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A DYNAMIC ANALYSIS ON PUBLIC BUS TRANSPORT'S SUPPLY QUALITY BY USING AHP

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Abstract. Nowadays, it is a really important issue to improve the supply quality of city public bus transportation in many cases. Meanwhile, the different participants of transport systems have different ideas on the ways of improvement, for this reason the taken measures can be inefficient and expensive. The operational costs are steadily increasing (e.g. price of fuel, wages, etc.) therefore the decision makers do not really have the opportunity to lower the price of tickets. For solving the above mentioned problems, before creating a plan of improving a certain public system, a clear image should have been gained on the preferences of passengers, company managers and governmental decision makers. In the current paper a general three-level-hierarchical model has been set up to analyze dynamically the public bus transport system of a city. The price is excluded, only the elements of supply quality are assessed in the hierarchy. Based on the model, questionnaires were created and for the analysis, Analytic Hierarchy Process (AHP) was used to determine preference weights of evaluators from different evaluator groups. Passengers, company managers and governmental officers evaluated exactly the same type of questionnaires so the results are comparable. Avoiding the difficulties of other AHP applications, we used a simplified Saaty-scale for scoring so that the missing data of the matrices could be calculated by an algorithm as well. This study revealed a priority ranking of the elements of supply quality within each level, and this ranking is comparable among the participants of public bus system. This may help the policy makers to synthesize various aspects of public transportation.

Keywords: public bus transport, supply quality, opinion synthesis, AHP.

1. Introduction

Many of the scientific papers on urban public transportation are focusing on one certain element or a certain group of elements on transport. Lin (2001), Burinskienė (2009) examined the sustainability of transportation systems. Bokor (2009) emphasized the accurate costing of transport services and developed a model delivering more reliable cost information in complex transport systems so as public transport. Asakura, Kashiwadani (1991) pursued a research on the most important factors that have an impact on the reliability of public transportation networks. Bramel, Simchi-Levi (1996) and Chien, Yang (2000) were analyzing the optimal public bus station locating problem.

They considered not only the pure time interval of starting the journey from one station and finishing it at another, but also integrated the process of reaching the station of departure and from the arrival stop reaching the final destination for a passenger. In their model, the variables of: average distance covered by every travel, the constant speed of the vehicle in the distance between stations, the stopping time in every station, etc. were used to calculate the total travel time and by that the optimal average distance of bus stops in the examined area. On the other hand, some authors aimed to characterize public transport systems as a whole. Hu *et al.* (2010) applied attribute recognition to evaluate a transport network. Strategically, long-term point of view, Murray (2001) identified the most important issues of a system. There are given standards of public transport service: IEC (1990) and Quattro: Quality Approach… (1998) are referring the key points of supply quality in public transportation.

Another step forward is trying to determine the weights of these elements. Van Nes, Bovy (2000) aimed to distinguish the importance of objectives in creating, maintaining and developing an urban transport network, while Sivilevičius, Maskeliūnaitė (2010) determined the weights of supply elements of a public railway system.

The determination of the weights of certain elements in transport supply, gives the opportunity to set up a priority rank of these issues. Su *et al.* (2006) carried out a research project by applying a simulation-enhanced approach to be able to rank different transport projects and the already cited Sivilevičius, Maskeliūnaitė (2010) gained a priority rank for the elements of railway supply. In their paper, they found that the most influential factor is the temperature inside the wagons (air conditioning was another issue but got high scores as well) for the passengers, then speed of the journey became the second and in time departures and arrivals were mentioned as the third. Price of the journey was also included in the model so they concentrated on the supply quality and costs simultaneously.

In the current paper, we aim to integrate all issues of public bus transportation into a three-level-hierarchical model. Applying this detailed hierarchy, strong connection among the elements can be kept. Moreover, the model is capable of covering strategic, tactical and operational issues of the analyzed transportation system. The first level is a rather general one, the second level is more specific and the third is very specific, so we can gain important information on all kinds of elements in a strictly logical way, keeping the hierarchy. Fix price is assumed, so only supply quality issues are analyzed. Another significant point in our approach is separating the different participants of public transport: government as a maintainer, company as the operator and passengers as users. The conflict of their different image on key-points of a certain system can be the cause of making wrong decisions on transport development.

