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IMPROVING THE URBAN PUBLIC TRANSPORT IN DEVELOPING COUNTRIES: THE DESIGN OF A NEW INTEGRATED SYSTEM IN SANTIAGO DE CHILE

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INTRODUCTION

In the early 2000s, Santiago de Chile saw the most impressive expansion in the transport infrastructure of its history. 150km of urban highways at an investment of some 1,600 million EUR and the duplication of the metro network from 38 to 80km at a cost of approximately 1,400 million EUR should change the face of the city by 2006.

Nevertheless, another change in the transport system promised to have an even bigger impact in the city and its population. Several changes in the bus system were proposed by the Chilean Transport Planning Office (Sectra), including a new property structure, a new routes scheme, a new fare structure, a new ticketing system and the use of new types of buses, together with the integration of buses and metro in terms of routes and fares. The aim of this paper is to review and analyse the design of this new bus system, which began by the end of 2001. The implementation of the plan started in 2005 and should be completed finishing 2006.

After a brief description of Santiago and its public transport system, the evolution of the bus system in the last decades is analysed and the need for a deep change is discussed. Then, the design of a plan to reach the required improvements is presented, starting with the main objectives and strategies, following with the key aspects of the proposition and finishing with

a description of some additional aspects of the plan. At the end, a discussion is presented and several future challenges are identified.

SANTIAGO AND ITS BUS SYSTEM

General description of Santiago

Santiago, the capital city of Chile, had 5.4 million inhabitants with an average population density of about 10,000 people per square kilometre in 2001. Santiago had more than one third of the population of the country (15.1 million) and generated 47% of the Chilean gross domestic product. The Chilean per capita income has been rising in the last decades reaching some EUR 6,000 in 2001, but the income distribution is quite regressive. The average income of the richest 20% of the Chilean households is 15.3 times higher than the average income of the poorest 20% (CASEN, 2000).

The increase of the income levels, along with a permanent rise of the city population, produced a fast increase in the number of cars in Santiago in the last decades. Between 1977 and 2001 the number of households has been amplified 2.3 times, while the number of cars quadruplicated, reaching 848,000 vehicles. The average motorisation rate increased from 80 to 148 cars per 1,000 inhabitants. But in the low-income zones of the city the motorisation rate can be as low as 52 vehicles per 1,000 inhabitants, while in the high-income zones the figure can reach 430 veh/1,000 inhab. Nevertheless, the average motorisation rate is still low in comparison with developed cities, and it will certainly continue rising in the next decades.

According to the last origin-destination survey (EOD, 2001), in a typical working day 16.5 million trips are made in Santiago, 10.2 million by motorised modes. The modal split shows that 36% are walking trips, 26% are made by bus, 24% by car, 4% by metro, 4% by taxi and shared-taxi and 6% by other modes.

The increase in the income levels and motorisation rate, along with the bad quality of the bus system, yielded an important decrease in the public transport modal split in the last decades. Moreover, the car use has augmented and congestion has increased steadily. Considering only the motorised trips, table 1 shows the strong decline of the public transport modal split. It has to be said that this relative decline in the public transport modal split does not imply an absolute decline in the number of public transport trips. In fact, as the population of the city and the number of trips per person have increased, the absolute number of public transport trips has increased as well. But the absolute number of car trips has augmented much rapidly.

Table 1. Evolution of the modal split.

Year	Public Transport (%)	Private Transport (%)	Others (%)
1977	83.4	11.6	5.0
1991	70.5	19.7	9.8
2001	51.9	39.2	8.9

Source: EOD (2001)

The public transport system of Santiago in the early 2000s

In 2003 Santiago had 3 metro lines, with a total length of 38 kilometres, operated by a public owned company that did not receive operational subsidies. In addition, there were around 8,000 buses running in 380 lines. Beside the buses, there were shared-taxis (*taxis colectivos*) that ran in specific routes with regular intervals. The services were similar to a typical bus service, but with smaller vehicles (cars). Buses and shared-taxis were privately owned and did not receive operational subsidies either. There was one suburban rail line (*Metrotrén*) with five stations inside Santiago that accounted for just 0.1% of the urban public transport trips. Fares were not integrated, i.e. users had to pay a fare every time they boarded a bus, a shared-taxi, or when they entered the metro network. In the case of the buses, the full and students fare were circa 0.45 EUR and 0.15 EUR respectively in 2003. Approximately 1,600 million trips were made in that year in the public transport system, implying some 290 yearly trips per inhabitant in average. In a year, the users of the public transport system paid about 570 million EUR in fares.

In 2001 there were some 15 corridors with a bus patronage of 5,000 or more passengers per hour in one direction in the morning peak. The highest bus demand was in the main street of the city (*Alameda*), close to the central train station, where more than 30,000 passengers per hour travelled in the morning peak in west-east direction (and another 30,000 travelled in the metro at the same time). The aggregate frequency of the bus lines in this place was more than 600 buses per hour per direction (Sectra, 2001). The average length of the 380 bus lines was around 60km (adding both directions), each line running from one extreme of the city to another, and overlapping with other lines in some parts of their routes. So, it was possible to travel from many origins to many destinations without transfers. Therefore, the average number of transfers per trip was only 0.1 for bus trips and less than 0.2 for trips using bus and/or metro. This very low transfers value was also explained by the absence of integrated fares.

