MINIBUS SERVICES IN A EUROPEAN BUSINESS ENVIRONMENT

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ABSTRACT

In many European cities public transport, particularly buses, are unattractive and underused, due to the lack of direct connections, the need of transfers and the loss of time and comfort. Hence, this study aims at developing a business concept and an applied case study of an alternative or complementary type of public transport which enables a quicker and more flexible service and enhances patronage by using comfortable minibuses.

The study covers the business environment and the integration of a new service in the urban mobility market. Then, a concrete case study concerning a minibus service between the cities of Lisbon and Oeiras (Portugal) is applied for its validation. A mobility survey and focus group interviews are analysed to identify the current supply and demand. Based on a discrete choice model, a factor analysis and further descriptive statistics the main target group of previous car users with needs of a quick and flexible transport service with a competitive tariff, particularly during peak hours, has been addressed. Furthermore, some user groups with a lower value of time and interests in a comfortable and easy accessible minibus service out of peak hours are identified. Hence, the proposed service combines all needs, incorporating short routes, few stops and high frequencies during peak hours and an adapted, flexible service with significantly lower frequencies and the possibilities of additional on-demand service out of peak hours and on the weekends.

At the end the potential risks for the operator companies are identified and the technical, operational and financial feasibility of the service are critically discussed in the frame of future urban mobility systems in Europe. However, before the real implementation of the proposed minibus concept, a deeper marketing research should be carried out, examining the expected demand for these types of services and the establishment of partnerships.

TO THE BACKGROUD OF THIS PAPER

This research project has been developed in frame of a six-week course on Urban Mobility System, offered by the University network TransportNET and hold in June and July 2008 in Lisbon, Portugal. TransportNET is a network composed by eight leading University groups involved in Transport research, funded by the European Union under the Sixth Framework Marie Curie Actions Programme. Set up in 2003, the academic network launched in October 2006 a 2-year EST (Early Stage) program, in order to introduce a group of 16 fellows from 11 different countries in transport-related research.

The fellows, originating from different professional backgrounds such as civil and environmental engineering, economics, urban planning and architecture as well as law, were able to achieve high-level education in the frame of a European doctoral school. While in the first year several one-week courses dealing with research methodology, transport modeling and forecasting, transport economics and policy as well as transport systems were given in the different university locations all over Europe, in the second year the fellows attended four stream in-depth courses dealing with transport business and markets, trade transport and policy, urban mobility as well as infrastructure development and management. In frame of these courses the fellows were grouped into international and interdisciplinary research teams and asked to elaborate a project dealing with a given topic in the particular course field. All courses did not lack of contact with the "real world" outside of the academic research environment, since they also incorporated technical visits to relevant institutions and companies involved in the planning, regulation and operation of transportation, for all transport modes (land-, water- and air-based) and types (passenger and freight transport).

In this context, the research presented below is an example of common work by four participants of this EST TransportNET program, who highly profited from the 2-year training described. It is needless to say that not only new knowledge and skills related to transport research were acquired, but also important lessons to the challenges and advantages of interdisciplinary and intercultural teamwork were learned. Due to the different national and professional backgrounds of the participants, the groups were able to gather individual knowledge, skills and experiences and to compile together missing information and facts.

1. INTRODUCTION

"Society is changing, and is expecting more intelligent and affordable mobility solutions […]. They [*people; own comment*] expect more flexible transport solutions for both freight and passenger mobility" (EC, 2007). With this statement in the Green Paper on Urban Mobility the European Commission expresses its policy goal to enhance the development of environmental friendly and technologically innovative transport modes and alternative solutions to the use of private cars (City of Strasbourg et al, 2008).

In this context one has to remember the fact that currently almost 75% of kilometres made in the EU are done by cars, causing among others most of the congestion, air and noise pollution in cities. This is strongly linked to the fact that mobility patterns of European citizens have been subject to radical changes in the last decades, due to several factors, mostly linked to changes in demographic, socioeconomic and household structures as well as modifications in the organization of work, residential choices and lifestyle patterns. These changes have greatly diminished the ability of regular transport to satisfy the travel needs of the citizens (Cubillos et al., 2007).

Despite the fact that 40% of the EU households do not have an own car and mainly depend on public transport (City of Strasbourg et al, 2008), it can be stated that conventional public transport operating on fixed lines does not often meet urban travel needs. While public transport is efficient for well defined corridors of movement with clustered travel demand and has traditionally been designed to serve downtown oriented trips, it is hardly profitable and rarely attractive in the growing suburban areas. The need to cover more diffuse travel patterns, varying periods of low demand, city-peripheral journeys, as well as commuting trips often make conventional public transport systems unable to guarantee the level of service required to address the user needs (Cubillos et al., 2007). So, frequencies are low and riders must take long and inconvenient walks and often carry out various transfers until reaching the final destination (Morlok et. al., 1997). In this context the role of para-transit (taxis) has become more and more crucial, being aware of the fact of higher costs and an exclusive, semi-private character.

Facing the challenge to serve the rapidly growing number of trips in suburban and other low density areas, the use of minibus system represents an alternative solution. As additional part of urban transportation system, they are able to fill the gap between private transport and the conventional public transport and to provide mobility and complementary service to the other modes. Thus, the minibus system is principally designed for low travel demand zones but with high frequency (Morlok et al., 1997). In other words, the implementation of these services must consider zones of constant demand but not the concentration of it.

Considering the existent examples of minibus services abroad - often in developing cities and regions- one has to take in consideration potential societal problems and risks, due to a wider set of environmental, economical and social impacts. In many developing countries the minibus services under private supply represent mostly a good example for profitable public transport in an almost door-to-door-way but affect often eminent air pollution and noise emissions and serious safety problems.

