

<sup>1</sup>József GÁL, <sup>2</sup>István Tibor TÓTH

## SURVEY OF PASSENGERS' BEHAVIOR TRAVELLING BY PUBLIC TRANSPORT IN SZEGED

<sup>1-2</sup>University of Szeged, Faculty of Engineering, 6724 Szeged, Mars tér 7, HUNGARY

**Abstract:** In Horizon 2020 Program University of Szeged, Faculty of Engineering and Szeged Transport Ltd. as partners involved in the ELIPTIC (Electrification of Public Transport in Cities) [5] project. (Figure 1; 17) Their aim is to learn about more travel behaviour, environmental-friendly passengers point of view and public transport quality in Szeged, the development of electric-powered modes. Participants are more than 30 partners, from different countries include transport operators, authorities, research centres, universities and other organizations. The problems, so that the tasks are similar, but they differ from each other significantly as well due to the local circumstances. After the test, scheduled for the trolleybus-network wireless and more electric-powered modes of development

**Keywords:** public transport, environmental protection, Szeged, traveling behaviour

### INTRODUCTION

Basic idea is extension of trolleybus and tram network, which makes environmental friendly mode of transportation. This paper presents some results of a survey, which based on Smart City project (TÁMOP-4.2.1.D-15/1/KONV-2015-0002) [6]. For this purposes, for investments good to know environmental friendly transportation looks good idea to use electric powered public transportation as trams or trolleybuses. Problem is the network, and interesting inhabitants' point of view. Two additional possibilities can be interesting as battery powered trolleys where there is no network.

Electric public transport can also be highly cost efficient for the operator, when a long-term perspective is taken. A number of new vehicle concepts has been introduced over the last years, innovative energy management and storage technologies are being tested and public transport energy networks are expected to make a major contribution to the smart grid of the future. Exciting tram-like bus systems, the renaissance of the trolleybus, as well as autonomous electric buses are examples of the innovation capacity of Europe's public transport sector.



Figure 1. ELIPTIC Project logo

Among the ELIPTIC (Figure 1) partner cities, all modes of electric public transport are covered and these will be the basis for analysing the potentials for upgrading and/or regenerating electric public transport systems while ensuring the safe integration of electric vehicles into infrastructure. This approach will overcome the main barriers for further integration of electric vehicles in cities with existing electric public transport infrastructure by cost-effective principles of double- or even multi-use of this existing infrastructure. In particular, the often lacking city-wide coverage of charging infrastructure (due to high investment cost) and the limited driving range of electric vehicles – the two biggest challenges for electro mobility – will be overcome by providing different options for opportunity charging along the existing infrastructure thus extending driving ranges and/or reducing the size of the required battery packs.

### 2. LITERATURE REVIEW

Europe's bus fleet, which transports 30 billion people per year in the EU, is still approx. 95% diesel-fuelled. Electro mobility is a trend, but a lack of expensive city-wide charging infrastructure and the limited driving range of electric vehicles are barriers for deployment. But rather than building new and costly stand-alone charging infrastructure, ELIPTIC aims to further electrify road vehicles (in particular buses) using existing electric public transport infrastructure. To date, the only

demonstration in Europe of electric bus operation using tram infrastructure is in Vienna. In order to exploit the full potential of existing electric public transport infrastructure as a basis for further safe integration of electric road vehicles, ELIPTIC will provide a range of options for opportunity charging along existing infrastructure (en route or at sub-stations) extending driving ranges and/or reducing the size of the required battery packs. The technical development in the field of electric storage (e.g. trolley-hybrid-buses equipped with battery and supercapacitors) and power management allow for new solutions for practical operation. [3; 4]

