Simulation Process of Optimal Transport Department Regarding to Transport Vehicles Based on AHP Method – Applied to Slovakia

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ABSTRACT— ***Decision making method AHP delivers real results based on selected criteria analysis and solution variants. As a weighted sum of the output of decision analysis determines the order of significance compared variants. It represents "Base model" for simulation. Sensitive changes in input data for the decision-making process may result in a reordering output of AHP method. The simulation model makes it easy to simulate the desired conditions with increasing or reducing the importance of each criterion in relation to variants percentage change their addictions.***

Keywords— AHP, transport department, simulation

1. INTRODUCTION

Analytical method for multi-level AHP provides a framework for devising effective decisions in complex decision-making situations, helping to simplify and accelerate the natural process of decision making.

For the implementation of decision analysis, it is important to properly identify:

- objective of decision-making process,
- criteria,
- version of decision.

Objective decision consists of determining the transport department, which is the most suitable for the transportation of cars, depending on the selected criteria. For the application of the decision-making process, we chose five criteria decision-making (transportation cost, time of delivery, degree of building infrastructure, transport safety and environmental aspects).

Variants decisions represent transport unions involved in the transportation process cars. The process of decision analysis, we chose the road, rail and water transport, which is currently involved in the process of shipping cars. Air transport can be examined solely from the process as it related to the transport wheeled equipment is not used, or used only in specific cases (for the transportation of military equipment, which is not subject to review).

2. MULTICRITERIA DECISION MAKING METHOD AHP

In determining the value of comparing various criteria based on the results obtained from statistical surveys from respondents in the investigation area (logistics, government and professionals). Based on the results to determine its own matrix vector "wi" according to the horizontal structure of decision-making matrix. Normalized vector matrix "vi" is the weight of each criterion.

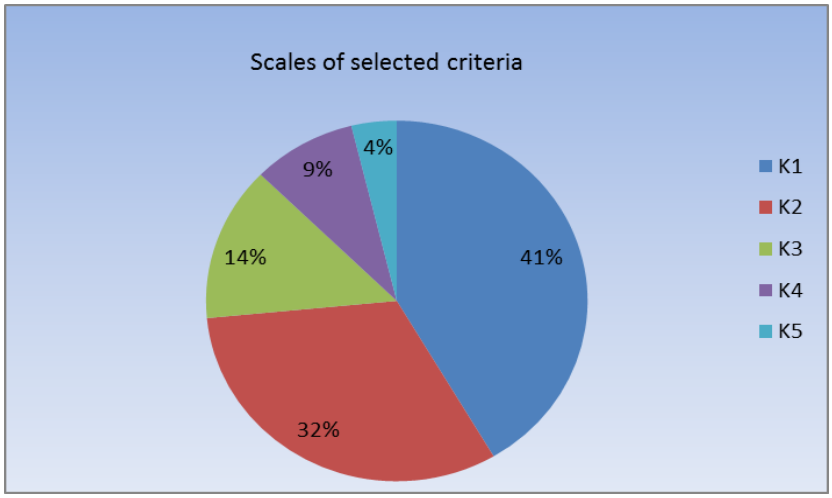

Figure1: Evaluation criteria weights

Table1: Determine the weights of criteria in the process of shipping cars

s(i,j)	**Criteria**								
Criteria	**K1**	**K2**	**K3**	**K4**	**K5**	**Π S(i,j)**	**w(i)**	**V(i)**	**λ(i)**
K1	**1,00**	2,00	6,00	6,00	9,00	648,000	2,942	0,415	8,910
K2	0,50	**1,00**	5,00	6,00	9,00	135,000	2,265	0,320	8,265
K3	0,17	0,20	**1,00**	3,00	9,00	0,9000	0,983	0,139	6,713
K4	0,14	0,17	0,50	**1,00**	5,00	0,0595	0,625	0,088	6,216
K5	0,11	0,13	0,14	0,20	**1,00**	0,0004	0,271	0,038	5,577
Sum							7,086	1,00	35,681

The weights of the criteria, and then comparing the investigated variants using AHP method may be made final assessment compared transport modes in relation to the choice of a suitable transport department for transport vehicles in Slovakia.

