Evaluation of journey planners based on survey data

D. Esztergár-Kiss, A. Serres & B. Caesar
Department of Transport Technology and Economics,
Faculty of Transportation Engineering and Vehicle Engineering,
Budapest University of Technology and Economics, Budapest

Abstract

Nowadays many journey planners are available on the internet, but the users do not have enough information as to the comprehensive services that they offer. A quantitative analysis was performed to evaluate multimodal journey planners, and for this purpose a framework of aspects was developed and user groups were created, so that all the different needs and expectations could be represented. In order to gain realistic answers from the user groups, a survey – based on the aspects – was composed. Using the answers and the aggregated data, the evaluation can be validated. Thus the weighting numbers and final results can be calculated, and a ranking among the journey planners can be realized.

Keywords: journey planners, user groups, aspects and evaluation, survey, data analysis.

1 Introduction

The topic covers a highly up-to-date issue, which also appears in the EU transport strategy [1]. The White Book states that the enhancement of the quality of public transport can be realized through actions on a physical [2] and on an information level [3]. In this article, the information level actions were analyzed in the form of an evaluation and a survey.

The European Union recognized the importance of trip planning issues, which was handled in the Easyway [4] project, which has a column concerning the development of travel information services, especially emphasizing the need to create a comprehensive and fully multimodal journey planner. The "smart multimodal journey planner" competition was announced in 2011, when many

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applications were evaluated and some of them were given an award. However, a detailed quantitative evaluation was not performed. This investigation is based on a quantitative analysis of journey planners, where a framework of aspects was created in order to realize the most important features of these journey planners.

2 Aspects and evaluation

Concerning the aspects a classification was realized (Table 1), which was divided into 5 main features: route-planning services; booking and payment; handled data and operational features; comfort service information; supplementary information.

In the first group we handled data input opportunities (e.g. address, GPS, facilities), different planning aspects, the data, which appear for the passengers and the design and visualization of data.

The second group contains features of booking information and payment services, such as tariff information (e.g. zones, prices), data input modes and payment options (e.g. printed or mobile ticket).

The third group is about static and dynamic data. Static data information can be the timetable, travel conditions, while dynamic data can be restriction, delay info, information about alternative routes.

In the fourth group the passengers may receive information about comfort services at the stops (e.g. WiFi, luggage storage) and on board (electrical supply). Also, additional services were analyzed, such as weather forecast, opening times of shops.

The fifth group contains information about environmental impacts, available information in foreign languages, customer service connections (e.g. via telephone, e-mail or social media) and opportunities for disabled persons.

Table 1: Aspects of journey planners.

Route-planning services	Booking and payment	Handled data, operational features	Comfort service information	Supplementary information
data input	tariff information	static data	services at the stations	environmental impacts
planning aspects	method of booking	semi-dynamic data	services on board	foreign language information
displayed data	payment options	dynamic and estimated data	additional services	customer service
visualization		personal data		equal opportunity information

The evaluation was performed using a compensational multi-criteria method [5, 7]. To each journey planner (j) and each aspect (i) a value between 0 and 10 was given. By summing up these values the general evaluation number (u_j) was calculated.

Creating user groups may help to understand basic user needs (Figure 1), thus all passengers were separated into 5 groups: student; worker; tourist; businessman; pensioner. The definition of the user groups was based on their age (younger, middle aged, older), their motivation for travel (school-based, work-based, leisure-based), and possible difficulties of travel (handicapped, without problem).