The objective of this study is to establish a business model for a minibus service in the European environment, targeting especially residents with strong car use attitudes. In this frame is has to be seen to what extent different organization models and the stronger use of ITS (Intelligent Transport Solutions) can be used to attract former car drivers. Besides, the introduction of a new transportation mode in the urban transport market asks for the examination of existent travel behaviour patterns and the definition of different market segments. In order to guarantee supply diversity for those different segments, the

competitiveness of minibus services with existent modes and its integration in one urban mobility system are of major interest.

The subsequent paper consists of six major parts. First of all, the theoretical framework based on literature review is presented. The third part describes the methodological approach of the study which is principally based on a mixture of qualitative and quantitative measures. The fourth part exposes the general business model for a minibus application in a European city in order to be applied in an exemplified way in a case study for a minibus service in the metropolitan area of Lisbon in Portugal (part 5). In the sixth chapter some conclusions are drawn.

2. THEORETICAL FRAMEWORK

The approach to identify the different user groups of a urban mobility system used for the present study takes into account the main influence factors on travel behaviour such as land use, socioeconomic and household characteristics (2.1), as well as resultant requirements for an efficient transportation service (2.2). Moreover, an overview is given on the existent minibus concepts worldwide (2.3), related problems and advantages (2.4) as well as indicators for their performance assessment (2.5).

2.1. Travel behaviour patterns in an urban mobility system

According to El-Geneidy et al. (2007) the users of public transport and of private car can be generally classified in two different types: The first are captive riders who do not have other modes to choose from except transit. The second type is people who have access to alternative modes for their activities but they choose transit because it is either convenient, cost efficient, or for other reasons, the so-called choice or occasional riders. The automobile dependence might exist due to a wide set of factors, ordered by Zhang (2002) in either external or idiosyncratic aspects. While the former incorporate e.g. the actual lack of other travel alternatives, inconvenient land use, or family commitments such as the need to drive relatives to other places, the latter refers for instance to insufficient knowledge about other transport alternatives and a negative (mis)perception of service quality, safety and reliability of other modes. Those reasons are often linked to the income and social status of the person, influenced by gender, age, education and income level, physical mobility restrictions etc. Finally, there are some attitudinal aspects, i.e. people who simply enjoy driving and will hardly change their habits.

The concept activity based approach assumes that people have daily activity-travel patterns and consequently, organize “their derived travel demand (mode choice, number of trips, route choice, etc.) around these planned activities” (Pas, 1996). According with Krygsman, et al. (2004) the transport mode choice for the daily routine is determined principally by activity choice. The mode choice is extensively affected by intermediate activities while intermediate activities are not as much influenced by transport mode choice. Moreover, these intermediate

activities are linked with specific transport modes, land use and socio-demographic characteristics. Based on Van de Covering and Schwanen (2005) employed people tend to concentrate their activities in and around their work places, public transport use is much easier for commuting than for other travel purposes. On the other hand, a higher level of economic prosperity of a population leads to less public transport kilometres, probably related to the preference of faster travel modes, i.e. in many cases the private car (ibidem).

2.2. Implications for transport supply

It has become obvious that different lifestyles and travel behaviours are linked to different mode choices and demand elasticities. In most of the metropolitan areas it is possible to identify important differences in travel demand and mode choice decisions among the urban and suburban or even peri-urban environment and among different lifestyles expressed by different residential location preferences, household structures, their economical characteristics as well as the variables age and gender (Kaufmann et al., 2001). The divergent living environments and lifestyles affect different attitudes and behaviour flexibilities which are important to consider in the case of the introduction of new transport services.

After the general demand of a safe and secure travel, the main interest is on a quick and efficient transport mode (Winters et al., 2001, cited in Viegas et al., 2007). The inconvenience of public transport is particularly ought to the additional penalty times for accessing the train stations or bus stops and for carrying out transfers between the same or several transport modes. Mohring et al. (1994) found for instance the value associated with in vehicle time is around half the equivalent of an hourly wage, while out-of-vehicle waiting time is valued at 2–3 times of that. Costs play often a subordinary role while criteria of travel comfort and convenience might be equally crucial (Winters et al., 2001, cited in Viegas et al., 2007).

In general, private transport is considered as the more convenient mode for daily trip making, particularly in the lower-density, suburban areas, due to perceived advantages in travel speed, comfort and flexibility. Nevertheless, it is conceivable to capture a part of the demand of daily private car users for at least occasional trips in a public transport service, if this service provides a higher level of travel convenience in terms of speed, flexibility and comfort (Kaufmann et al, 2001).

2.3. Existent minibus concepts

In many countries, especially in developing countries, the minibuses are the main transport system. They are often privately owned and have an anarchic operating style, lacking central control or organization. In many countries the way in which they are driven and the conditions of their minibuses cause important externalities. Perhaps, these aspects are one of the main problematic for being used in developed countries, where the aim is to offer a reliable, safe and environmental efficient transport. However, the same problematic aspects

are the reason of their success since costs are importantly reduced and therefore they offer a time effective transport at low prices.

In many developing countries (e.g. in Latin America and Africa) the minibus system is operating as corresponding system to public transportation and providing mobility to citizens, even though often informally. In these countries the problems of minibus systems are mainly related to violation of traffic rules and low levels of safety and comfort (Adinfosys, 2008). However, there are already many cases of good applications of minibus systems in the industrialized countries such as United States, England, Switzerland, UK and Germany. There the minibus systems fulfil an important role as complementary feeder system for the conventional public transport in big buses and light rail transit. In the United States and recently also in Europe, attempts go even a bit further, exploring innovative concepts of minibus applications as integral component of a modern UMS (Martinez and Geraldes, 2005).

