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## **Urban development and transport disadvantage: Methodology to evaluate social transport needs in Latin American cities**

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### **Abstract:**

This article examines the theoretical framework for accessibility, social exclusion and provision of public transport. The socio-economic and urban characteristics of Latin American cities require the creation of specific indices to determine social needs for public transport. In the article an index of social transport needs is drawn up. It can be used to highlight a problem which is severely affecting wide groups in Latin America who suffer social exclusion aggravated by a deficient provision of public transport, and that the planning of public transport systems must take into account mechanisms which include social needs in the decision making process.

**Key words:** Transport disadvantage; Social transport needs; Social exclusion; Accessibility; Latin America

## 1. Introduction

There is growing evidence about the close relationship between accessibility, mobility transport disadvantage and social exclusion. Transport disadvantage or deprivation can contribute to social disadvantage because the lack of transport choices affects access and the creation of social networks (Burchardt *et al.*, 1999; Kenyon et al., 2002, TGS, 2005).

Transport disadvantage arise from several factors as a lack of access to private transport or to transport services or a lack of suitable information about transport services. Although transport disadvantage can lead to social *exclusion* of individuals, there is a lack of empirical evidence. Those most likely to experience transport disadvantage are those on low incomes, women, the elderly, disabled people and children, ethnic minorities (Hine and Mitchell, 2007). Traditional planning methods for urban transport systems have demand as the principal objective and do not take into account aspects related to socio-economic or spatial equity. This means that the concept of people and regions with “transport disadvantage” is now included in mobility analyses.

In numerous Latin American cities the lack of access and mobility is a factor of social exclusion which shows itself to a great extent in peripheral groups with difficulty of access to opportunities which allow them to break out of the vicious circle of poverty. Social inclusion requires relative measures to be put in place for improvements in, and/or implementation of a high quality network of public transport with tariffs suitable for these sectors, or measures directed towards the reduction in the need for mobility.

In Latin America there is no empirical evidence of the relationship between the provision of public transport and social transport needs. Consequently, public transport policies result, in some cases, in false measures of integration of the socially excluded sectors. This article succeeds in giving evidence of a problem which is severely affecting wide social groups in Latin America which suffer social exclusion, aggravated by deficient public transport provision and demonstrates that planning of public transport systems must take into account mechanisms for the consideration of social needs in the decision making process.

Section two of this article presents the theoretical “Research Context” on the relationship between accessibility, social exclusion and transport. Section three shows the reasoning to

explain the close relationship between social exclusion and access to public transport in Latin American cities. Section four covers the methodology used in this study an index of social transport needs is drawn up. Finally the conclusions are presented in Section five.

## **2. Research Context**

It can be asserted that accessibility, social exclusion and mobility are intimately linked, indeed to travel is a basic necessity, as it permits access, the creation of social networks and can be considered one of the rights of democratic societies (Hine and Mitchell, 2001; Cass *et al.*, 2005; Preston and Rajé, 2007; Lazo, 2008). A deficient transport system implies an increase in the individual and social costs and contributes to social exclusion by restricting access of citizens to opportunities for work and education. Moreover the less privileged population is more exposed to accidents and the contamination produced in their transportation (SEU, 2002; Litman, 2003; Blumenberg and Shiki, 2003; TGS, 2005; Yi, 2006; Qureshi, 2007; Gullo et al., 2008).

