The role of public urban transport in the context of social inclusion – the Transantiago case

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Abstract

"Santiago de Chile is implementing a new urban transport system that may give important incentives for other world cities". This World Bank citation refers to the sophisticated public urban transport system called Transantiago started in February 2007. It represents the answer of the national government on the eminent traffic problems in the metropolitan area of Gran Santiago which are ought to continuously growing motorization rates and vast spatial expansion.

Specific emphasis by the public authorities is put on the social benefits expected from the new urban transport policy. Taking into account the high correlation of social inequalities and spatial segregation within the city, the accessibility for low income households should be improved and social exclusion should be combated. Within this context the integration of land use and transport policies plays an important role. But as there does not exist any explicit definition for the key term "social inclusion by accessibility improvements", it is unclear how the actual planning output can be measured and the social gains of the Transantiago system be assessed. However, the experiences with the new system in the first months have been merely negative due to a set of technical, capacity, organizational and information-related problems.

The paper consists in five basic parts. After a short insight into the topic, the theoretical framework is presented and the key issues are defined, in order to then present the methodological approach perceived as appropriate for evaluating the specific Santiago case. This approach is based on a set of quantitative and qualitative methods which will be implemented in frame of a PhD thesis related within the next years. The third part consists in the summary of the very first research results which already may give a hint on the explanatory variables for the role of a public urban transport system in the context of social inclusion. The results so far will are particularly related to the case before the Transantiago implementation. The final conclusion part offers some ideas which elements are to consider within a model that presumes to describe the role of public urban transport in frame of social inclusion.

Keywords

Public urban transport - social inclusion – segregation - accessibility planning – land use integration

1. Problem background and motivation

Social equity gains by adequate local transport policy – especially related to public transport - have gained new importance in transport research in the last years. As an ambitious example may be named the UK where the government funded in 2003 the so-called "Social Exclusion Unit (SEU)" as research body that examines the relationship between transport and social inclusion and introduced obligatory *accessibility planning* into all spatial development policies[1]. Accessibility problems are often ought to disperse urban development due to increased private car ownership rates which especially in societies with big income gaps affect neglecting the transport needs of households without a private car, resulting in difficulties to arrive their places of daily activities in an affordable and acceptable way[2].

Increased motorization, spatial expansion and different accessibility conditions can also be manifested for the metropolitan area of *Santiago de Chile*. Due to its – in Latin American relations - modest settlement densities and eminent socio-spatial segregation patterns the Chilean capital represents a convenient example for the present research. Ought particularly to segregation housing policies in the previous Pinochet-era, the so-called "Greater Santiago area" is today highly fragmented, with an economically active CBD, a very affluent eastern sector and wide lower-income areas in the southern and western periphery.

Previously characterized by its deregulated private bus supply[3], the public transport system in Santiago has in the last months been objective to a total re-design by the national government, in order to face serious environmental and safety problems. Considering famous examples such as the entire BRT system in Bogotá, the *Transantiago plan* was developed, a comprehensive transport project that desires to extend the metro network and to order the bus lines accordant a trunk- and feeder system. The system is publicly planned and controlled, but privately operated. An important focus is done also on the social gains of the new system: Thanks to a tariff union and the optimal coordination of the operators, the travel expenditures for the households on the periphery should be decreased and the accessibility conditions for all inhabitants improved. Nevertheless, the first experiences with the Transantiago have been merely negative, resulting in the stigmatization of the project as "enemy of the poors" and motor of social exclusion.

[1] F.C. Hodgson et al. 2003 : 265.

[2] K. Lucas 2006: 802.

[3] Typical for the majority of Latin American cities.

As there does not exist any specific "prescription" how a public transport system might contribute to social inclusion and reduced segregation, the author of this paper dedicates therefore to this topic in frame of her PhD thesis, regarding the specific Santiago case concerning the potentials, but also limitations and constraints related. The *research* is in a *beginning stage*, so the present paper will primarily explain the theoretical framework (chapter 2) and the methodological approach (chapter 3), whilst then will be presented *first analysis results* (chapter 4), related particularly to the situation before the Transantiago implementation, and some *preliminary experiences* with the Transantiago system itself. The final conclusions (chapter 5) already give a hint on the elements of a model that presumes to describe the role of a public transport system in the context of social inclusion.

2. Theoretical framework

In the following will be given a theoretical insight into the key terms *social ex-and inclusion*, *spatial segregation* and *sustainable mobility and public urban transport*.

2.1 Social ex- and inclusion

The concept of *social exclusion*[4] describes the coexistence of a set of social problems associated with the fragmentation of traditional social structures, the decline in participation in normal processes of society, as well as increasing deprivation among particular social groups. An individual may be described as socially excluded if "he/she is geographically resident in a society but does not participate in the normal activities of that society"[5]. The multi-dimensional character of the term has lead in theory to the clear distinction from the "poverty" term which considers merely the material dimension of social deprivation. *Social inclusion* is rather used as a normative term asking for the possible measures to be implemented by policy makers in order to reduce the phenomena of social exclusion, in order to reduce negative impacts on entire society and social costs.

Having a concrete look to the *role of transport*, there are two key aspects to be emphasized as potential barriers to social inclusion: On the one hand there are certain inadequacies in transport provision, i.e. access or usage barriers for some individuals or groups, affecting limited participation in their daily activities. On the other hand the transport system itself may generate disbenefits in the form of environmental and social externalities such as pollution, increased congestion, negative employment affects and forced residential displacements which bear disproportionately on societal members[6]. Accordant the SEU findings, people are exposed to the risk to be "excluded from activities *spatially* (if they cannot get there at all), *temporally*, if they cannot get there in appropriate time, *financially* because they cannot afford to get there and personally, because they lack the *intellectual* or *physical* equipment to handle the available means of transport"[7].

Nevertheless, a transport system that fulfils all these requirements cannot guarantee increased social cohesion. Transport improvements may have even counterproductive effects, if an

[4] The term has its origin in French social policy debates of the 1980s.
[5] Burchardt 1999, cited in F.C. Hodgson et al. 2003: 265.
[6] Imperial College and University of Leeds w. y.: 1f., 19, 20.
[7] Imperial College and University of Leeds w. y.: 16.

individual gets e.g. the possibility to access a place it did not have access to before, ought to legal barriers or social discrimination, and may so exacerbate the individual perception to be excluded from society. Besides, modifications in a transport system may raise gentrification processes and displace established households towards the disadvantaged areas in a city. The *impacts* of transport improvements on social inclusion are therefore *manifold, uncertain* and have to be examined for the specific case.

2.2 Spatial segregation

Clearly linked to the phenomenon of social exclusion is the issue of *spatial*, particularly *residential segregation*. A population may be said to be segregated if the *conditional* distribution of households by socioeconomic characteristics over space differs from the *unconditional* distribution"[8], i.e. if socioeconomic differences are manifested in a spatial pattern that hinders the free and daily interaction among the groups.

It is mostly the expression of voluntary decisions of some individuals to live in socially homogeneous groups and to keep a physical distance from other groups. Segregation in one area forces so segregation in other areas[9]. While the most privileged groups can achieve to live in the preferred areas with neighbors of similar social characteristics, the deprived groups will concentrate in the less advantageous areas of a city. Some areas may then develop to so-called "*no-go-zones*" (*ghettos*) whose existence complicates political coordination and may reduce social welfare. The gap between the different social groups increases. There have also been identified positive feedback loops of unequal distribution of public goods where affluent areas attract more and more investments while deprived areas remain underdeveloped.

As the less advantageous areas are often located in the periphery, presenting less income and social opportunities and complicating the access to daily activities, residential segregation has to be regarded in the context of *land use and transport policy*[10]. Being aware of the difficulties to combat the tendencies of segregation, public policy making has to aim the amelioration of its negative affects, enforcing a city with less distance impedances between the different social groups and supporting their mutual interaction.

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[8] Miller and Quigley 1990: 5.

[9] The relationship between voluntary and forced segregation is explained in literature by the failure of the Coase theorem which means the optimal allocation of property rights (e.g. housing) by private players who bargain with each other the equal distribution of externalities (e.g. noise or pollution). The failure of the optimum residential allocation is ought to transaction costs, particularly financial resources that enable information and social reputation, which results in different opportunities to settle down at the preferred location within a city.

[10] M. Gonzalez Wahl et al. 2006 : 22 ; Pancs and Vriend 2006: 21.

2.3 Sustainable mobility and public urban transport

Being aware of the wide set of existing definitions for sustainable transport, the current research is based on one that roots back to studies on the role of the built environment for transport demand in Santiago de Chile: There a sustainable transport system is meant to "provide more welfare per unit of throughput", where the welfare is given by the *accessibility* of daily activities and the throughput by the *mobility* needed to reach the related locations[11]. The mobility term is defined here as simple *ease of movement*, related to the generalized reduction of travel time and costs per trip length. Accessibility is understood in the context of location based concepts[12] as *ability or opportunity to reach destinations*, in order to participate in a particular activity or a set of activities[13]. Accessibility strategies strive hence for reducing the generalized costs for reaching destinations and incorporate *advantageous land use policies* that contribute to a compact city development and land use mixing[14].

As mobility behavior can be strongly influenced by the accessibility conditions, the *potential adaptation of trip making and destination choices* are of interest. Deficient access may affect not only a reduced number of trips but also trips to "second choice destinations", due to less travel impedances. Within this context the feature of *auto-contention* should be considered, i.e. the trips that start and end in the same residential area, particular for other than work and study purposes as "non-obliged trips". For the current research the emphasis is put on mobility behavior in the context of *public urban transport* as one of the main modes for lower-income groups, particularly in less developed regions.