2.4. Advantages and problems

The most important advantage of minibuses is their higher operating speed against conventional buses due to fewer stops, greater manoeuvrability and better acceleration (Morlok et al., 1997). Furthermore, higher operating speed allows higher frequency (or greater route density and more demand-tailored routes). Minibus service can also be seen more flexible (e.g. stops when required) and having greater service options (e.g. better adapting the needs of different passenger groups, such as travellers with disabilities, elderly or parents with infants) compared to buses. The comfort and ride quality are also better in most applications and if required the driver is able to provide more personalized service to passengers due to smaller vehicles.

The minibuses have in general lower energy consumption and emissions (though certain emission could be greater) and lower negative environmental impact due to lower noise level and less vibration compared to conventional busses. Moreover, minibuses can provide service on town and village centres which have narrow streets and are not appropriate for large buses. In addition, the minibuses impose less noise and vibration close to buildings (Attard and Hall, 2003).

The problems related to minibus services compared to conventional buses are concerning greater costs per space-kilometre (bigger passenger density per m^2), shorter vehicle life (could be a plus), greater congestion due to a totally higher number of vehicles and lower passenger volume capacity (Morlok et al., 1997). However, when comparing minibus to a private car all of these problems turn out to be benefits.

2.5. Service and impact assessment indicators of minibus services

The main direct impacts of public transportation are vehicle delays, energy and emissions and travel time impacts (Litman, 2008). Vehicle delays are considered important impacts of

public transportation, because they increase the travel time. Based on the results of Southworth et al. (2003) a bus or trolley/shuttle used by public transportation contributes about twice the congestion per vehicle mile as passenger car. However, there are differences between peak and off-peak congestion and the results show that a bus may be equal to anywhere from 1.5 passenger car equivalents under light congestion to as much as 4.4 passenger car equivalents in congested conditions with regular stops.

It is also possible to say that if public transport service is convenient and comfortable, unit travel costs for public transportation are lower than for driving, because public transport users experience less stress and can use their time to rest or work (Litman, 2007). If also external factors (e.g. crowding, noise and dirt) are considered, travel time unit cost increases significantly.

In general, in terms of environmental issues, the slower forms of public transport using lighter vehicles use less energy and produce the least CO_2 emissions (Potter, 2004). However, the energy use depends on individual designs of vehicles and their operating regimes. The comparison made by Potter (2004) shows that public transport uses a third or less the energy and CO_2 emissions per seat kilometre compared to a car. This result is twofold since the real emissions make more sense if they consider real cargo loads. Therefore, the occupancy level of the vehicle crucially affects the actual emissions per passenger kilometre. Only one person in a private car consumes 10 times the energy per passenger kilometre compared to a fully loaded bus or minibus (peak hour car occupancy 1,17 persons). This means that the biggest environmental gain in modal shift from car to public transport (and to minibuses) is achieved when cars are poorly occupied. Once the occupancy level of public transport drops, its energy and emissions performance decreases dramatically (Potter, 2004).

3. DATA SOURCES AND METHODOLOGICAL APPROACH

As this paper aims at establishing a business model for the exploitation of minibus services, tackling the demand of divergent user groups, the empirical part of the paper is divided into two main parts: a general business approach based on the theoretical framework, as well as a case study for the Lisbon Metropolitan Area based on thee analysis of qualitative interviews, a mobility survey and the regard of further information on cost structures.

The interviews were conducted during February 2008 in Lisbon Metropolitan Area in order to find out if new services and transport modes can be attractive enough to the former car drivers (Viegas et al., 2008). The aim was to collect information about (i) attitudes and perceptions concerning current transport alternatives and (ii) problems experienced by the respondents. The approach used in the study included Focus Group interviews (three group interviews, each with eight people) which were directed to residents (between 18 and 65 years) having the possibility to use a private car in Lisbon and its suburbs. From the three groups, two were well connected by PT and one inadequately served by public transport.

The mobility survey was carried out from November 2005 to January 2006 through website in Lisbon Metropolitan Area with the aim to find out individual lifestyles and attitudes, actual travel behaviour and relative perception towards a new service like a minibus. The questions about individual lifestyles had the purpose of defining population segments on the basis of household types, economical activities, age and gender of the household heads as well as expected value of time and expected preferred residential location. The information collected through the travel behaviour questions aimed to obtain travel routines, transport mode used, among others. With the attitudinal questions the objectives were to understand how changes in travel attributes such as travel time and walking distance affect people's behaviour. Additionally, in the same group of questions the perception of benefits and other aspects associated with the use of the car or PT, in a daily routine, were examined. From 1600 responses only 1163 surveys were considered valid, because around 400 people commute everyday by foot or on a motorcycle and the interest was just concerning the answers from the car and PT users.

The data for the fares' calculation was obtained through websites providing realistic prices for the minibuses and their characteristics (e.g. emissions, capacity, consumption) as well as for the insurance for such a service. The IT, repair, administrative and garage cost were obtained through previous minibus studies (e.g. Morlok et al. (1997), Paulley et al. (2006) and Bertozzi (2008)). All costs were collected for the year 2008.

The data from mobility survey was analysed with the help of (1) *a discrete choice logit model* (Mcfadden, 1978) in order to better understand the most important characteristics influencing people's transport mode choice, (2) *factor analysis* to estimate market segments within the car users, because the aim when implementing the minibus is to attract people that choose to commute everyday by car and (3) *further service criteria* to understand the type of attributes that the new transport service should have, in order to increase the people's acceptance level and therefore, its market penetration. In further service criteria a new service, like a minibus, with the following attributes: PT, small-medium dimension, door-to-door, seat always available and without transfers (direct) was introduced and people were asked about the relative importance of some operational attributes of this new service. According with the results from both survey and focus groups along with literature review, an exemplified route for a minibus service between the centre of Lisbon and its suburbs is chosen. For this case study a rough impact assessment is carried out on the basis of performance indicators of transportation, comparing the minibus mode to the two major competitive modes 'private car' and 'conventional public bus'.