At the end of the 1950s, accessibility, as an indicator of the economic and social consequences of the alternative relationships between the uses of land and the transport systems, was defined in terms of the potential opportunities for interaction (Hansen, 1959) and topologically as the analysis of the efficiency of the network (Kansky, 1963). From the 1990s, according Sen (1999), the concept was more broadly re-formulated and became a political goal more than a relative aspect of transport, with reference to the territorial management or to greater safety on the streets. It is not the lack of food or opportunities which limit development, but the lack of access to food or opportunities. In the new narratives on access, aspects such as social inclusion, social justice and sustainability are emphasized (Farrington, 2007). Access is thus linked with the satisfaction of human rights (housing, sanitation, education, work, etc.) and the opportunity for an individual's participation in activities in different places (Sathisan and Srinivasan, 1999; Geurs, 2001; Ramjerdi, 2006; Omer, 2006; Farrington, 2007; Ataieyan, 2010; Carvalho et al., 2010; Mackett et al., 2010). In this way, different authors have related accessibility with the freedom of the individual to participate in activities in the environment (Miller and Wu, 1999); with the impact on land use; with the evolution of transport and with the planning for the function of society in general (Geurs and Wee, 2004); with the capability of a place to be reached or to be accessible from different places (Rodrigue et al., 2006); or with the facility to reach the goods, services, activities and destinations which, as a whole, are designated as opportunities

(Litman, 2010a). The capacity and the provision of transport infrastructures are key elements in the determination of the level of accessibility (Rodrigue et al., 2006). The means of accessibility, the planning of urban environments where long distance journeys are reduced, and the methods of mobility for the improvement of infrastructures and services of public transport as an alternative to the private vehicle, need to be coordinated (Lizarraga, 2006).

The concept of social exclusion began in France in the 1970s and became more widely recognized in the 1980s on an academic, political and social scale. The expression “excluded” referred to a section of the population affected by problems which were not resolved by the Welfare State (unemployment, ghettos, changes in family structure (De Haan and Maxwell, 1998). Social exclusion implies, therefore, the denial of access for an individual or a group, to the opportunities for participating in the social and political life of the community, so that the material and non-material quality of their life is reduced and they also have fewer opportunities and choices and may be considered “half citizens” (Burchardt, et al., 1999; Kenyon, et al., 2002; TGS, 2005). Social exclusion implies lack of access, closely linked to the use of transport modes which allow individuals to travel. The way which social exclusion and transport are linked depends on the activities from which a person is excluded, on the determining factors of the exclusion and the degree in which transport forms a part of them. There exist three distinct types of natural processes which influence the relationship between social exclusion and transport: the organisation of space-time in the homes; the system of transport and the spatial-temporal organisation of the destinations along with the goods or services which a person is attempting to access. The categories of exclusion related to transport are numerous: physical (related to physical barriers inhibit the accessibility), geographical (due to the poor transport provision in some areas), economical (explained by the high relative transport cost), temporal, fear-based exclusion (about the influence of fear in the use of public transport).

Users of public transport confront barriers of access and availability, and of cost and time to access the system. The mobility of citizens has increased with the utilization of the car by 40% in the second half of the 20th Century, but the people who depend on public or non-motorized transport are experiencing a very wide disparity between the place they need to go and the possibility of reaching it. Government directives have favoured the use of the car and only recently the potential for alternative or sustainable modes of transport to which the less

privileged population has access has been proposed as state policy (SEU, 2002; Cebollada, 2008; Currie, 2009, 2010).

A public transport system can generate effects or network economies when the increase in the number of users creates an increase in the frequency of regular bus routes and an infrastructural improvement in general, and the amplification of connections, which is translated into shorter waiting times and less uncertainty about the duration of the journey (De Rus and Campos, 2005). Moreover, the energy consumption and CO<sub>2</sub> emissions per transported passenger, in distances up to 10 km, by private vehicle are double the emissions and consumption of the bus and are five times higher in general than with electrified modes of transport, such as tram or metro (CEC, 2003). In addition, public transport fulfils a function which goes beyond territorial connection and becomes an instrument of social inclusion. The tariffs are a determining factor at the time of deciding to use it, and to provide low tariffs is another element of integration for low income families who manage to reduce their travel costs, through its decrease, or substituting motorized transport by walking part or the whole of the route. However, these strategies only give them limited access to the opportunities offered by the large cities (Avellaneda, 2008; Cebollada and Avellaneda, 2008).