For the analysis, we selected Analytic Hierarchy Process (AHP) as method. Although the AHP has been criticized by many publications – Dyer (1990); Tversky, Simonson (1993); Pérez (1995); Pan *et al.* (2011); Negahban *et al.* (2012); Tupėnaitė *et al.* (2010); Medineckienė, Björk (2011) – there have been many remarkable results in practice that may prove the existence of this operational method (Zahedi 1986; Carlsson, Walden 1995; Yang, Shi 2002; Farhan, Fwa 2009; Sivilevičius 2011a, 2011b). From the theoretical side, the criticizers claim mainly the complex mathematical adequacy (concerning the measure of consistency), while the practical experts are against of the arising false conclusions. Avoiding this, usually a preliminary study is required on the adequacy of hierarchical elements and after having drawn the conclusions, an ex-post expert evaluation is also necessary to secure the proper results of the examined problem. There are complains on the too complicated questionnaires used in AHP processes, in our model we tried to reduce this complexity. By some applications, missing data of the matrices caused difficulties (the evaluators did not fill in all the necessary brackets), in this research the missing data could be calculated by an algorithm. The measure of consistency – recommended by Saaty (1977) – is rather experiential than mathematically proved, but considering the several applications it can be accepted to calculate Saaty's consistency ratio (CR) and to use the 10% rule (although sometimes it can be treated in a more flexible way). The created AHP model can be found in the following section and the results of the application are in the third.

The novelty of this paper can be summarized as follows:

- creating an overall three-level-hierarchical AHP model on dynamically analyzing public bus transport supply quality,
- examining the three main participant sides of public transport: government, company, passengers; and then making a comparison,
- showing a possible way that makes the evaluators' job easier in AHP: using modified Saaty-scale and calculating the missing data,
- setting up a priority rank among different elements of public transport with strong determination by the hierarchy,
- by the general model, weight determination is obtained and applying that, different development projects can be elaborated on arbitrary public bus transportation systems.

2. Creating a General AHP Model for Urban Bus Transportation Supply

Usually, four steps are to be made in AHP applications:

- identification of the accurate decision problem and establishment of hierarchy;
- pair wise comparisons between the factors of decision;
- evaluate the final impact of criteria;
- produce the final procedure of selection.

For the 1st step, supply elements had to be determined and ordered in a hierarchical structure. As mentioned in the previous section, we gained the elements from scientific literature review and from some preliminary studies on the examined city (Yurihonjo, Japan). The goal of the research was not to identify the current situation of public transport, but to come to conclusion on the preferences of different participants related to the necessary development of the system. Therefore, according to the model the dynamic analysis can be made and in step 2 it should be considered.

The general model has been created in Figure.

As it can be seen, three different levels are determined in the hierarchy. The Level 1 contains service quality, transport quality and tractability as the general transport issues. It is important to emphasize that these issues can be evaluated separately within the topic of an urban transport system, so for the participants these are not too general to evaluate. During the evaluation process, the whole hierarchy should be shown for the evaluators in order to be aware of the proper meaning of each issue. The Level 2 embodies elements that can be bounded directly to one issue of the previous level. These elements are obviously more specific and more understandable for the evaluators. In the Level 3, the very specific elements can be seen that belong to one issue of the previous (second) level. For the possible interactions among transport elements (Sivilevičius 2011b).