Furthermore, zero-emission public transport systems, in particular electric (trolley)bus systems, are often neglected in national electro mobility investment and research programmes. And although significant research efforts are underway to develop and demonstrate innovative electric bus concepts across Europe in real life contexts, public transport operators and authorities too often launch stand-alone test projects to gain initial experience with electric buses. This trial and error approach can however be inefficient and the likelihood of costly mistakes being made by selecting sub-optimal electric buses and charging station solutions is high. ELIPTIC aims to avoid these pitfalls through a moderated software-based planning process based on validated ELIPTIC use cases and available information and data of demos from outside the project, e.g. through exchange with the ZeEUS Observatory. More and more, public transport operators are not just public transport providers but mobility providers. They facilitate seamless multimodal travel, often by partnering with providers of shared cars or bikes to create a full chain of mobility. ELIPTIC's objective of analysing the potential of multiple-use infrastructure to facilitate seamless multimodal door-to-door electric travel (e.g. linking e-bike charging to tram or bus infrastructure) will give an important new dimension to clean mobility options. This is also important as a shift from individual car traffic can make a large impact on fossil fuel consumption and air quality. By introducing more electric options, both mobility and access to urban areas will improve. [1; 2]

### 3. ASSESSMENT OF THE RESEARCH RESULTS

Passengers were asked about the use of the frequency of public transport. The respondents said bus, trolleybus or tram, because all three modes of transportation are available in Szeged with extensive network. It is a characteristic in Szeged – but not unique in Hungary – that two companies are in the service of passengers, during operation passengers cannot take difference when travelling, but causing significant accounting technical tasks to

be solved. The recently formed DAKK (Southern Great Plain Transport Center Ltd.) has the same duties of accepting and operating former Tisza Volán Transport Ltd. bus lines and Szeged Transport Company Ltd. (SZKT) trolleybus and tram lines. Both companies are state-owned, profit-making supply obligation in the form of work, but they work according to local government order too. The common purpose of transport companies to organize transport are available to meet the needs of passengers. The obvious fact that this is an important task to determine optimum. In the case of companies, very important is operating the control, economic -organizational issues as well. Since the interests of the passengers are frequencies of vehicles, but this can be financed, which is a difficult task, since it can disencumber limited central budget, local government budget, and the price of the tickets, season tickets to passengers are also limited.

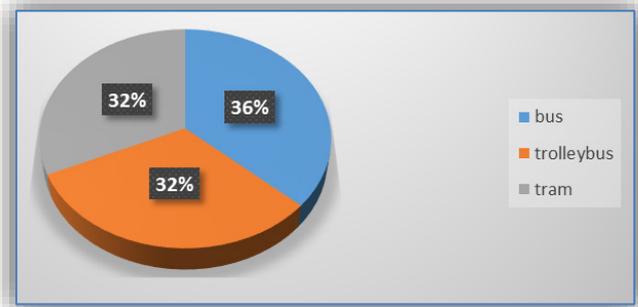


Figure 2. Distribution use of public transport

This survey was made in 2015, which is a star point of development of public transport development in Szeged using modern environmentally friendly forms of it. There are hybrid vehicles (powered electricity online or batteries), but offline mode has not been used yet. To learn more about travel habits of passengers gives more information for transport companies (DAKK and SZKT) to develop public transport network in Szeged.

How often do you travel by local public transport (tram, trolleybus, bus)? – was the question. Respondents could select one or more options with mentioning frequency. Optional answers were daily; once or twice a week; once or twice a month; rare and almost never. Respondents could choose just one option. Further options were ‘don't know’ and the ‘did not respond’ technical categories.

In the case of this survey – inspected 1002 individual measures – can be processed taking into account average shows that 94% of the interviewed at least a monthly basis, the services of at least one type of public transport in Szeged. However, the numbers in this form distort, since it can be assumed that some of them transfer to different lines. Questionnaire does not focus how

representative is the sample in this respect. A more detailed examination is suggested. First approximation can be read from the data (Figure 2 and 6) that the three technology in carriage of passengers cannot be discussed, passengers use them about the same proportion. At this stage remains to be seen is the frequency at which significant deflection effect. Figure 3 shows most of passengers travel on a daily basis (218) by bus, but you can also use other 80 people once a week or several times.