### **3. Spatial configuration of the Latin-American metropolitan areas**

The processes of urbanization which characterise the growth of cities in the second half of the 20th Century have greatly affected urban mobility and by the same token the development of means of transport have transformed land use. This has been evident for several decades (Hansen, 1959; Pushkarev and Zupan, 1977; Newman and Kenworthy, 1996; Wegener and Fürst, 1999; Geurs and Wee, 2004). Urban transport and land use form one integrated environmental, social and economic system that interacts with the surrounding region without clear delineation (Lautso et al., 2004). The impact of transport on land use is affected by a change in the accessibility of a location. Higher accessibility increases the attractiveness of a location for all types of land use, thus influencing the direction of new urban development. Accessibility is an essential location factor for retail, office and residential uses and locations with high accessibility tend to be developed faster than other areas (Wegener and Fürst, 1999). Inversely it can be asserted that a lack of accessibility hinders development, creating greater marginality for poorer people. This interaction between transport and land use has been clearer in the developed countries of North America and Europe (Cervero, 1989; Hall,

1995; Newman and Kenworthy, 1996), with significant suburban growth in regard to those found in developing countries and with a high percentage of informal land occupations. Currently, efforts in developed countries are aimed at combatting urban sprawl through smart growth strategies (Danielsen *et al.*; Weitz, 1999; Burchell *et al.*, 2000; Handy, 2005; Filion and McSpurren, 2007) and towards the achievement of a more sustainable development, integrating transport and land use planning (Bertolini *et al.*, 2005).

The case presented by Currie (2004; 2010) regarding Australian cities, similar to that of other developed countries, is totally different to the reality of Latin American cities. As Cohen (2004) recognizes, Latin American cities have experienced an extraordinary urban growth, and consequently Latin America has become a region with some of the greatest income inequality in the world. Absolute and relative poverty is visible in all Latin American cities and is evident in the existence of extensive slums, a greater number of poor and of high official numbers of unemployment, but with high levels of informal employment and black economy. Moreover the cities show a deficient urban infrastructure with precarious public services and their citizens are faced with high levels of crime and environmental contamination. This has led to the elite becoming isolated in gated communities, increasing the spatial polarization between rich and poor (Calderia, 2000). The methods of structural adjustments put in process in the 1990s did not aid development, and quality of life in the majority of the large Latin American cities has worsened compared to that in the 1970s (Gilbert, 1996; Stiglitz, 2002; Rodrik, 2006).

The uncontrolled growth of these metropolitan areas implies serious problems of social exclusion, degradation and disorganization (Gilbert, 1996; United Nations, 2003; Cohen, 2004), and the problems of accessibility result in being especially serious for the most underprivileged groups. In 2007 there were four “mega cities” (those with more than 10 million inhabitants) in Latin America (San Paulo, Mexico City, Buenos Aires and Rio de Janeiro) and the number of inhabitants of urban areas has increased to an estimated 78.5% of the population in the case of Colombia (CEPAL, 2009).

In Latin American cities there are growing signs of the dissolution of the work market, creating greater black economies, especially in some large cities such as San Paulo or Mexico City. This fact, combined with the deterioration in the conditions of public urban transport and the impossibility of being a vehicle owner, implies, for the poorest, an important factor of

social exclusion. In the centre of Mexico City, Manila, Shanghai or San Paulo, on a working day, traffic circulates between 8 km/hour and 15 km/hour. For Mexico there is research which shows that 20% of workers spend more than three hours in their daily commute to work, and that 10% spend more than five hours (World Bank, 2002).