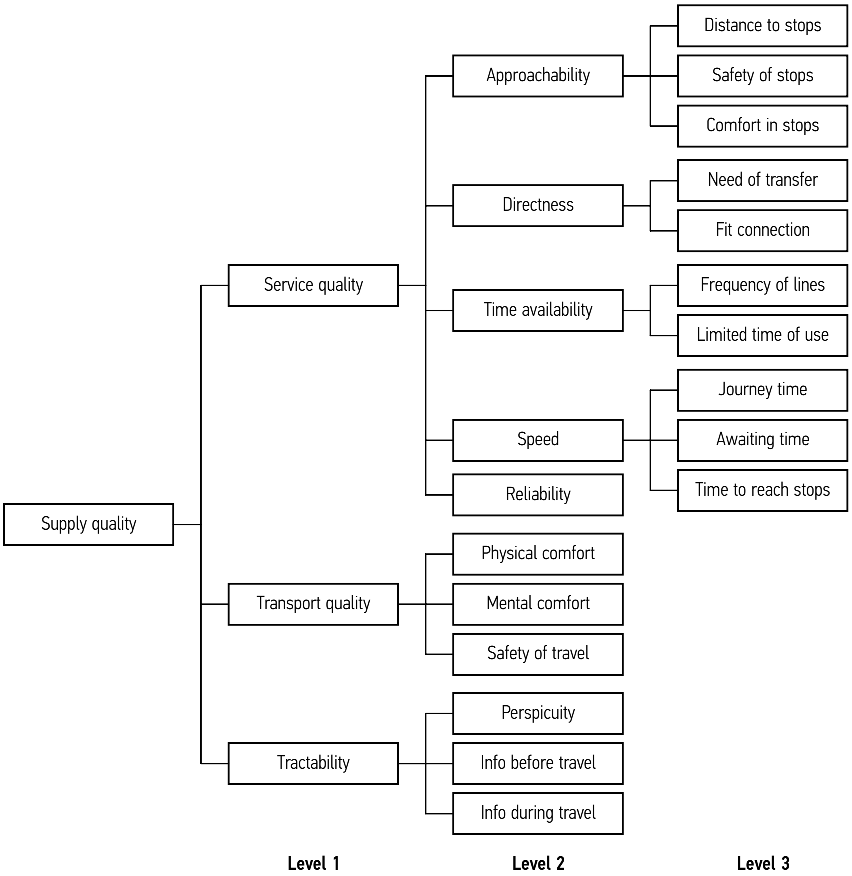

Fig. The hierarchical model of public bus transportation supply quality

Perhaps the segment of 'mental comfort', within transport quality should be explained in detail. All issues were integrated in mental comfort that reflect the mental feelings of a passenger during the journey e.g. the image inside the vehicle, politeness of the driver, environmental consciousness.

3. Pair Wise Comparisons Among the Elements

The idea of AHP is based on the assumption that a decision maker is more able to compare two issues than make a decision among many elements. That is why the AHP process is basically a row of pair wise comparisons, strictly determined by the set up hierarchy.

The theoretical pair wise comparison matrix for 3 elements can be described below and presented in Table 1.

Table 1. The structure of theoretical pair wise comparison matrices

w_1/w_1	w_1/w_2	w_1/w_3
w_2/w_1	w_2/w_2	w_2/w_3
w_3/w_1	w_3/w_2	w_3/w_3

This matrix evidently fulfils the criteria of reciprocity:

$$\left(a_{ji}\right)=\left(1/a_{ij}\right) \tag{1}$$

and consistency

$$\left(a_{ik}\right)=\left(a_{ij}\, a_{jk}\right). \tag{2}$$

It is also trivial to accept that one eigenvector of the matrix above is $\left\{w_1; w_2; w_3\right\}$. Saaty (1977) proved that this eigenvector belongs to the maximum Eigen value of the matrix.

For any AHP applications, similar type of matrices must be constructed with the alteration of letting the evaluator filling the rubrics above the main diagonal. By this, the reciprocity criterion is still provided, however the criterion of consistency is (by great probability) not kept. These types of matrices are called experiential pair wise comparison matrices. For these types of matrices: $\left(a_{ji}\right)=\left(1/a_{ij}\right)$ and $a_{ii}=1$ provided, however the consistency criterion (2) most likely is not provided.

Although the experiential matrices most of the time are not consistent, their consistency should be examined by Saaty's Consistency Index (*CI*) and Consistency Ratio (*CR*):

$$CI=\frac{\lambda_{\max}-n}{n-1}, \tag{3}$$

where: *CI* is the consistency index, $\lambda_{\max}$ is the maximum Eigen value and n is the number of rows in the matrix.