4. GENERAL BUSINESS CONCEPT FOR A MINIBUS SERVICE IN EUROPE

The challenge of this study was to setup an alternative or complementary transport service that might fill the gap between conventional public transport and private cars, in suburban or other low density areas in Europe. As a result, the minibus system is presented as a solution

of a convenient and quick transportation service, designed for low travel demand zones and specific market segments.

An adopted version of Porter model (Porter, 1979) was used in the present study as a basis for understanding the business environment for the minibus service and its profitable operation (see Figure 1). The use of the model helps to understand the different actors in the business environment and the uncertainties that need to be taken into account. According to the Porter model the industry is influenced by five forces: industry competition (rivalry among existing modes and operators and transport demand), new entrants who see the market attractive (other minibus operators and barriers to entry), suppliers (availability of vehicles and skilled drivers), buyers (referred as customers, meaning mainly "previous car users") and substitutes with similar needs (e.g. collective taxi, private car, car sharing and existing public transport operators).

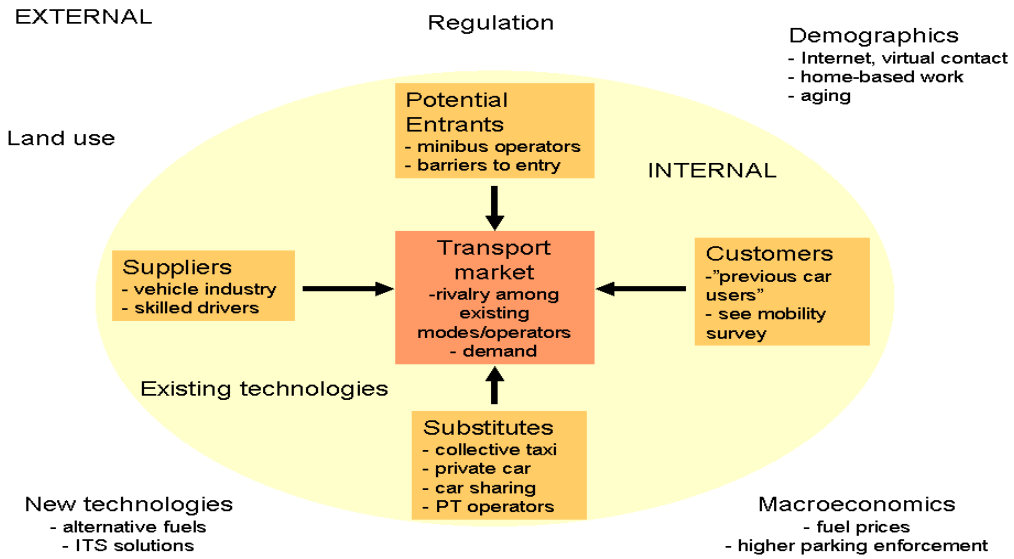

Figure 1 - Competitive forces model (OWN ELABORATION, BASED ON PORTER, 1997)

In addition to the previously mentioned internal factors there exists dynamic external factors (regulation, land use, demographics, technology and macroeconomics), which make the business environment more uncertain. In terms of external factors, the regulation can act as a barrier for new minibus operators to entry in the market. However, the regulation is not the only barrier for the entry, because in addition there might exist unwillingness of existing public transport operators to cooperate concerning sharing the infrastructure or ITS platforms and therefore render the entry of minibus service providers more difficult.

After identifying the business environment it was necessary to describe and characterise a possible operation scheme: agents involved (drivers, administrative personnel); related vehicles (capacity for 9 or 15 people) and infrastructure (including existent dedicated bus lanes and stops), route characteristics (short routes with few stops) and frequencies (high) plus additional services. In this context, one should take into consideration that both peak hours and the frequency considered are the main factors when determining the fleet size and consequently, costs and drivers. Moreover, if a profitable service should be made up, one

has to focus on the concrete market segments, which are approached by the minibus services. It is also important to take into consideration that the management and financing system have to be in line with the European context and related technical and infrastructural requirements.

Additionally, partnerships with the Metro, mainly due to its image of high frequency and reliability, or other services like car sharing could also create the potential for even greater benefits (Shaheen et al., 1999). Particularly, if one of the market segments is solo drivers, the car sharing partnership could be perceived an important advantage as it enhances the mobility and accessibility usually given by the car, lost with the minibus solution. Therefore, the management of partnerships with other complementary modes is also considered within the framework of minibus concept developed in this paper. However, operators have to be aware of service limitations in the terms of profitability and efficiency. Moreover, the competition with other existent modes such as para-transit (taxis) and conventional public transport in big buses has to be taken into account.

Nonetheless, before the implementing the minibus services, some deeper analyses of the demand in the proposed area and the identification of the origins and destinations should be conducted. The analyses concerning residential neighbourhood should include the identification of the existing public transport connections and existing pedestrian and bicycle facilities (Bruun et al., 1997). Furthermore, the ridership estimates produced by local public transport provider should be considered and taken into consideration. It is known that persons are easily willing to walk until 400 meters (e.g. based on Knoblauch et al., 1996), which means that if public transport station/stop (e.g. metro, suburban rail) is reachable, no additional service is needed in-between. The next step is to identify the needs of the community. This means making a survey to habitants concerning their work location and their normal mobility patterns. In addition, other market niches (e.g. feeder service to metro interface) that could be served in the same area should be studied. Other important indicators are time to reach the city by public transport, population/km^2 and education level (or income level) of the neighbourhood.

The attractiveness of the destination should be analyzed based on two values, which are the employment/office concentration per km^2 and the concentration of active population (excluding children and elderly people) and university students per km^2. Furthermore, a survey can be used, for example, in a case of university or other companies to students/employees concerning their residential location and their normal mobility patterns.