The 8,000 buses were operated by approximately 4,000 “companies”. In fact, there were circa 2,500 bus owners that had just one bus, and 1,000 that owned 2 or 3 vehicles. There were only 3 companies with more than 50 buses (Sectra, 2003). The fare, which was directly collected by the bus driver, had to cover all the operational costs, as the operators did not receive any

subsidy. Each operator, trying to maximise the number of passengers carried in each bus, paid to the driver a part of the fares collected. Therefore, the driver's wage was proportional to the number of passengers he carried. If the driver wanted to earn more money, he had to compete with all the other buses to catch as many passengers as possible.

The evolution of the bus system in the last decades

Prior to 1975, bus lines, frequencies and fares were defined by the authority. The operators were not allowed to introduce changes and the bus system was highly inflexible (Transantiago, 2005a). Afterwards, a process of deregulation began in the industry.

By 1980, the bus system was complete deregulated in terms of fares, frequencies and route design. The entrance to the industry needed the authorisation of the Transport Ministry, but an incorporation application was never denied, except for formal reasons. In 1988 even the need for this authorisation was eliminated, and therefore any bus passing a mechanical test could operate without any restriction on fares or routes (Fernández, 1994).

Fares grew constantly in real terms and this was accompanied by increases in the vehicle fleet, which in turn made the fares rise again and so on. Between 1979 and 1989 the bus fleet doubled and the fare more than doubled in real terms. Small buses were mostly used and high levels of congestion between buses, pollution and accidents were observed. On the other hand, routes density and frequencies increased, reducing walking and waiting times (Fernández, 1994). There was no actual competition in fares or service quality, because after the government stopped regulating the industry, a cartel of operators took over the control of the activity (Darbera, 1993; Fernández, 1994). The only competition was on the streets, with buses fighting to catch the next passengers.

At the beginning of the 1990s a big effort was made to move competition from the streets of Santiago to a competitive tendering process. Only the lines which crossed the centre of the city where tendered, i.e. the routes with higher demands. This produced a break in the operators' cartel, and they actually competed in the tendering process that granted operation concessions for three years. Nevertheless, in the following processes almost all the lines where tendered, allowing the operators to agree in advance which line would every one operate and avoiding a real competition in the tender. So, in the last tender 97% of the operators presented the maximal fare and 76% presented an offer for only one line, although it was allowed to present offers for two lines (Sectra, 2003).

This new system had some success in diminishing the excessive number of buses, reducing the fares and improving the technical conditions of the vehicles. Nevertheless, those lines with small operators (owning a few vehicles each) did never act as a real company. On the contrary, each bus owner managed his own income, independent of the revenues of the other buses. So, competition in the streets remained as a reality even between vehicles of the same

line. Because of this, uncertainty in waiting and travel times and high levels of accident risk did not disappear.

On the other hand, the authorities did not increase their role in the planning of the bus system. Only small changes in the routes design were made during the 1990s, and those were propositions of the operators, that were normally accepted by the authority. The fares were regulated, but the authority could not change them at will. Initial fares were determined in the tendering process, and afterwards they changed according to a mathematical equation established in the contracts, which reflected the variations in the operation costs.

Diagnosis

By the end of the 1990s, the bus system still presented important problems that produced a very bad perception of the service in the population. Surveys comparing the satisfaction of the people with different public services (water, electricity, supermarkets, etc.) always show the public transport in the last places. So, the bus system was mainly used by those who did not have an alternative, i.e. captive users. But as the motorisation rate increased, a higher proportion of people could switch to the car, explaining the drastic drop in the public transport modal split in the last decades.

The main negative characteristics that **users** perceived in the bus system can be listed and explained as follow:

1. **Waiting times were unpredictable** and sometimes high, because buses competed on-the-street not only with other lines, but even again other vehicles from the same line. So, it was normal to see two or even three buses from the same line travelling together, “fighting” to catch the passengers in the next stop. This form of operation intensified bus bunching, increasing the headways and waiting times. And even worse, a passenger waiting in a low-demand stop could experiment the highly frustrating experience of seeing how one or more buses he would like to board do not stop, because they are trying to arrive first at a following high-demand stop.

2. This form of conduction (competition), together with drivers working to many hours a day, implied a **high accident risk** and the often-aggressive **drivers** were anything but friendly to the users.

3. Moreover, this aggressive form of conduction increased the **noise and pollutant emissions** of the system. On the other hand, an excess of buses running in the off-peak periods and the overlapping (competition) of bus lines and metro increased the perception that the bus system was highly pollutant. Nevertheless, strict emission norms were introduced in the 1990s and at the beginning of the 2000s almost all the vehicles fulfilled the emission norm Euro II, while new buses had to fulfil Euro III.