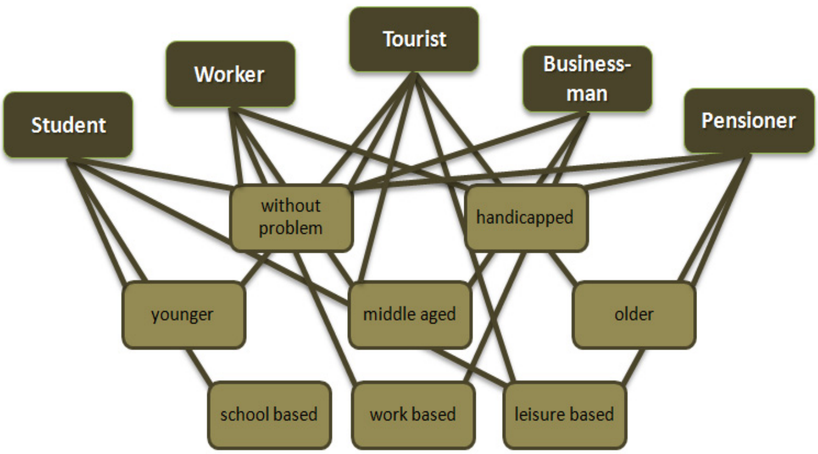

Figure 1: User group definition.

We assumed that these groups have different preferences, as the students are more interested in dynamic data, tourists would like to know more about route-planning and payment and for the pensioners supplementary information is quite important.

In order to take the specific needs and expectations of the user groups (k) normalization and weighting (s) was performed [6]. The normalization is based on the difference between the maximal possible and the maximal given value for each aspect. The weighting is based on the preferences of the user groups. Finally, the weights of the user groups were taken into account by their transportation share (r), which results in the average qualifier number (u_j*).

3 The survey

The key for collecting reliable data was the elaboration of a survey [8] based on the aspects, which was necessary to get realistic weighting coefficients for the user groups. Therefore, a survey of 12 questions was created.

The first part of the survey contained questions about the users' age, their occupation (student, worker, pensioner), their health situation (whether they are handicapped or not), and the reason why they use journey planners (work, leisure, tourism). According to these data it was possible to identify to what user group the participants belong.

The users were also asked to rank the main aspects (route-planning, booking and payment, handled data, comfort service information, supplementary information) according to how important are these services in general for them. This will allow the results to be balanced in accordance with their expectations.

The rest of the survey was divided into 7 question groups, each part focusing on a category of journey planning features: route-planning; booking and payment; information about the journey; services information; other information. All together 57 thematic questions had to be answered. The 10-grade scale for each answer enabled us to get a wide and accurate range of answers, which would represent the variety of users' requirements.

3.1 Method of survey's result analysis

After receiving the results of the survey, a statistical analysis was performed [9, 10]. For all questions the mean values and variances were calculated concerning each user group. Then the Bartlett test was performed, which examines whether the samples (user groups) have the same standard deviation or not. For the whole set the ANOVA (ANalyis Of VAriance) was used, which defined whether the user groups have the same mean values or not. Finally, in those cases, where the results of the ANOVA did not match, the t-test was conducted, which examines how much the two examined user groups are similar to each other.

In the Bartlett test the number of the samples (user groups) is r, which contains n_1, n_2 … n_r elements, where the mean of the sample ($\bar{x}_i$), and the standard deviation (s_i) was defined, where i is a certain user group. Using the Bartlett test we assume that the deviances of the user groups are similar (hypothesis). If the result of the Bartlett test is lower than the critical value, the test is accepted. The critical value (based on χ^2 distribution) depends on the degree of freedom (n_i-1), which is in our case the number in the user groups, and the significance level (α), which is the rejection of our hypothesis. In our case α was 0.05.

In connection with the Bartlett test, the ANOVA (based on F distribution) and the mean values were tested for all user groups, where significant deviations could be defined.

In the cases where the results of the ANOVA were significantly different, the t-test was used in order to define the difference between which two groups. Therefore, the deviances between the chosen groups (s_1, s_2) had to be tested using the F-test. If the F-test is lower than the critical F value, the deviations are similar.

Then for all test methods (e.g. for t-test, μ_1, μ_2) the following hypothesis was applied:

$$H_0 : \mu_1 = \mu_2 \tag{1}$$

$$H_1 : \mu_1 \neq \mu_2 \tag{2}$$

The critical value (t_c) for the t-test also depends on the significance level (α) and the degree of freedom (n_i-1). If the t-test is higher than the critical value, the H_0 hypothesis is rejected, this means that the two user groups are different.