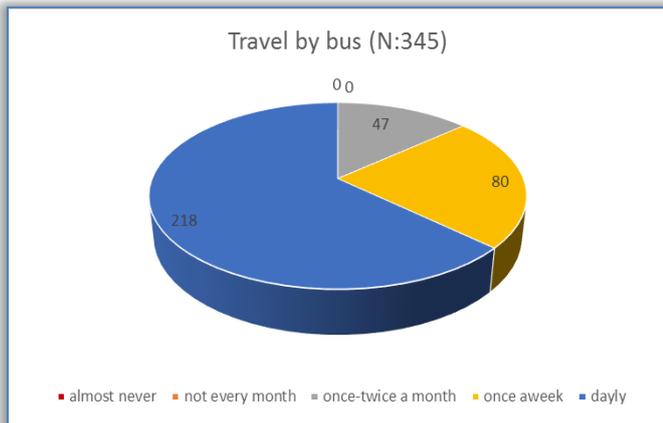


Figure 3. Travel by bus

Figure 4 illustrates similar rates travelling by trolleybus, so the values you see are most likely to suggest that it is also possible the significant overlap between different types of vehicles.

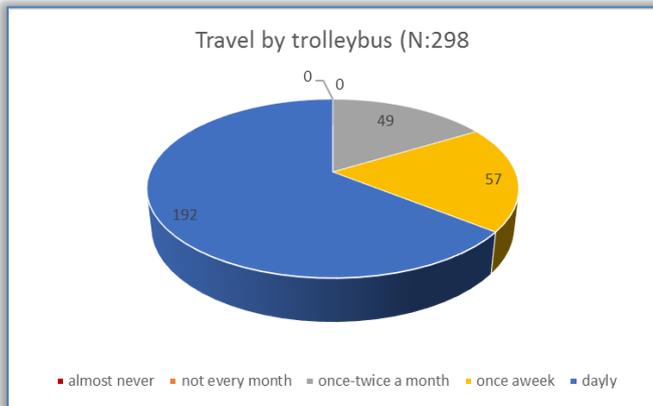


Figure 4. Travel by trolleybus

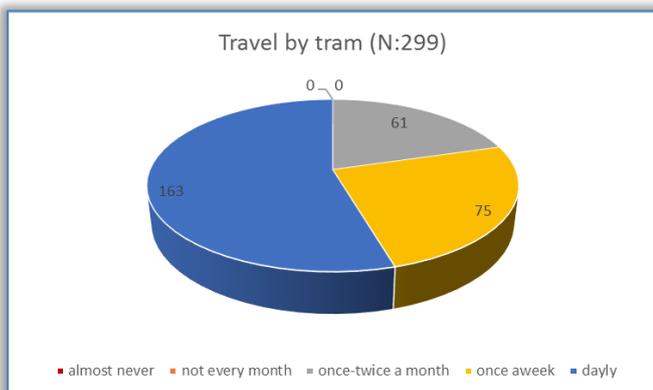


Figure 5. Travel by tram

Figure 5 confirms this, using the tram. Well you can see that a lot less trolleybus and tram lines, which represent big proportion of the major travel flows.

This can be generalized by the interviewees get real information in order to organize developments.

