

## Research Article

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# The Methodology of Selecting the Transport Mode for Companies on the Slovak Transport Market

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**Abstract:** Transport volume in the Slovak Republic is growing continuously every year. This rising trend is influenced by the development of car industry and its suppliers. Slovak republic has also a geographic strategy position in middle Europe from the side of transport corridors (east-west and north-south). The development of transport volume in freight transport depends on the transport and business processes between the European Union and China and it is an opportunity for Slovak republic to obtain transit transport flows.

In the Slovak Republic, road transport has a dominant position in the transport market. The volume of road transport has gradually increased over the past years. The increase of road transport is reflected on the highways and speed roads in regions which have higher economic potential. The increase of rail transport as seen on the main rail corridors is not as significant as in road transport. Trade globalization also has an influence on the increase of transport volume in intermodal transport. Predicted increase in transport volume for this transport mode is from 2,3 mil ton per year at present to 8 mil ton in the year 2020. Selection of transport mode and carrier is an important aspect for logistic management, because companies (customers) want to reduce the number of carriers which they trade and they create the system of several key carriers. Bigger transport volume and more qualitative transport service give a possibility to reduce transport costs. This trend is positive for carriers too, because the carriers can focus only on the selected customers and provide more qualitative services.

The paper is focused on the selection of transport mode based on the proposed methodology. The aims of the paper are, definition of criteria which directly influence the selection of transport modes, determination of criteria based on the subjectively methods, creation of process for the selection of transport modes and practical application of proposed methodology.

## 1 Introduction

The Selection of transport mode is not a random process, but it depends on the knowledge of transport market. This process is influenced by the criteria and factors, which support or restrict the choice of transport mode. Next necessary indicator is personal skills of employer, who is responsible for the selection of the transport mode. Final selection decision of transport mode is still on the customer.

## 2 Attributes of freight transport modes in Slovak republic

### 2.1 Railway transport

Strong side of railway freight transport is geographic position of Slovak republic. Location of Slovak republic is in the middle of Europe and railways is an important transport crossing which is connecting transport flows in direction east-west and north-south. The advantages are good density of rail network and possibility of movement of the bulk substrates for heavy industry. Disadvantages are bad technical condition of rail infrastructure, the low speed of time period of consignments from loading place to unload-

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ing place and low ability of reaction for customer's requirements.

The opportunity for railway transport is development of intermodal transport. This fact is caused by the globalization of world economy. For successful use of this transport, the railways to meet the following conditions: improved responsibility, optimized network of intermodal terminals and flexible reaction of carriers to customer's requirements. When railway transport is able to connect to the intermodal transport mode effectively, then it is possible to move transport volume of goods from road to railway [1, 2, 4].

## 2.2 Road transport

The advantages of road transport are for example: operative management, transport from house to house, high density of road network, low administrative and consignment is under the control of driver during the whole transport time. Delivery time on short distance is without competition. Low fixed costs, profitability by the low weight consignments, enforcement in special transportations and smaller damage of goods are further advantages of road transport. On the long distance, the transport period time is restricted by the European Agreement concerning the Work of Crews of Vehicles engaged in International Road Transport (AETR).

Disadvantages of road transport are: restriction of loading possibility – low capacity of loading space, dangerous goods are forbidden on road transport, dependence of weather and traffic situation and traffic accidents.

In Slovak republic about 80% of goods on short distance (up to 150 km) are transported by road transport. Road transport, except for direct connection, provides collection and distribution of goods from (to) railway station and port. In this case the benefit is achieved via low capacity of road vehicle. Disadvantage is mainly badly planned routes i.e., empty ride of vehicles and when high loading capacity vehicles are used based on customer's requirements [2, 5, 7].

## 2.3 Air transport

Air transport is the fastest transport mode and its exploitation is in the international trade, for long distance transportation and tourism. Air freight transport has a small importance in the Slovak transport market condition. Significant airports in Slovak republic are in the Bratislava and Košice. Airports are also in the Poprad, Sliač and Piešťany,

but they have only regional importance and are used only during the tourism season [6].

## 2.4 Water transport

Water transport has the lowest energy consumption, higher productivity of work and less influence on the environment. But it is slow. Slovak has a small importance because there are no inland waterways here built here and only two rivers can be used, namely, Danube and Vah. River Danube has a great importance for international trade and it is part of 7<sup>th</sup> Pan-European transport corridor [6].