4. **Lack of cleaning and preventive maintenance**: Buses were not cleaned enough and they deteriorated quickly, as not-critical damages were not repaired soon (graffiti, damaged seats, dents, etc.). Moreover, only the few bigger companies did preventive maintenance, while the small operators used their buses until something broke. And when this happened, the vehicle had to be fixed as soon as possible, because having their vehicles in the garage for maintenance was perceived as a direct loss of revenue (as their only income was the fares directly paid in the bus). Nevertheless, after the tendering of the 1990s, buses could not exceed a maximal age of 10 or 12 years, so that new vehicles were continuously entering the fleet.

5. Although not directly perceived by the users, **inefficiencies in the route and frequency design** had an impact in the fares. First, every bus line was designed over the years with the aim of maximising the passengers of that route, i.e. competing with other bus and metro lines. Second, given that every bus generated income only when it was running in the street, no operator was willing to let it in the garage in the low-demand periods. All this implied an excess of veh-km that had to be paid by the fares.

On the other hand, there were following **positive** aspects for the users in the bus system:

1. Tough unstable, frequencies were high (some 8 buses per line per hour in average) not only in peak-periods, but also in the off-peak an weekend. Moreover, as many lines overlapped, passengers could use different lines in the main streets and had therefore very **low waiting times**. In addition, there was a **high probability of getting a sit** in the off-peak and weekend.

2. There was a high density of routes, yielding **low access (walking) times**.

3. As bus lines were long and many of them overlapped, **it was possible to travel between many origins and destinations in a direct route**, i.e. without a transfer.

There were two characteristics of the operation of the bus system that, implying higher costs for the bus owners, where never modified by them. These were: (1) The driver's wage was highly dependent on the number of passengers he caught. This produced the on-the-street competition, even between buses of the same line, which implied an aggressive form of driving and higher operation and maintenance costs. (2) All the buses operated in the off-peak periods, implying a higher operation costs than if some buses would have been ran only in the peak periods. Why had the operators such a strange behaviour, operating in a form that implied higher costs for them?

Two aspects of the system have to be kept in mind, to understand this paradox. First, there were more than 4,000 operators and the majority of the buses belonged to an operator that owned less than 4 buses. And second, lines overlapped in extended sections of their routes, so that many passengers could travel indistinctly in different lines. This means that the potential demand (and income) was shared between distinct lines.

If one operator had decided to pay a fixed salary to his drivers, his vehicles would have transported fewer passengers, because of the on-the-street competition of other buses. His income would have fallen. If he had decided to let some of his buses stopped in off-peak periods, again he would have lost some passengers that would have been transported by other operators. It has to be taken into account that the marginal cost of running a bus in the off-peak was quite low: according to the cost estimations made by Sectra (2003), if a bus ran an additional cycle of 60km, the consume of fuel, lubricants, tyres, the payment of the driver, etc., could be recovered with just 50 passengers boarding the vehicle, i.e. less than one passenger boarding per kilometre. Therefore, running a cycle in the off-peak normally produced a profit, even with a very low occupancy of the bus.

The cartel did not have power enough to reach an agreement between all the 4,000 operators in order to change the salary policy or the off-peak operation frequencies. In fact, if such a change had been agreed, the system would have been in an unstable equilibrium, as every operator would have had an economic incentive to change back to the previous behaviour. On the contrary, the observed behaviour was a stable equilibrium, because no operator had incentives to change his form of operation. The only way in which lower frequencies in off-peak periods could actually be implemented was through a number plate based running restriction that the authority implemented with the aim of diminishing the pollutant emissions of the industry.

On the other hand, a similar analysis can be made to explain the absence of express services and shorter lines. These would have reduced the total operation cost of the system, but every operator perceived that making a change in those directions would have reduced his potential demand and earnings.

The existence of too many operators sharing the demand was one of the key aspects of the problem. In addition, a coordinated design of routes and frequencies was needed! It is interesting to note that the problems in the public transport system of Santiago were similar to the problems in many other Latin-American cities.

THE PROPOSITION

Objectives and strategy

A deep change was needed in the bus system of Santiago de Chile. Therefore, a plan was developed with the aim of stopping the decline in the public transport modal split, through a deep improvement of the complete bus system. The main strategies that should help reaching the objective were:

1. Increasing the participation of the authority in the planning and regulation of the system, keeping the operation in the private sector.

2. The improvements had to encompass the bus system as a whole, and not just a part of it.

3. Implementing a new route and frequency design, coordinating the bus lines not only between them, but also with metro.

4. Implementing an integrated fare system encompassing buses and metro.

5. Changing the property structure of the industry, from thousands of bus owners with a few vehicles to several bigger bus companies.

6. Giving adequate incentives to the operators, in order to eliminate the on-the-street competition and reach a higher quality in the service.

7. Avoiding the loss of the positive characteristics that the system had: high frequencies, high route density and low level of transfers.

