






# Investigation of Minibus Public Transport Service Characteristics in an Urban Area Through the Use of a Stated and Revealed Preference Survey

Maria Akrioti<sup>1</sup>, Socrates Basbas<sup>1</sup> , Georgios Georgiadis<sup>2</sup> ,  
and Eftihia Nathanail<sup>3</sup> 

<sup>1</sup> School of Rural and Surveying Engineering, Faculty of Engineering,  
Aristotle University of Thessaloniki, 54124 Thessaloniki, Greece

<sup>2</sup> School of Civil Engineering, Faculty of Engineering,  
Aristotle University of Thessaloniki, 54124 Thessaloniki, Greece  
ggeorgiadis@civil.auth.gr

<sup>3</sup> School of Civil Engineering, Faculty of Engineering, University of Thessaly,  
Pedion Areos, 38334 Volos, Greece

**Abstract.** The operation of minibuses as public transport modes worldwide is considered as a both efficient and effective way to meet the mobility needs of special population groups in urban areas. Minibus services are more flexible in terms of routing and scheduling as well as more affordable compared to regular bus public transport. This paper investigates the potential introduction and the characteristics of a minibus transit service in the Municipality of Kalamaria (~90,000 pop.) in Thessaloniki Greater Area, Greece. The research is based on a joint revealed and stated preference survey, which took place in 2015 and was addressed to the citizens of the Municipality, where such a minibus service was formerly active. The revealed preference survey mainly explored the current travel behavior of citizens and their level of acceptance for such a service in case of its reopening. The stated preference survey investigated the intentions and travel preferences of the respondents under different scenarios of travel time, service frequency and travel cost. A total of 140 questionnaires was collected and analyzed using descriptive and inferential statistics. Causal analysis was conducted to reveal interrelations of respondents' willingness to use the service depending on the above attributes. According to the research findings, the perceived "quality of service" is strongly associated with safety, reliability and comfort of the transport mode used. Additionally, travel time is considered more important than cost. Although respondents seem to prefer a free of charge service, it was found that Willingness-to-Pay for minibus services ranges around 0.5 euros.

**Keywords:** Minibus · Public transport · Willingness-to-pay · Travel time · Travel cost · Urban mobility

## 1 Introduction

The achievement of sustainable urban mobility goals is largely dependent on well-functioning Public Transport (PT) systems [1]. Worldwide, cities are struggling to improve and modernize their current PT networks by implementing intelligent transport system technologies, optimizing PT routes and schedules in response to rapidly changing lifestyles and travel habits as well as by introducing innovations and investing in PT fleet and infrastructure. Such initiatives are gradually being considered as required steps towards successfully compete with private car use and result in greater PT ridership figures.

In this context, a lot of cities are currently dealing with the introduction or formalization of minibuses as a special-purpose or complementary PT mode. Minibuses are small buses, typically capable of carrying 20 passengers or less [2]. They are already extensively used as PT modes in Asia, Latin America, eastern European countries [3–5] and USA, where minibuses' fleet has been substantially increased during the previous decade [6]. Their further introduction continues to be studied in other parts of Europe and Asia [7–10]. Minibuses are most often used for making short trips [11], delivering demand-responsive transport services for special user groups, such as students and people with disabilities [7, 11], realizing tailored PT services in low-density areas [7] or historical urban districts [12], providing additional supply to regular PT services [7, 9] as well as for accommodating last-mile and feeder transport services to main PT routes [10]. Past research findings indicated that minibuses, due to their greater flexibility and higher speed they achieve compared to standard buses, can be profitable, even at lower occupancy rates and higher fares, and less detrimental to traffic congestion and environmental conditions [5, 13, 14]. Recent findings highlight comparatively greater customer satisfaction rates from minibus services than standard bus ones [8].

