The impact of demand management on public transport use in relation to socio-economic characteristics
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Abstract

The paper presents a study on the impact of various demand management policies (i.e. restriction of traffic, improvement of public transport services, road pricing etc.) on public transport use, taking into consideration the socio-economic characteristics of the population. The applied methodology is based on behavioural response and was materialized by asking people to indicate their opinion and attitudes to different demand management implementations. For the purpose of the study the data collection was made through a questionnaire survey using face-to-face method at 500 randomly selected households in the greater area of Thessaloniki, Greece. The analysis and interpretation of the results of the study concern:

(i) the public transport use in relation to socio-economic characteristics,
(ii) the impact of various demand management policies on public transport use by socio-economic group and
(iii) the public attitudes and opinions to the different demand management implementations.

1 Introduction and objectives

The European cities suffer from increasing traffic. More and more the general policy is to avoid private traffic and force people to use public transport means which have less negative environmental effects. Especially in large towns great effort is made in order to make travellers move from private car to public transport and in particular to buses which carry about 50-70% of the total passengers-kms within an urban area [1]. This effort is based on various demand management scenarios - which, in general, lead to the solution of traffic
problems in city - such as restriction of traffic in specific areas, improvement of public transport, road pricing. etc.

Improvement of public transport can be made by various ways (better information, higher frequencies, increased safety etc.). In the framework of the European research and development programmes advanced telematics systems designed and tested supported this improvement-by implementing better control systems of public transport operations and by providing better information about the services-and contributed to modal shift [2,3].

The objectives of the present study are:

(i) to investigate the present public transport use in the city of Thessaloniki, Greece in relation to socio-economic characteristics of the population.

(ii) to examine the possible effects of various demand management policies - including the improvement of public transport itself - to public transport use for different socio-economic groups, and finally

(iii) to investigate the public attitudes in general to different demand management implementations, aiming to improve the traffic conditions.

2 Methodology

The methodology followed in the present study was basically oriented towards achieving the objectives of investigating the public opinions and attitudes to different demand management implementations. However, more emphasis has been given to the impact on public transport use caused by different improvements taking into consideration the socio-economic characteristics of the population.

For such problems a number of techniques have been available for some years, which can be either more suited to exploratory analysis or to quantitative analysis such as stated preference methods [4,5]. In the present study the method applied is based on behavioural response and was materialized by asking people to indicate their opinion for different demand management scenarios concerning their acceptability and their effectiveness.

In the following the methodologies for both survey design and data analysis are presented.

2.1 Survey design and execution

The survey questionnaires were designed to address the different demand management scenarios. In general, the questionnaire is divided into three main parts.

The first part was designed to acquire information on mode of transport used, trip purpose, frequency of trips etc. The second part covered details about the characteristics of the respondents such as age, occupation, income etc. The third part deals with the levels of knowledge and acceptance of the demand management scenarios and their impact according to people’s perception on the
public transport use. In addition, some questions were designed specifically to investigate the public willingness to improve public transport and provide and allocate the necessary resources to do so.

The survey was carried out using face-to-face household method. Interviews were performed at randomly selected houses in the city centre, inner city and outer city areas of Thessaloniki, Northern Greece. The sample size was 500 households. A specific method has been followed in selecting the number of households in each area which was based on the population densities in the city sectors.

Some basic guidelines were considered in the survey sampling which are: random sample, representative, covering all the social and economic characteristics.

2.2 Data analysis

All the survey data was entered and saved in database and SPSS files after the field work. Quality reviews and corrections were made to finalise the task on data coding before carrying out statistical analysis.

The data was classified into three main categories based on the social and economic characteristics of the population. Then cross sectional analysis was carried out to study different levels of public transport use against these categories. The influence on public transport use caused by different demand management implementations was then analysed. The public opinions categorised by the main classes of socio-economic characteristics were always covered in the analysis.

Finally public attitudes, i.e. knowledge, acceptance and effectiveness, to different demand management policies were analysed.