8. Maintaining the fares in similar levels, without operational subsidy. Tough economic justification for subsidising the public transport were known (Jara-Díaz and Gschwender, 2005), the absence of any operational subsidy was an active political restriction.

9. Avoiding any legal change, in order to reduce the risk of delays because of political discussions. Two already existing laws could be used: first, a law allowing to regulate the operation of the transport system when high congestion, pollution or accident

levels existed (which was created for the tendering processes of the 1990s), and second, a law that allowed the concession of infrastructure investment to the private sector.

10. Avoiding intensive requirements of new infrastructure, to reduce the risk of financial deficit.

Main aspects of the proposition

The main aspects of the proposed system are presented and discussed in the following points.

A transport authority that externalises the operation to the private sector.

Following successful experiences in other Latin-American cities (e.g. Bogotá), the creation of a transport authority that externalises to the private sector the operation of the buses, tickets selling and income management was proposed. This transport authority should be responsible for the coordination of services and fares. The final design also incorporated the externalisation of the information management. So, the authority externalised to the private sector the following three concessions:

First, the operation of the buses, which is tendered to different private companies. This issue will be explained more in detail later. Such an organisation model that allows co-ordination and competition, classified as "authority and multiple operators" by Costa (1996), is also used in some European cities (e.g. London and Copenhagen).

Second, a finance administrator (*Administrador Financiero de Transantiago*, AFT): the main tasks of this concessionary are (a) the selling and charging of a contactless smartcard which will become the main payment form in buses and metro, (b) the administration of the revenues and payment to the bus operators, metro and other agents, according to the payment conditions established in the different contracts and the instructions of the authority regarding penalties and rewards and (c) providing, installing and maintaining ticket-reading machines for the buses. The payment to the AFT will be a fixed amount plus a percentage of the users fares.

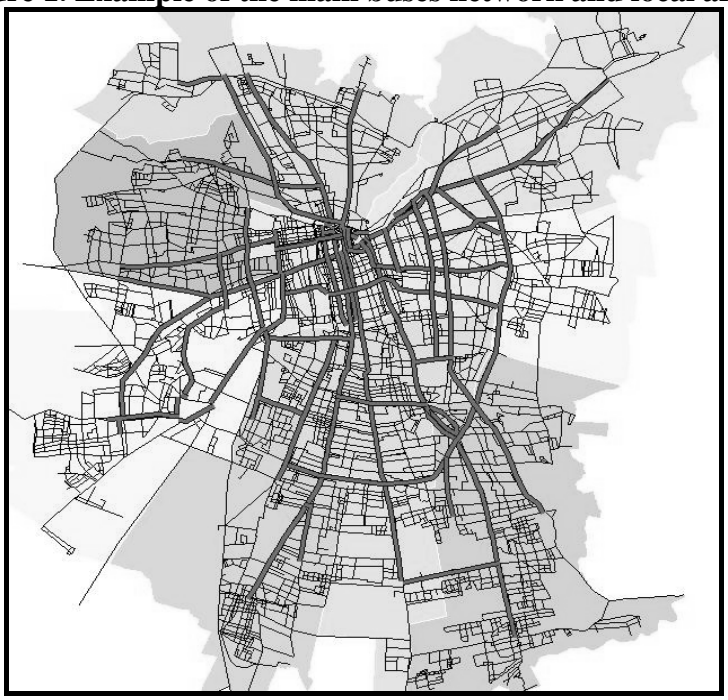
And third, an information manager and users' information provider (*Servicios de Información y Atención a Usuarios de Transantiago*, SIAUT): the main tasks of this concessionary are (a) the collection, storing and distribution of operational information from the buses (GPS position, etc.), (b) processing the operational information and producing reports for the authority, in order to supervise the fulfilment of the contracts and determine penalties and rewards and (c) provide users' information. The SIAUT will receive a fixed payment.

New bus routes structure and operators' payment system.

A new bus route, frequency and vehicle size design, along with a new bus operators' payment system was proposed, with the aim of eliminating the on-the-street competition and avoiding excess of offer due to competition both between bus lines and between bus and metro lines.

The routes scheme proposed included three complementary public transport networks: (a) the already existing and the under construction metro lines, (b) a network of main bus routes and (c) a network of local and feeder bus lines, organised in separate areas. Figure 1 shows an example of the main bus routes network and the local areas.

Figure 1. Example of the main buses network and local areas.



Source: Sectra (Chilean Transportation Planning Office)

The decision of dividing the bus system in two separate networks was made with the aims of (1) reaching a better adjustment between demand and offer, through the use of bigger vehicles in the main routes and smaller ones in the feeder lines, and (2) allow the authority to make a good planning of the main routes. In effect, considering the difficulty that the design and adjustment over the time of all the bus lines imply, the idea was that the authority should have a high inherence in the design of the main routes (where the city development and the patronage are more consolidated), and that the adjustment of the feeder lines should be proposed by the operators themselves. So, it was necessary to give them adequate incentives in this direction. On the other hand, the available data and the design tools developed by the authority were able to give adequate answers to the route design in the main lines, but were

not so reliable in the periphery of the city, where the demand is spread across and changes quickly. Some experiences of dividing a bus system into main and feeder lines already existed in other Latin-American cities as Quito and Bogotá.