In any case, however, transport authorities need to be aware of both local travel needs and conditions for the establishment of such minibus PT systems in order to ensure their public acceptance. This paper investigates the introduction of a minibus PT system which would operate as an alternative travel option for trips with origin and destination points within a single urban municipality (*internal trips*). The study area is the municipality of Kalamaria, which belongs to the functional urban area of Thessaloniki, Greece. The specific objective is to highlight the main service characteristics of a potential minibus PT system which would be compliant with local travel preferences, needs and expectations. For this reason, a customized Revealed Preference (RP) and Stated Preference (SP) questionnaire survey was conducted with Kalamaria's citizens and a corresponding analysis setting was developed to provide the necessary research findings.

The remainder of the paper is as follows. Next section gives a short profile of the study area in terms of its demographic and transport related characteristics. The questionnaire survey method, the collected data and their analysis are explained in Sect. 3. Results are presented and discussed in Sect. 4. Section 5 summarizes the main conclusions.

## 2 Background

Municipality of Kalamaria is located in the southeastern part of Thessaloniki's functional urban area. The latter has almost 1 Mio. Residents while the municipality of Kalamaria has a so far increasing population of 91,258 inhabitants and its corresponding population density is approximately 14,258 inh/Km<sup>2</sup> [15]. Within the boundaries of Kalamaria there are critical points of interest, such as hospitals, commercial buildings and sports related facilities, that attract visitors from all over Thessaloniki's greater area.

Currently, PT in Kalamaria, and in Thessaloniki in general, is provided only by buses. There is only one PT operator in the city which is named UTOT (Urban Transport Organization of Thessaloniki). UTOT schedules standard and articulated diesel buses except for the Thessaloniki's historical district of Ano Poli where minibuses are deployed [16, 17]. UTOT PT lines connect Kalamaria to Thessaloniki's city center with high and medium service frequencies which are dependent on the specific line and time period. PT stops for UTOT lines are placed along the main arterial roads that pass through Kalamaria's central areas. Therefore, though the existing PT services are considered as satisfactory for commuting to/from Thessaloniki's city center, they fail to properly support internal trips, since no PT lines and stops are assigned to collector and local roads. In addition to this, PT coverage inadequacies are observed in the municipality's recently developed areas, where residential land uses are mostly hosted.

In response to this, municipality of Kalamaria had before long launched municipal PT services with minibuses in 1991 with the aim to: (a) increasing the existing PT coverage of the area under its responsibility by providing additional routes and services to those delivered by UTOT, (b) stimulating economic and leisure activities in the municipality and (c) reducing private car use along with tackling congestion and parking problems in municipality's central districts. The municipal PT fleet was comprised of two (2) 19-seat and one (1) 33-seat minibuses. The network was built onto two (2) circular fixed PT lines which connected locations within municipality and had bus stops which enabled access to all important places of interest, such as public sector services, healthcare facilities, educational establishments and commercial and recreation areas. Timetable frequencies were approximately 20–30 min, span of service was 12 h (06:00–21:00) during weekdays only and there was no charge for minibus PT passengers. Averagely speaking, the highest number of minibuses' passengers was observed during morning periods (i.e. approximately 50 passengers per itinerary) and the lowest figures in the afternoon (i.e. approximately 10 or fewer passengers per itinerary). Due to severe financial difficulties, the municipality permanently stopped minibus PT services in 2009. Limited resources already had affected PT system's operation and reliability before closure since the frequent cancellation of itineraries and the incapacity to modernize fleet have disappointed its users. Along with these shortcomings, certain service design drawbacks were also affecting minibuses' performance and patronage since the circular routes often resulted in high travel times between locations that, in practice, were within walking distance to each other. The quality of minibus PT services was further deteriorated by the fact that no serious

investment was ever made for creating and delivering either static or real-time information to passengers. Due to all these issues, there were PT users who continued to prefer UTOT services over minibuses even when they had to make internal trips. Additionally, private car use for internal trips was never significantly threatened because of minibuses' operation.