The average values of the consistency indexes are determined by random-generated (probably inconsistent) pair wise comparison matrices for all n and marked *RI*.

By this, *CR* can be determined:

$$CR = \frac{CI}{RI}. \tag{4}$$

For positive and reciprocal matrices $\lambda_{\max} \geq n$, so the quotient is non-negative. Based on expert consensus and also, on software *Expert Choice 11.5. protocol*, the *CR* can be accepted if its value is less than 0.1.

In our AHP application, matrices were constructed to make the pair wise comparisons among the issues of the same level. The task was: to compare the importance of development of issue 'A' to issue 'B' of the city's public bus transportation. Level 1 constructed matrix is presented in Table 2.

The elements of a_{12}, a_{13} and a_{23} were to be filled by the evaluators. On the Level 1, there were 3 issues (*A*1, *A*2, *A*3) to be compared. The structure of the matrix follows the criteria of experiential matrices.

For *A*2 and *A*3, 3 × 3 matrices were constructed in the same way.

In these cases similarly the rubrics above the main diagonal were to be filled.

The elements had to be indexed based on the connection to the related previous level element.

Table 3 demonstrates the 5 elements of Service Quality, which is *A*1; so *A*11 is the Approachability, etc.

For *A*2, *A*3 and *A*4 two 2 × 2 and a 3 × 3 matrices were constructed in the same way.

Certainly, in these cases also only the rubrics above the main diagonal were to be filled.

As previously demonstrated, the elements had to be indexed by the previous connected elements, in this case from Level 2. So *A*111 is the Distance to stops, because it is connected to the Approachability (*A*11), etc. Level 3 constructed matrix is presented in Table 4.

So the evaluators had to fill altogether 8 matrices, one 5 × 5, five 3 × 3, and two 2 × 2 types. While the sizes of the matrices were not too large, consistency could be kept with great proportion. Only a few passenger evaluators exceed the $CR < 0.1$ criterion, but applying *EC11.5* software for some minor modifications all matrices could be transformed acceptable. The relatively high rate of consistency has probably been due to the applied modified Saaty-scale.

For the evaluation, AHP recommends the Saaty-scale: 1 expressing equality; 2, 3, 4, 5, 6, 7, 8, 9 expressing majority; 1/2, 1/3, 1/4, 1/5, 1/6, 1/7, 1/8, 1/9 expressing inferiority.

After testing the above mentioned scale we found that mainly the passenger evaluators found the fractions and this interval was too complicated and they used only a few values of the scale. That is why we applied a modified Saaty-scale in order to help the decision makers to compare the offered issues. By this application we might have lost some sophisticated information but gained more understandability, enthusiasm by the respondents, and more consistency.

The modified Saaty-scale: 5 expressing equality, 1, 2, 3, 4, inferiority with 1: extremely inferior. 6, 7, 8, 9 expressing majorities with 9: extreme majority. For the calculation, the values had to be re-transformed definitely.

Table 2. Level 1 constructed matrix

*L*1	*A*1	*A*2	*A*3
*A*1	a_{11}	a_{12}	a_{13}
*A*2	a_{21}	a_{22}	a_{23}
*A*3	a_{31}	a_{32}	a_{33}

Table 3. Level 2 constructed matrix

*L*2*A*1	*A*11	*A*12	*A*13	*A*14	*A*15
*A*11	a_{111}	a_{121}	…	…	a_{151}
*A*12	a_{211}	…	…	…	…
*A*13	…	…	…	…	…
*A*14	…	…	…	…	…
*A*15	…	…	…	…	a_{551}

Table 4. Level 3 constructed matrix

*L*3*A*1	*A*111	*A*112	*A*113
*A*111	a_{1111}	a_{1211}	…
*A*112	a_{2111}	…	…
*A*113	…	…	a_{3311}

The individually filled questionnaires' results had to be aggregated into a matrix based on the procedure of Saaty:

$$f\left(y_1,\dots,y_l\right) = \prod_{k=1}^{l} y_k^{\frac{1}{l}};$$

$$l \geq 2;\ \left(y_1,\dots,y_l\right) \in I^l, \tag{5}$$

where: f is the summarizing function; l is the number of the evaluators; y_k represents the proper indexed matrix element of the evaluator k; I^l is the set of positive numbers. This aggregated matrix must fulfill two criteria: reciprocity and positive homogeneity. By a random checking procedure, both criteria were verified in the survey analysis.