As it was clear that the decision of dividing the bus system in two networks would imply an increase in the transfers, the route design should avoid a high number of transfers at least inside every network. This means that in every network overlapped routes allowing direct trips should be preferred instead of single corridor lines. Jara-Díaz and Gschwender (2003a) showed that the former tends to be a better option when the demand levels are high.

Having these considerations in mind, the following solution was proposed for each bus network: First, in the case of the main bus routes, the objectives of eliminating on-the-street competition and minimizing transfers inside the network could be reached by overlapped routes and a payment to the operators mainly dependant on the veh-km (to avoid on-the-street competition). And second, for the local and feeder lines the objectives of eliminating on-the-street competition and giving incentives to adjust the services and look for demand increases could be reached through separate areas with a monopolistic operator in each of them and a payment to the operators dependant on the number of passengers carried (as an incentive to the adjustment of the services). Again, there is a similarity between this proposition and the systems in other Latin-American cities. In the TransMilenio bus system in Bogotá, the payment to the operators also depends on the veh-km in the main routes and on the passengers carried in the feeder routes.

Nevertheless, the decision-makers finally decided that all bus operators should be paid according to the passengers carried, i.e. in a similar way as they were historically paid. Therefore, the payment system had to be changed in the case of the main lines. The final design considers that the revenue received by the bus operators depends on the number of passengers carried, but is semi-guaranteed, in order to reduce the operators' risk and try to increase the number of bidders: if the actual demand differs from a reference figure, the operators only perceive a drop (or increase) in their income representing 10% of the demand change.

The new routes and frequencies were designed using a tool developed by the authority (Sectra, 2001). This design model optimises the frequencies considering the total users and operators cost, an approach that has been reviewed by Jara-Díaz and Gschwender (2003b). In addition, routes are generated using heuristics. More details about this design model can be found in Sectra (2001), Malbran et al. (2004) and Fernández and De Cea (2006).

New fare structure and ticketing system.

There was a high level of consensus about the need of an integrated fare for the public transport system. Moreover, the new routes structure could not be implemented without integrated fares. In effect, as additional transfers would appear, the old

pay-each-time-you-board scheme would have implied higher fares for those trips that would already have been penalized through the new transfers.

Travelcards allowing unlimited travel within a period of time (week, month, etc.) were discarded, at least for the first years. Therefore, in this case an integrated fare system implies that the total fare that a passenger has to pay for a trip with transfers is fewer than the addition of the single fares that would have to be paid separately for each stage of the trip. When a transfer is made, a reduced fare (eventually zero) is charged. In order to introduce such a fare structure, a technological change is necessary. A paying method that "remembers" if the passenger already paid is needed, in order to recognize if the user has to be charged the full fare or the reduced transfer fare. The introduction of a smartcard as the main paying device is therefore a key aspect of the proposed system[1]. Nevertheless, it will also be possible to pay with money, but at a substantially higher fare and without possibility of fare integration ("emergency" fare).

On the other hand, a new form of understanding the relation between users fare and operators revenue was needed. Formerly, the operators' income and the users fare were exactly the same. In the new system, the money has a longer way between the user and the operator, as it first has to be charged in the smartcard, then the smartcard has to be read by the ticket machines inside the vehicles, which subtract the fare from the smartcard, and finally the AFT has to periodically pay to the operators according to the rules established in the contracts.

Under the new fare system and operators payment scheme, what the user pay (the fare) will normally be different to what the operator receives for transporting that passenger. Nevertheless, as no direct operational subsidy is considered, equilibrium between incomes and operators costs has to be reached. This equilibrium implies that a relation between users fares and operators payments has to exist. In effect, given a fare structure, it is possible to estimate the value of each fare as follows:

Let d_i be the demand for each type of fare, i.e. the number of passengers that pay each one of the different available fares. If the value of each fare, which has to be determined, is f_i, the total income (I) paid by the users is

$$I = \sum_i d_i \cdot f_i \ . \qquad (1)$$

On the other hand, let p_j be the patronage of each operator, and c_j the payment that each operator receives for every passenger, i.e. the unitary cost of each operator for the system. If all the other costs of the system, e.g. the payment to the SIAUT, are assumed fixed (A), then the total cost of the system (C) can be written as

[1] The use of a contactless smartcard already began in 2003 in the metro.

$$C = \sum_j p_j \cdot c_j + A \ . \qquad (2)$$

If relations between the different fares f_i are defined ($f_1 = \alpha f_2$, etc.) it is possible to obtain the value of every f_i as a function of d_i, p_j, c_j and A, by equalling (1) and (2). Thus, the dependence of the users fares (f_i) with the payment to the operators (c_j) can be seen. The values of c_j and A will be known, as they are results of the different tenders. But the values of d_i and p_j have to be predicted, in order to calculate equilibrium fares.