2.4 Catenation of the terms

The *relationships* between social exclusion, spatial location and accessibility are *highly complex*. Nevertheless, there is an approved tendency for spatial clustering of social exclusion phenomena and its manifestation in residential segregation. Different mobility conditions affect different accessibility of daily activities and may exacerbate the *societal gap*.

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[11] C. Zegras 2005: 2.

[12] Zegras classifies accessibility definitions e.g. in four groups: (1) infrastructure-based concepts dealing with travel speeds for different modes, operating costs and congestion levels and thus, merely regarding the mobility dimension, (2) location-based concepts which consider the distance to cumulative or potential opportunities such as gravity models and spatial interaction models, (3) person-based concepts regarding individual spatial-temporal constraints in form of "space-time prisms", and (4) the whole set of utility-based concepts considering random utility-based measures, resulting mostly in discrete choices or constrained entropy models (C. Zegras 2005: 44).

[13] J. B. Odoki et al. 2001: 602.

[14] J. B. Odoki et al. 2001: 608.

The challenge for social transport policies consists in *enhancing interaction between the different social groups*, on the one hand via lower travel impedances in terms of time and costs, on the other hand – related to *collective transport* - by unavoidable contacts in the transport vehicles. Particularly among the deprived households can be expected lower car ownership rates which asks for an affordable, but also efficient and socially acceptable public transport service. A modern and high-quality service might also attract car owners as new collective transport users, in favor of increased urban life quality for everyone.

Considering the strong *links between transport and land use dynamics*, one has to be aware of the *ambivalent role of transport development*, as the network extension may induce via higher land values the up-grading of a previously deprived area, with the risk of gentrification.

3. Methodological approach for the Santiago case

The general idea is to compare the situation of the *previous public transport service in* Santiago (period 1990s-2007) with the *new Transantiago system* (since 02/2007), taking into account the influence factors on demand and utilization. A deeper look will be taken to the *socioeconomic development* in the different parts of the metropolitan area and the *evolution of the spatial patterns*, particularly to residential location. For that purpose a *mixed approach* is recommended, with an emphasis on quantitative methods reducing bias and subjectivity, but completed by some qualitative methods, in order to catch the real essence of social issues[15].

For the four dimensions *socioeconomic differences*, *spatial segregation*, *public transport supply* and *mobility behavior,* quantitative data for the period *before* and *after* the Transantiago implementation are analyzed via SPSS and Excel. With regard to available data the present research is done in a first round on whole metropolitan ("macro") and on comuna (municipality/ "meso") level, in order to get an idea of the socio-spatial variations. Accordant the example of the OD survey in 2001, the comunas are classified moreover in six geographical sectors with comparable socioeconomic characteristics. In a second round will be regarded land use patterns and mobility behavior before the Transantiago implementation also on lower ("micro"), i.e. traffic zone level. Due to the lack of data for the current situation some own empirical works have to be carried out which will be primarily related to the metropolitan and comuna level (see 3.4)[16].

3.1 Socioeconomic differences and social exclusion

The socioeconomic status of inhabitants and social exclusion levels are examined primarily on the basis of census data and social surveys carried out between 2001 and 2006, as well as for the current situation by data extrapolation. With regard to the SEU approach, *six key domains* are considered: (1) income development, (2) employment rates and economical activity, (3) access to educational facilities and education levels, (4) access to health facilities

[15] T. Huissoud et al. 1999: 1

[16] A deeper look was taken to the "Modifiable area unit problem" (MAUP), describing the potential sources of error that may arise by utilizing geographical data sources which are summarized into zones, due to scaling and aggregation problems (V. Dupont 2003: 162 f.). Previous research on the links between land use and transport demand in Santiago referred to three levels: (1) the metropolitan area (macro level), (2) the 38 comunas building together Gran Santiago (meso level) and (3) the 779 traffic zones (micro level). On lower than traffic zone level were not found any significant results Accordant Ortúzar and Willemsen, basic travel forecasting does not necessarily ask for high resolution in travel area zones as it is highly expensive and data intensive (C. Zegras 2005: 58-60; 78).

and health levels, (5) quantitative and qualitative housing standards, as well as (6) participation in community life and access to cultural facilities[17]. The different values are summarized via the *deprivation index*, a standardized value between 0 and 1, as indicator for social standards and life quality for the two periods in the several comunas.

3.2 Residential segregation and land use patterns

In literature a wider palette of *different measurement methods* of residential segregation can be found, varying concerning their focus on actual segregation effects. As different concepts may lead to divergent results, experts recommend applying several concepts. Besides the computation of the two most classical segregation methods (*dissimilarity-evenness* and *isolation-interaction* indices), the *relative proximity* and the *spatial concentration* of low-, middle-, and high-income groups are regarded, on the basis of data from 1991 and 2001. The results are compared with a segregation index applied in previous studies for the Santiago case. The following table summarizes the theoretical concepts and their mathematical computation.

[17] Imperial College and University of Leeds w. y.: 12, 15.

Table 1 Different concepts of segregation indexes applied

Source	**Theoretical concept**	**Mathematical computation**	**Adoption for Santiago**
Wong 1998	Dissimilarity index : Degree of even distribution across the comunas in whole metropolitan area	$Dxy = (\sum \lvert (x_i/X - y_i/Y) \rvert)/2$ With x_i and y_i as members of social groups in comuna i and X and Y as share of social groups in the whole city	Consideration of > 2 groups via aggregation of indices by difference between all scales
Morgan 1983	Exposure index: Degree of potential contact or interactions between different groups, taking into account their relative numerical size: Isolation + interaction index	Isolation index: $Ix_i = \sum (x_i/X) \times (x_i/t_i)$ Interaction index: $Ixy_i = \sum (x_i/X) \times (y_i/t_i)$ With t_i as total population in a comuna i	"Social difference coefficient" s_{dc} as higher weight for interaction between low and high-income groups[18]: $S_{dc} = (\lvert R_x - R_y \rvert/2)$
Whites 1986, Grannis 2002	Spatial proximity: Sum of average proximities between members of the same and different groups in a comuna, weighted by the share of the specific group in the whole study area	Proximities between members of same group: $Pxx = \sum\sum x_i x_j w_{ij}/X^2$ Proximities between members of different groups: $Pxy = \sum\sum x_i y_j w_{ij}/XY$ With w_{ij} as average distance between comuna i and j	Rx and Ry as ranks of (low-, middle-, high income) groups Aggregation of indices by sum of weighted indices; for spatial proximity division by all distances ($\sum w_{ij}$)
Jemelin et al. 2003	Concentration: Over- or under-representation of income strata in comuna, compared to metropolitan average	$I = \Delta (xi-X)$	Presentation of results via GIS in order to summarize different criteria in one map/view
Fahrah et al 1993	Adapted dissimilarity index: Reflecting composition in comuna compared to whole city, without reflecting income differences.	$Ii=(\sum_g (x_i - X)/Y_j)^2)^{1/2}$ with x_j as share of members from socioeconomic group x in comuna i and Yj as share of members from group y in city	Version already adapted by Zegras[19]

Source: Own elaboration, based on C. Jemelin et al. 2003, Grannis 2002, C. Zegras 2005, G. Meng et al. 2006 and Population Studies Center at the University of Michigan 2007

[18] G. Meng et al. 2006: 282-286; Population Studies Centre at the University of Michigan 2006; w. p.

[19] C. Zegras 2005: 118-120.

For the analysis of the general *spatial structure* of the city, the locations of construction and housing areas, dwelling densities, land and housing prices, also in relation to distances to the CBD, are examined concerning their spatial and temporal variation. This analysis will be done on the basis of quantitative data and via qualitative interviews to relevant stakeholders in the urban planning sector and real estate market.

For determining finally the availability of opportunities and daily activities, so-called "*land use diversity indices*" for the several quarters in the 38 comunas are computed. The formula applied roots back to Rajamani 2003[20], capturing the mix of uses relative to a perfect distribution of spaces, including six different land uses, measured in floor-m^2: The diversity indices are standardized and compared over space and time.

$$DI = 1 - \frac{[((r/T - 1/6) + (c/T - 1/6) + (h/ /T - 1/6) + (p/T - 1/6) + (s/t - 1/6))]}{5/3}$$

With r = m^2 of residential area, c = m^2 of commercial area, h = m^2 of health area, o = m^2 of office area, p = m^2 of administrative area and s = m^2 of social service covered area. T = r + c + h + o + p + s; the index describes a value between 0 and 1, where o means one single use and 1 perfect mixing in an area.

3.3 Transport supply: Public transport system

The aim consists in the evaluation of the previous and current public transport system for the metropolitan area of Santiago, accordant the requirements for a socially appropriate system. With regard to existing data, the *spatial and temporal accessibility* conditions will be evaluated on the basis of a simple Hanson-type gravity model[21], following the formula:

$$A_i = \sum w_j f_{ij} * 100$$

With *Ai* as accessibility measure for public transport in zone I; *fij* = exp(-bTTij), with TTij as travel time in public transport between the zones i and j (taken for the period before the Transantiago implementation from Santiago's forecasting model ESTRAUS[22], for the new period from Transantiago schedules and model up-dates) and parameter b as factor for travel time sensitivity (with regard to previous studies= 0.4[23]); *wj* as the share of attraction by each zone j, considering the total of m^2 (constructed floor area) of housing, commerce, health facilities, manufacturing units, offices, social and community services, public administration, indoor sports facilities, and the total of m^2 (land surface) of parks and outdoor sport facilities.

[20] Applied also by Zegras for the Santiago case (Zegras 2005: 134).

[21] Following the Zegras studies for Santiago (C. Zegras 2005: 161).