For determining the eigenvectors of the aggregate matrices the following method was applied:

$$w_{Ai} = \frac{w_j}{w}\frac{w_{ij}}{\sum_{k=1}^{n} w_{ik}} = \left(\frac{w_j}{w}\frac{1}{\sum_{k=1}^{n} w_{ik}}\right) w_{ij}, \tag{6}$$

where:

$j = 1,\dots, m$ and $w = \sum_{i=1}^{m} w_j$;

$w_j > 0$ ($j = 1, \dots, m$) is represents the related weight-coordinate from the previous level;

$w_{ij} > 0$ ($i = 1, \dots, n$) is the eigenvector computed from the matrix in the current level,
w_{Ai} ($i = 1, \dots, n$) is the calculated weight score of current level's elements.

Equation (6) shows, that the weight score of an element in any level can be computed by calculating the normalized eigenvector of the related matrix (based on the determination of pair wise comparison eigenvectors) and then multiple the result with the respective normalized weight-coordinate from the previous level.

When the eigenvectors are normalized, the calculation can be made as Equation (7):

$$w_{Ai} = w_{ij} w_j,\ i = 1, \dots, n, \tag{7}$$

where:
w_j ($j = 1, \dots, m$) is the normalized weight of the previous level;
w_{ij} ($i = 1, \dots, n$) is the normalized eigenvector-coordinate of the current level.

As pointed out previously, only the rubrics above the main diagonal were to be filled by the respondents. In some cases however (mainly in passenger evaluators) some missing elements still can be found because of negligence or having not enough information, etc. (Podvezko 2009). For solving this problem Bozóki *et al.* (2010) created an algorithm to amend the incomplete matrices. The algorithm is based on minimizing the maximum eigenvalue of the incomplete matrix:

$$\min \lambda_{\max}\left(M\left(x\right)\right), \tag{8}$$

where: $\lambda_{\max}$ is the maximum eigenvalue and $M(x)$ is the incomplete matrix.

Let x_i denote the missing elements of the matrix. Regarding – as introduced – we did not use large matrices, we show an example, where $i = 4$, although the algorithm can be used for larger numbers as well. For the calculation *MatLab v.6.5* software can be used.

Let x_i^k denote the value of x_i in the k-th step of the iteration which has 4 sub steps (the same as the missing elements) for each k.

```
For $k = 0$:
Let the initial points be equal to 1 for every variable $x_i^0 := 1$ ($i = 1, 2, 3, 4$)
while $\max_{i=1,2,3,4} \left\| x_i^k - x_i^{k-1} \right\| \succ T$, $T = 0.001$ (if we want 3 digit precision of calculation)
$x_i^k := \arg\min_{x_i} \lambda_{\max}\left(M\left(x_1^k, \dots, x_{i-1}^k, x_i, x_{i+1}^{k-1}, \dots, x_4^{k-1}\right)\right)$
next $k$
end while.
```

4. Results of the Conducted Research

Based on the above mentioned model, a research has been pursued on a Japanese city, called Yurihonjo. 41 users, 3 governmental officers and 3 company managers evaluated the constructed questionnaires. So the sample was small, but for the governmental and company side, the respondents can be regarded as experts, therefore their opinion could be considered as reliable in decision making. In spite of that, the conducted survey is still rather a test phase than a basis of a final conclusion.

Considering the separation of the 3 different sides of public transportation and firstly ignoring the weights of the previous level, the calculated normalized matrix eigenvectors (w_{ij}) are presented in Table 5.

The coordinates (scores) of the proper eigenvectors provide the opportunity to set up a rank order of preferences among the participants of public transport on the issues of the system considering the weights of the previous level(s) as well.