## 3 Performance of freight transport by mode in the Slovak Republic

Diversification of transport market in the Slovak republic is shown in Table 1. The main share (average 70%) on the transport market has a road transport in monitoring years 2010 – 2014. Transport volume decreased after the year 2010, the largest decrease was in road transport. This decrease was caused by the world financial crises that started in year 2008. Transport volume in railway transport had balanced character in monitoring period. In year 2014 rail transport volume was increased a little (about 6%). Based on Table 1 we can say the main transport mode in the Slovak republic is road transport, second position is for railway transport on the market and other transport modes have a little share on the market [8–11].

Dominant position of road transport is caused from its advantages (specified in Section 1) and also from the characteristics of Slovak economy (industry). After the planned economy, Slovak business market was created more for the services and some factories are engineering based. And then the railway transport lost its customers and this fact resulted to loss position on the transport market. Slovak trademarked is currently more oriented to customer satisfaction and companies are oriented to economy cost side and that includes also transport problematic. Road transport is more efficiency for short distance and also it is faster, for that have road transport a dominant position.

**Table 1:** Transport volume of goods in Slovakia (thousand tons).

Indicator tis.ton	2010	2011	2012	2013	2014
Rail transport	44 327	43 711	42 599	48 401	50 997
Road transport	143 071	132 568	132 074	128 855	142 622
Inland waterway transport	3 109	2 454	2 472	1 920	1 838
Air transport	11	1	4	7	9 116
<b>Together</b>	<b>190 507</b>	<b>178 733</b>	<b>177 145</b>	<b>179 176</b>	<b>195 466</b>

## 4 The proposal of methodology for selection of transport mode

The aim of the proposed methodology is creating the procedure for selection of transport mode in conditions of Slovak republic. Selection of transport mode is proposed as a multi-criteria decision and for creation of the methodology several scientific and research methods are used. For example: Sperling's method, quantitative survey, methods for information processing, questionnaire survey and others. Result of the proposed methodology is a manual that includes effective selection process of transport mode in the Slovak republic for customers of transport companies.

### 4.1 Setting the criteria for selection of transport mode

Selection of criteria is determined based on the questionnaire survey between customers of road and railway transport and also based on [10–17]. On the creation of the methodology for selection of transport mode, experts from transport companies and research institutes participated in answering the questionnaire survey.

**a) Price for transport (C<sub>1</sub>)** – price in road transport falls under the economy category and carriers are determined by self-decision. Price in road transport, however, respects pricing law and also the company's objectives. Pricing in road transport respects cost principle and utility principle. Amount of price for transport should be determined based on the value of goods. Prices in rail freight transport are calculated individually or based on the tariff. The price includes economically justified costs and reasonable profit. In rail freight the transport price affected by several factors: kind of transport, tariff distance, weight of goods, number of wagon axes, owner of wagon, etc.

**b) Transport time (C<sub>2</sub>)** – based on the questionnaire survey, time constitutes one of the important priority. In railways, transport time is defined based on the transport law (national or international) as a delivery time (or time pe-

riod for consignment). On roads, transport time is determined based on the agreement between carrier and customer.

**c) Transport safety (C<sub>3</sub>)** – it means protection of goods against damage and loss. We can assess transport safety from two sides. (i) transport safety is expressed on the number of accidents. In this case railway transport has better position compared to road transport. (ii) expressed as damage of goods during transportation. In this case railway transport is in the worst position among all transport modes.

**d) Reliability of carrier (C<sub>4</sub>)** – it means fulfilment of delivery times and contractual conditions. Reliability in railway transport is conditional based on timely notice of loading in station with relevant authorisation for transport. In the road transport reliability depends on the vehicle fleet of carrier.

**e) Information (C<sub>5</sub>)** – it means common designation about the location and condition of the consignment. It also includes the information about the carrier via their internet portal or other marketing tools. This means possibility to obtain the relevant information about consignment in real time. In road transport, the possibility is a basic standard. In railway transport, this kind of service is more complicated and not all rail carriers offer this service for their customers.

**f) Additional services (C<sub>6</sub>)** – these services include activities as loading and unloading of goods, determination of weight of goods, writing the consignments note, cleaning the wagons, etc. These activities, based on the questionnaire survey, taken from the customers of transport services, have led to additional services in railway transport. However, these services are also charged.

**g) Expertise and References (C<sub>7</sub>)** – these criteria are very subjective. Every expert can have different view for providing transport services. It depends on their experiences. Good references can help carrier to increase market share.