### 3 Material and Methods

#### 3.1 Survey Method

The necessary data for meeting the study's objective were collected via an ad-hoc questionnaire survey which included face-to-face interviews with a representative sample of Kalamaria's citizens. The interviews were based in a structured questionnaire form which combined both RP and SP survey methods and included four parts. The first part included questions on the socioeconomic characteristics of survey participants, such as their age, gender, household income and use of household's car (if any). In the second part, respondents were asked to provide details, i.e. trip purpose, cost, duration, origin-destination etc., on their most recent internal trip as well as to share their experiences from the former minibus local PT service, in case they have used it. Third part examined, in a general sense, the willingness to replace current travel mode with a potential minibus PT service. It also explored the relative importance of travel quality attributes such as comfort, cost, duration, safety and reliability.

**Table 1.** Alternative travel options and attribute levels for card sets A, B and C of SP survey.

Attribute	Card set	Travel option 1 Bus (A), Car (B), Walking (C)	Travel option 2 Minibus (All sets)
Travel time (%)	A	As today	-30, Equal, +20
	B	As today	-20, Equal, +20
	C	As today	-30, Equal, +30
Frequency (min)	All sets	As today	10, 20, 30
Travel cost (€)	All sets	As today	Free, 0.4, 0.8

For the fourth part of the questionnaire (SP survey), respondents were clustered into three (3) groups according to the travel mode they used for their most recent internal trip within Kalamaria (A: PT bus; B: Private car; C: Walking). Then, they were shown a set of nine (9) cards in line with the group they belonged to. In each set of cards two (2) alternative travel options for their most recent trip within Kalamaria were described. These options were the actual mode they previously used (A, B or C) and a hypothetical minibus PT service with routes inside Kalamaria and vehicle sizes of 15 persons. Each alternative was further defined by specific attributes, i.e. percentage difference of travel time between the two (2) alternative travel options, service frequency and travel cost. Attribute levels varied across cards so that each card would present a specific combination of travel options (Table 1). Respondents were asked to

select one (1) travel option from each card that better expressed their personal preferences compared to the other available ones in the same card. All cards also contained a third “don’t know/ don’t answer” option.

### 3.2 Data Collection and Process

The questionnaire survey was performed in March 2015. Interviews were conducted, within the municipality of Kalamaria, with citizens at bus PT stops of UTOT and at specific locations, where important activities (e.g. commercial, employment, leisure etc.) along with pedestrian flows are concentrated. A total of 140 valid interviews were completed.

Table 2 presents the general characteristics of the survey participants and shows that our sample was well distributed against gender, age and monthly household income categories. Most of the respondents lived in households with cars and they were also their main users. Almost half of the most recent internal trips, which were reported by respondents, was made on foot and the other half was equally shared between private car and PT bus. This modal split probably explains the relatively low travel time and cost figures of Table 2. Thought that all trip purpose main categories appear in respondents’ answers, leisure and commuting are the most popular ones. Regarding the former municipal minibus PT system, Table 2 indicates that more than half of the survey’s participants had no experience from using it, but those who had were satisfied from its services.