5. CASE STUDY: LISBON METROPOLITAN AREA

As mentioned before, the case study refers to the Lisbon Metropolitan Area, where the researchers had access to qualitative data from interviews done in 2008 (Viegas et el., 2008), and data from a quantitative web survey done in 2005/2006 by Bertozzi (2008). Main results are presented in Appendix A1, A2 and A3. In the following first the different information sources are analysed, in order to get to know the potential demand in the case

study area (5.1), in order to then propose a minibus concept that intends to meet the demand by the target groups identified (5.2).

5.1 Demand analysis and user groups

The results from the Focus Group interviews show that the main reasons for the respondents to choose their commuting mode were safety, comfort, travel time, costs, transit pass flexibility, hygiene, conditions of public transport and further practical aspects. These factors are the basis for the new minibus service in the present paper. In the study of Viegas et al. (2008) it was also concluded that in general the non users of public transport tended to evaluate public transport services in a more negative way and respondents did not have a clear idea concerning the existing public transport services. Since the new alternative transport solutions were evaluated during the study, the perceived reactions concerning the minibus service were mainly related to the service schedules and functioning periods. The minibus service was considered to be able to solve the problems related to different multimodal tickets and when compared to conventional buses, minibuses were indicated to have better ride comfort. The indicated disadvantages concerning the minibus service were its lack of flexibility to serve people with more complex travel patterns and the cost of the service. The proposed measures obtained from the interviews concerning the mobility problems within the Lisbon Metropolitan Area were related to increasing public transport supply and performance and increasing interoperability. Moreover, some answers support the idea of implementing new and innovative transport systems such as the concept of minibus services.

With respect to the analysis methods of the web survey, first a discrete choice model was carried out, where all answers by car and PT users were considered. Its main results pointed out some strong interdependencies confirming the literature findings presented above. Thus, they show a relationship between the probability of choosing a transport mode and the following variables: trip chains before and after work; the travel time; the PT availability; free, difficult or expensive parking at the working place; the transport monthly budget; not having a driving license; number of cars in the household and the municipality working area (table 1). The logit model obtained a pseudo-R^2 of 0,6037, and all variables included were considered as significant (with a confidence interval of at least 95%). Due to the fact that the variables used to calibrate this model were people's actual travel behaviour and other individual characteristics (including socio-demographics and socio-economics) it was not possible to forecast a modal shift change, since transport alternative attributes were not included.

Table 1 Logit output and variables in the equation, all users (OWN ELABORATION, 2008)

Variables X in the Equation		Coefficient (β)	Wald test / Z statistic	Significan level
type	Constant (βcar)	-2,639675396	11,41037912	0,0007303
binary	Trip chaining at school before going to work	1,66084828	24,86261503	6,15648E-
binary	Trip chaining at another working place before going to work	2,566163268	23,2746372	1,4044E-0
scale	Travel time for going to work	-0,066725239	111,6857722	4,18677E-
binary	Trip chaining after leaving work	-2,217722672	102,6806439	3,93773E-
binary	Trip chaining after work to study	-0,60042582	4,638990855	0,0312533
binary	Bus Availability	-0,986590288	6,583036705	0,0102955
binary	Train Availability	-0,751896788	11,91936989	0,0005555
binary	Metro Availability	-1,274403273	26,41852305	2,74892E-
binary	Free parking at the working place	1,570875493	44,45298146	2,6054E-1
binary	Difficult or expensive parking at working place	-1,021320475	18,40425744	1,78658E-
scale	Monthly travel budget	0,552774016	46,49858574	9,16846E-
binary	Not having a driving license	1,873063671	15,77862003	7,12026E-
scale	Number of cars in the household	1,308761235	58,65734831	1,87666E-
scale	Work Municipality	0,090331678	10,15556962	0,0014386

Second, a factor analysis only with car users answers was implemented, in order to estimate the potential market for the specific minibus poject and to study the importance of different operational attributes for a new minibus service with the following features: PT, small-medium dimension, door-to-door, seat always available and without transfers (direct).

The results of the factor analysis exhibit the possible existence of eight market segments: the upper class family; the careless driver; the inflexible driver; the price sensitive/occasional driver; the suburban worker; the captive driver; the suburban elderly and the yuppie women with driving license (table 2). While the inflexible driver will probably rely further on his own car for carrying out their daily activities (independent of additional mobility management measures in form of economical incentives or awareness campaigns), seven target groups can be defined as target groups for the minibus service use, at least in the form of occasional riding. In this context, the introduction of a new semi-public transport service requires an adequate marketing to be known as well as an overall mobility management system supported by the public sector, enforcing mode shift from private to collective modes. Nevertheless, the extraction of eight factors covers a variance of only 61,77% of the overall sample, wherefore the first factor only explains 11.54%.

Table 2 - Rotated component matrix (varimax rotation) for the Lisbon mobility survey, only car users (OWN ELABORATION, 2008)