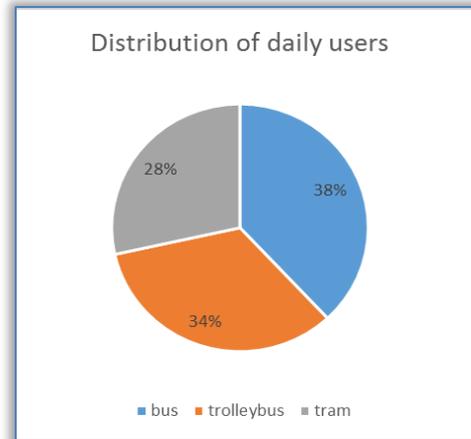


Figure 6. Distribution of daily users

Interesting and useful ideas for the development come from the survey. The interviewees were already among those who have used one form of public transport or even more. The number of respondents are between 529-559, which are among 1002 previously indicated respondents, so answers can be authoritative value, since nearly half of the remaining respondents not or very rarely use the trams, trolleybuses and buses, so that they cannot be of the same regarding the development.

Increasing frequency (Figure 7) might appear important and goal to the users, so it's no surprise that the blue field, characterized by "it is not particularly important" category is below 25%, regardless of the frequency.

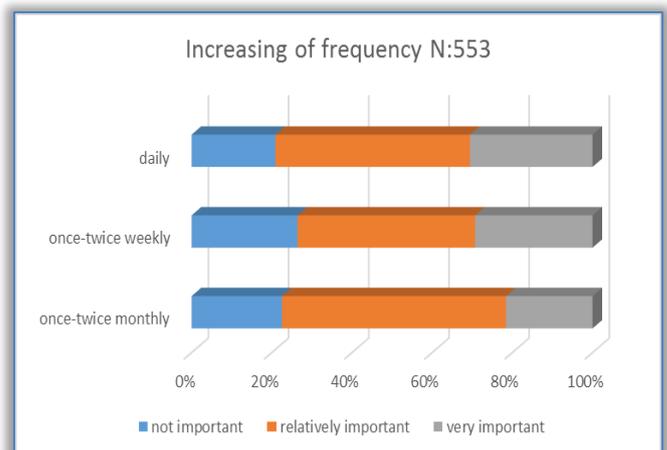


Figure 7. Increasing of frequency

It should be noted that the passenger full demand cannot meet, so unrealistic goal, since the passenger does not want to bear the extra cost – perhaps – they do not even think of this. Of course, legitimate expectation, that the service providers follow the utilization of vehicle capacity and usage of vehicles

(present them to the local government) in order to reach constantly more streamlined and better reflecting the changes.

Figure 8 illustrates opinions on the environmental protection. just a little ratio of the population is non-sensitive on this area. Majority of them prefers gas buses instead of diesel powered. Although, the idea is absolute eligible, it should be noted that the majority of the buses currently have adequate diesel ones, so early changes would be a significant additional cost of distributed applications, the lack of promotions should be enforced. In recent years, SZKT and DAKK focus significant attention (otherwise, the law also required) to buy more and more advanced, far under from the limit value emission engines, so with less carbon gas emission in new vehicles.