3.2 General results of the survey

During the evaluation of the results, the presented tests were used to analyze user groups. The main goal of this analysis was to find out in which questions a significant difference arises among the user groups.

The research was conducted online, where 133 participants filled in the survey. A significant proportion of the participants came from Hungary, but we also got answers from abroad. The distribution of the user groups is shown in Figure 2.

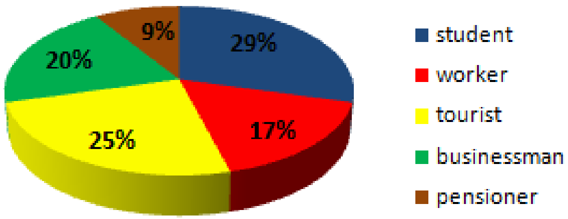

Figure 2: Distribution of the user groups.

The rest of the survey contained questions related to the aspects of journey planners, where the maximal possible value for each question was 10. In the figure, the squares represent the mean value and the lines 1 sigma deviation.

In the first question group (Figure 3) the participants were asked to give information about data input modes (e.g. address, stop, GPS coordinates, POIs, points on the map) when using a journey planner.

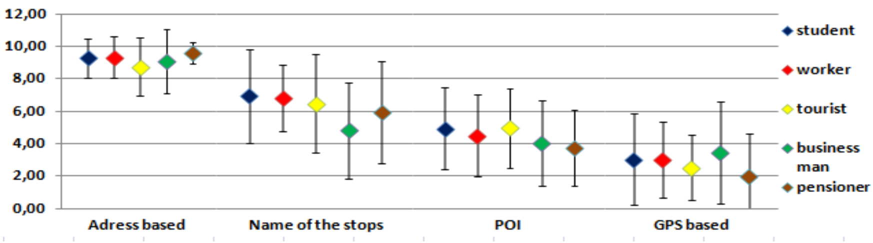

Figure 3: Results of the first question group (data input modes).

It has been revealed that only a small proportion of the passengers consider the GPS-based input important (mean; variance – 2.91; 2.61). However, most of them prefer address-based data input (9.14; 1.53). In Figure 3 the address based data input is analyzed for the user groups, where the mark represents the mean value, and the vertical line is the standard deviation.

Using the Bartlett test for the address-based input, the standard deviation was rejected, because the critical value was 9.41 at 5% significant level, but the test value was 20.1. That means there is a significant difference among the groups. Although the name of the stop is equally important among most of the user groups (6.48; 2.76) except for the businessman (4.81; 2.96). This is because the businessmen generally use the means of public transportation less. In this case, the t-test had to be performed, where our result was 2.92 (while the critical value was 2). Other data input methods, such as points on the map (4.96; 2.89) or choosing POI (4.95; 2.53) has an average importance for the user groups ca. 5.

The next group of questions (Figure 4) were about route planning information (e.g. travel duration, cost, waiting times, alternative routes, visualization on the map).

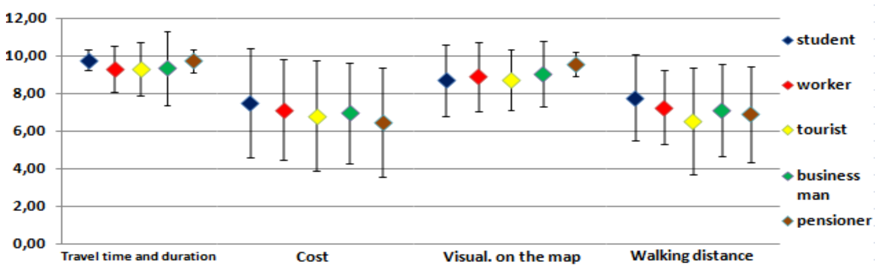

Figure 4: Results of the second question group (route planning information).