[22] Calculated for AM peak period, including in-vehicle time, access, egress and waiting time (ibidem).

[23] Should be empirically derived from a trip distribution model, but 0.4 has been commented as a robust average value (C. Zegras 2005: 162).

The accessibility assessment takes also changes into account in the *number of modal shifts* to reach the final destination, as first experiences show a significant augmentation for the Transantiago. Besides, *transport affordability* indicators, i.e. the tariffs and average household expenditures on public transport purposes are to consider. Finally, the *users' general satisfaction* level and passengers' perception of service changes have to be captured, including also "*soft" criteria* such as security and comfort, information, intellectual viability and social reputation of the system. These items will be based on findings in previous studies, so-called "ad-hoc surveys" in some representative comunas (see 3.4) and some qualitative interviews at central transfer nodes. The *global evaluation* of the public transport service has to be done by an argumentative trade-off, bringing together the different quantitative and qualitative assessment results and regarding the paradigm shift in public transport policies.

3.4 Transport demand: Mobility behavior

For determining transport demand and mobility behavior *before* the Transantiago implementation, the Origin-Destination studies of 2001 are used[24], providing information for the low-, middle- and high income groups on trip rates and purposes, destination and modal choice in dependence of motorization rates. For the new situation an *ad-hoc-survey* to circa 2000 households is perceived, to be carried out in 2008 in five representative comunas, giving at least an idea of changes in travel behavior. The survey will be done in the households' residences, asking for their daily activity patterns[25] and their perception of travel times and number of modal shifts in the new public transport system. The links between socioeconomic characteristics and travel behavior will be identified on the one hand by statistics (on metropolitan and comuna level particularly by identifying their *bivariate correlation* on the basis of Pearson's correlation factors), on the other hand by interviews to relevant experts in the field of transport research, planning and policy.

3.5 Catenation of the terms

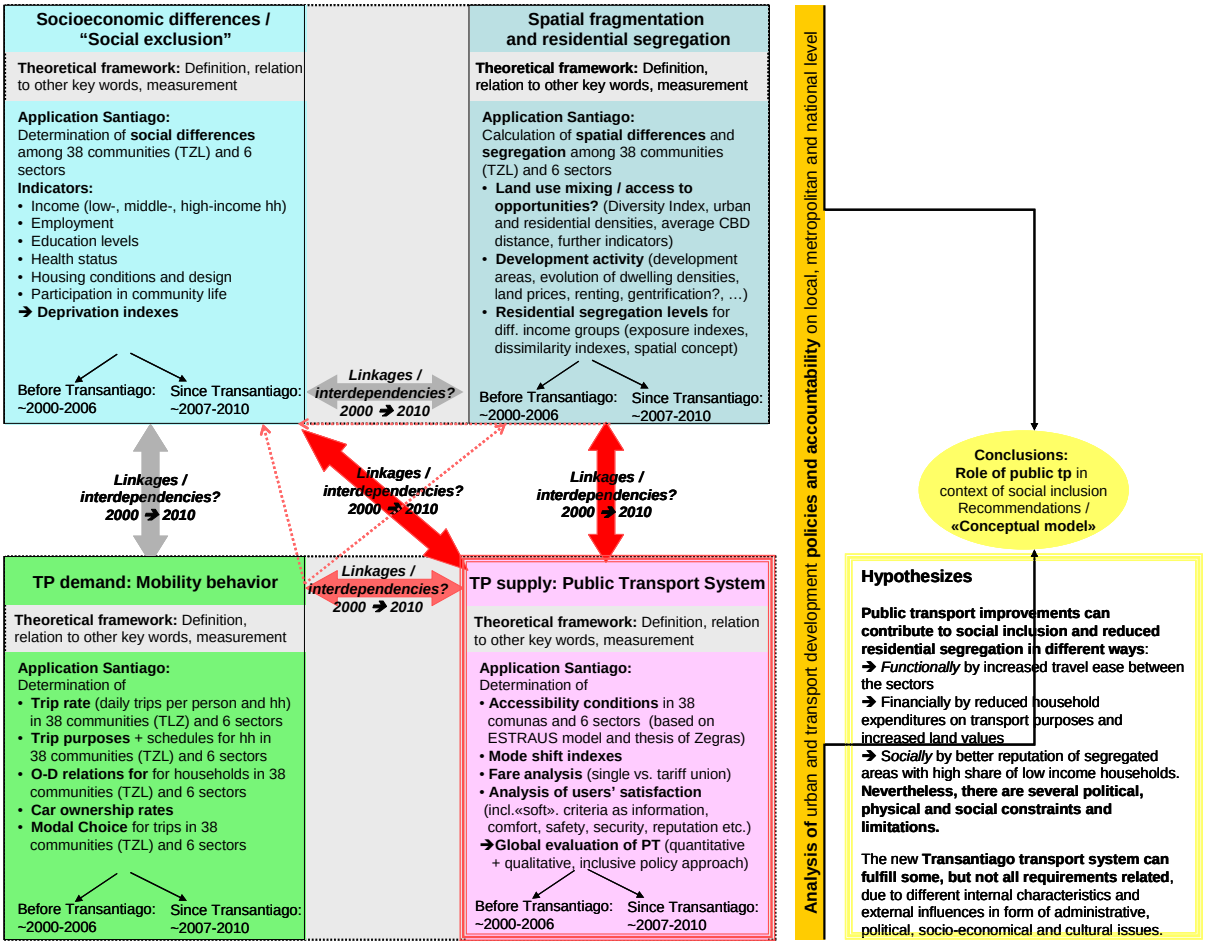
The *influences* of changes in the public transport system on social inclusion and residential segregation may be of *direct or indirect manner* (i.e. over reduced travel impedances,

[24] The survey of 1991 is merely used for a rough comparison and appreciation of changes in mobility conditions.

[25] The application of an activity based concept is also recommended by the UK experts for social exclusion modeling, taking into account entire home-based "tours" and being aware of the individuals' involvement in daily key activities under "spatial, temporal, financial and situational constraints" (Imperial College of Science, Technology and Medicine and University of Leeds w. y. 26, 32-36).

adaptations in individual mobility behavior, employment affects but also over changes in the urban morphology, land use and land values). As research result is perceived a *conceptual model* (including some mathematical elements) that describes these links and interdependencies as well as related limitations and critical success factors. The model will be defined explicitly for the *Santiago case* as support for further policy making but might be *transferable to other case study areas*. The following scheme demonstrates the work flow scheme perceived to follow within the next three years.

Figure 1 Work flow scheme



Source: Own elaboration, 2007

4. First results for the Santiago case

The research is related to the *Greater Santiago area* with its 38 comunas in four different Chilean provinces[26]. The whole *study area* covers a surface of 76,000 hectares and comprises about 5.5 million inhabitants (census 2002), related to 40% of the population of entire Chile.

The *morphology of the city* is characterized by a rather mono-centric-radial structure with the traditional CBD in the central (homonymous) comuna of Santiago and radial transport axes, connected by a ring road highway (see subsequent figure to the left[27]). In the last years a second economical centre has emerged in the affluent eastern sector of the city (the so-called "cone of wealth") which gains more and more dominance over the traditional CBD. *Residential activi*ties match generally the spatial income distribution over the city (see subsequent figure to the right), with low income areas and high dwelling unit densities in the southern and western periphery as well as single-family houses of lower density, often in form of gated communities, and some multi-storey apartment buildings in the central and the up-marked eastern comunas. Accordant a relatively high Gini coefficient for *income distribution* (value of 57.1 in 2002)[28], the per-capita income of the richest tenth part of the population is 40 times higher than the one of the most affluent part. Even if in the last decades poverty concentration and unemployment could be decreased, inequalities have remained and the income gap between the poorest and the richest households has become even more evident.

Urban expansion is directed for middle and high-income groups mainly towards northern direction, for lower income strata mainly towards west and south, taking into account general topographical restrictions. The topography is also – in combination with permanently growing motorization rates and a high share of private car use - the main reason for very low air quality. With regard to - on the one hand - the morphological structure, colonian style street patterns, some densification and revitalization projects in the central areas, but - on the other hand - vast development schemes, strong residential segregation and car-ought pollution problems, the city has been described as *typical manifestation of planning tensions* between the compact European-style development and the Anglo-Saxon garden city movement[29].

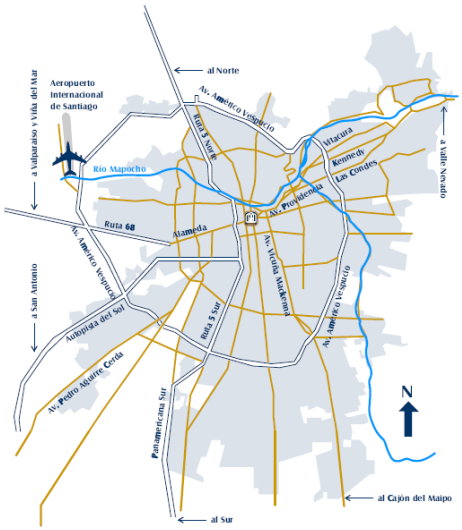
[26] The provinces are Santiago, Maipo, Cordillera and Chacabuco where 26 comunas form totally part of the metropolitan area; and 12 comunas are represented by its urbanized parts.