So, a fare structure and the relations between the different fare types was defined by the authority, but the actual values of the distinct fares will be a result not only of the unitary payments arising from every tender, but also from predictions of the demand. In order to avoid short-term deficits due to unexpected changes in the demand, a compensation fund (administrated by the AFT) will be maintained.

New property structure for the bus industry.

It was wanted to change the property structure of the bus operators industry in order to have bigger companies. Therefore, each tendering unit should have a fleet of some hundred buses or more. Furthermore, longer periods of concession were considered, especially in the cases in which only new buses were allowed. When this was the case, the concession period should be approximately the same as the allowed vehicles' lifespan (10 years for diesel buses). It was considered that all this would also increase the attractiveness of the business for new operators, and would therefore grow the competence in the tendering processes.

The design of the main bus routes over a previously defined roads network yielded approximately 50 main lines. These were finally grouped into 5 tendering units, with some 500 buses each, trying to avoid the coexistence of different operators in the same streets. Nevertheless, in a few cases there will be different operators running lines in the same street. In the case of the feeder lines, 10 areas were defined, trying to follow the existent inner frontiers of the city (rivers, hills, roadways, etc.). All the feeder and local lines inside each area would be tendered together, and each area would need some 200 buses or less. So, a total of 15 tenders had to be made for the operation of the buses, implying that there would be at the most that number of operators. In order to prevent the emergence of monopolistic powers in the industry, a single operator could not win more than two main routes concessions or more than four concessions in total.

Awards and penalties scheme.

In order to give incentives to the operators, with the aim of drastically improve the quality of the service, a system of penalties and awards was proposed. So, a list of faults (e.g. running with open doors, boarding or alighting passengers in an unauthorised place, etc.) and corresponding penalties is defined in the contracts. All the income generated by the penalties

will be returned to the operators, through a system of awards that considers punctuality and users' satisfaction. A similar penalties/awards scheme is applied in the bus operation in TransMilenio (Bogotá).

Financial balance.

The operation of the new system had to be financed with the income of the fares paid by the users, which should not be significantly higher than the previous fares. No operational subsidy was conceived. Though, new cost items would emerge, for example for the ticketing system (AFT), and the information management and users' information (SIAUT). In addition, the new route design implying more transfers yields a need for new infrastructure in those points were a high number of transfers arise. Some of this new infrastructure had to be paid by the system itself, i.e. by the users fares.

On the other hand, an important reduction in the bus operation costs was expected, due to the new route design. Thanks to a better match between demand and capacity through the complementary conception of the bus lines (between them and with metro), instead of the previous competitive routes, a significant operation cost reduction should be reached.

Cost estimations considering all these variations showed that a financial equilibrium could be reached, maintaining the fares in similar levels as they were, i.e. with an average normal fare around 0.45 EUR and an average students fare of 0.15 EUR.

Additional descriptions of the proposition

Together with normal 10-12m long buses, 18m articulated buses will be introduced in some of the main routes. 25m biarticulated vehicles were not considered because a competitive market for their provision seemed not to be sure, as too few providers existed. The local or feeder lines will operate with normal buses and 8m minibuses. All the new buses have to fulfil stricter noise limits and the Euro III emission norm. Excluding the minibuses, all the new vehicles will be partially low-floor with pneumatic suspension and a ramp for wheelchairs (all novelties in the city). In two of the five main lines concessions the operators had to acquire a completely new fleet (approximately 1,200 buses) and the concession period is 10 years, but can be extended to 16 years if low-emission vehicles are introduced (natural gas, hybrids or electric vehicles). In the other concessions, existing vehicles could be used. The other three main lines concessions have a period of three years, which may be extended if new vehicles are introduced. The extension of the local or feeder concessions is five years.

Express services stopping only in the most important bus stops were considered in the main network, in order to allow shorter travel times and reduce the fleet size and costs. Preliminary estimations suggested that the main bus fleet could be reduced between 5 and 9% through the introduction of express services.

The total fleet will be reduced from 8,000 buses in 2003 to some 4,500 vehicles, but the average size of the buses increases. So, the total capacity of the bus fleet will be reduced in approximately 25%. Metro, through the extension of its network and the non-competitive design of the bus routes, significantly increases its participation in the public transport trips. In terms of public transport trip stages, the participation of metro grows roughly from 30 to 40%. The reduction of the bus fleet, together with the fulfilment of the Euro III emission norm, will produce a huge decrease in the total emissions of the public transport system. This is important because air quality is a very sensible issue in Santiago, were smog still becomes a serious problem every winter.

An important growth in the number of transfers is expected. The previously figure of less than 0.2 transfers per public transport trip will be increased to some 0.8. In spite of this growth, the average trip should still have less than 2 stages.