Central American cities have experienced profound transformations due to demographic pressure, to the concentration of economic activities and to the lack of adequate urban planning for such pressure. The percentage of informal settlements in these mega cities is very high (Davis, 2006), with 18% of the total population in Colombia, a figure which rises to 59% in the case of the Colombian capital (Vargas *et al.*, 2010). Moreover they have an urban structure which is incompatible with the rapid increase in the rate of motorization; a transport demand which exceeds the limits of the supply; a high percentage of collective (shared) transport in the distribution by modes, together with an intense desire to own a private vehicle; and a deficient maintenance of roads and traffic areas (Gakenheimer, 1999). The growth of the cities follows a tendency radically opposed to the objective of sustainable urban mobility and proof of this is that in the last four decades the urban population percentage has grown from 56.4% to 79.5% and it is expected that this proportion will continue to grow. The phenomenon of urban sprawl has developed in two directions which have increased social segregation according to personal income. In Latin American countries the existence of large outer urban areas, where informal and irregular settlements predominate, are combined with gated residential areas, where medium and high income groups live. The initial economic disparity is transformed into marginality for some, due to the lack of security, of public amenities or of urban space which allows for a safe pedestrian movement; and dependence on individual motorized transport for others (Clichevsky, 2000; Giraldo *et al.*, 2009).

The middle and upper classes, as owners of private vehicles, which are the principal causes of traffic congestion, put pressure in favour of the changes in infrastructures which would increase the capacity and speed of circulation. The low income strata are divided between those who are able to access the public transport system and those obliged to opt for walking, cycling or informal modes of low grade and unsafe transport (Figueroa, 200; Lazo, 20085). As adequate infrastructures do not exist for pedestrian movement, or a safe network of cycle paths, urban accidents increase and the air quality deteriorates. The transport policies developed in recent decades are concentrated on the promotion of private vehicle movement (wrongly believing that its technological speed will coincide with a free circulation of traffic)



and the privatization of public transport. These strategies have been to the detriment of the least privileged groups, with the elimination of subsidies and increases in tariffs. Moreover the implementation of the public transport system does not guarantee the advancement of social cohesion, particularly when economic criteria are applied in its planning, because some areas and time periods are not covered (Avellaneda, 2007, 2008; Cebollada and Avellaneda, 2008).

In developed countries local policies are implemented which are aimed at individuals changing their mode of transport from private to public, or non-motorized means of transport, to reduce CO<sub>2</sub> emissions. Significant changes in technologies and infrastructures are being implemented specifically for these means, such as Light Rail Transit (LRT) and Bus Rapid Transit (BRT) systems, cycle lanes, bus lanes or wider pavements. The emphasis is on changing the increasing demand for mobility towards less polluting means of transport (CEC 2001, 2003, 2006, 2007, 2009). Strategies in favour of sustainable and equitable urban mobility are being implemented, relying on more efficient management prioritizing the means of transport which require less space per passenger-kilometre. In general, within the management of urban mobility, priority must be given, in this order: to emergency vehicles, then to pedestrians, bicycles, public transport, supply vehicles, taxis, high occupation vehicles and, finally, single occupancy private vehicles and free parking (Litman 2010).

In recent years various Latin American cities (Santiago de Chile, Bogota) have succeeded in modifying travel patterns through urban transport policies and projects with a high positive impact on accessibility, road and regional organization (Lazo, 2008). The solutions for urban mobility in the principal cities and their metropolitan areas have been rooted in the system based on buses circulating in lanes exclusively designated *Bus Rapid Transit-BRT*<sup>1</sup>. This system was first implemented in Curitiba (Brazil) in 1974 and is characterized by main line corridors fed by branch lines, with segregated and preferential lanes designated for the exclusive use of buses of high and medium capacity; and a network of branch-line routes with the circulation of vehicles of a lesser capacity (Wright, 2002). One of the social functions of public transport is for the connection of the poorest quarters with zones in which the opportunities for employment are concentrated. In 2004 a cable car was initiated in Medellin (Colombia) which connects quarters situated in mountain areas, and where the poorest sectors

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<sup>1</sup> The total estimated cost of the Project in 2005 is US\$ 633,399,800 of which 62% is public investment

live, to the BRT system of transport in the city. This strategy is being extended to other cities such as Manizales and Santiago de Cali in Colombia or Caracas in Venezuela.