Priority order of different elements in public bus transportation in terms of their development is presented in Table 6.

As it can be seen, all main participants of the analyzed public transportation system indicated the development of service quality as the most essential related issue. Interestingly, the governmental and company aspect showed stronger significance and the passengers would concentrate more on the improvement of tractability as well, while this need is not so clear yet for the decision makers of transport policy. Regarding the second level priority ranking, the computed scores are affected strongly by the previous weights; this explains the dominance of service quality elements. Considering this, the high scores from another group (tractability or transport quality) indicates a very strong preference of improvement by the certain evaluator group (this can be seen by the ignored weight calculations). Therefore, the element of information during the journey given by the passenger side has a very significant position, but the governmental and company sides are not really aware of this preference. For the perspicuity, the company should pay more attention; seemingly users are not too satisfied with the understandability of schedules. The factor of approachability seems to be the most important to improve, that is more deeply analyzed in Level 3. It is not too surprising, that for the evaluators of the company side, the development of the physical comfort meant a relatively key point in their responses; it is quite general that they indicate the need for purchasing new vehicles and sometimes it is not necessary at all. (The passengers had very little claim for that in the case of the analyzed Japanese city). Physical comfort during the journey is not surprising in the back of the ranking, taking into account that all public buses in Japan have air-conditioning systems and the seats are comfortably created. Moreover, the utility of vehicles is low, so most of the time the empty seats can be found easily. In spite of that, company managers think that improving physical comfort is still necessary (ranked in 4th place).

Analyzing the priority ranking of the Level 3 (note that the impact of the previous levels is even stronger here) for the users of the system it is the most important thing to increase the frequency of lines. Certainly it should be more analyzed in the future, which specific lines and in which period of the day it would be more frequent. Apparently, the distance to and from stops is not convenient either, although only the passenger and governmental sides are aware of that, the company experts put this issue just in the back of the ranking.

Table 5. Comparison of the results among evaluator groups

For the passenger side:

Service Quality	0.456
Transport Quality	0.21
Tractability	0.335

Service Quality:	
Approachability	0.322
Directness	0.238
Time availability	0.267
Speed	0.206
Reliability	0.158

Transport Quality:	
Phys. comf.	0.156
Mental comf.	0.444
Safety of j.	0.402

Tractability:	
Perspicuity	0.364
Info before	0.246
Info during	0.39

Approachability	
Distance	0.48
Safety S	0.25
Comfort S.	0.27

Directness	
Transf	0.54
Fit conn	0.46

Time availability	
Freq	0.75
Lim.time	0.25

Speed	
Journ	0.56
Awaiting	0.17
Reaching	0.27

For the governmental side:

Service Quality	0.724
Transport Quality	0.083
Tractability	0.193

Service Quality:	
Approachability	0.386
Directness	0.386
Time availability	0.101
Speed	0.032
Reliability	0.101

Transport Quality:	
Phys. comf.	0.143
Mental comf.	0.143
Safety of j.	0.714

Tractability:	
Perspicuity	0.106
Info before	0.632
Info during	0.259

Approachability	
Distance	0.43
Safety S	0.14
Comfort S.	0.43

Directness	
Transf	0.75
Fit conn	0.25

Time availability	
Freq	0.25
Lim.time	0.75

Speed	
Journ	0.286
Awaiting	0.556
Reaching	0.139

For the company side:

Service Quality	0.714
Transport Quality	0.143
Tractability	0.143

Service Quality:	
Approachability	0.16
Directness	0.067
Time availability	0.367
Speed	0.336
Reliability	0.067