Table 2: The final evaluation of compared variants

Criteria	Scale of criteria	Variants decisions		
		Road transport	Rail transport	Water transport
Transport costs	0,415	0,2138	0,2933	0,4929
Time of delivery	0,320	0,5117	0,3402	0,1481
Infrastructure	0,139	0,5095	0,3463	0,1481
Transport safety	0,088	0,1775	0,2770	0,5455
Environmental aspects	0,038	0,1550	0,2928	0,5522
Sum		0,3446	0,3142	0,3418
Ranking		**1**	**3**	**2**

For critical criteria that influenced the outcome of decision analysis can be time delivery rate and build infrastructures that are interdependent. Flexibility, speed and density of the road network features are compared, transport modes are not able to compete with the current conditions.

3. METHODOLOGICAL PROCESS OF SIMULATION

The simulation consists of a sequence of steps, which are interlinked and depend on the method used by decision. Application of AHP method in determining the significance of selected variant t. j. most appropriate transportation department provides the basis for simulating the desired conditions. The basis for the simulation process is to determine the matrix that compares each individual criteria and the subsequent calculation of the normalized vector "vi", which is the weight of importance of the criteria. To calculate the weighted sum - order of importance of each variant is necessary to apply decision analysis for each criterion, particularly in relation to transport modes. Calculating a weighted sum of the sequence we get the significance of transport unions on the basis of criteria weights. The result of the analysis of decision-making is called 'base model'. It forms the basis for the desired simulation conditions. Process simulation is to increase or. reducing the significance of selected criteria in relation to the transport department. The rate of change is defined as a percentage. The rate of change in the significance criteria in relation to one transport department has an effect on the change in value of the standard vector "vi", which is the basis for the calculation of the weighted sum and for final order of the significance of transport modes. Percentage change in the significance of each criteria in relation to variants get "desired model".

4. SIMULATION OF THE TRANSPORT DEPARTMENT APPLIED TO SLOVAKIA

Application of simulation model to a specific condition consists of a variant selection criteria decision analysis. As the “base model” is chosen outcome AHP multi-criteria analysis.

Simulation process can be devided into 2 phases of the project:

- Multicriterial decision making method AHP,
- Simulating conditions.

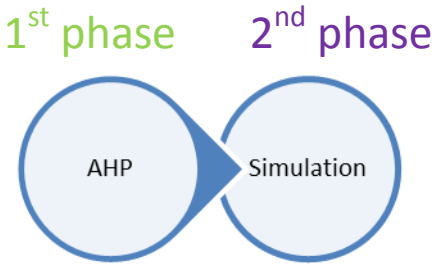

Figure 2: Phases of project

The importance of simulation lies in the easy access to information about it, what criteria need to be addressed to create the desired output of the model and how they impact on the overall change. First phase consists of multi-criteria decision making method AHP, resulting in the use of road transport to the most appropriate department for transport vehicles in Slovakia. The second phase consists in simulating the significance criteria, resulting obtain the desired output - the transport department. Since waterways are not used to transport cars, it is necessary to simulate the conditions under which it would use to potential participants in the transportation process conveniently. For a starting model simulations (phase no. 2) use also called "zero state" i.e., desired model without changing the significance of individual criteria.

Table 3: Simulation of the changes of significance selected request – Transport costs

Variant	Road T.	Rail T.	Water T.	**Π S(i,j)**	w(i)	v(i)		Price increase	Price reduction
Road T.	1	0,6667	0,2	0,13333	0,7148	0,2238		0,00%	0,00%
Rail T.	1,5	1	0,286	0,42857	0,8683	0,2718		5,00%	0,00%
Water T.	5	3,5	1	17,5	1,6113	0,5044		0,00%	0,00%
					3,1943				

Table 4: Simulation of the changes of significance selected request – Time of delivery

Variant	Road T.	Rail T.	Water T.	**Π S(i,j)**	w(i)	v(i)		Time reduction	Time increase
Road T.	1	3	7,5	22,5	1,6802	0,5054		0,00%	0,00%
Rail T.	0,33	1	5,5	1,83333	1,1063	0,3328		0,00%	0,00%
Water T.	0,13	0,1818	1	0,02424	0,538	0,1618		15,00%	0,00%
					3,3245				

Change of importance of each criteria is automatically converted and applied to the output of the model, which is a result of the simulation (excel version). Simulation results is the impact of changes to the original condition and the result of AHP method adjusted for the impact of the significance criteria.