#### **4. Index of Social Transport Needs: alternative methodology for Latin American cities**

The economic and social indicators of transport are closely linked to the methods of economic evaluation. The former include the analysis of the generation of employment, impact on Gross National Product and cost-benefit analysis in relation to transport modernization. The latter refer to the equity, that is to say, to the influence of the configuration of the transport system on the distribution of economic costs and benefits between regions and social groups. Other methods of evaluation relate to the provision of transport and traffic safety, equity or the possibility to have different work opportunities or access to public services (Geurs, 2001). In this context, horizontal equity of opportunities requires the existence of a minimum level of public transport services in their area of influence, or the assignment of toll incomes on road infrastructure. The vertical equity comprises of three components: spatial, social and economic. Spatial equity is related to the equitable provision in the territory of public transport services and improvements in infrastructure, particularly in peripheral and/or rural zones. Social equity refers to the availability of special public transport services adapted for disadvantaged persons. Economic equity refers to public transport services designed for users without access to a private motorized vehicle (Banister, 2005; Litman, 2010), or even, as in the Latin American context, those without economic means to pay for the public transport tariffs. Traditional planning methods for urban transport systems are aimed principally at demand and do not take into account aspects related to socio-economic or spatial equity. This fact has meant the incorporation of the concept of people and regions with “transport disadvantage” in mobility analyses (Hine and Mitchell, 2001). “Transport disadvantage” is a multi-dimensional and complex phenomenon which is caused by various factors: low income, non-ownership of a private motorized vehicle, disability, language or cultural barriers, being from an ethnic minority, social isolation, residence in isolated areas, accompanying children or adults with disabilities, dependence on frequent medical treatment, etc. (Litman, 2010). Various studies show the relationship between ethnic minorities, situations of civic insecurity and low income groups, which are in a situation of “transport disadvantage” (TGS, 2005; DfT, 2005).

At present, statistics compiled for journeys and travel in urban areas do not give information on unsatisfied demand or latent needs, which makes it difficult to analyse the role of transport

in social exclusion (McCray and Brais, 2007). To create the indicator of transport need, the structure of the index proposed by Currie (2004, 2010) for Australian cities and later used for Palermo (Italy) (Amoroso *et al.*, 2010) is taken as a basis. The variables and weights considered by Currie (2004, 2010) are indicated in table 1:

Table 1: Social Transport Needs Indicators and weights

Need indicator	Weight
Adults without cars	0.19
Accessibility distance from Melbourne	0.15
Persons aged over 60 years	0.14
Persons on a disability pension	0.12
Low income households	0.10
Adults not in the labour force	0.09
Students Census	0.09
Persons 5–9 years	0.12

Source: Currie, 2010

However, given the particularities shown for Latin American cities, a revision is proposed of the built-in variables and their weighting, more according to the socio-economic and urban conditions of these cities. The ITSN can be calculated as the weighted sum of the indicators of transport disadvantage, though it is understood that this factor is indicative of a greater social need for high quality public transport, with tariffs adapted for the groups which most require this service:

$$ITSN_j = \sum_{i=1}^n T_{ij} P_i \quad (1)$$

Where:

$ITSN_j$ : Index of Transport Social Needs for the area j

$TI_{ij}$ : Standardized Indicator of Transport Disadvantage for factor i for the area j

$P_i$ : Weighting of the Indicator of Transport Disadvantage for factor i

The indicators of transport disadvantage for each factor are standardized so that they take values between 0 and 1, using the following equation:

$$TI_{ij} = \frac{I_{ij} - I_i^{\min}}{I_i^{\max} - I_i^{\min}} 100 \quad (2)$$

Where:

$TI_{ij}^j$ : Standardized Indicator of Transport Disadvantage for factor i for the area j

$I_{ij}$ : Indicator of Transport Disadvantage for the factor i for the area j

$I_i^{\max}$ : maximum value of indicator of transport disadvantage for factor i

$I_i^{\min}$ : minimum value of indicator of transport disadvantage for factor i

The partial indicators of transport disadvantage ( $I_i$ ) are produced from a combination of the figures. As previously mentioned, the theory on social exclusion and transport considers individual aspects of disadvantage: having levels of low or very low income, or being from an ethnic minority, the lack of access to a private motorized vehicle, old age, illiteracy and employment situation (Denmark, 1998; Litman 2010). Added to these are the specific aspects of each area which mean that the population living in it find themselves in a position of transport disadvantage regarding the distance to the city centre, the level of insecurity, the average socio-economic level of the area, the level of accessibility to health services, education, recreation and to economic activities, giving a higher value. In Table 2 the quantitative indicators of transport disadvantage are shown and the factor of disadvantage which it represents. As we can observe, the number and type of variables is much greater than the ones considered by Currie (2010).