The travel time and duration (mean value – 9.51) is more important than costs (7.07). Comparing the deviations there is a big difference between students and workers. The visualization on the map seems to be highly interesting for all user groups (8.91; 1.71), where the deviation is quite low compared to the other questions in this group. In the case of the pensioners (9.58; 0.7), visualization plays a much more important role, than for other user groups, because it helps them much more in orientation.

The third group of questions contained questions about prices, zones and reduced fares. The prices were equally relevant for all user groups (7.51). Concerning reduced fares, students (8.05) were more curious about this possibility than pensioners (5.58), because pensioners may use public transport services for a fixed price (usually free).

The fourth group of questions referred to the payment options, such as cash, credit card or mobile payment opportunities. The most appreciated payment option was the credit card (5.96), then cash (4.99). But in these cases a high deviation was measured (deviation: 3.64). The mobile phone was rarely used (2.1), because this mode is not so wide-spread among the passengers.

In the next group of questions (Figure 5) operational features were investigated, such as static (e.g. timetable, travel conditions), semi-dynamic (e.g. planned restrictions) and dynamic (e.g. traffic situation, estimated delay, alternative routes) data according to the journey.

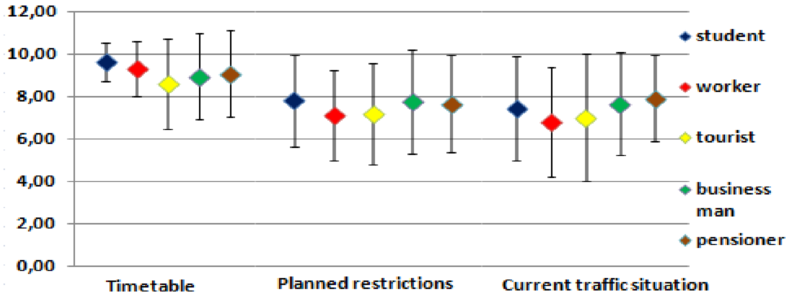

Figure 5: Results of the fifth group of question (operational features).

Information about the timetable is by far the most needed feature (9.15), but concerning the deviation there are differences. In the case of students, the deviation (0.93) is smaller than among businessman and pensioners (deviation: 2.03).

The travel conditions – as expected – have less importance for all user groups (6.5; 2.6). But it is surprising that the actual traffic situation (7.32; 2.57), estimated delay (7.6; 2.3), and planned restrictions (7.5; 2.3) resulted in very similar values; however, alternative routes are a bit more important (8.41; 2), because this information may provide a solution, not only info about traffic.

The questions of the sixth question group apply to comfort service information, which can be an export feature (e.g. printing or saving as PDF), favourites, Wi-Fi accessibility, luggage storage, electric supply or weather information. The answers for this question group resulted between 3 and 4, which is not a very high value. Only the information about weather conditions was significantly higher (5.2; 3.2), where the most interested user group was the group of pensioners.

In the last question group (Figure 6) the participants were asked about supplementary information, such as environmental impacts, customer service, handicapped opportunities and low floor vehicles.

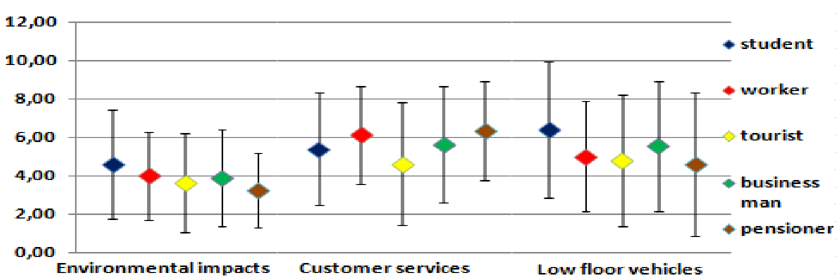

Figure 6: Results of the seventh question group (supplementary information).