Variables	Component							
	Upper class family	**Careless driver**	**Inflexible driver**	**Price Sensitive/ Occasional driver**	**Suburban worker**	**Captive driver**	**Suburban elderly**	**Yuppie women with driving license**
For you to drive to work is…	0,017139	-0,020051	-0,015512	0,393786	0,322694	0,568352	0,069994	-0,114763
For you to drive with traffic is…	0,00087	-0,106315	-0,028156	0,079417	-0,06191	0,806912	-0,099852	-0,066585
The parking spaces available in your working area are…	0,024141	0,042979	-0,156492	0,199644	0,690019	0,088373	-0,300172	0,092880
Do you think that the car is mainly responsible for traffic jams?	0,001565	0,771265	0,128567	0,027126	-0,02150	-0,0015	-0,035465	0,096145
Do you think that the car is mainly responsible for increased air pollution?	-0,013638	0,786312	-0,019558	-0,0154449	0,070332	-0,0930443	0,0401444	-0,1159751
Do you think that the car occupies too much urban space?	0,0009737	0,7937132	0,0555784	0,0151755	0,079963	-0,0227716	-0,0836421	0,0763636
How do you consider the costs for maintaining your car?	-0,0824912	-0,1242477	-0,2835195	0,5745327	-0,053022	-0,0528343	-0,0292196	-0,009605
By using a car are you able to control the travel time?	-0,012435	0,0564901	0,0074518	0,700077	0,214706	0,157699	0,0055649	0,1144472
Driving your car without having accidents is…	0,0668473	0,079313	0,0933285	0,593897	-0,076011	0,1880584	0,1636636	-0,1068977
Would you be willing to use a type of transport where you could book your seat beforehand?	0,0068708	0,0458202	0,910174	-0,0217622	-0,05229	-0,0042675	-0,0028506	0,0307306
Would you be willing to use another type of transport if no transfers were necessary?	0,0238364	0,1076417	0,8979022	-0,0590947	-0,032686	-0,044493	0,0056005	0,0649881
Gender	-0,002829	-0,0529186	0,0279211	0,0474572	0,103353	-0,1815336	-0,0746015	0,7669507
No Driving license	0,0808265	0,0747031	0,0505555	-0,0446587	-0,06901	0,0297283	0,077953	0,4812484
Age	-0,055681	-0,0631403	-0,0012635	0,1628492	-0,08445	-0,1216383	0,8369064	0,0089581
Household size	0,8064708	0,0162987	0,0204293	0,0525676	0,0525535	-0,0387615	-0,119507	-0,141948
Children per Household	0,4888089	-0,0079484	0,0893146	0,2192548	0,222700	-0,2625503	-0,0319206	-0,2938654
Cars per Household	0,7122457	0,0522012	-0,0677262	-0,0917033	-0,08540	0,1277713	-0,1166268	0,2593524
Household rent	0,7177014	-0,0841657	0,0549068	-0,0969286	0,071234	0,0293355	0,2519846	0,2009589
Home Municipality	0,0225554	-0,0426119	-0,0243743	-0,4752875	0,212135	0,2533635	0,4649896	0,1212458
Work Municipality	0,0831279	0,1012094	0,0283597	-0,122727	0,777424	-0,0275417	0,1477052	-0,0746911

Finally, some further descriptive statistics were carried out, which showed that the current private car users consider transport service schedules adjusted to the users' needs as the most important attribute for the minibus service followed by (in order of importance) assured return journey; the walking time to the transport service station or stop; the seat level of comfort; the easy access to service information concerning schedules, travel time and

possible connections; the possibility to modify or cancel reservation and the suitability to transport luggage. The indicated operational attributes show the strong importance of a flexible timetable (especially related to stop locations and service frequency) for the current private car users in order to attract them as future minibus users.

5.2 Minibus service proposed

With the issued results on the potential demand, a route is proposed for a minibus service between Lisbon and Oeiras. Both locations were considered as the main generation and attraction sources during peak hours. Both are residential dense and show also a high concentration of offices and education centres as shown in figure 2. In particular, the route will serve the main residential areas of Oeiras and the office area “Tagus Park” in the parish of Porto Salvo where also a seat of the IST and the Catholic University are located. Furthermore, the public transfer stations of Amoreiras and Marques Pombal in the city of Lisbon are also located in the neighbourhood.

Two possible route alternatives for peak-hours were proposed, differing from each other by the route length and expected demand, i.e. determinants of the profitability of the system: the loop and the shuttle services while for off-peak hours the services were provided with less frequency. On the one hand, the loop service consists in four stops at Oeiras (including Tagus Park) and two strategic stops, namely, Amoreiras and Marquês do Pombal, following the return loop. On the other hand, the shuttle service would be operated on the same route of the loop, but with one less stop at Oeiras (excluding Tagus Park) in the direction to Lisbon. However, the return service will stop at Amoreiras and Tagus Park. All stops where chosen according to the mobility survey. Due to the main vehicle-km run over the highway and one stop less, a high commercial speed of 41 km/h is assumed at this segment, giving an average travel time between Oeiras and Marques Pombal of 25 minutes during peak hours.