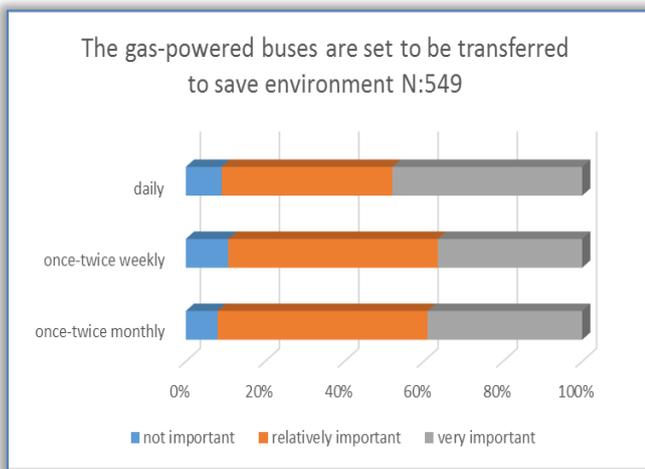


Figure 8. Gas-powered buses

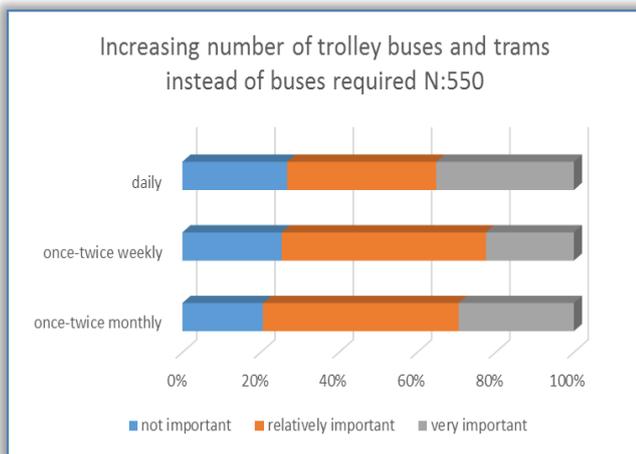


Figure 9. Change buses to trolley and tram

This is a kind of alternative to the next group of answers. Figure 9 shows that for respondents is acceptable alternative expansion of tram and trolleybus network. However, due to the rail transport infrastructure development may have a significant footprint and costly. I'd like to point out that a tender H2020 is on-going on some extension of trolleybus lines in such a way that the vehicles without overhead contact line and pantograph

contact, powered with a battery between networks or in districts where overhead wires cannot be built.

Today's legitimate need to public transport for people with mobility disabilities also available alternative. Figure 10 illustrates expected daily frequency of vehicles for disabled people assuming the eventual losses, longer running time is also accepted.

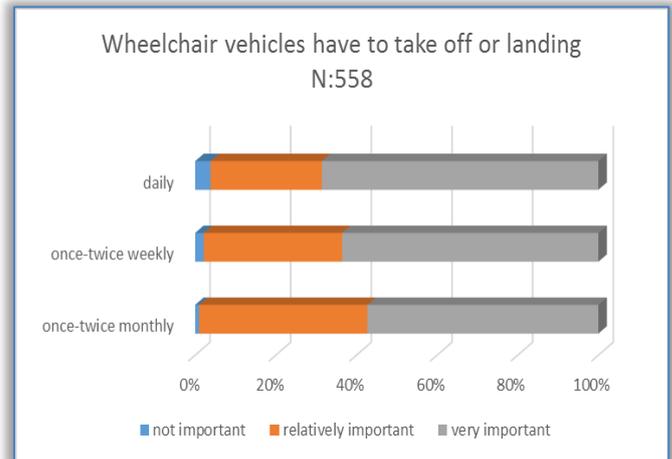


Figure 10. Easy access by wheelchair

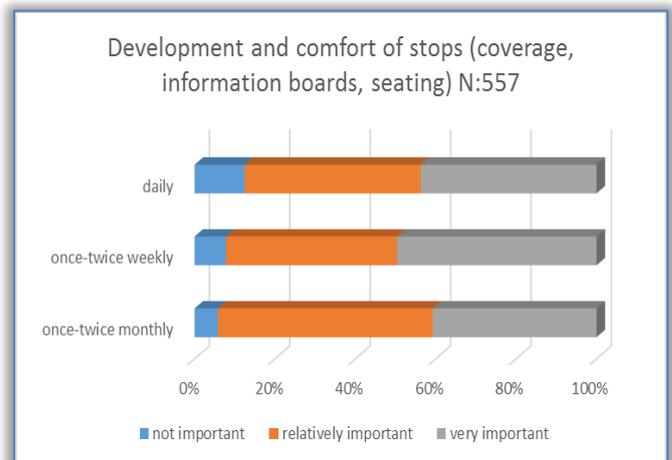


Figure 11. Development of comfort of stops

Passenger comfort solutions not only must cover the vehicles. A significant part of the total duration of the trip can be – especially during off-peak hours – long, therefore convenience aspects important. According to Figure 11 shows, that majority of passengers have great importance for weather protection and the to be well-informed. Of course, here also the realities within the boundaries of worth, since they cannot be expected to, as the United Arab Emirates that come from a variety of local bus stops are with air conditioning. It is interesting that the largest number of travellers on a daily basis 'is not particularly important' category, the proportion of which suggest that these passengers are familiar with the timetable for the vehicles and to spend less time at stops.