**h) Flexibility (C<sub>8</sub>)** – this criterion can be understood as adaptation to customer's needs. Accommodating negotiation of carrier, with a view to satisfy a customer's needs, is very important. Carriers are aware that offering such flex-

ibility gives them a higher profit margin in transport market. Based on this fact, carriers may offer to satisfy customer's requirements with quality services.

**i) Responsibility (C<sub>9</sub>)** – responsible behaviour of carrier is basic condition for successful business. Irresponsible actions from carrier side can result in loss of customers and their transition to competition.

Next chapter includes setting of weights of selected criteria. Setting of weights of selected criteria was made due to the increase of objectivity in the proposed methodology

## 4.2 Weights setting of selected criteria

For weights setting of selected criteria the subjective measurement and evaluation with the Sperling's method is used. Sperling's method is used on the measurement and evaluation of quality services by indirectly measured criteria, which follow from customer's feeling, wishes and requirements. By the determination of importance of weights of criteria a scoring method (1 to 3 points) is created, where 3 points mean maximal importance of criteria and 1 point means minimal importance of criteria. Importance of weights identified 10 respondents from praxes – carriers and customers of transport services and also experts from research. Table 2 shows the scoring table for importance of weights based on criteria.

**Table 2:** The scoring table for importance of weights based on criteria.

Number	Criterion	Importance of weights		
1	Price for transport	1	2	3
2	Transport time	1	2	3
3	Transport safety	1	2	3
4	Reliability of carrier	1	2	3
5	Information	1	2	3
6	Flexibility	1	2	3
7	Additional services	1	2	3
8	Expertise and References	1	2	3
9	Responsibility	1	2	3

Results of analysis of importance weights based on criteria are in Table 3. Results are based on the analysis that was made with 10 Slovaks experts of transport field. Experts were addressed by the questionnaire survey.

From results it can be observed that the most important criteria are price of transport, transport time and

**Table 3:** Results of questionnaire.

Number	Criterion	Importance of weights
1	Price for transport	2.7
2	Transport time	2.7
3	Transport safety	2.6
4	Reliability of carrier	2.5
5	Information	2.4
6	Flexibility	2.2
7	Additional services	1.8
8	Expertise and References	2.4
9	Responsibility	2.6

transport safety. Average important attributes are responsibility, information and reliability of carrier. Criteria with minimal importance are flexibility and additional services.

## 4.3 Process of decision by the selection of transport mode

This part of article discusses the proposed process of decision by the selection of transport mode from customer's side. Decision process is conceived as a chain of several steps. Proposed process is divided into following elements: definition of the problem, goal setting, determination of possible variants to goal, settings of criteria, and selection of suitable methodology for evaluating of variants, decision, realisation and control.

Based on the defined elements the scheme of process decision was created. In Figure 1 is shown variant A, where the selection of transport mode is made by the customer. Scheme A includes possibility of contractual commitment with carrier (customer has framework transport contract).

### Variant A

At the beginning customer has transport need – transport requirement started. Customer uses the transport office and its employee selects the transport mode by the analysis of the transport criteria. When framework transport contract exists with some carrier and it satisfies transport conditions then the contract of carriage is closed. If framework transport doesn't exist, contract must determine the criteria for selection of carriers. Then the proposed alternative is evaluated and the most efficient transport mode is selected.