The indices of transport social needs can be produced on the one hand from the A-ITSN (Absolute Index of Transport Social Needs), in which the personal indicators of disadvantage were taken for the population as a whole, and on the other from the relative need, the R-ITSN (Relative Index of Transport Social Needs), with the values of population as a proportion of the total population of the area.

Table 2: Factors of transport disadvantage and indicators used (Ii)

Type of disadvantage	Factor of transport disadvantage	Indicator (I <sub>i</sub> )
Personal factors of transport disadvantage	Non-ownership of private vehicle	Population over 16 years of age without access to private vehicle
	Old age	Population over 60 years of age
	Disabilities	Population with disabilities
	Unemployment	Population without work
	Academic study	Number of students
	Socio-economic situation	Population belonging to low and very low strata of income
	Children	Under 5s, not included in the statistics of mobility and who, moreover, require accompaniment of an adult by law
	Ethnic minority	Figures about ethnic minorities
	Illiteracy	Illiterate population
Factors of transport disadvantage specific to each geographical area	Degree of accessibility to the centre	Distance from the centre of activities to the central point of the respective area
		Topological index of accessibility
	Degree of accessibility to educational services	Student population/academic institutes
	Degree of accessibility to recreation and leisure	Population/square metres of recreational units Population/number of libraries
	Degree of accessibility to health services	Population/number of health centres
	Socio-economic level of the area	Inverse of the average socio-economic strata of the area
	Degree of insecurity	Annual number of homicides per thousand inhabitants
	Degree of accessibility to economic activities	Population/number of economic units

Source: Authors

The weightings for each indicator can be obtained by the application of a multi-variant analysis, the principal components analysis (PCA). The use of this method brings about a reduction in the high number of selected indicators to another smaller group of uncorrelated components, which explain the total variance and are a lineal combination of the original

variables (Joliffe, 2002). After testing the matrix of correlations of the indicators, the factors with a weak correlation with the first principal component were taken out of the analysis until two principal components remained with a greater characteristic value (eigenvalue) than one (ABS, 2001). Thus, from both indices, the representative indicators of the level of accessibility to health services or recreational services/facilities were taken out. The combination of the related variables with the first unrotated component allows an index to be obtained for transport social needs, produced with the most important explanatory factors of transport disadvantage. Likewise with this method it is possible to identify the characteristics of the city studied. The weightings of the variables of the first principal component were recalculated as a proportion of the total sum.

This way it is obtained a specific index for every city, specially, taking into account the singular features of each one.

## **6. Conclusions**

This paper has analysed the relationship between public transport provision and social needs by means of the development of an index of social needs for public transport, in absolute and relative terms. The indices of transport needs represent a quantitative approximation of a complex problem which is affected by a considerable number of variables. To produce the indicator of transport need, the index proposed by Currie for Australian cities, and which was later used for Palermo (Italy) (Amoroso et al., 2010), was used as a basic structure. However, given the particularities shown in Latin American cities a revision was put forward of the built-in variables and their weighting, more in accordance with the socio-economic and urban conditions of these cities.

This article highlights a problem which is severely affecting wide groups in Latin America who suffer social exclusion aggravated by a deficient provision of public transport, and that the planning of public transport systems must take into account mechanisms which include social needs in the decision making process. Finally, it must not be forgotten that the policies for public transport and local social policies must be co-ordinated in order to achieve the reduction of needs for motorised mobility and the improvement of the public transport services.

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