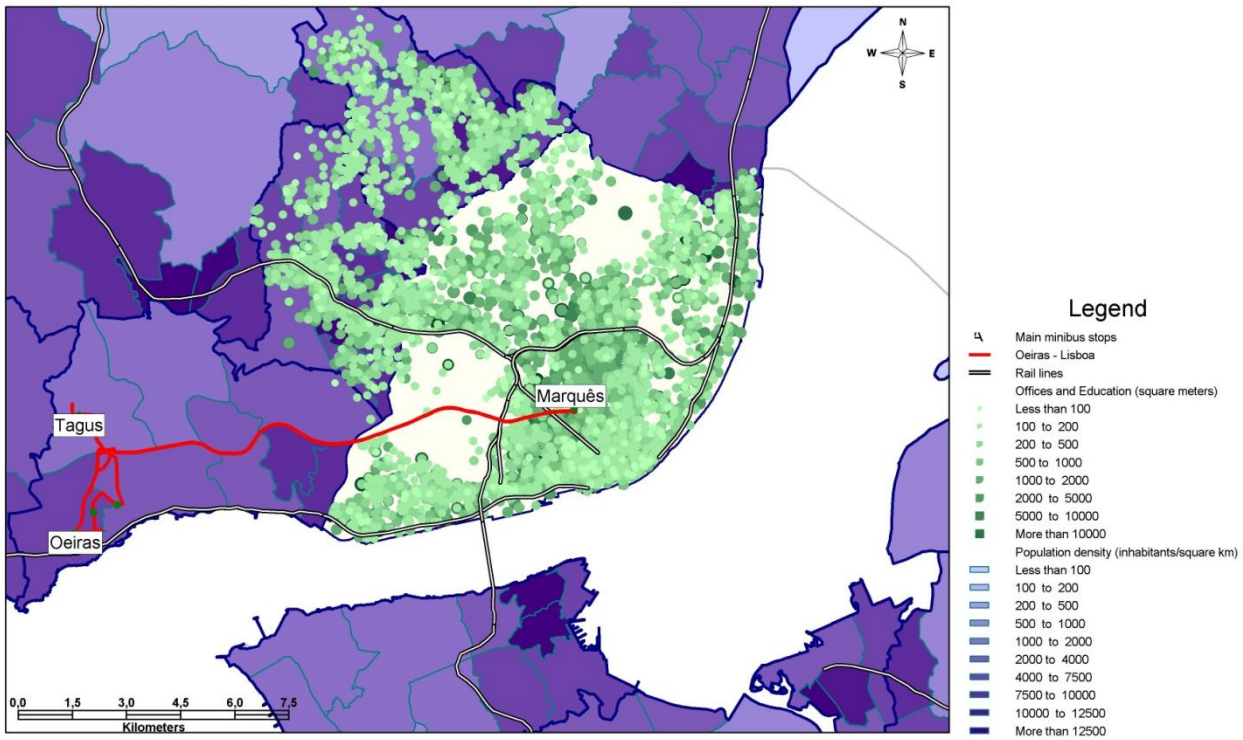

Figure 2 - Minibus route proposed between Oeiras and Lisbon (MARTINET ET.AL., 2008, BASED ON BERTOZZI, 2008)

Once the service was established based on the results coming from the demand sources, the fare calculation was carried out as an indicator of the feasibility for the case study. Two considerations become important in order to check the results obtained from the tariff calculation: the fare should be cheaper than the cost for a taxi or even a collective taxi and more expensive than the conventional public transport. So, the route length, the frequencies, number of busses and drivers needed as well as load factors per drive had to be determined.

After introducing all the cost items incurred in the service, the shuttle service resulted to be cheaper than the loop service due to the time and distance required for each route. In other words, a higher frequency and a longer route involve more drivers, more minibuses and more maintenance. As such, the more influencing costs are (i) the supplies, tires and fuels, (ii) the drivers' wages and (iii) the IT solutions. Only these three cost items represent 65 percent for the loop service and 54 percent for the shuttle service out of the total costs (12 items). Considering that the service is only provided for the routes mentioned above, the required fares are too expensive with these conditions, ranging from 9,50 to 19 euros.

Hence, it would be necessary to include alternative services with the aim of reducing the fares. The alternative services proposed for the presented study were: off-peak rent of the available minibuses and on-demand rental services for the evenings, nights and weekends. Both services are covered in the costs since the routes allow available drivers' hours that can be used for the alternative services. Supposing then a 50% of demand on the alternative services, the concrete cost calculations were based on 52 return trips per working day for both (loop and shuttle) services, using minibuses for eight passengers and load factor of 3–5 passengers per minibus. Based on this calculation, the fare per direction (including 10%

profit and 5% VAT) resulted to be only 2,94–4,89 € for the loop service and 2,52–4,19 € for the shuttle service, in dependence of the earlier mentioned load factors. Taking additionally the externalisation of external costs into account (a not totally unrealistic cost factor in the future), and assuming a cost of 30 €/t CO_2, these fares should be increased by further 0,05 euros per trip.

These fares would be feasible, being located between the real costs of a collective taxi and the conventional public transport (10 euros and 2,10 euros respectively). Nevertheless, it remains doubtable, if there is enough demand in order to justify the existent vehicles and possible services inclusive those out of peak hours and for alternative services.

6. CONCLUSIONS

Before the real implementation of the proposed minibus service, a deeper marketing research should be carried out, examining the expected demand for these types of services and the establishment of partnerships with, for example, condominiums and private hospitals. In this context, further demand irregularities, i.e. due to seasonal peaks and valleys (summer breaks, Christmas, etc.) have also to be taken into account.

When considering the environmental impacts, the gains or losses of a minibus service depend of course on the modes it is compared with. The space consumption and environmental emissions such as air pollution and space consumption are much lower for a fully loaded minibus than for the number of cars it could replace. However, the comparison with conventional PT is obsolete if the objective of the minibus system is rather complement than compete with PT or offer a different service, for a segment not using the PT on a daily basis. Moreover, in the cases where a minibus actually replaces, for example, big busses, due to low demand, the gains in energy consumption and emissions are clear. Therefore, in this paper the use of a minibus system has been presented as a more sustainable solution and still covering the travel needs of a specific market segment, mainly cars users.

Finally, it has become clear that a strong, independent and coherently acting regulation authority is needed; not only to control and manage the introduction of a new transport system in the market, but also to coordinate its integration with the existent transport providers. Moreover, there are a set of socioeconomic benefits and risks which have not been taken into account. So, the public sector should examine the mini-bus concept in detail on the basis of a Cost-Benefit analysis before licensing the operator to provide its service. However, this is out of the scope of this paper. In this context, the entrance of new operators in the transport market might even help to revitalize the competition among operators and put pressure on incumbents to re-design and improve their service. One has to consider that currently many public transport services in European cities are characterized by x-efficiencies and under-utilisation.

ACKNOWLEDGEMENTS

We would like to thank the support from our IST colleagues Patrícia Bertozzi, Gonçalo Correia, Luís Miguel Martinez, Rafaela Arriga and our IST supervisors Prof. José Manuel Viegas, Prof. Rosário Macário and Prof. João Abreu.