3 Results of analysis

The analysis of all the questionnaires that were checked and processed using the DBASE III+ programme provides the following results accordingly to the objectives of the present study.

3.1 Public transport use in relation to socio-economic characteristics

The analysis of the first part of the questionnaire resulted to Tables 1 & 2 which give the modal split in relation to trip purpose, and the frequency of transport mode used respectively. From the above tables the following main remarks can be drawn:

(i) In general there is a low level of public transport use (Table 1)
(ii) The use of bus is much higher in trips for shopping (26%) than in trips for work (Table 1)
(iii) The majority of the total public transport passengers (around 42%) uses bus once a day or more (Table 2).

Table 1. Modal split in relation to trip purpose (expressed in percentages)

<table>
<thead>
<tr>
<th>Trip purpose</th>
<th>Car (Driver)</th>
<th>Car (Pass.)</th>
<th>Bus</th>
<th>Train</th>
<th>Motorbike /Moped</th>
<th>Taxi</th>
<th>Bicycle</th>
<th>Walk</th>
<th>No ans.</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Work</td>
<td>32.32</td>
<td>4.68</td>
<td>25.53</td>
<td>0.23</td>
<td>6.32</td>
<td>2.11</td>
<td>0.70</td>
<td>28.10</td>
<td>17.56</td>
<td>100.00</td>
</tr>
<tr>
<td>Shopping</td>
<td>26.69</td>
<td>7.57</td>
<td>32.27</td>
<td>0.00</td>
<td>4.38</td>
<td>6.57</td>
<td>0.00</td>
<td>22.51</td>
<td>100.00</td>
<td></td>
</tr>
</tbody>
</table>

Table 2. Frequency of transport mode used (expressed in percentages)

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Car (Driver)</th>
<th>Car (Pass.)</th>
<th>Bus</th>
<th>Train</th>
<th>Motorbike /Moped</th>
<th>Taxi</th>
<th>Bicycle</th>
<th>Walk</th>
</tr>
</thead>
<tbody>
<tr>
<td>once a day or more</td>
<td>64.10</td>
<td>39.37</td>
<td>41.51</td>
<td>0.00</td>
<td>51.35</td>
<td>12.50</td>
<td>9.09</td>
<td>67.02</td>
</tr>
<tr>
<td>3 or 4 days a week</td>
<td>8.97</td>
<td>19.00</td>
<td>18.49</td>
<td>0.00</td>
<td>18.92</td>
<td>15.00</td>
<td>18.18</td>
<td>13.03</td>
</tr>
<tr>
<td>once or twice a week</td>
<td>20.94</td>
<td>37.56</td>
<td>37.74</td>
<td>12.50</td>
<td>16.22</td>
<td>70.50</td>
<td>22.73</td>
<td>19.68</td>
</tr>
<tr>
<td>never</td>
<td>5.98</td>
<td>4.07</td>
<td>2.26</td>
<td>87.50</td>
<td>13.51</td>
<td>2.00</td>
<td>50.00</td>
<td>0.27</td>
</tr>
<tr>
<td>Total</td>
<td>100.00</td>
<td>100.00</td>
<td>100.00</td>
<td>100.00</td>
<td>100.00</td>
<td>100.00</td>
<td>100.00</td>
<td>100.00</td>
</tr>
</tbody>
</table>

In the second part of the questionnaire, a classification of the population involved in the survey was made, according to the income level as well as the type of occupation. With respect to income, the population was classified into three categories, high, medium and low. As far as the social characteristics are concerned, the population was also divided into three categories, according to the type of the occupation: high (managers), medium (clerks) and low (manual workers).

Following the above classification an investigation of the impact of the socio-economic characteristics of the population on the public transport use was attempted. Tables 3 & 4 give modal split for the considered social and income groups, respectively (by trip purpose).