Customer service information via phone or email was more important for the workers (6.14), than for the tourists (4.64). The users are less concerned about environmental questions (4.00). The last question about low floor vehicles was the most surprising, because it was more essential for the students (6.41; 3.5), than for the pensioners (4.6; 3.7). However, in both cases there was an enormous deviation, which means disagreement among participants about its importance.

Finally, international differences were analyzed (Figure 7), where we have to emphasize that the survey was not representative, as the number and distribution of the participants was disproportionate (most of the international participants were students and tourists). Thus, the analysis was performed only among students and tourists (42 Hungarian and 9 international participants).

In the case of international students, the name of the stops was more appreciated (Hungarian – international: 6.8–7.6), while the address was less, and the usage of credit card as a payment method was more widespread (5.7–8). In the fifth question group (static and dynamic data handling) all features decreased, the most was observed in the case of alternative routes (8.3–5.1). However, concerning comfort service information all questions reached higher values, especially the electric supply (4.1–7.4), which is because of the more wide-spread usage of laptops abroad.

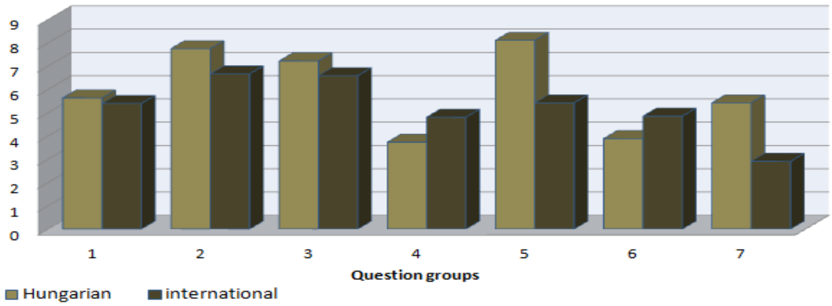

Figure 7: International differences among the question groups.

4 Results based on the evaluation and the survey

In order to apply the results of the user groups, an evaluation was performed according to the aspects and method. Then the weights of the user groups were defined, and finally the average qualifier numbers were calculated, which represent the different expectations of the user groups.

Using the results of the survey, the weights were assigned to the main aspects (Table 2). These weights were first determined by the estimation [6] of the expectations of the user groups (estimated), and then based on the results of the survey (measured). In the rows there are the user groups (k), in the columns there are the main aspects (i), and in the last column the transportation share (r), the values of which are based on the results of the National Traffic Data Survey [11]. This value can be generalized to other European countries.

The estimated and measured averages are quite similar to each other, which proves the correctness of the estimation. Only in the handled data and comfort service information was a significant difference obtained.

Table 2: Main aspects and users groups (estimated/measured).

	Route-planning services	Booking and payment	Handled data, operational features	Comfort service information	Supple-mentary information	Transport-ation share
Student	0.2/0.24	0.15/0.18	0.3/0.27	0.25/0.13	0.1/0.18	0.3
Worker	0.3/0.24	0.2/0.19	0.25/0.26	0.1/0.14	0.15/0.17	0.3
Tourist	0.25/0.24	0.3/0.19	0.15/0.28	0.2/0.14	0.1/0.15	0.15
Businessman	0.25/0.24	0.1/0.17	0.15/0.28	0.3/0.14	0.2/0.18	0.1
Pensioner	0.3/0.24	0.1/0.17	0.1/0.29	0.2/0.13	0.3/0.17	0.15
Average	**0.26/0.24**	**0.17/0.18**	**0.19/0.28**	**0.21/0.14**	**0.17/0.17**	**-**

However, among the user groups the outcomes of the survey did not result as expected, because all user groups behaved similarly and preferred the same features. Furthermore, comparing the results of the students and workers there is almost no difference between these user groups, thus these 2 groups could be joined later. Further research on the redefinition of the user groups should be conducted. Using the Ward method the user groups can be classified automatically.