According to estimations and given the fare structure defined, 14% of the trips will only use local or feeder services, paying a local fare of about 0,4 EUR. Transfers between local lines inside an area are free. Another 75% of the trips will be made using only main bus lines or metro, at a fare of approximately 0,45 EUR. Transfers between main bus lines, between metro lines, and between main bus lines and metro lines are also free. 10% of the trips will use local lines and main bus lines or metro. In those cases, a transfer fare will have to be paid, yielding a total fare of about 0,48 EUR. Finally, 1% of the trips should use feeder lines at the start of the trip, then main bus lines or metro, and at the end again a feeder line in another local area. Those trips will have to pay a transfer fare twice, and the total fare should be approximately 0,52 EUR. As before, a reduced students fare at 35% of the normal fare will exist. The exact amount of the different fares depends on the prices of the different contracts and will therefore only be known after finishing all the tendering processes (Transantiago, 2005b).

The payment per passenger received by the bus operators will be adjusted over time according to a mathematical formula established in the contracts, which reflects the impact in the operation costs of changes in the prices of the production factors (fuel, wheels, oil, etc.). The passengers' fares will also be adjusted, according to these changes in the payment to the operators, in order to maintain the financial equilibrium.

In order to reduce the financial risk of the bus operators, several measures were considered. As already explained, the patronage dependant revenue is semi-guaranteed, as only 10% of the difference between the actual and the reference demands are transferred to the operators. Other examples of this risk control are: (1) a minimum income is guaranteed, varying between 85% and 60% of the reference income depending on the type of concession (main lines with/without new buses and feeder lines), (2) the concession period can be extended up to 24 months, until an expected present value of the incomes is reached, (3) revenue adjustments in case of changes in the patronage because of changes in the commercial speeds are considered and (4) the compensation fund assures the payment in the first months, even if big mistakes would have been made in the prediction of fares or demands, and assures that the

payments to the operators can be made if important drops in the demand occur in the future. Even, in order to assure a long-term financial sustainability, it is established that if the fares reach an upper limit, measures to rationalise the use of the car in the city will be introduced with the aim of increasing the public transport use (Transantiago, 2005b).

An infrastructure plan consisting of the following components is being implemented: (a) 14km of segregated busways, in addition to the existing 11km, (b) two big interchange stations between metro and buses, (c) 35 smaller transfer stations, (d) road surface and geometric improvements in 63km of the main roads (e) two strategic road connections and (f) improvement of about 5,000 bus stops. The cost of this infrastructure plan is approximately EUR 210 million. 25% of it will be publicly financed, while the other 75% correspond to private investment that will be charged to the users fares (Transantiago, 2005c).

In addition, the metro network is being expanded from 38km in 2003 to 80km in 2006. Part of this investment will be paid by metro, i.e. will be charged to the users fares.

Without considering public investment in infrastructure, the system has a total yearly cost of EUR 570 million. From this cost, 43% correspond to the main bus routes, 32% to the metro, 14% to the feeder and local lines, 5.5% to the AFT and SIAUT and 5.5% to infrastructure (Transantiago, 2005b).

FINAL DISCUSSION AND CONCLUSIONS

The design of the main aspects of this plan, aiming to improve the public transport system (especially the buses) in Santiago de Chile, began at the end of 2001. The bids for the operation of the buses were awarded in January 2005. Some of the winner companies are formed by former bus operators of Santiago, while others correspond to new Chilean and foreign operators. The AFT was in turn awarded to a partnership of the biggest Chilean banks and a technology company in April 2005. In June 2005, the tendering process of the SIAUT was not yet finished. The implementation phase of the new system will last approximately one year, beginning at the end of 2005. So, by the end of 2006, all aspects of the new system should be fully implemented. Thus, the new integrated public transport system of Santiago de Chile has still to prove its success in the streets!

In the main routes tenders, between two and seven bids were received for each tender. The highest number of bids were in the tenders were a completely new fleet was required. The lower interest in the tenders with old buses is partially explained by some uncertainty about the used buses market in Santiago (no used buses can be imported). In the case of the feeder and local area tenders, between three and five bids were received in each one. The financial conditions of the different offers show that a previous agreement between the bidders is highly unlike to have occurred. In the future, it will be important to be able to maintain the

competition in the bus tendering processes. The next should begin in 2008, and it would be a shame to repeat the mistakes from the 1990s, when after the first tendering the following processes could not reach competitive conditions. A direct negotiation with the incumbents, as proposed by Hensher and Stanley (2003) as an alternative to the competitive tendering, seems not to be in the plans, at least for the next years.

Coming back to the winners of the present bus tenders, it still has to be seen if they assumed adequate conditions for their bids. An eventual occurrence of the "winner's curse", i.e. a too optimistic bidder winning the concession, cannot be discarded, as the tendering procedure selected the best financial offer, from those which were technically eligible.

On the other hand, it will also be interesting to discover if the final operators' payment system (per passenger) will allow to achieve the elimination of the on-the-street competition, especially in the main routes. In the case of the local areas, special attention has to be put in the process of looking for new patronage and adapting the services. Had the operators the right incentives in this direction? This has to be carefully analysed in order to introduce, if necessary, eventual changes in the following tenders.