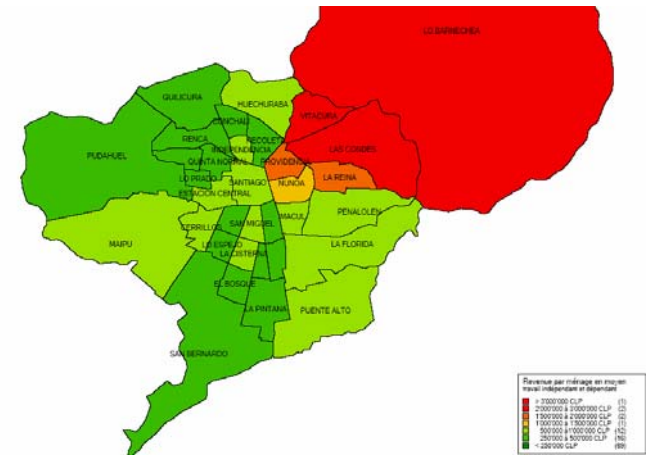
[27] For all GIS maps a green-red scale is applied, with lowest values in dark green and highest values in red.

[28] The Gini coefficient measures inequality over the entire distribution of income, with a value of 0 representing perfect equality and a value of 100 total inequality (C. Zegras 2005: 101, 104).

[29] C. Zegras 2005: 214.

Figures 2 and 3 Main street pattern (left); Average income distribution per comuna (right)[30]





Sources:
Left: Plaza San Francisco 2007
Right: Own elaboration, based on M. Greene and F. Soler 2004: 50, 123 and INE 2007

4.1 Before the Transantiago implementation

The preliminary results presented below focus on the *socioeconomic, spatial and mobility-related framework*, with some appreciations of the *public transport system*. So far they refer merely to the metropolitan and comuna level and have to be further disaggregated in advance[31].

4.1.1 Socioeconomic differences and social exclusion

The deprivation indices and their *comparison with life quality indices* which have been identified by the National Government in 2005, show the same basic result: *Average income is a very important, but not the only explanatory variable for social deprivation*. So the most problematic areas are located in the western and southern periphery while the most affluent sectors are located in the east.

[30] The rather rural comunas Calera de Tango, Colina, Lampa and Pirque are not presented.
[31] Up from October 2007 when the first field visit will be done and more disaggregated data are available.

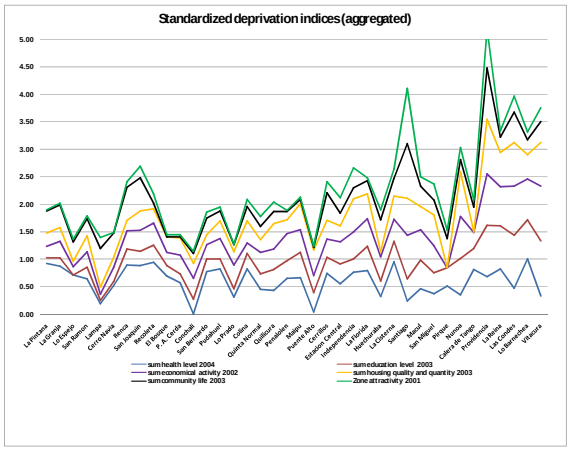
Regarding in detail the results of the own computed deprivation indices, the average household incomes per comuna are strongly correlated to the share of economically active population (Pearson's coefficient c=0.743, $\alpha<0.05$), to the education level and quality (Pearson's coefficient c=0.857, $\alpha<0.05$) and considerably correlated to housing standards (Pearson's coefficient c=0.564, with $\alpha<0.05$). Nevertheless, despite considerable spatial variances among the comunas concerning community life and trip zone attraction for work and study purposes, these variables seem to be less dependent on average household incomes, being other criteria such as land use diversity and centrality more important[32]. So, also for some rather low-income areas such as Renca or San Joaquin and the rather rural comunas could be stated rich participation in community life as important indicator for social inclusion.

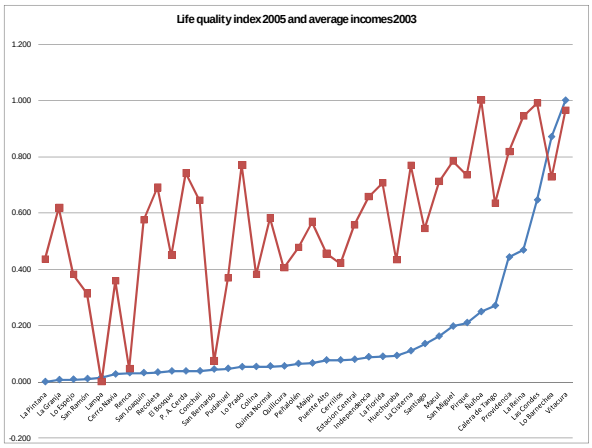
The following figure presents on the upper-left the standardized values for the *deprivation indices* in the several comunas, listed from left to right by the lowest to the highest average income. As most deprived areas result on the one hand the peripheral, less urbanized comunas of Lampa, Conchalí and Pirque, on the other hand comunas with low average incomes located in the western and southern surroundings of Santiago-comuna, such as Cerro Navia, Lo Prado and Lo Espejo. Having then a look (on the right) to the *national life quality indices* which takes additionally into account the quality of open space (i.e. availability of green space, street quality, crime rates and environmental conditions), one observes again a higher life quality with increasing average incomes but no explicit relationship (Pearson's correlation factor c=0.589). The now resultant deprived areas are the comunas Lampa, Renca and San Bernardo, wherefrom the first one is again a rural comuna and the two latter ones rather low income areas with few economical activities in the west and south of the city[33]. The two maps below show clearly the *east-southwest-gap*.

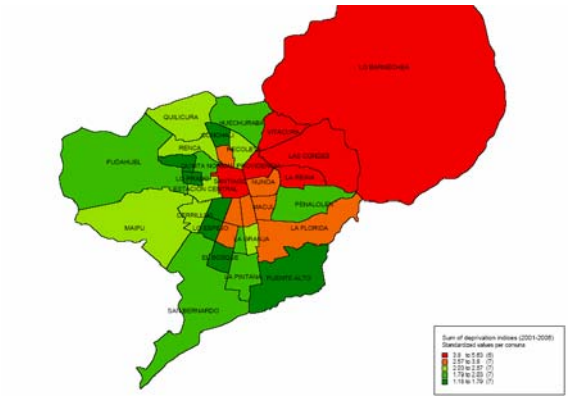
[32] So far the *land use diversity* indices have been calculated only for the whole comunas, based on m^2 of soil surface. As the results show very few variances among the comunas, the analysis has to be repeated in advance on lower level, on the basis of m^2 construction surface. As the present land use diversity indices are little useful, the *attraction by a zone of work and study trips* may give a hint on land uses and is used as interim explanatory factor.

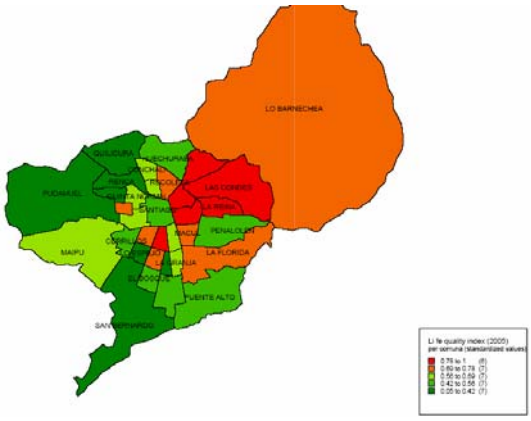
[33] The *differences* between the own computed deprivation indices and the life quality indices refer on the one hand to different criteria, but also to divergent sources and basis years. The biggest differences are related to the comunas with the lowest values in both approaches. The low life quality stated for Renca and San Bernardo is also reflected in the low values for housing and education in the deprivation indices and ought among others to severe crime problems (A. Petermann et al. 2006: 218).

Figures 4 and 5 Own deprivation indices (left) and metropolitan life quality indices (right).









Sources:
Left: Own elaboration, based on Gobierno Regional Metropolitano 2006, INE 2007 and Mideplan 2007
Right: Own elaboration, Gobierno Regional Metropolitano 2006: 119

4.1.2 Spatial segregation and land use development

As can be derived from the segregation indices calculated for 1991 and 2001 for the metropolitan area, *segregation has still increased over time*, with higher spatial concentration and clustering of the members of the same income strata in specific sectors of the city. Except of the interaction index - based on the numerical relationship between different groups in the whole metropolitan area - all segregation indices deliver that result[34]. Concerning the dissimilarity indices one has to take into consideration its statistical dependence on the scale of the geographic units used. Being computed for comunas with large populations, the values

[34] For the isolation and interaction indices it the increased number of high and middle income groups from 1991 to 2001 has to be taken into account, due to economical development in whole Chile. This does not mean a reduced gap to the lowest income groups.

are numerically *relatively* small and would be even higher for smaller units considered[35]. So, *segregation remains to be a strong phenomenon* in 2001.

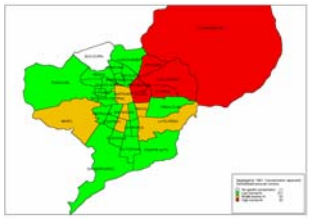
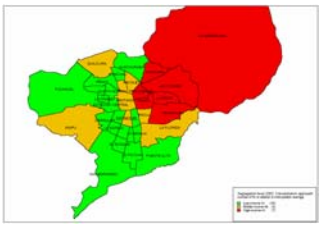
The following table resumes the results. As the proportions of the population in and between the comunas have changed over time, the comparison between the two years asks for net standardized values[36] which are represented always in brackets.

