative analysis of the different geographical zones (RA) of Rio de Janeiro City.

3 The city of Rio de Janeiro and the social exclusion

The City of Rio de Janeiro is the second largest metropolitan region of Brazil, with a population of 5,857,904 inhabitants, 32 administrative regions, 91 local



places like boroughs and four main geographical zones (South, North, West and Central). The municipal region has 122,456 square hectares, 144,336,257 square meters of built environment and 1,479,450 built units (houses, flats, shops, offices, amongst others).

Besides being an extremely beautiful city and present intense and special cultural and natural resources, the problem of social exclusion is present and strongly aggravated as a result of recent social developments: the growth of the poor segment of the population (2,900,000 inhabitants are living on a level below any acceptable situation (Gomide, [8]); a substantial housing crisis; the renovated growth of the slums since 1996, when 17,2% of the city population were living in such conditions (IPP, [12]) and a very low population mobility for the lower income segments (45% of the total population) which accounts for near 60% of the total number of non motorized trips in view of reduced wages for paying for public transport fares (Gomide, [8]).

According to Hodgson and Turner [10], the problem of social exclusion is a social dynamic process which incorporates isolation as an essential issue. As said by Lago [13], the comprehension of the problem of social exclusion in the City of Rio de Janeiro is on the context of social values and should be faced through the poverty growing phenomena and the break of acceptable patterns of social development, which, in turn, are contributing to the vision of this miserable part of the population as dangerous and belonging to a different world: the excluded people.

As a consequence, it has been observed the increase in urban violence and land dispute between the formal and informal spatial types of occupation. The evidence shown by the growth of the slums in the city mountains, even on some regions which have the most valuable land in the city, are strong enough for considering such places as a characterized form of territory.

4 Accessibility and development

According to Hansen (1959), the concept of accessibility is related with the opportunity of an individual to take part in some activity in some place at some time. This opportunity to take part in activities is provided by the land use and urban transport system (*Apud* Raia Junior, [14]).

The influence of the urban transport system on the spatial and economic characteristics of the region was observed, at the end of the 18th Century, when the railroad was the main guide of the city spatial development in detriment to any policy or planning actions. The accessibility provided by the urban railway was a fundamental aspect in the definition of the city urban structure, as the land development occupation has followed the railway lines, particularly in relation to residential location for the low-income part of the population (Abreu, [2]).

The relationship between transport accessibility and urban development is a very complex issue of research. In this paper, some relevant aspects regarding this relationship in the context of social exclusion and urban segregation are reviewed.

According to Ferreira [5], social and economic developments are associated with growth, progress and the level of economical and political maturity of a



determined community. Would it be possible to develop in social and economic terms without economic growth? The growth, specially the one which is measured by income per capita is an essential contributor, but its absence does not preclude the occurrence of some important social progress. As mentioned by Abranches [1], the human development index for the country Brazil reflects a country that changes and shows development in some crucial aspects, despite the reduced economic growth.

The historical origin for the urban segregation problem is connected with the Industrial Revolution, when the residence locations for high and low income segments of the population were established in a distinct way. For the Brazilian case, up to the year of 1980, the pattern of urban segregation could be resumed in the question regarding the city center and the suburbs, where the first are inhabited by the high-income people and the latter by the low income one. Referring to Lago [13], the move and the development of a homogeneous suburban low income residential area was a process of segregation and social discrimination. From 1950, this process is consolidated by the growth of slum central areas in the main metropolitan regions of Brazil, which did not change the dual spatial situation between the centre of the city and its suburban areas.

However, considering the scale and the pattern of urban segregation in the city, and the strategies originated from the need to survive from the low income population, the question of the dual situation between the city centre and the suburbs could mean an inadequate simplification as can be observed from the results of the analysis carried out in this research study.

5 Analysis of the results

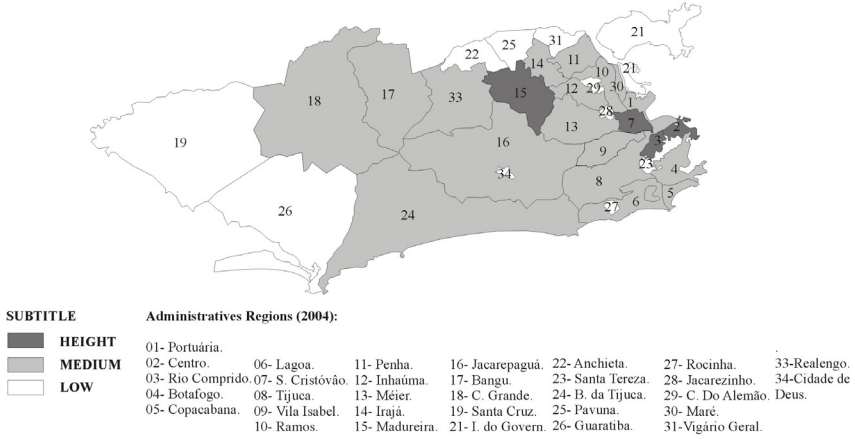
The analytical procedure considers, as already said, a number of administrative zones as their geographical units. It is important to mention that the zones present an elevated degree of social and economic homogeneity. These zones are specified below in terms of its components units:

- Central Zone: *Portuária, Centro, Rio Comprido, São Cristóvão and Santa Teresa;*
- South Zone: *Botafogo, Copacabana, Lagoa and Rocinha;*
- North Zone: *Tijuca, Vila Isabel, Ramos, Penha, Inhaúma, Méier, Irajá, Madureira, Ilha do Governador, Anchieta, Pavuna, Jacarezinho, Complexo do Alemão, Maré and Vigário Geral;*
- West Zone: *Jacarepaguá, Bangu, Campo Grande, Santa Cruz, Barra da Tijuca, Guaratiba, Realengo and Cidade de Deus.*

When looking at Map 1, it is possible to observe that the region is satisfactorily served by public transport, as most of the zones are situated in the medium level according to this indicator.

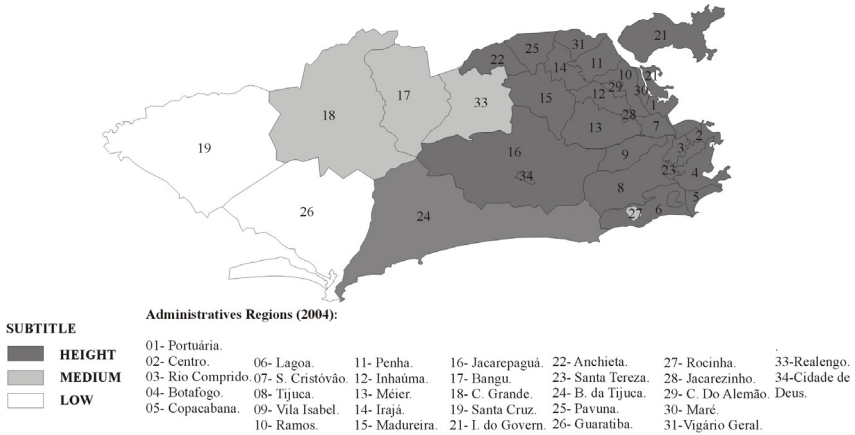
It is convenient to mention that, when looking at Map 1, it is also possible to note that the supply of public transport through an indicator of bus frequencies is low on the suburban areas which are far from the city centre. On the other hand, the indicators of public transport supply are classified as medium for the areas where the slums are located in the proximities of the city centre. That means that

accessibility, when treated as access to the public transport system is far from reasonably distributed within the study area.



Source: Four Wheels Guide of Streets of Rio de Janeiro [9].

Map 1: Public transport supply indicator spatial distribution for the City of Rio de Janeiro (2002).



Source: FERNANDES [4].

Map 2: Road network accessibility indicator spatial distribution for the City of Rio de Janeiro (2002).

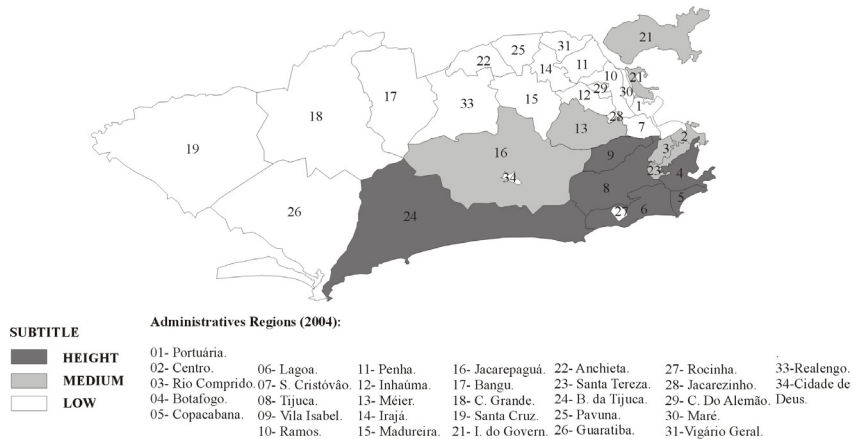
In contrast with the indicator of public transport supply, the other indicator of accessibility, meaning the average distance from one zone to all the other zones, has shown a quite good situation for the whole municipality. It can be seen on Map 2 that the road accessibility indicator assume higher values and is concentrated on the south, north and central zones, covering a large proportion of the city population.