Table 3. Modal split for different social groups by trip purpose

<table>
<thead>
<tr>
<th>Social Level</th>
<th>Car (Driver)</th>
<th>Car (Pass.)</th>
<th>Bus</th>
<th>Motorbike</th>
<th>Taxi</th>
<th>Bicycle</th>
<th>Walk</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>39.40</td>
<td>3.85</td>
<td>17.79</td>
<td>7.69</td>
<td>6.96</td>
<td>0.96</td>
<td>29.33</td>
</tr>
<tr>
<td>Medium</td>
<td>27.46</td>
<td>4.15</td>
<td>19.31</td>
<td>2.70</td>
<td>4.15</td>
<td>1.45</td>
<td>40.78</td>
</tr>
<tr>
<td>Low</td>
<td>19.71</td>
<td>5.66</td>
<td>46.65</td>
<td>4.72</td>
<td>0.94</td>
<td>0.00</td>
<td>22.33</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Social Level</th>
<th>Car (Driver)</th>
<th>Car (Pass.)</th>
<th>Bus</th>
<th>Motorbike</th>
<th>Taxi</th>
<th>Bicycle</th>
<th>Walk</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>34.33</td>
<td>6.44</td>
<td>25.32</td>
<td>5.15</td>
<td>10.3</td>
<td>0.00</td>
<td>18.45</td>
</tr>
<tr>
<td>Medium</td>
<td>13.19</td>
<td>8.71</td>
<td>33.54</td>
<td>5.85</td>
<td>5.19</td>
<td>0.00</td>
<td>33.52</td>
</tr>
<tr>
<td>Low</td>
<td>19.06</td>
<td>1.13</td>
<td>39.06</td>
<td>3.13</td>
<td>1.56</td>
<td>0.00</td>
<td>34.06</td>
</tr>
</tbody>
</table>
From Tables 3 & 4 it can be seen that the use of buses increases as both levels (social and income) move from high to low, whereas the car use (as driver) decreases respectively. More specifically in trips for work the percentages of people using bus are 17.14%, 26.62% and 37.50% for high, medium and low income levels respectively, while the corresponding figures for car drivers are 50.00 %, 27.93% and 15.63% (Table 4). The above results confirm the effect of car-ownership on modal split as car-ownership is directly related to the income level. Considering the social levels the percentages of people using bus for work are quite similar with the above i.e. 17.19%, 19.31% and 46.65% for high (managers), medium (clerks) and low social levels (manual workers) respectively. From Tables 3 & 4 it can also be seen that the use of bus is higher in trips for shopping than for work.

### Table 4. Modal split for different income groups

<table>
<thead>
<tr>
<th>Income Level</th>
<th>Car (Driver)</th>
<th>Car (Pass.)</th>
<th>Bus</th>
<th>Motorbike</th>
<th>Taxi</th>
<th>Bicycle</th>
<th>Walk</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>50.00</td>
<td>4.29</td>
<td>17.14</td>
<td>2.86</td>
<td>4.29</td>
<td>0.00</td>
<td>21.43</td>
</tr>
<tr>
<td>Medium</td>
<td>27.93</td>
<td>4.72</td>
<td>26.62</td>
<td>7.13</td>
<td>2.43</td>
<td>1.06</td>
<td>30.11</td>
</tr>
<tr>
<td>Low</td>
<td>15.63</td>
<td>3.13</td>
<td>37.5</td>
<td>12.5</td>
<td>0.00</td>
<td>0.00</td>
<td>31.13</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Income Level</th>
<th>Car (Driver)</th>
<th>Car (Pass.)</th>
<th>Bus</th>
<th>Motorbike</th>
<th>Taxi</th>
<th>Bicycle</th>
<th>Walk</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>44.16</td>
<td>7.79</td>
<td>23.38</td>
<td>2.60</td>
<td>11.69</td>
<td>0.00</td>
<td>10.39</td>
</tr>
<tr>
<td>Medium</td>
<td>22.79</td>
<td>8.32</td>
<td>31.71</td>
<td>4.88</td>
<td>6.03</td>
<td>0.00</td>
<td>26.28</td>
</tr>
<tr>
<td>Low</td>
<td>19.15</td>
<td>2.13</td>
<td>46.81</td>
<td>6.38</td>
<td>2.13</td>
<td>0.00</td>
<td>23.40</td>
</tr>
</tbody>
</table>