Table 2 Results of computation of segregation indices

Approach	**1991**	**2001**	**Comments / explanation**
Dissimilarity index (even distribution over whole city)	0.645 (0.006)	0.699 (0.008)	The higher the value, the higher the segregation level. **Segregation has slightly increased over time**, with a high segregation level for both years.
Isolation index (numerical relation of same groups in comunas)	Overall value: 0.476 (-1.127) High income: 0.249 (3.156) Middle income: 0.322 (0.073) Low income: 0.801 (-1.640)	Overall value: 0.412 (0.218) High income: 0.271 (0.061) Middle income: 0.563 (0.034) Low income: 0.465 (0.000)	The higher the value, the higher the isolation level. In total, **intra-group isolation has increased**. A look to the *standardized* values for the 3 groups shows reduction for the high and middle income groups but also augmentation for the low income groups.
Interaction index (numerical relation of different groups in comunas)	Overall value: 0.324 (0.035) High-middle: 0.498 (12.270) Middle-low: 0.820 (44.552) Low-high: 0.310 (12.353)	Overall value: 0.317 (0.208) High-middle: 0.622 (14.823) Middle-low: 0.892 (42.437) Low-high: 0.187 (13.381)	The higher the value, the higher the interaction possibilities. Regarding the standardized overall values, inter-group interaction possibilities have slightly increased. A separated look to the 3 groups shows the highest interaction between middle and low income groups.

[35] University of Michigan / Population studies centre: 2007: w. p.

[36] Standardization by formula $z = (xi-\mu)/\sigma$ (comuna value minus average divided by standard deviation), see also Zegras 2005: 118

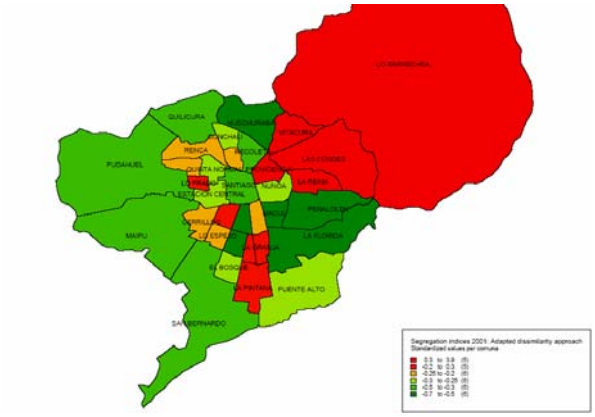
Spatial proximity (average proximity between same and different groups)	Overall value: 0.039 (-0.102) Among same groups: 0.820 (22.331) Between different groups: 0.728 (20.186)	Overall value: 0.640 (0.025) Among same groups: 0.362 (0.024) Between different groups: 0.279 (0.029)	The higher the value, the higher segregation. **Segregation has increased over time**. The spatial proximity (clustering) of same group members is higher than separation (segregation) between different group members.
Concentration (of income groups in comuna, compared to metropolitan average)	High inc.: 6 comunas Middle income 6 Low income: 22 (no concentration: 4) 	High income: 9. Middle income: 8 Low income: 23 	**Spatial concentration (segregation) has for all groups increased**, with the consolidation of low-, middle- and high-income sectors (see maps to the left).
Adapted dissimilarity approach (Zegras)	1.74 (0.014)	1.77 (-0.079)	The lower the value, the higher the segregation level. **Segregation has increased over time.** High income areas show stronger segregation.

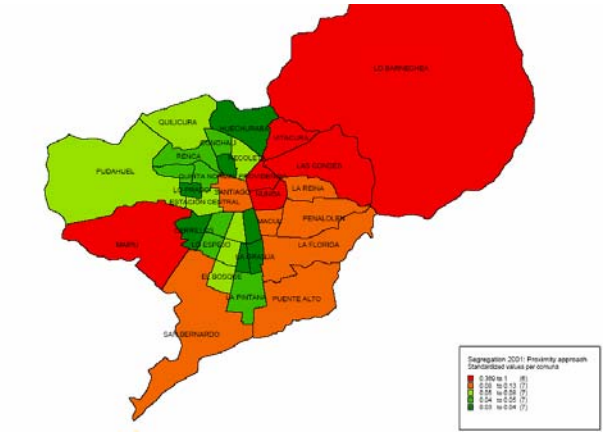
Source: Own elaboration, based on SECTRA 2002

Having a look to the *spatial distribution* of segregation values, one finds for the two *dissimilarity* approaches a significant correlation between high segregation levels and high average *household incomes* (Pearson's correlation factor c_d=0.759 for the dissimilarity index and even c_{ad}=0.913 for the adapted dissimilarity approach by Zegras; values for 2001; α <0.05). These results are obvious, accordant the formula applied and the "common sense" that rich households can decide where they want to live, preferably in socially homogeneous environments. The *distances among the comunas* seem to play a weaker but still considerable

role, as was pointed out by the *spatial proximity* approach[37]. Thus, segregation increases also with distances to overcome, resulting in higher values at the urban fringe. This forms particularly a problem where high segregation coincides with low average incomes and mobility restrictions as in the southern periphery of Santiago (see also 3.4). The two followings GIS maps present the distribution of the results for the adapted dissimilarity approach and the spatial proximity concept.

Figures 6 and 7 Spatial distribution of segregation indices: Adapted dissimilarity / Zegras approach (left) and Spatial proximity approach (right).





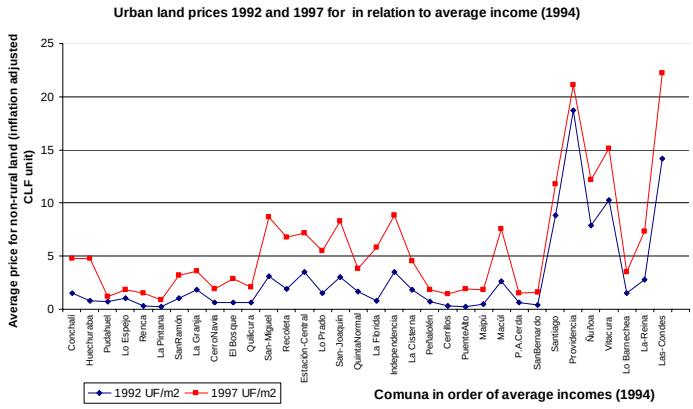
Sources:
Left: Own elaboration, based on Zegras 2005: 118-120
Right: Own elaboration, based on SINTIA 2003: 4-9; Mideplan 2007

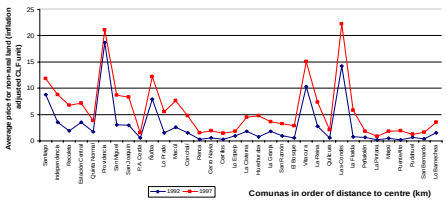
The *decisions for residential location* are ought also to the distribution of economical and social activities and public space. While commercial activities are concentrated mainly along two main axes (west-centre rather for middle income demand and centre-east rather for high income demand), the industrial activities concentrate especially in the less affluent western communities, impacting residents' life quality. On the contrary, green and open space of higher amenity such as private gardens and vast public parks are located especially in the affluent eastern sector, while only smaller plazas and soccer fields are homogeneously distributed over the city[38].

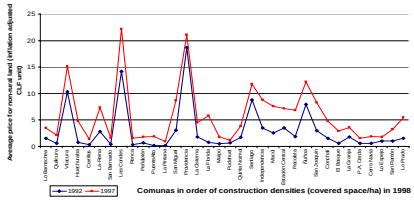
[37] The correlation factors between the sum of distances and the proximity among the same and between different groups are c_{sg}=0.385 and c_{dg}=0.387 respectively.
[38] Zegras 2005: 131.

Closely related to advantageous living environments are housing, construction and *land prices*. The current segregation patterns in Santiago root already back to the fragmentation policy during the Pinochet era when urbanization was characterized by radical liberalization. Urban delimitations were dissolved, land in state property was purchased, and a set of socio-spatial separation policies was set up, related e.g. to the eradication of informal settlements in central and their re-location at peripheral areas and periphery and the declaration of new comunas accordant a "social homogeneity index". Despite the augmentation of urbanizable land, prices increased significantly, even *after* democracy establishment, until the late 90s[39]. The graphics below show the land purchase prices in 1992 and 1997, put into relation to average household incomes per comuna, the average distance to the CBD and dwelling densities. One sees that is less the distance to the centre or the dwelling density[40] than the concentration of population with high incomes (Pearson's correlation factor c_{ai}=0.596) which influences high purchase prices. Prices have even stronger increased in the middle and high income areas, which might have affected gentrification processes and entrance barriers against low income households. The lowest land prices can actually be identified in the far periphery (20-30 km off the CBD), where people are exposed to the risk of social exclusion in case of deficient transport. The *links between land prices and residential mobility* have to be analyzed more in advance.

Figures 8, 9 and 10 Urban land prices for 1992 and 1997 in relation to average incomes (left), in relation to distance to CBD (right above) and dwelling densities (right below).







Sources: All figures: Own elaboration, based on D. Simioni et al. 2002: 75 and INE 2007

[39] Sabatini explains this phenomenon by three reasons: (1) Land of Santiago is not completely geographically substitutable, (2) not reproducible and (3) object to serious real estate speculation (F. Sabatini 2000: 7f.).

[40] The Pearson's correlation factor between land prices of 1997 and distance to the CBD is c_{lp}= -0.320, between land prices and dwelling densities only c_{cd}= -0.147.

4.1.3 Public transport system

The public urban transport system has been characterized on the one hand by the modern *metro system* in the hands of a national enterprise, constructed in 1975 and subsequently extended. At the Transantiago start in February 2007 it comprises five lines over 73 km of tracks and 82 stations, offering a quick, high-quality service that carries daily about one million passengers. Fares depend on the day time, varying between 370 CLP (0.85 CHF) and 460 CLP (1.05 CHF)[41]. On the other hand, there was a rather *deregulated private bus supply*[42], based on about 8000 so-called yellow "micros" and 3500 operators who provide a high-frequent, almost "door-to door"-service. The busses were particularly in the periphery the main or only transport service available, while the metro has been reserved for the inner-city areas. Bus tariffs were with 300 CLP (0.69 CHF) lower than the metro fares, but passengers had to buy for each bus a new ticket.