In the case of the West Zone, the administrative regions have shown medium levels of accessibility, which confirms that the accessibility levels are declining from the city centre towards the suburbs, where the low income segment live. It is relevant to comment that some regions which are considered to be deteriorated, poor and violent have presented very high values for both accessibility indicators (*Penha, Irajá, Madureira, Ramos, Inhaúma, Méier, Vila Isabel, São Cristóvão, Portuária* and *Rio Comprido*). On the other hand the main slum regions which are located near the city centre have also presented very high levels of accessibility, particularly for the road network system indicator.

Map 3 shows the spatial distribution of household income for the region of Rio de Janeiro. It can be immediately verified that income levels are very low for most of the urban population. That fact can be noted not only for the suburbs, but also for some central regions which presented a mix of high-income households with near slums of very low-income levels. That is an evidence of the difficulties for treating the question of urban segregation in a city like Rio de Janeiro. In the same Map (3), it is not possible to deny the existence of clear aggregate differences between central and suburban areas, which function like barriers between these two areas of the city.

As opposed to the income distribution indicator, which shows a predominantly low level for most of the region, clearly reflecting a reduced degree of income distribution, the indicator that represent the human development index is observed to be medium to high in the majority of the administrative zones, independently of the location within the municipal region.

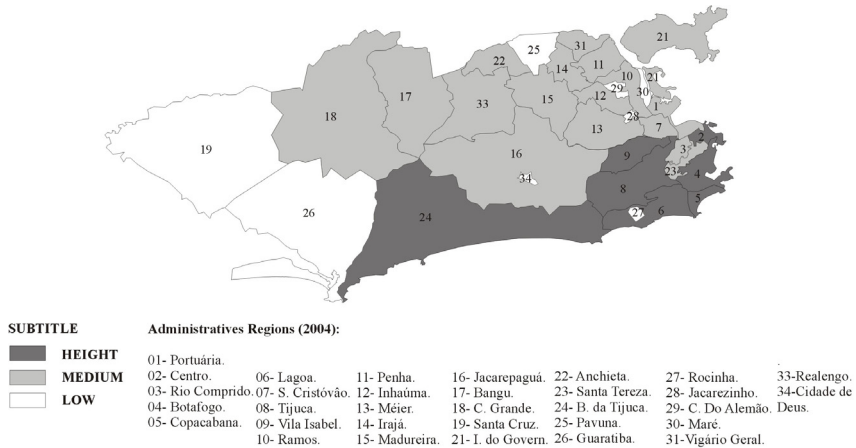
In this case, it is possible to detect that the values for the human development indicator for the regions where exist large slum areas, involving degradation and urban violence, presented very low levels.



Source: Organization/ Pereira Passos Municipal Institute of Urbanism - IPP, Direction of Geographic Information - DIG [11]

Map 3: Income distribution indicator spatial distribution for the City of Rio de Janeiro (2000).





Source: FJP/PEPA/PNUD - João Pinheiro Foundation - IDHM 2000 e IBGE Demographic Census [7]

Map 4: Human development index spatial distribution for the City of Rio de Janeiro (2002).

6 Conclusions

The results of the statistical analysis have shown some strong evidences that, for the city of Rio de Janeiro, high values of transport accessibility indicators are not associated with high values of urban development indicators. This correlation was verified for a small number of administrative regions (RA) of the study area.

For instance, the administrative regions of *São Cristóvão* and *Madureira* presented very high levels of transport accessibility for both indicators adopted, bus transport supply and road distance, but their levels of income are classified as low. On the other hand, the locations characterized by the presence of slums, like *Complexo do Alemão*, *Rocinha*, *Jacarezinho*, *Maré* and *Cidade de Deus* have presented medium levels of accessibility and their values for urban development and income were very low.

The absence of correlation between transport accessibility and urban development indicators was also noted for the South and North zones of the city. It is important to mention that both these zones have shown elevated values for the road distance indicator and medium values for urban transport supply indicators, the North zone presents low values for urban development indicators and the South zone shows high values for both urban development indicators.

On the other side, an evident correlation between transport accessibility and urban development is observed for the West zone, where all the indicators, being of transport accessibility or urban development, were classified as low.

The model of segregation which considers the difference between the city centre and the suburbs is confirmed, as from the spatial analysis carried out the values for transport accessibility indicators presented a down trend behaviour from the city centre towards the suburbs (see Map 2). The indicator of bus transport supply was classified as medium for the majority of the city

administrative zones except for the far suburbs area (see Map 1). It is convenient to comment on the clear segregation in terms of income from the city centre towards the suburbs (see Map 3).

On the other hand, the distinct social and transport system characteristics between the city centre and the suburbs cannot be assumed as a general situation for the city of Rio de Janeiro, as it used to be like the concentration of wealth in the city centre areas. The city centre has presented medium levels of urban development and income, although it has high levels of transport accessibility. It is also noted that the growth of slums within the high-income residential locations has influenced the modifications on the existing social patterns. It can be verified by observing the development of new high valued land areas in the West zone (*Barra da Tijuca*) and also in the North zone.