It is worth a little attention is paid to the Figure 12 as well, since the development of the passenger information system is included in it. The responses received some criticism, and suggest a little differently to understand. Of course, it is important to the information in stops, but less busy places – because of the availability of today's mobile technology – public mobile application operation of passenger information system more realistic, not to mention the cheaper development and less running costs. This – of course – is shared between the experts' opinion, to expect a passenger to have access and use of the mobilnet. Maybe it's becoming less and less possible obstacle.

types and fares are interesting for passengers depending on distance, workday or weekend, etc. In this case, however, there is also the issue that the passengers – mainly during peak hours – expect that to the right, forward or use pre-paid ticket, sometimes different types of ticket or pass. This structure only the e-wallet functions may be a reasonable solution.

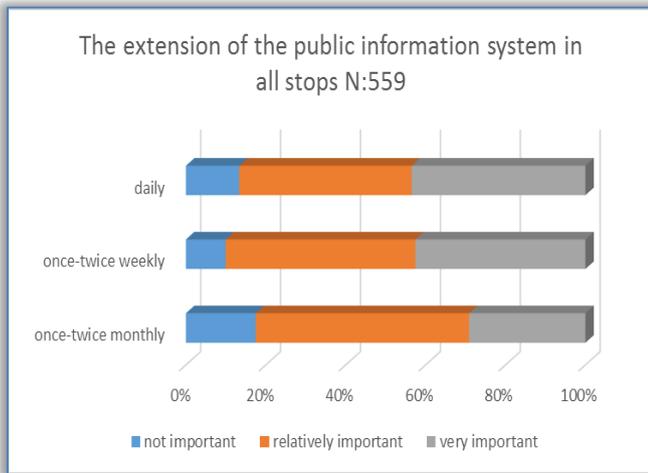


Figure 12. Information system in stops

This view seems to be supported by Figure 13 the distribution of responses published. Practically, more than 70% of those who specifically would like access to the passenger information system by Internet, Smartphone use. From this it can be assumed that the passengers do not poses a significant problem for the query needs to use a device or application.

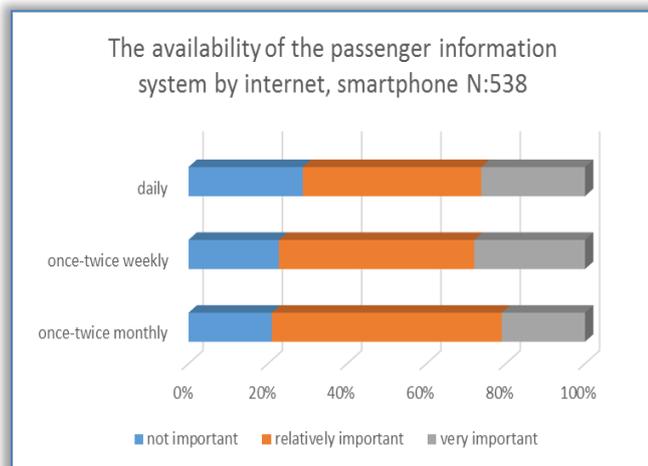


Figure 13. Information system by internet, smartpone Proposed improvements require more or less budget. It is interesting to consider how the views of passengers on fares? (Figure 14) Different ticket