Even if at the current stage the *spatial and temporal accessibility* conditions cannot be finally evaluated on the basis of zone attraction and travel times, it is quite obvious that the system covered the metropolitan area very well with routes. The oversupply of busses reduced the need to carry out *modal shifts*, resulting in - at least individually perceived - shorter travel times. Previous studies have shown a generally low rate of modal shifts in public modes, varying among the city sectors (origins of trips) between 3.9% and 6.0%, which should have affected low *travel expenditures* despite the lack of a tariff union. Due to the availability of diverse systems with different prices (lower-comfort bus-based and high-comfort rail-based), different passenger clienteles could be addressed. Despite the lack of a proper *information* system, people seemed to orientate rather well, due to long-year experiences with the service. Deficient information was also compensated by the rich (over-)supply of lines and frequencies. Nevertheless, the bus service affected *eminent social externalities* such as frequent accidents and environmental emissions (especially PM10, NOx and noise). Moreover, perception of personal security in the busses and at the bus stops has been described as low, especially by women living on the periphery, - a fact which may have affected serious *accessibility restrictions* when no car and driving license have been available[43]. So, the bus service had a rather bad social reputation as being the preferred mode for the urban poor.

[41] See Metro de Santiago 2007. The currency conversion refers to the values in August 2007 (100 Chilean Peso~0.23 CHF and 0.19 US$).
[42] After a totally liberal period in the 80s, public regulation efforts have subsequently in the last 15 years.
[43] See A. Rodríguez and L. Winchester 2004: 133 and C. Zegras 2005: 150.

4.1.4 Mobility behavior

As presented in table 3, people's mobility behavior differs significantly with *household incomes*: Low income households do less daily trips but much more trips in non-motorized and public transport modes, especially in affordable and better accessible busses (see 4.1.3). The low income population has to compensate lower mobility conditions by *long travel times*[44]. The fact that high income groups tend to travel faster, more often and sometimes also farer stands against the given definition of sustainable mobility. Regarding trip purposes for all trips, a relatively high *share of non-obliged trips* (not for work or study reasons, i.e. health, leisure, visiting trips etc) can be observed, with slightly higher shares for low-income households, probably ought to less economical activity and shorter education periods (see 4.1.1). While public transport remains to be the dominant mode for work, study and private affair trips, private modes are preferred for leisure, commercial and social trips, particularly on weekends.

Table 3 Mobility behavior in relation to average incomes in Greater Santiago area (2001)

Criteria	**Low income households**	**Middle income households**	**High income households**	**Metropolitan av. or total**
Average hh income in CLP (US$ of 2001)	< 450,000 (< 730 US$)	450,000 – 1599,999 (730-2,600 US$)	> 1599,999 (>2,600 US$)	655,251 (1,064 US$)
Abs. number of households (%)	983,900 (65%)	444,800 (29.4%)	85,200 (5.6%)	1,513,900 (100%)
Daily trips/per.	1.3	1.9	2.6	2.39
Daily trips/hh	4.5	7.7	11.2	8.89
Veh./1000 p.	85.5	140.2	309.5	147.4
Vehicles/hh	0.35	0.51	1.18	0.56
Modal split (all trips)				
Auto	12.8	35.2	68.8	27.4%
Bus	29.2	23.7	7.7	30.4%
Metro	2.7	6.3	5.9	5%
Walk	45.1	25.7	9.9	26.6%
Others	10.2	9.1	7.7	10.6%

[44]While average travel times in private transport are only 24 minutes, trips in public transport take almost double of the time (45 minutes). The value of 1.4 hours daily puts Santiago on the high top in international comparison. The comparison scale ranges from 0.78 hours in Delhi suburbs to 1.42 in Switzerland (Schäfer 2000: 5).

Modal split (motorized trips)				
Auto	23.4	47.4	76.4	39%
Bus	53.2	31.9	8.5	51.8% for
Metro	4.9	8.5	6.5	whole public
Taxi	6.8	5.2	3.9	transport
Other	11.7	7.1	4.6	9.3%
Trip purposes (all trips)				
Work trips (%)	24.6	28.2	27.5	26.8%
Study trips (%)	17.1	19.1	21.0	18.7%
Other (%)	58.3	52.8	51.5	54.5%

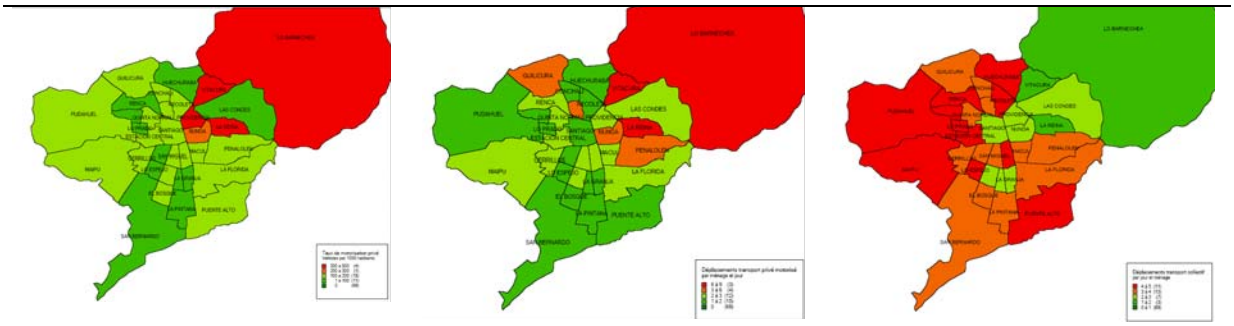
Source: Own elaboration, based on SECTRA 2001: 11, 15; O. Figueroa 2006: 13f

Comparing these data from 2001 with the *survey results of 1991*, one observes also significant augmentations of the motorization rate and share of private car use (+4.2 % and +6.2% respectively), affecting losses in the collective transport use (-7.3%, but + 3.8% in para-transit/taxis). Moreover, the share of non-obliged trips has strongly increased (+35%), as increased mobility may give incentives for additional trip making.

As presented in the maps below, the population of the lower-income areas in the western and southern periphery depends primarily on an efficient public transport system, due to lower car ownership rates.[45]. Taking the *divergent mobility conditions* into account, one might wonder if some deprived households had problems to reach their daily activities. As mobility restraints may affect travel not only *less* but also to other (i.e. closer) destinations, they may have an effect on *auto-contention rates* and by this way on *socio-spatial segregation*.

[45]The Pearson's correlation factor between average income per comuna and car ownership rate is c_{co}=0.772, the income correlation with number of trips / household in private cars c_{nct} = 0.708, and with the number of public transport trips c_{npt}= -0.761; $\alpha < 0.05$.

Figure 11, 12 and 13 Spatial distribution of car ownership rates (left), number of daily trips / household in private cars (centre) and in public transport modes (right).



Source: Own elaboration, based on SECTRA 2002: 12, 18, 26.

The adaptation of mobility behavior asks for the OD relations for trips in different modes and for different purposes. The matrix below presents the *OD-relations for all trips* in 2001 for the six geographical sectors. One sees that the highest *share of auto-contention* is found in the southern and western sectors, which have been described as the less affluent ones[46]. The same result is gained if the percentages are calculated for the same row, i.e. considering only the trips which have their origin in the same sector. Compared to the survey results of 1991, the shares of auto-contended trips have even increased. Having a look to the *trip purposes*, the western and southern sectors are also those ones that present the biggest differences between the auto-contention rates for obliged (work and study trips) and for other purposes. Especially for non-obliged trips people prefer to remain in their sectors which might be among others ought to shorter distances that can be made in non-motorized modes[47]. Finally, the OD pairs for the *public and private modes for motorized trips* are examined. One observes the lowest auto-contention rates (shares over totals of rows, i.e. same origins) in public transport modes for the centre and the eastern sector, despite more leisure and commercial opportunities there. One reason could be a better public transport access, thanks to several metro lines and a wide set of bus connections. Considering on the other hand the auto-contention rates of trips in private cars, a very high value of 73% for the trip starting and ending in the eastern sector attracts the attention, where the private car is used by the affluent population for more than ¾ of all motorized trips. This phenomenon manifests again the segregation level of the high income areas which do very few trips to other sectors and remain "among their peers".

[46] One has to be again aware of the MAU-problem that may affect a higher auto-contention rate for bigger units considered as the surface may be related to more opportunities in the same sector. Nevertheless, considering the auto-contention-rates on lower (comuna) level, similar results were gained. Additionally, the distances between the comunas are taken into account (see below).

[47] Unfortunately there is no information available on OD pairs for only non-motorized trips, disaggregated by the different purposes, so it is not possible at the current stage to testify this hypothesis.

Table 4 OD-relations for sectors in Greater Santiago Area (Survey 2001).