It is interesting to note that the massive introduction of the contactless smartcard was very attractive for the banks, as its technology allows using it also for other purposes as, for example, a money card to pay in the retail, etc. So, its introduction permits to reach a great number of persons, many of whom do not have any other bank product, because of their low incomes. This aspect was relevant to increase the interest of the banks in participating in the tender of the AFT. Which new functions (outside the transport system) will be added to the smartcard is still unknown, as this has to be decided by the banks that form the AFT.

There were important technical and political conditions that helped or were useful for the design and implementation of the new system. Technically, the availability of good travel information from origin-destination surveys was crucial, as it was the modelling capacity. It is not to be overlooked, that a new routes and frequency design model was implemented and used, based on a long tradition of modelling knowledge in Chile. In addition, a good knowledge of the particular conditions and deficiencies of the public transport system in Santiago de Chile was indispensable.

Politically, the tendering experiences of the 1990s, together with the law that allowed them, were extremely useful. A change in the complete bus system could not be imagined, if there were not been tendering processes before. In effect, if the former deregulated bus system would still have been in force, the authorities would have been practically obliged to negotiate with the operators the changes in the system, making all the process more difficult. Most probably, the changes would have only be able to reach a part of the bus system, maintaining the rest more or less in the same previous conditions, as a niche for the old operators. This is what can be observed in Quito (Trole) and Bogotá (TransMilenio), and also what happened in Santiago as the metro was built and extended without changing anything in the bus system.

But as all the operators in Santiago now had contracts with an expiring date, after that period they did not have any legal right to continue operating.

Moreover, the public opinion about the bus system and the bus operators was very bad, which implied a support to the authorities in order to introduce changes in the system. The strikes made by the bus operators in opposition to the new plan were strongly rejected by the population. Even the arrest, because of the stopping of the traffic in many streets of the city, of some of the bus operators' representatives after one of the most serious strike in opposition to the plan, was well received by the citizens and the press. Without this strong support from the population, it would have been much more difficult for the authorities to make progress with the plan. It has to be emphasised, that many of the former operators finally participated in the new bids, after forming companies as required. The same occurred in Bogotá when the operation of TransMilenio was tendered some years before.

In addition, the fact that successful experiences about deep changes in the bus system in other Latin-American cities (Quito and especially Bogotá) were known, made it easier for the decision-makers to convince themselves that it was possible to succeed with such a plan.

It is interesting to note that in this case there was no strong political figure promoting and defending the plan over all its steps, as was the case in the successful experiences in Curitiba, Quito and Bogotá. On the contrary, the lack of such a political leader, together with an unclear institutional design behind the transport system, brought some difficulties that even risked the implementation of the plan. In some of these cases, it was the president of the country, as the only political authority superior to all the different government departments involved in the design and execution of the plan, who had to decide about key aspects of the implementation.

So, a first big challenge arises. The creation of a transport authority was one of the key aspects of the proposition. So far, a secretary called „Transantiago", which has the executive responsibility and coordinates the different government departments related with the public transport system, has assumed this role. Will this institutional design be adequate to the future development of the public transport system? Should a political transport authority be created, concentrating all the responsibilities that are still spread out between different government departments and local authorities? The question remains open.

A second challenge is the provision of congestion-free infrastructure for the buses. Only a minor part of the main bus routes network (25km from a total of about 350km) will have segregated busways in 2006. Some other main streets have been declared car-free in the morning peak period in the last years, as a way to improve the commercial speed of the buses. But being a soft policy measure, it is difficult to assure if it will survive over time. In effect, after its introduction in the early 2000s, the length of this car-free network has been reduced year after year. Considering the rapid growth in the motorisation rate, the extension of the physically segregated busways network should be a priority in order to prevent the future

negative impacts of the congestion in the circulation of the buses. The guarantee offered by the authority of compensating the bus operators for looses in the demand which can be attributed to drops in the commercial speed, is an interesting incentive to the authorities to seek to avoid the impact of congestion in the buses.

Other possibilities of improving the future system can be recognised. Transfers increased drastically, due to the new routes scheme. For the users, this is the main loss (probably the only one) in comparison to the previous system. Would it be possible to reduce the number of transfers in the future, as it is known that they negatively affect the demand because of a worse perception of the system's quality? On the other hand, the fare integration could be extended to other minor public transport modes as suburban rail and shared-taxi. In addition, the creation of travelcards (unlimited travel in a month, week, etc.), which seem to be an interesting option in order to augment the patronage (Hass-Klau and Crampton, 2002; Matas, 2004), or other price strategies to encourage the frequent use of the system could be analysed. Given the high heterogeneity of the population in Santiago in terms of income, it could be interesting to analyse the creation of different public transport products. For example, an expensive high quality service that should compete to the car for the high-income users, and a cheaper service directed to the low-income population.

All the changes in the bus services and the integration between buses and metro represent a deep improvement in the public transport system of Santiago de Chile. Nevertheless, in order to reach a sustainable transport system in the city, further efforts have to be made for example in the internalisation of the costs of the car users and in the encouragement of non-motorised modes.

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