Transport Quality:	
Phys. comf.	0.63
Mental comf.	0.26
Safety of j.	0.11

Tractability:	
Perspicuity	0.43
Info before	0.14
Info during	0.43

Approachability	
Distance	0.14
Safety S	0.43
Comfort S.	0.43

Directness	
Transf	0.50
Fit conn	0.50

Time availability	
Freq	0.75
Lim.time	0.25

Speed	
Journ	0.43
Awaiting	0.14
Reaching	0.43

Table 6. Different ranking of elements by evaluator groups

	Passengers:			*Government*:			*Company managers:*	
	Level 1:			Level 1:			Level 1:	
1	Service Quality	0.456	1	Service Quality	0.724	1	Service Quality	0.714
2	Tractability	0.335	2	Tractability	0.193	2	Transport Quality	0.143
3	Transport Quality	0.21	3	Transport Quality	0.083	2	Tractability	0.143
	Level 2:			Level 2:			Level 2:	
1	Approachability	0.147	1	Approachability	0.279	1	Time avail.	0.262
2	Info during	0.131	2	Directness	0.279	2	Speed	0.24
3	Time avail.	0.122	3	Info before	0.122	3	Approach.	0.114
3	Perspicuity	0.122	4	Time availability	0.073	4	Phys.com.	0.09
5	Directness	0.108	4	Reliability	0.073	5	Perspic.	0.06
6	Speed	0.094	6	Safety of journey	0.059	5	Info during	0.06
7	Mental com	0.093	7	Info during	0.05	7	Directness	0.048
8	Safety of journ.	0.084	8	Speed	0.023	7	Reliability	0.048
	9,10,11: Infobe, Rely, Phys			9, 10, 11: Persp, Ment, Phys			9,10,11: Mental, Infobe, Safety	
	Level 3:			Level 3:			Level 3:	
1	Frequency	0.092	1	Transf. need	0.209	1	Frequency	0.196
2	Distance	0.071	2	Distance stops	0.12	2	Journey t.	0.103
3	Transf.	0.058	3	Comfort stops	0.12	3	Reach time	0.103
4	Journey t.	0.053	4	Fit connect.	0.07	4	Lim time	0.066
5	Fit conn	0.05	5	Lim time	0.055	5	Safety stop	0.049
6	Comf stops	0.04	6	Safety of stops	0.039	5	Comf stops	0.049
7	Safety stops	0.037	7	Frequency	0.018	7	Awaiting t.	0.034
8	Lim time	0.03	8	Awaiting time	0.013	8	Transf.	0.024
9	Reach time	0.025	9	Journey time	0.007	8	Fit conn.	0.024
10	Awaiting t	0.016	10	Reach time	0.003	10	Distance	0.016

By the gained results it can be stated that bus stops should be placed differently in the analyzed system. The need of transfer issue indicated the number of transfers that a passenger has to take to reach its destination. For the governmental experts, this element should be improved at first stage, while the passengers ranked it at third, so they estimated this problem as vital as well. Having accomplished the re-locating of bus stops, they can modify the transfers of a journey, so this issue should be considered in the creation of the new structure of stops. Journey time played a significant role in the evaluations of the company side, but according to the users and governmental experts, there is no need to spend money on this issue in the current situation.

5. Conclusions

1. Evaluating AHP questionnaires requires serious mental performance from the respondents. In case the evaluators are not experts or professionals of the topic, it is advisable to help them by offering a simplified Saaty-scale and not the original one with 17 grades. Moreover, the traditional scale contains fractions as well (expressing minority) and that can be difficult to bear in mind for some passengers. The gained values have to be re-converted for the calculation afterwards.
2. Some respondents might be not so focused on to fill in all rubrics of the offered matrices. If there are just some elements missing, by an algorithm using the principle of minimizing the maximum eigen values of the matrices, the missing numbers can be calculated so that some information can be saved for the calculation.
3. Applying a 3-level-hierarchy, the preference order of the issues will probably be very sensitive to the calculated weight scores (eigenvector coordinates) of the respective previous level. Therefore, checking the sensitivity of the gained results they should be calculated by another operations research method. However, this is a matter of another further research.
4. The separation of evaluators groups (government, passengers, company) may shed light on the different image of development thinking related to a certain public transportation system. By the synthesis, the opinions of passengers have to be the basis, because they formulate the demand side of transport. Aspects of government and company (they consider probably costs, technological issues, economy of scale, etc.) should be also integrated, but with less proportion than users.

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