	Destinations								
Origin	**North**	**West**	**East**	**Centre**	**South**	**Southeast**	**Extern**	**n.n.**	**Total**
North	*8.98*	0.58	0.69	1.00	0.37	0.33	0.02	0.62	**12.58**
West	0.60	***13.59***	0.97	1.74	0.71	0.36	0.02	0.76	**18.74**
East	0.68	0.93	*11.11*	1.50	0.69	1.72	0.03	0.55	**17.22**
Centre	1.00	1.76	1.41	*4.21*	1.17	0.91	0.01	0.27	**10.67**
South	0.03	0.72	0.73	1.16	***15.07***	1.15	0.04	0.85	**20.06**
South-East	0.34	0.36	1.71	0.90	1.14	*11.62*	0.04	0.85	**20.06**
External	0.02	0.02	0.03	0.01	0.03	0.02	0.00	0.00	**0.14**
n.n.	0.62	0.78	0.56	0.22	0.85	0.68	0.00	0.08	**3.80**
Total	**12.59**	**18.73**	**17.22**	**10.74**	**20.03**	**16.79**	**0.14**	**3.76**	**100.**

Source: Own elaboration, based on SECTRA 2002: 36

As *further potential explanatory variables for trip making and OD relations*, particularly auto-contention, have been examined so far the distance to the CBD (comuna of Santiago), the role of metro availability (access to metro stations in 2001), as well as the linear average distances among the comunas[48].

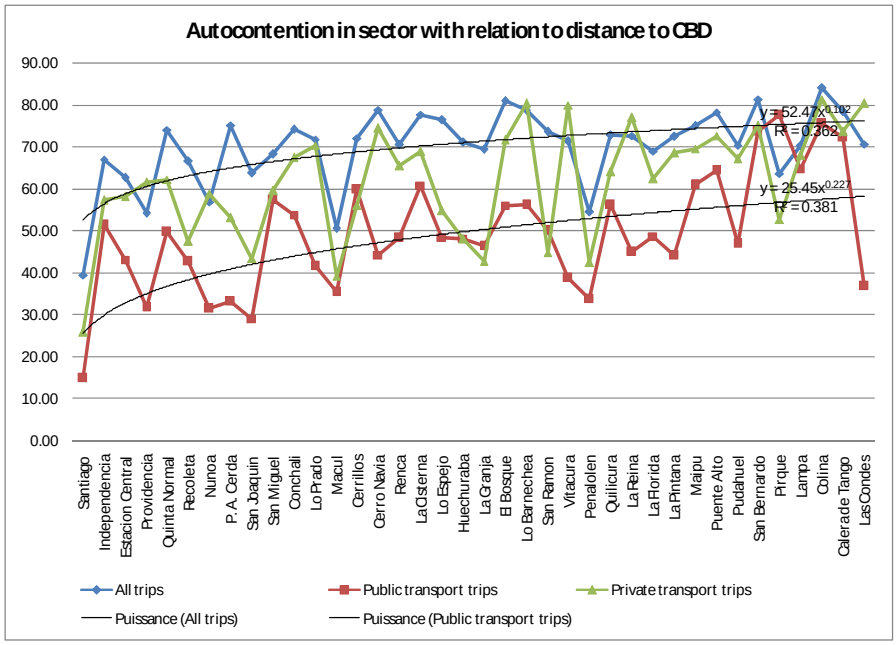
First of all, an ambiguous relationship between the *distance to the centre* and public transport usage was identified, in dependence of the specific land use patterns: Shorter average distances to the CBD *in combination with* high dwelling unit densities and high diversity indices affect a higher use of public transport, which is the case for some middle-and upper-income areas east, south and west of the CBD. While adjacent areas are rather car-dependent, public transport importance *increases* generally with growing distance to the CBD, with highest public transport shares in the low-dense, low-income periphery[49]. The distance to the centre seems to influence slightly also auto-contention rates in the same sector, particularly for all and for public transport trips. Some people tend to do more trips in the same sector if

[48] The concrete travel times in the public and private motorized modes accordant the ESTRAUS model have to be analysed in advance, when the related data are available.

[49] The private car use is then reduced by a factor of almost -0.5 with every km increasing distance to the CBD (see Zegras 2005: 163-165; 183-194).

they live in farer distance from the centre (see graphic below presenting exponential curve estimations)[50].

Figure 14 Influence of average CBD distance on auto-contention rates in sectors



Source: Own elaboration, based on SINTIA 2003

Second, the *accessibility of a metro* in the communal area plays a certain role for public transport use: The correlation factor between the number of stations per comuna area and absolute number of trips in public transport / 1000 people is c_{npt}= 0.713, and for all motorized trips even c_{nat}=0.729. The metro seems to stimulate general mobility in motorized modes while the influence on the share of public transport in the aggregated modal split (only motorized trips) is less strong (c_{spt}=0.590)[51]. Furthermore, *auto-contention rates* for public transport trips appear to be in some areas higher if no metro is available, especially in the peripheral comunas Colina, Lampa, Pirque and La Pintana[52]: The weakest relationship is identified in the Southern and Western comunas where the predominant lower income households often prefer the cheaper busses even if there might be a metro access.

[50] The Pearson's correlation factor between average CBD distance and auto-contention for all trips is c_{aat}=0.523, for public transport trips c_{apt}=0.592 and for private car trips only c_{act}=0.415.

[51] In previous more disaggregated studies the influence of the average walking distance to metro stations was examined, identifying that households with a private car living 1km away from the stations (600 meters above average) do up to 3.8 additional car-km. (see Zegras 2005: 183-194).

[52] The Pearson's correlation factor between metro availability and the percentage of public transport trips starting and ending in the same area is c_{pts}=-0.392.

Finally, the *linear distances among all comunas* and their relationship to the OD linkages for all trips, the trips in public transport modes and in private vehicles have been regarded. For all three categories of trips can be found a *negative relationship* between the *average distances* between the comunas and the *number of trips* done between them. There is a stronger bivariate correlation for the sum of all trips, as they include the non-motorized trips (Pearson's coefficient c_{at}=-0.371). The impacts of inter-comuna distances on the number of motorized trips result to be modest, and there aren't any considerable differences between the public and private modes[53]. Remembering that high-income households as main car user tend to travel faster, the differences in space-time prisms for the societal groups are confirmed. As public transport users have to do the same trip-distances in almost double the time, they can spend less time at the destination places.

4.1.5 Interim conclusions

As expected, *social differences* expressed particularly in different incomes, housing and education standards, *are manifested in residential location*. Due to general economical development, this phenomenon has *increased over time* and the *east-southwest-gap* has become more evident. Housing and urban development policy has been decoupled from transport policy, affecting a *sprawling metropolitan area* with growing distances to overcome and even enhancing social segregation by North-American urbanization types, such as gated communities and up-marked, highly secured apartment-buildings for the affluent population.

There are certain differences in mobility conditions as the lower income households and predominant users of public transport have to overcome similar distances than private car users, resulting in overall more time spent on transport. Trip making analysis alludes to the assumption that *mobility restrictions force the adaptation of mobility behavior*: Lower income people do fewer trips, and many activities are preferably carried out in the same urban sector. The tendency to remain in the same – socially homogeneous - sector can also be stated for high income people, despite a high mobility due to car ownership, which confirms the *socio-spatial fragmentation of the city*. So far it is not clear if increasing land prices have also raised gentrification processes, pushing the deprived households' even farer to the less accessible areas in the periphery.

[53] On the basis of equally low coefficients (c_{ct}=-0.264 for public transport and c_{pt}=-0.277 for private transport) one cannot make a concrete statement on users' distance sensitivity in dependence of the modal choice. Other graph estimations than linear regression did not deliver any stronger results.

The previous public transport system has affected *serious social externalities and costs* whose victims are again merely the residents of the comunas with lower average incomes. Nevertheless, the deregulated *bus* supply offers *affordable and convenient transport service especially for the residents of the metropolitan fringe*, and the modern, highly-efficient *metro* is a potential transport mode that enables *social interaction* between socially different clienteles, particularly for the less segregated comunas close to the CBD.

4.2 Since the Transantiago implementation

For the current situation in Santiago, the work results are related exclusively on the *new Transantiago system* which has been officially started in February 2007. Changes in the social and spatial structure of the city and in mobility behavior will be considered in advance.

4.2.1 Public urban transport system: Transantiago

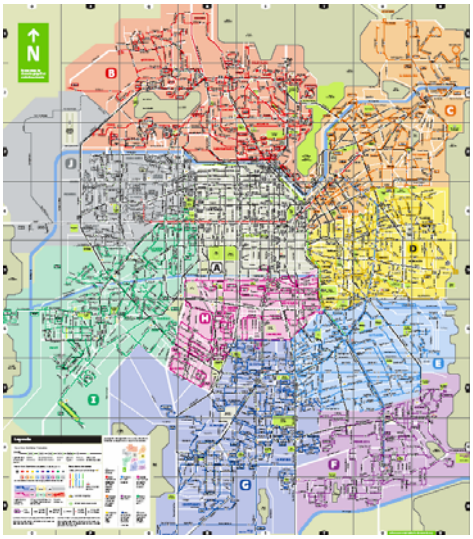
Transantiago is a *comprehensive plan* that aims to establish a coordinated, efficient public transportation system in favor of reduced social and environmental costs. It has been developed on national level in coordination by the infrastructure, housing, environment, telecommunication and transport ministries, under support of the Intendancy of the Metropolitan Region[54]. The *general idea* has been to extend the metro network and re-structure the bus lines, classifying them into trunk lines along main transport corridors, as well as feeder lines that guarantee local access in the outer areas. The concessions for bus lines are given to eight medium-scale entrepreneurs. The old uncomfortable busses should be subsequently withdrawn from the system and replaced by modern low-floor vehicles. Besides, an electronic payment system (called "Tarjeta BIP"), new comfortable bus stops, some proper bus lanes and a coherent satellite based control and information system were designed. A tariff union between the entrepreneurs should enable lower travel expenditures, as a single ride including up to 3 mode shifts (only one to the metro), should generally cost 380 CLP (0.87 CHF)[55].