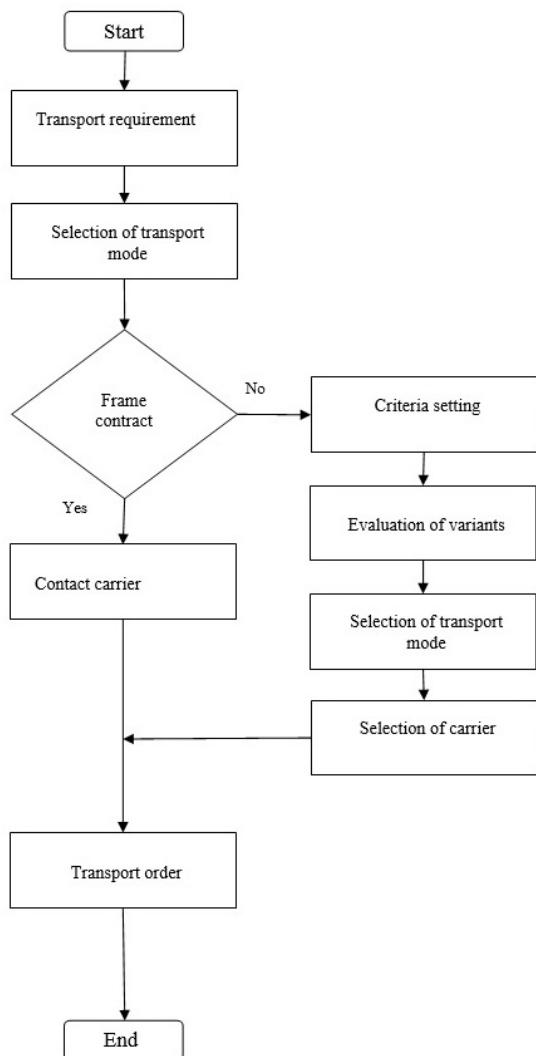


Figure 1: Scheme of process decision variant A.

### Variant B

Figure 2 shows variant B, where selection of transport mode is not made by customer, but by a third subject (for example forwarder).

At the beginning of variant is the transport need and the requirement is send to transportation department. In this variant it is important to question if the mode of transport is determined by the customer or forwarder who procures the transport of goods from the loading place to the unloading place, and the carrier pays a fee for it.

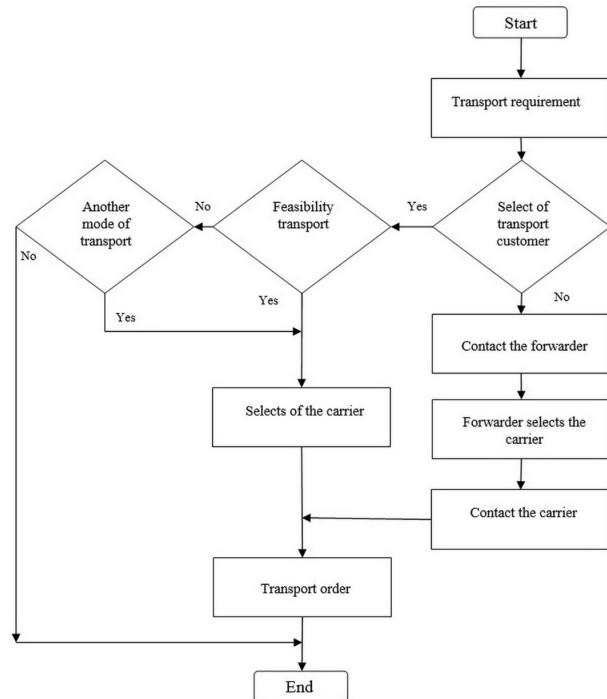


Figure 2: Scheme of process decision variant B.

## 5 The application of the proposed methodology to a model example

The proposed methodology, its procedure and results of the processes were applied to the model example.

**Model example:** the manufacturing company in the field of production of automotive components must decide what kind of transport will be the most effective for the export of its products. The company XY produces alloy rims and in the foreseeable future will be the supplier for an unnamed automotive company (the customer A) in the area of central Slovakia. Sales of goods by the customer is required for every 5 calendar days in a total volume of 6 000 discs. The company XY does not have its own siding.

Parameters of goods: alloy rims – the weight of one disk is 7.7 kg. The rims are transported in metal cages owned by the customer in a total number of 32 pieces (4 pieces in 8 layers) in one metal cage. The weight of one full cage is 24 kg + 246.4 kg (goods) = 270.4 kg. The volume of transport is so designated at 51 tonnes once a week for a model session Sady nad Torysou (Košice - surroundings) – Teplička nad Váhom (Žilina). The customer must decide between the services of road freight transport and rail freight transport.

Criteria for the selection of the type of transport with associated weights of importance (according to the ques-

tionnaire survey) are listed in the following table. In both types of transport are assigned digits 0 or 1 to the selected criteria, where 0 = worse in comparison with the other type of transport and 1 = better in comparison with the other type of transport.

Evaluation of individual criteria is determined on the basis of a subjective measurement. According to the results of model example the road transport is more efficient type of transport in comparison with railway transport. The individual criteria are analyzed in detail in the following section.

## 5.1 Evaluation of individual criteria from Table 4

### Price for transport

Rail transport:  $27,67 * 51 = 1411,17$  € it is the price only for transport without additional charges. We calculate only with this price in our model example. The price is understood as the official price from the tariff while the actual price may be lower by 20% because the customer is a regular client.

Road transport: According to information from the selected road carrier is the price of transport about 0.85€ per 1 km ( $242 * 0.85 = 206.426$  – the price for one transport on the route Sady nad Torysou – Teplička nad Váhom). Total price in terms of volume of transported goods is 619.278 €. Accounting for the price of return rides depends on the agreement between the customer and the carrier.