3.2 The impact of various demand management scenarios on public transport use

The impact of different demand management scenarios on public transport use was then investigated using data from the third part of the questionnaire. The considered demand management scenarios, in the present study, which in general lead to the solution of traffic problems in a city (e.g. traffic jams, deterioration of the environment), by encouraging people to shift from car to public transport are:

(i) Restriction of traffic in certain areas  
(ii) Improvement of public transport  
(iii) Increase of parking cost  
(iv) Reduction of parking spaces  
(v) Payment on congested roads  
(vi) Payment to use roads in general.

The effectiveness of the above demand management scenarios in increasing public transport use according to people’s perception is given in Fig. 1. From this figure it is obvious that the majority of people, over 90%, believe that the improvement of public transport would result in a significant increase of public transport use.
transport use, while the 65% of them believe that the payment on congested roads wouldn’t affect dramatically the public transport use.

![Figure 1: Increase of public transport use as a result of demand management scenarios](image)

Considering the increase of public transport use due to the improvements of the system by income group (Fig. 3) it can be seen that medium income group reacts in a more positive way than the other groups to the improvements of public transport. This can be easily explained by the fact that this income group has a choice between car and public transport, while the low income group doesn’t having any alternative would use the public transport in any case - in its current situation or in an improved one.

![Figure 2: Increase of public transport use by income group](image)
3.3 Public attitudes to different demand management implementation

Analysing the public attitudes to nine different measures for traffic improvement, people asked to share ten units among these improvements, taking into consideration the relative importance of each measure. The considered measures are: better environment, improvement of public transport, provision of facilities to cyclists, construction of new roads, reduction of taxation, maintenance of existing roads, pedestrianization schemes, speed reduction and improvement of the implementation of traffic regulations. The results of this analysis are given in Fig. 3, and show the following:

(i) 2.08 units out of total 10, - just over 20% - were given to the improvement of public transport, which is therefore considered the most important measure for traffic improvements

(ii) 1.82 units were given to the construction of new roads - making it of second priority - while only 0.32 units were given to improve the implementation of traffic regulations.

Figure 3: Average units (out of total 10) spend for each measure for traffic improvements

Finally the analysis of public attitudes and more specifically of knowledge, acceptance and effectiveness to the different demand management policies - mentioned above - showed that among these policies people know better, accept more and believe more in its effectiveness to the improvement of public transport (Fig. 4).
4 Conclusions

The main conclusions drawn from the present study, according to its objectives, are summarized as follows:

Public transport use increases from 17.14% to 37.5% as we move from high income to low income group. A corresponding increase in public transport use - from 17.79% to 46.65% - happens when we move from high to low social group i.e. from managers to manual workers.

According to public opinion from the various demand management scenarios considered in this study, the most effective in increasing public transport use is the improvement of public transport system itself. Among the three income groups, the medium one reacts in a more positive way to the demand management policies, with a greater increase in public transport use. This is due to the fact that people of this group are choice riders, while people with low income are mostly captive riders.

People believe in their majority that public transport improvement is a first priority measure for the solution of traffic problems in the cities and they are prompt to allocate the necessary resources to do so.

Finally, the investigation of the levels of knowledge and acceptance of the demand management scenarios showed that these are much higher for public transport than any other policy concerning restriction of traffic, payment on congested roads, increase of parking costs etc.
5 Acknowledgements

This research uses information acquired in the framework of the MIRO (Mobility Impacts Responses and Opinions), Project V2060. MIRO project has been partially-funded by the European Commission DGXIII in the framework of DRIVE II programme. The content of this manuscript does not necessarily reflect the views of the Consortium.

References