As an example, the simulation can be determined that the timing of delivery of water transport and the change in the price of rail transport. Time of delivery in water transport will be reduced by 15% compared with other transport modes and rail transportation costs will increase by 5%. Other values weights remain unchanged. The impact of the changes can be seen in the table and shown graphically.

Table 5: Final evaluation of transport modes

Criteria	**Scale of criteria**	**Variants decisions**		
		Road transport	**Rail transport**	**Water transport**
Transport costs	0,415	0,2238	0,2718	0,5044
Time of delivery	0,320	0,5054	0,3328	0,1618
Infrastructure	0,139	0,5094	0,3464	0,1442
Transport safety	0,088	0,1808	0,2759	0,5433
Environmental aspects	0,038	0,1552	0,2927	0,5521
Sum		0,3470	0,3028	0,3502
Ranking		**2**	**3**	**1**

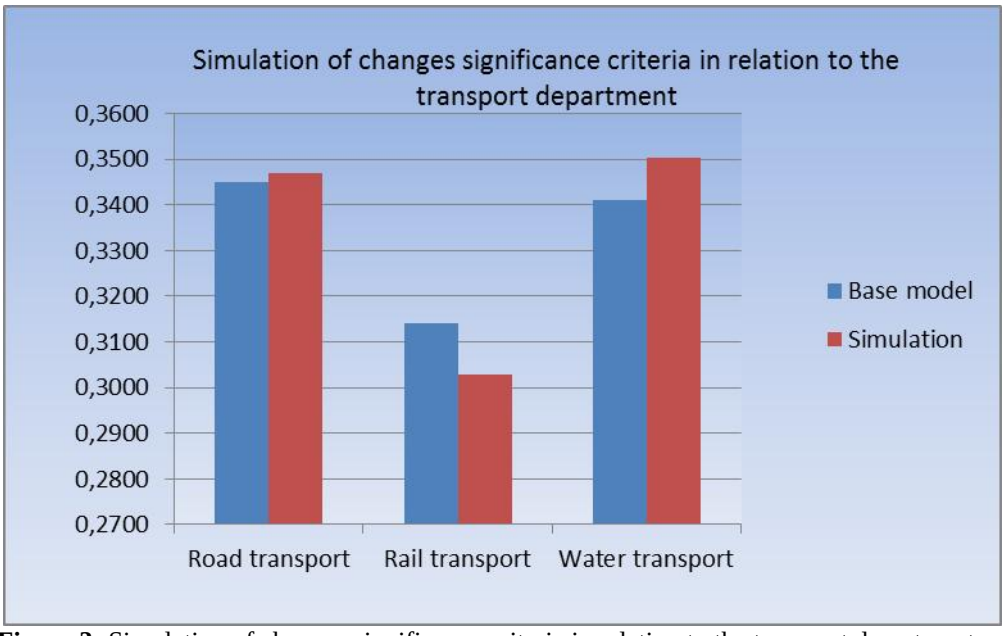

Figure 3: Simulation of changes significance criteria in relation to the transport department

5. CONCLUSION

Information obtained from statistical surveys and assigning weights to each criterion represent the baseline examination. For credible simulation is necessary to work with current data, as the significance of individual criteria may change over time.

Process simulation requested conditions based on the percentage increase or reducing the significance criteria in relation to the transport department, under which there are changes in the results of decision analysis. Changes in the status of the significance of individual criteria in comparison with other transport departments can result in significant changes in the final evaluation and hence the choice of a suitable transport vehicle for the transportation department. Simulation of changes in the criteria in relation to the transport department can best simulate respectively "desired model".

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