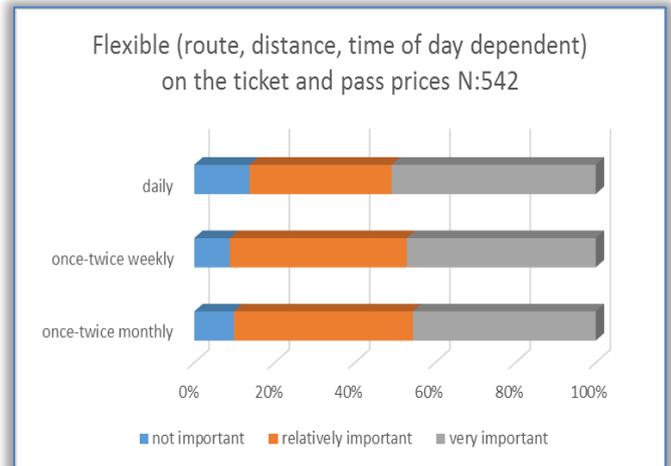


Figure 14. Flexible fares

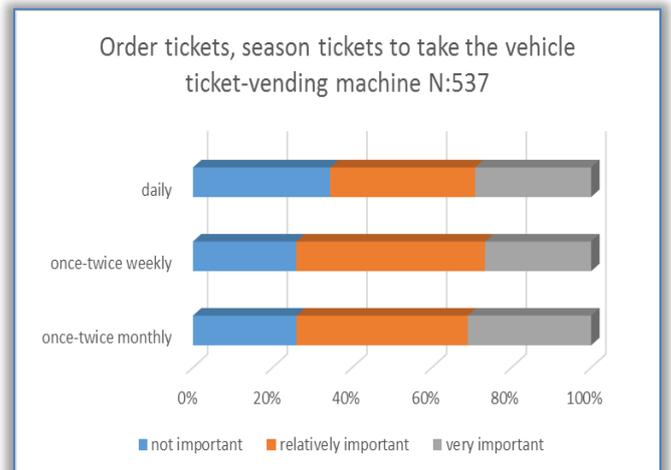


Figure 15. In vehicle vending machines

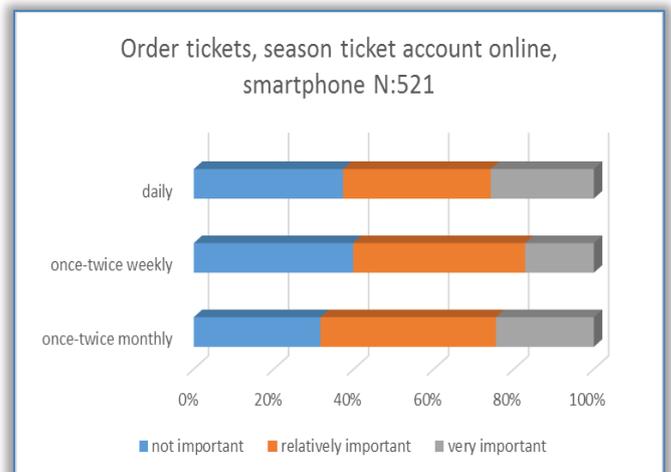


Figure 16. Internet and smartphone sales

#### 4. CONCLUSIONS

It is important for the development of easy purchase tickets or monthly pass. Figure 15 and 16 on diagrams illustrate this development. Despite the fact that the drivers sell for higher price, but it is not the best and not the real solution. The driver will interfere with this activity, distract attention from driving time, and the other passengers not keen on the travel time loss due to delay. Not a new idea, or technical solution, since in many countries also now practice of accepting credit cards often have ticket vending machines at the cabin.

This option is extended by Smartphone or Internet sales option, which is technically already realized in many places. However, you must see and understand paper-based ticket system is used in Szeged, so it is difficult to find the best form of it. The situation is complicated by two transport companies operate in Szeged, so the settlement on the basis of ticket sales and lease parameters should also think about.

Passengers are open to accept and use modern, environmentally friendly technology and it is a common goal for transport companies, local government as well. Operating new trolleybuses combining different bus a trolley lines looks a good idea for the future.

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#### Note

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