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APPENDICES

Appendix A1.1

Table A1 - The general description of the sample in mobility survey (BERTOZZI, 2008)

Socio-economic characteristics	Sample Share
Gender	
Feminine	45,10%
Masculine	54,90%
Age	
15-24 years old	12,70%
25-49 years old	77,70%
50-64 years old	9,30%
more than 65 years old	0,30%
Household size	
1 person	18,40%
2-4 people	73,40%
5-7 people	6,50%
more than 7 people	1,50%

Socio-economic characteristics	Sample Share
Number of children of the household	
0 children	68,70%
1 child	18,10%
2-3 children	12,10%
more than 3 children	1,10%
Rent of the household	
Not answering	7,80%
<750€	2,60%
751-1870€	26,50%
1871-3000€	35,50%
more than 3000€	27,50%
Number of cars of the household	
0 cars	4,40%
1 car	29,60%
2-3 cars	61,70%
more than 4 cars	4,20%

Appendix A1.2

Table A2 -1st part of the survey: Socio-economic questions for both car and PT users (BERTOZZI, 2008)

Socio-economic Questions	Answers
Gender	Masculine (1); Feminine (0)
Driving license	Yes (1); No (0)
Age	15-24 years old (1); 25-49 years old (2); 50-64 years old (3); more than 65 years old (4)
Household size	1 person (1); 2-4 people (2); 5-7 people (3); more than 7 people (4)
Number of children of the household	0 children (1); 1 child (2); 2-3 children (3); more than 3 children (4)
Number of cars of the household	0 cars (1); 1 car (2); 2-3 cars (3); more than 4 cars (4)
Rent of the household	Not answering (1); <750€ (2); 751-1870€ (3) ; 1871-3000€ (4) ; more than 3000€ (5)
Home Address	Address
Home Parish	Address
Home Municipality	Lisbon (1); Suburbs (0)
Work Address	Address
Work Parish	Address
Work Municipality	Lisbon (1); Suburbs (0)

APPENDIX A2

Table A3 - 2nd part of the survey: Travel behaviour questions for both car and PT users (BERTOZZI, 2008)

Travel behaviour Questions		Answers
Do you have another car?(if you are a car user)		Yes (1) No (0)
Do you have a car?(if you are a PT user)		Yes (1) No (0)
Someone from your family is joining you on the trip? Who?		Yes (1) No (0)
	Child < 5 years old	Yes (1) No (0)
	Child < 18 years old	Yes (1) No (0)
	Adult < 65 years old	Yes (1) No (0)
	Adult > 65 years old	Yes (1) No (0)
	Person with mobility restrictions	Yes (1) No (0)
Do you make any stops between home and work to drop off the passengers? Where?		Yes (1) No (0)
	At school	Yes (1) No (0)
	In another working place	Yes (1) No (0)
	In a PT interface	Yes (1) No (0)
	In other place	Yes (1) No (0)
Do you a have a particular hour to leave the house?		Yes (1) No (0)
	Can you specify the hour?	Time
How long do you take to arrive to work (minutes)?		Time
Usually, at what time do you leave work?		Time
How many days per week?		1, 2,3 days (1), more than 3 days (0)
Do you leave work directly to home?		Yes (1) No (0)
How frequent you do other trips before going home? What are the motives?		1, 2,3 days (1), more than 3 days (0)
	To pick a family member	Yes (1) No (0)
	To study	Yes (1) No (0)
	To shop or to leisure	Yes (1) No (0)
	For health issues	Yes (1) No (0)
	For personal issues	Yes (1) No (0)
	For other motives	Yes (1) No (0)
What PT exists in your residential area? (Consider the ones that are less than 15mn walking from your house)	Bus	Yes (1) No (0)
	Ferry	Yes (1) No (0)
	Train	Yes (1) No (0)
	Metro	Yes (1) No (0)
	None	Yes (1) No (0)
Do you have free parking place in your working place?		Yes (1) No (0)
Is it difficult to find a parking place or expensive?		Yes (1) No (0)
How much do you spend per month in transports in your daily routine?		Nothing (0); <15€ (1) ; 16-30€ (2) ; 31-50€ (3); 51-80€ (4); >80€ (5)

APPENDIX A3.1

Table A4 - 3rd part of the survey: Attitudinal questions for car users (BERTOZZI, 2008)

Attitudinal Questions		Answers
Car users		**Likert scale (1-5)**
For you to drive to work is…		Pleasant - Unpleasant
For you to drive with traffic is…		Pleasant - Unpleasant
The parking spaces available in your working area are…		Satisfying - Not satisfying
Do you thing that the use of the car is the main factor associated with the increase of traffic jams?		Agree - Disagree
Do you thing that the car is the main transport leading to the increase of air pollution?		Agree - Disagree
Do you thing that the car occupies too much urban space (roads and parking)?		Agree - Disagree
How do you consider the costs for maintaining your car and use it on a daily basis?		Low - High
By using a car are you able to control the travel time in your daily routine?		Possible - Impossible
Driving your car without having accidents is…		Possible - Impossible
Would you be willing to use another type of transport if the parking in your working area would be twice more expensive?		Likely - Unlikely
Would you be willing to use a type of transport where you could book your seat and therefore, guaranteeing always a seat?		Likely - Unlikely
Would you be willing to use another type of transport if did not have to change mode (transfers)?		Likely - Unlikely

APPENDIX A3.2

Table A5 - 4th part of the survey: Car users relative perception towards a new service (minibus) regarding service operational parameters (BERTOZZI, 2008)

Relative perception towards a new service (minibus): PT, small-medium dimension, door-to-door, seat always available and without transfers (direct)	**Answers**
Car users perception of service operational parameters	**Likert scale (1-5)**
Transport service schedule adjusted to the user needs	Most important - less important
Walking time to the transport service station/stop	Most important - less important
Return always assured	Most important - less important
Suitability to transport luggage (shopping bags, baby car, etc.)	Most important - less important
Possibility to modify or cancel a reservation	Most important - less important
Easy access to service information concerning schedules, travel time, possible connectivities	Most important - less important
Seat comfort	Most important - less important