**Table 2.** Personal and trip characteristics of the respondents (n = 140).

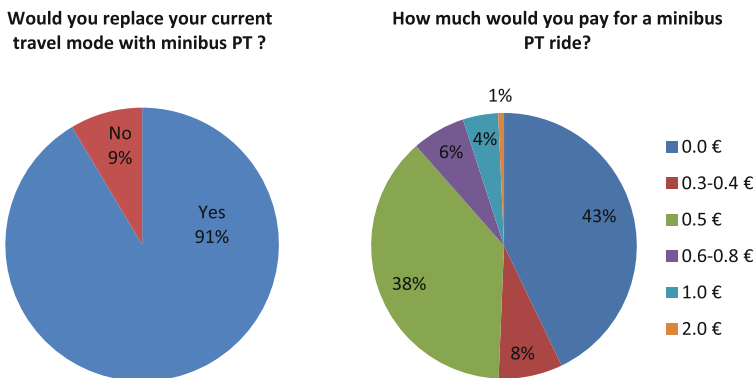
Characteristics	Statistics
Gender	Male: 45.7%; Female: 54.3%
Age group	19–24: 15.7%, 25–39: 37.9%; 40–54: 25.7%; 55–64: 15.7%; > 64: 5.0%
Monthly household income (€)	0–800: 21.4%; 801–1,600: 46.4%; 1,601–2,400: 7.9%; > 2,400: 7.1; No answer: 17.2%
Possession of household car	Yes: 88.6%; No: 11.4%
Most frequent user of household’s car	Yes: 59.7%; No: 40.3%
Trip mode	PT bus: 28.6%; Private car: 28.6%; Walking: 42.8%
Trip purpose	Commuting: 27.8%; Shopping: 17.1%; Leisure: 36.4%; Business: 11.4%; Other: 7.3%
Travel time (minutes)	3–5: 16.4%, 7–10: 42.8%; 11–15: 23.5%; 20–30: 15.7%; > 30: 1.6%
Travel cost (€)	0: 55%, 1: 22.9%; 2: 17.9%; 3–5: 4.2%
User of former minibus PT service	Yes: 37.9; No: 62.1%
Satisfied from former minibus PT service	Yes: 92.3%, No: 7.7%

In order to investigate citizens’ preferences and opinions towards a potential minibus PT system for Kalamaria, we further analyzed the collected data. We used descriptive statistics to underline the factors that affect travel experience, to investigate whether willingness-to-use minibus PT is affected by travel time, service frequencies and travel cost as well as to highlight the fares that would be considered as affordable for such a PT service.

Furthermore, we employed inferential statistics methods to investigate whether current mode choice and willingness to use a potential minibus PT mode are dependent on personal characteristics. In order to examine personal characteristics’ variables with two (2) categories, i.e. gender etc., the Mann-Whitney U test was performed and in all other cases the Kruskal-Wallis test was applied. For all test statistics, the null hypothesis ( $H_0$ ) we adopted is that there is no relationship between personal characteristics and (current and future) mode choice. The alternative hypothesis ( $H_1$ ) is that there is a statistically significant relationship between them. We rejected the null hypothesis for p-values lower than 0.05. All calculations were performed with SPSS software [18].

### 4 Results and Discussion

Descriptive analysis of RP results showed that almost all respondents would be interested into trying minibus PT services for their internal trips, since Fig. 1 demonstrates that the willingness-to-shift rate is over 90%. Figure 1 also shows that many of them (43%) expect that such service would be free of charge. In fact, willingness-to-pay results imply that the maximum acceptable fare for travelling by PT minibuses would be 0.5 euros.



**Fig. 1.** Willingness-to-shift to (left) and willingness-to-pay for (right) a potential minibus PT service.

SP results, however, indicate that the willingness-to-shift rates may greatly vary against minibus PT service characteristics. Travel time appears to be a key decision factor for preferring minibuses over current travel modes. Specifically, Table 3 reports

that the highest acceptance rates for minibuses were observed when travel time was reduced, and routes were scheduled every 10 min. Willingness-to-shift rates significantly dropped when travel time was increased, and service frequencies were over 20 min. Travelers seem to accept a fare that does not exceed 0.4 euros, considering that all tested combinations which included a fare of 0.8 euros are associated with very low selection rates in favor of minibuses. This finding reconfirms Fig. 1 willingness-to-pay results.