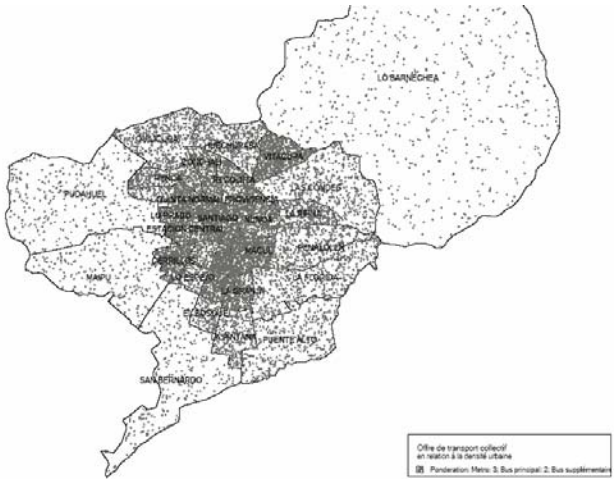
The following figures show the new network accordant the initial plan in February 2007 and the results of a rough evaluation of *spatial accessibility* on the basis of available metro and bus lines in relation to the residential density in the comunas (with the highest weighting for metro access and a higher weight for a trunk line than a feeder line, due to higher frequencies

[54] See Transantiago informa 2007 a.
[55] See Transantiago informa 2007 b.

scheduled). Although the approach gives no information on effective travel times[56], it gives already a hint on possible route deficiencies at the urban fringe, while especially the central and some of the eastern comunas (see Vitacura as second economical centre) seem to be well served. *Travel expenditures* are expected to be lower in average, but could be up to 27% higher for people who used to take only one single bus as direct connection. Serious problems may arise concerning the *intellectual viability*, despite a coherent information system, as in one fell swoop the route, vehicle, infrastructure, tariff and payment system have changed and user have to become familiar with the new technology, i.e. the electronic ticketing.

Figures 15 and 16 New Transantiago network (02/2007; left) and rough accessibility evaluation (availability of lines in relation to residential density; right)





Sources:
Left: Transantiago informa 2007 c
Right: Own elaboration, based on Transantiago informa 2007 c

Actually, the experiences in the first half year of functioning have shown a wide palette of *serious problems* which can not all be justified as starting problems. So have been commented the *lack of routes* especially at the periphery, of adequate busses, skilled drivers and information, increased transfer rates (up to 6 shifts per trip) as well as technical problems with ticketing and the GPS (making public control over the actually provided service accordant the contract conditions impossible). Furthermore, serious *capacity problems* on the trunk lines have affected metro collapses and shut-downs, sexual harassment in overcrowded vehicles

[56] The proper accessibility evaluation has to be done in advance on traffic cell level, taking into account real travel times accordant the up-dated ESTRAUS model and the latest route adjustments.

and various accidents. The failures impair also significantly *extended travel times* and delays, culminating in sometimes violent conflicts between passengers and drivers. People require re-establishing the previous ubiquitous micro-bus system or a nationally provided one which are both expected to be socially advantageous, particularly for the urban poors.

Even if the national government has in the last months put all its efforts in the quick elaboration of *appropriate improvements* (route extensions, technical adjustment, new provider contracts for remuneration based on a passenger-key etc.), the *peoples' skepticism* against the system remains. Strong criticism refers also to *lack of coordination* of public stakeholders of different sectors and levels, despite the comprehensive bracket by the national transport, housing and environmental ministries. Since May 2007 a new metropolitan transport authority is responsible for the planning, implementation and monitoring of all transport related projects in the Greater Santiago area, but local politicians on comuna level still claim not to be sufficiently included in the organization of improvements. So far the *sustainable working of the Transantiago system is unclear*, as the adjustments required already additional costs of over 290 million US$ and the government pledged itself not to increase the tariffs.

5. First conclusions

Both the previous as well as the new public transport system seem to represent *potentials* as well as *deficiencies* concerning their role for social inclusion. The *previous bus system* was especially advantageous for the (rather low income) households at the periphery, thanks to its convenient spatial and temporal accessibility and low tariffs, but ought to its low comfort and safety standards it was stigmatized as preferred "mode of the poor". With regard to the parallel metro system as high-quality service, one can assume less interaction between preferred bus and metro passengers, nevertheless the strongest isolation is to state for bus against daily car users. The considerable negative externalities had negative impacts on everyone, particularly on the inhabitants of central areas with a denser network and higher frequencies. The *Transantiago* plan tries to improve the social reputation of public transportation and to reduce social costs by providing a modern and sophisticated but affordable service for everyone, as active contribution against the isolation of peripheral households and in favor of interaction among the social groups. But ought to a set of planning, technical and organization deficiencies, the system seems to have failed, resulting in its (current) rejection by all income groups.

Having a look to the paradigm shift in transport policy[57], one has to consider the changes in *public responsibilities*. The integrative Transantiago plan was an important step towards better *integration of land use* and transport policy, as it was developed under cooperation of five national ministries. However, the predominance of the national sector for local transport policy remained, despite the additional integration of the Intendancy of the Metropolitan Region. The criticism of local politicians not to have been involved in the planning and implementation process is a certain device for *missing coordination* over the various administrative levels. One may also ask until which degree the Transantiago plan really took current and future *land use development* into consideration. The vast urbanizations schemes for single-family houses for middle and higher income groups which are currently under development in the northern periphery are opposed to the principles of a compact city development leaded by a strong public sector that handles the economic interests of private developers. So the current housing schemes let expect even *increased residential segregation* in the future. So far it is also unclear if possible land dynamics and *gentrification risks* due to new transport infrastructure have been considered sufficiently, as it has been the case for the BRT system *Transmilenio* in Bogota[58].

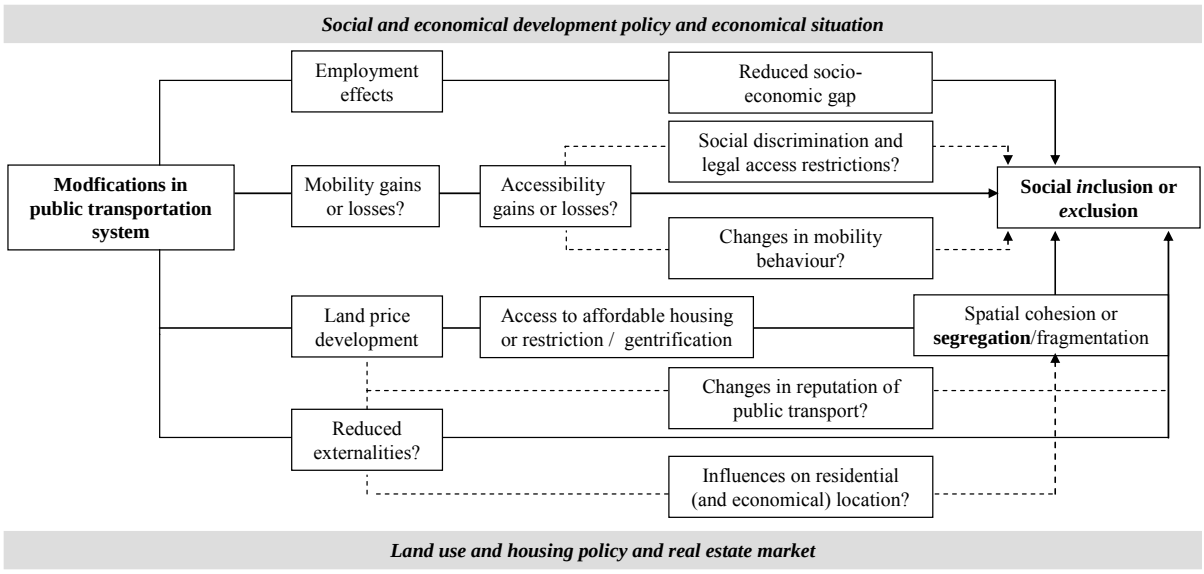
[57] There was a general shift from total liberalization and deregulation in the 80s to increasing regulation in the 90s until the concessionary system of today with strong public regulation and the nationally owned metro.

[58] In Bogota the national government bought in advance land close to posterior Transmilenio corridors, in order to establish ¾ of its national housing schemes in convenient location, designated preferred to the dwellers of informal

Finally, there is the question if the Transantiago is able to become a *profitable* and *sustainable* service at currently low fares of if tariffs will be adjusted soon, as this depends also on supportive transport policies and mobility management in frame of continuously increasing motorization.

Having analyzed roughly the evolution of socioeconomic characteristics, land use structure and mobility behavior and described in general the two transportation systems, at least the *elements* to take into account for the desired *conceptual model* can be named. In advance a deeper look has to be taken to the *land use* in the metropolitan area, also on lower disaggregated level, examining also residential mobility due to transport development, urbanization policies and housing schemes. Besides, the *economical and spatial effects* of the new transport system have to be scrutinized, taking into account employment effects by the Transantiago[59], impacts on land values, average travel expenditures and travel behavior. The following scheme resumes the main links between the elements, clarifying already the ambiguous relationship between transport development and social inclusion but not entitling to be complete.

Figure 17 Model scheme describing the links between public transport and social inclusion



Sources: Own elaboration, based among others P. Waddell et al. 2007: 387

settlements from the periphery. The Transmilenio is often considered as "big sister" of the Transantiago even if it is not really comparable as it is exclusively bus based. So suffered the Transmilenio in the last years e.g. also serious capacity problems, resulting in reduced use by middle/higher-income groups (R. Cervero 2005: 25, 27-30).

[59] Within this context one has to pay attention to the significant reduction of number of operators but an increased number of probably higher-quality jobs in service offices and a set of jobs in construction business.

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