The examined journey planners were selected by their importance, popularity or outstanding solutions. A general evaluation number was calculated to all journey planners (Figure 8), and then using the normalization and weighting the average qualifier number was produced. These values represent in percent (%) how close the journey planners are to the theoretical optimal journey planner with all possible features (in the case of the general evaluation number), and how close they are to a realizable journey planner with only the features that already exist in any of the journey planners (in the case of the average qualifier number).

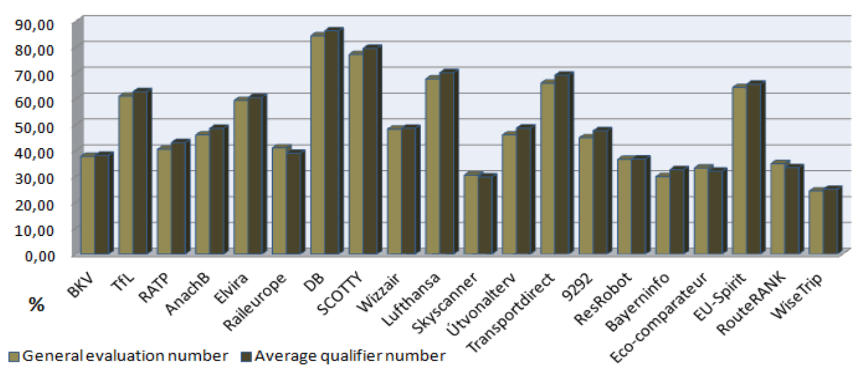

Figure 8: Comparison of the general evaluation numbers and average qualifier numbers (measured).

Concerning the results the journey planner of DB was the best of all the others. It provides advanced dynamic information, comfort services and also supplementary information. The railway based journey planners, such as Scotty and Elvira also reached high values because of their well-developed booking system and comfort information. The urban journey planners (BKV, TfL, AnachB) offer high level services in the aspects of route planning; however, concerning booking and comfort services they are definitely weak. While the airplane based systems (Wizzair, Lufthansa) provide more information about supplementary services.

Comparing the general evaluation numbers and average qualifier numbers, only a slight difference was detected (Figure 8). In most cases, the average qualifier number was changed by some percent.

The biggest alteration was 3%, which can be observed in the case of AnachB, Scotty, Útvonalterv, Transportdirect and 9292. This means that the users put more emphasis on those functions, which are already realized by these journey planners. Actually this can be claimed in general, as 1.16 % of enhancement was observed among all journey planners, only in some cases did it result in a decrease (Raileurope, Skycanner, Eco-comparateur and RouteRank).

The strengths and weaknesses of the journey planners are already known, therefore we provide development opportunities according to the user group's needs; thus the quality of public transportation might be enhanced. In the case of the urban journey planners – which provide detailed solutions for the planning aspects, but have no solution for booking and payment – a development and integration of an electronic ticketing system should be performed. Based on the survey results the development of credit card and cash payment systems are more important for the passengers than using a mobile application for that purpose. The journey planners should provide more useful routes, which would include transfer information and POI-s through Location Based Services (LBS); of course different information would be given to each user group.

It is possible to decompose OD matrices according to the user groups, thus more exact values can be provided, and alternative routes can be assigned to each user group. For example, for the pensioners a longer travel time, but using only low floor vehicles or a route without stairs. Using current traffic situation data – which was quite important for the passengers – the support of transfers can be provided. If a transfer is no longer accessible because of a traffic jam, the passengers might travel to another destination, where the same service is available.

5 Conclusions

The elaboration of an evaluation method of multimodal journey planners enabled a quantitative comparison. First, the aspects of the comparison were defined, which resulted in the general evaluation number. Establishing user groups the results could be refined using the average qualifier number. Therefore, the journey planners were ranked. In order to get more realistic results, a survey was conducted with ca. 130 participants. Using variance analysis the different user groups could be analyzed. However, we expected big differences among the user groups, but according to the survey's results no significant differences could be detected concerning the main aspects. But when using single aspects, many differences were found.

Acknowledgements

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