**Table 3.** SP results: Selection of minibus as travel option.

Hypothetical Minibus PT trip attributes				Willingness to shift to minibus PT service
# Card	Travel time*	Service frequency (min)	Travel cost (€)	
1	Reduced	10	0	94.3%
2	Increased	20	0	45.0%
3	Equal	30	0	45.0%
4	Reduced	20	0.4	76.4%
5	Equal	10	0.4	90.7%
6	Increased	30	0.4	23.60%
7	Increased	10	0.8	18.60%
8	Reduced	30	0.8	35.70%
9	Equal	20	0.8	14.30%

\* compared to current travel option (all modes considered)

**Table 4.** Respondents' opinions on travel experience determinants.

Travel experience statements	Level of agreement
	1: Fully disagree; 5: Fully agree
Travel Safety is a key quality of service attribute	4.34
Travel Comfort is a key quality of service attribute	4.16
Travel Reliability is a key quality of service attribute	4.12
Travel Cost is more important than Travel Time	2.97

The higher importance of travel time over travel cost is also confirmed by the RP results. Table 4 shows the level of respondents' agreement, using a five-point likert scale, on certain statements which dealt with specific trip quality attributes. Table 4 results make evident that the majority of respondents thinks that travel time is more important than travel cost. In Table 4 it is also evident that safety is the most important travel aspect amongst those examined. Reliability and comfort are equally appreciated by local travelers. Both of these factors are assigned with relatively high importance scores which are similar to safety ones.

Table 5 reports the p-value results obtained from the application of inferential statistical techniques on selected variables of RP survey. The techniques followed were explained in Sect. 3.2. According to Table 5, both the selection of current mode for internal trips and the willingness-to-shift to a potential minibus PT service do not present any statistically significant correlations with gender, age and monthly income. This indicates that service characteristics of minibuses are more critical to personal ones when it comes to the acceptance of such a new PT service. Table 5 also shows that statistically significant relationships are found only for the mode choices of the most frequent users of households' cars (p-values < 0.05). This group of travelers, as expected, mostly use private car for their internal trips. They are also associated with statistically significantly lower willingness to use a hypothetical minibus PT system compared to the other respondents.

**Table 5.** Personal characteristics and mode choice: Inferential statistics results (p-values).

Personal characteristics	Mode choice		Test statistic
	Trip mode currently used	Willingness to shift to minibus PT service	
Gender	0.252	0.132	Mann-Whitney U
Age	0.998	0.571	Kruskal-Wallis H
Monthly income	0.721	0.396	Kruskal-Wallis H
Most frequent user of household's car	0.000	0.017	Mann-Whitney U

## 5 Conclusion

Minibuses are widely considered as a promising PT mode that due to its greater flexibility and lower cost can be utilized for a variety of PT purposes. Currently, minibuses are mainly used for short trips that pertain to demand responsive transport systems and PT lines which provide additional supply to the core PT networks.

In this paper we investigated the introduction of a potential minibus PT system that would accommodate internal trips within the urban municipality of Kalamaria in Thessaloniki's greater area, Greece. We accordingly designed and performed a joint RP and SP survey to collect data on personal characteristics, current travel preferences and opinions of Kalamaria's citizens regarding the future introduction of such a minibus PT service in their local community. We employed both descriptive and inferential statistics methods to determine those minibus PT service characteristics which would be compatible with citizens' needs and expectations.

Overall, we may conclude that any new minibus PT system for Kalamaria should have far better service characteristics compared to the former system which functioned ten years ago in the same area. Kalamaria's citizens would welcome the launch of a minibus PT network provided that its operation would realize tangible travel time and



quality of service benefits. More specifically, according to survey participants' views, an ideal minibus PT system for internal trips within their local area should: (a) provide shortened total travel times compared to the current ones, (b) schedule minibus vehicles every 10 min, (c) charge no fare or maximum 0.5 euros per ride and (d) meet the quality criteria of reliability, safety and comfort. This set of service characteristics is commonly agreed by all respondents regardless to their personal attributes. We also found that the frequent private car drivers were the most reluctant group of travelers to shift to minibuses. These findings indicate that the introduction and operation of a future minibus PT system should also be accompanied by a tailored marketing strategy which would both target specific groups of trip makers and promote the quality of service attributes of minibuses in order to gain considerable modal shares and most importantly reduce private car use.