### Transport time

In rail transport: the time needed before departure of the train - 12 hours + transport time for each started 400 km - 24 hours. The total transport time in our model example - 36 hours.

In road transport: depending on the length of route (254 km) and speed of road vehicle (first class road E50 with a maximum speed of 80 km/h), the transport time is about 3 hours 10 minutes. This time is only indicative because it is influenced by several factors such as weather, transport density or various reconstruction works. We have to calculate also with the second ride of vehicle, the driver's break and the time required for handling processes (loading and unloading of goods). The total time would be about 12 hours.

### Transport safety

Safety is characterized by the number of accidents when the road transport is the most dangerous according to data from the Statistical Office or from other studies. Rail transport is the safer option in this case.

### Information

Information on the state and the current position of the transported goods are very important for the carrier. This criterion is met quite well by both carriers. Smaller advantage is on the side of road transport, where a driver should be in most cases equipped with a mobile phone which could be used for the provision of current information to customers.

### Reliability of carrier

This criterion can be understood as the availability of road or rail transport from the customer's perspective. The customer does not have own siding therefore, if he decides for the services of rail transport, he will have to transport the goods to the nearest freight station by the road vehicles. Road transport is again more favorable according to this criterion in our model example.

### Additional services

This criterion is essential in its importance for the carrier. If a customer has own handling tools for loading the goods and sufficient manpower, then the services of the carrier associated with the handling processes with goods are irrelevant for him. The customer is interested to use the additional services of the carrier in our model example.

### Expertise and references

The selected carrier should be a sufficient expert because the transported commodity is very specific. Expertise is needed especially in handling work such as loading and unloading in order to eliminate the possibility of damage to the goods.

### Flexibility

Rail transport is seen as flexible in the case where the carrier can offer the required types of railway wagons for the customer and on the other hand in road transport it is due to a sufficient number of vehicles and sufficient transport capacity. In the model example the customer needs the services of the carrier once a week, but the exact hour they

**Table 4:** Criteria with associated weights of importance.

Number	Criterion	Importance of weight	rail transport	road transport
1	Price for transport	2.7	0	1
2	Transport time	2.7	0	1
3	Transport safety	2.6	1	0
4	Reliability of carrier	2.2	1	1
5	Information	2.4	1	1
6	Flexibility	2.5	0	1
7	Additional services	1.8	0	1
8	Expertise and References	2.4	0	1
9	Responsibility	2.6	1	1

always set during previous day. The road transport is more flexible in this case.

### Responsibility

To this criterion we can include for example the responsible handling of goods or the compliance of the delivery period. The alloy rims are more expensive commodity and therefore it is necessary to emphasize the responsibility for the condition of the goods throughout the transportation time

From a comparison of both types of transport, it is revealed that the customer will be more convenient to use road freight transport. This conclusion is based on of the selected criteria and the importance of weight assigned by the customers and experts. The price in railway transport according to the tariff TR1 with using the services of ZSSK Cargo would be 1411.17€ and the price for transport in road freight transport according to the information from a road carrier would be 619.278€. An important fact is also the possibility to transport goods with a weight of 51 t by one train while in road transport more road vehicles need to be used. Another factor is the connection with the rail network or road infrastructure. In our model example the customer does not have own siding and direct connection with the main track, therefore the availability is better in the road transport.

*According to the selected criteria based on the weight of importance the road transport is more preferable for the customer in this model example.*

because customers generally try to reduce the number of contract carriers and create a system of a few reliable carriers [18–20].

Conditions will change not only based on the method of transport of goods and the development of infrastructure, but also on the transport distance. Professionalism is very important, mainly because of the selection of the most suitable kind of transport for a transported consignment [21].

Rail transport is suitable for transporting through longer distances, and for heavy and bulk consignments. Other advantages in comparison with road, air and water transport are the safety in terms of the number of accidents, the accuracy and regularity due to the bad weather. Rail transport is efficient from the point of view of the volume, which is able to transport, it is environmentally cleaner than road transport, and its use reduces the congestion in road transport. Road transport is not limited by the place of loading and unloading, offers the transport from house to house and has relatively low investment costs of the vehicle. Other advantages of road transport are its large territorial dispersion, a dense road network and the flexibility [21–25].

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## 6 Conclusion

The selection of the type of transport and the carrier becomes a very important aspect of logistics management,

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