It is essential to place special attention to the case of *Barra da Tijuca* region which is the main expansion vector of the city of Rio de Janeiro. It presents satisfactory levels of transport accessibility and very high values for urban development indicators. It consists on a new alternative for residential location for middle to high-income segments of the population and it is situated far from the city centre of Rio de Janeiro. The region is characterized by very large residential condominium which creates a different type of exclusion, with a high degree of exclusiveness which involves a peculiar travel and social behaviour.

O problema da *nova exclusão* pode ser constatado através da emergência de segregação social baseada na exclusividade residencial e comercial, como vem acontecendo na Barra da Tijuca e através de uma dinâmica urbana marcada pela *entrada* das camadas sociais médias nas áreas até então destinadas à população pobre (periferia), como vem ocorrendo com o Méier (Zona Norte) e com Jacarepaguá (Zona Oeste), onde se observa a presença de indicadores médios de renda, de IDH.

The formation of a different pattern of land use involving a more fragmented type of activity location has shown the impacts of the economic crisis and the growth of social inequalities in the urban structure of the city of Rio de Janeiro. An important strategy for reducing social exclusion is to provide the adequate conditions for the population to access the fundamental urban public services, which includes the urban transport system. The appropriate understanding of the problem of social urban exclusion requires the detailed knowledge of the relationship between urban transport accessibility and urban development. In this paper, the case of Rio de Janeiro has shown that this relationship is far from being immediate and well understood. In the end, the main objective is to anticipate the impacts of public transport and land use policies in order to take better decisions

References

- [1] Abranches, S. Crescimento e Desenvolvimento Humano. Revista VEJA, Editora Abril: edição número 1811, ano 36 – Número 28 – 16 de Julho de 2003 – página 30 - 106 páginas.



- [2] Abreu, M. de A. (1987) *Evolução Urbana no Rio de Janeiro*. IPLANRIO. Instituto de Planejamento Municipal - Rio de Janeiro, Jorge Zahar Editor 147 p.
- [3] FJP/IPEA/PNUD (Fundação João Pinheiro) IDHM 2000 e IBGE Censo Demográfico 2000.
- [4] Fernandes, G. C. S. (2003) *Acessibilidade no município do Rio de Janeiro*. PET / COPPE / Rio de Janeiro, 9p.
- [5] Ferreira, A. B. de H. (1980) *Novo Dicionário da Língua Portuguesa*. 2ª edição revista e aumentada. Rio de Janeiro: Editora Nova Fronteira, 1838p.
- [6] Fundação Instituto Brasileiro de Geografia e Estatística. (IBGE), Censo Demográfico 1980 e 1991 e contagem 1996 - Tabulações especiais. Cálculos: Coordenadoria de Informações da Cidade, SMU, IplanRio, 1995.
- [7] Fundação Instituto Brasileiro de Geografia e Estatística. (IBGE). Censo Demográfico 1991 e Base de informações por setor censitário do Censo Demográfico 2000. Tabulação: IPP/DIG, 2000.
- [8] Gomide, A. de Á. (Rio de Janeiro, RJ, Brasil de 10 a 14 de Novembro de 2003). *Transporte Urbano, Pobreza e Inclusão Social*. In *Panorama Nacional da Pesquisa e Ensino em Transportes*. Anais do XVII ANPET. Congresso de Pesquisa e Ensino em Transportes. Volume 2. 1512 p.
- [9] *Guia Quatro Rodas de Ruas do Rio de Janeiro 2002*, Editora Abril, São Paulo, 2002.
- [10] Hodgson, F. C. e Turner, J. "Participation not consumption: the need for new participatory practices to address transport and social exclusion." In: *Transport Policy*. Number 10. Institute of Transport Studies, University of Leeds Ls2, 5JT, UK, 2003, 265-272 pp.
- [11] Instituto Municipal de Urbanismo Pereira Passos (IPP), Divisão Administrativa Municipal Geral. *Diretoria de Informações Geográficas*. DIG, 2004.
- [12] Instituto Municipal de Urbanismo Pereira Passos (IPP). "Moradia, segregação, desigualdade e sustentabilidade urbana". In: *Rio Estudos* 13. Maio, 2001.
- [13] Lago, L. C. do (2000) *Desigualdades e segregação na metrópole: o Rio de Janeiro em tempo de crise*. Rio de Janeiro. Revan: Fase. 240p.
- [14] Raia Junior, A. A. (2000) *Acessibilidade e Mobilidade na Estimativa de um Índice de Potencial de Viagens utilizando Redes Neurais Artificiais e Sistemas de Informações Geográficas*. São Carlos: Tese (Doutorado em Engenharia Civil - Transportes) – Universidade de São Paulo - USP, Escola de Engenharia de São Carlos, 212p.