A limitation of this study is the fact that the survey was conducted six (6) years after the termination of the local minibus PT service. Therefore, there may have been cases where participants did not adequately remember their previous travel experience on minibuses while they were providing their answers. Another limitation of the study is the sample size of respondents which should be attributed to the inherent difficulties of conducting face-to-face interviews with people who, during survey periods, may have time restrictions for participating. Web-based surveys and focus group discussions could be additional tools for obtaining a larger sample.

## References

1. European Commission: COM 2011 (144): White Paper. Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system, Brussels (2011)
2. American Association of State Highway and Transportation Officials: AASHTO Transportation Glossary. 4th edn. AASHTO, USA (2009)
3. Vandevelde, D.: A new regulation for the European public transport. *Res, Transp. Econ.* **22** (1), 78–84 (2008)
4. International Association of Public Transport (UITP): Organisation and major players of short-distance public transport. New developments in the European Union. UITP, Brussels (2010)
5. Gwilliam, K.: A review of issues in transit economics. *Res. Transp. Econ.* **23**(1), 4–22 (2008)
6. Federal Transit Administration: National Transit Summaries and Trends. National Transit Database 2010 Report Year. U.S. Department of Transportation, Washington, D.C. (2011)
7. de Jong, W., Vogels, J., van Wijk, K., Cazemier, O.: The key factors for providing successful public transport in low-density areas in the Netherlands. *Res. Transp. Bus. Manag.* **2**, 65–73 (2011)
8. Noor, H.M., Nasrudin, N., Foo, J.: Determinants of customer satisfaction of service quality: city bus service in Kota Kinabalu, Malaysia. *Procedia Soc. Behav. Sci.* **153**, 595–605 (2014)
9. Eiró, T., Viegas, J.M., Martínez, L.M.: A new optimisation procedure to design minibus services: an application for the Lisbon Metropolitan Area. *Procedia Soc. Behav. Sci.* **20**, 856–865 (2011)

10. Martínez, L.M., Eiró, T.: An optimization procedure to design a minibus feeder service: an application to the Sintra Rail Line. *Procedia Soc. Behav. Sci.* **54**, 525–536 (2012)
11. The Transit Cooperative Research Program (TCRP).: Report 165: Transit Capacity and Quality of Service Manual, Third Edition. Transportation Research Board of the National Academies, Washington, D.C. (2013)
12. Pitsiava-Latinopoulou, M., Basbas, S., Nikolaou, K., Toskas, G.: The use of environment friendly public transport system in historical urban areas. In: Sucharov, L.J., Brebbia, C.A. (eds.) 6th International Conference on Urban Transport and the Environment in the 21st Century – Urban Transport VI 2000, International Series: Advances in Transport, vol. 6, pp. 359–368. WITpress (2000)
13. Glaister, S.: Competition on an urban bus route. *J. Transp. Econ. Policy* **XIX 1**, 217–244 (1985)
14. Walters, A.A.: The benefits of minibuses. *J. Transp. Econ. Policy* **XII 3**, 320–337 (1979)
15. Hellenic Statistical Authority: Population and Housing census (2011). <https://www.statistics.gr/en/statistics/pop>. Accessed 07 Mar 2020
16. Basbas, S., Nikolaou, K., Toskas, G.: Relative contribution of various diesel vehicle classes to the Thessaloniki urban air pollution. *Water Air Soil Pollut. Focus* **4**, 55–63 (2004)
17. Basbas, S., Nikolaou, K., Toskas, G.: Environmental impacts of bus traffic in the Thessaloniki Metropolitan Area. *J. Environ. Prot. Ecol.* **2**(3), 567–574 (2001)
18. IBM Corp. Released 2017. IBM SPSS Statistics for Windows, Version 25.0. IBM Corp., Armonk (2017)