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Logistics Assessment of Functional Performance of Material Flows in Railway Transport

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Abstract. The article includes the proposal of new methodology assessment of functional performance of material flows as a tool for management decision-making in the selection of suitable suppliers of logistical services in railway transport. This selection is based on evaluation of key indicators and determination of their weights. The evaluation of the indicators and determination of their weights is realised by mathematic methods.

1 Introduction

Theories about the logistics evaluation of material flow of rail transport are overlooked by all stakeholders. In Slovakia, while we try to apply foreign knowledge and search the best solutions for our region (for example methods KPI, KPD, LPI, VDA 17, MS 9000 respectively MMOG) [1-9].

2 The proposal assessment methodology

The methodology is conceived to be usable for any company that will need to assess the functional performance of material flow in the implementation by different suppliers based on objective indicators. The procedure we propose is depicted in the following breakdown (see Fig.1).

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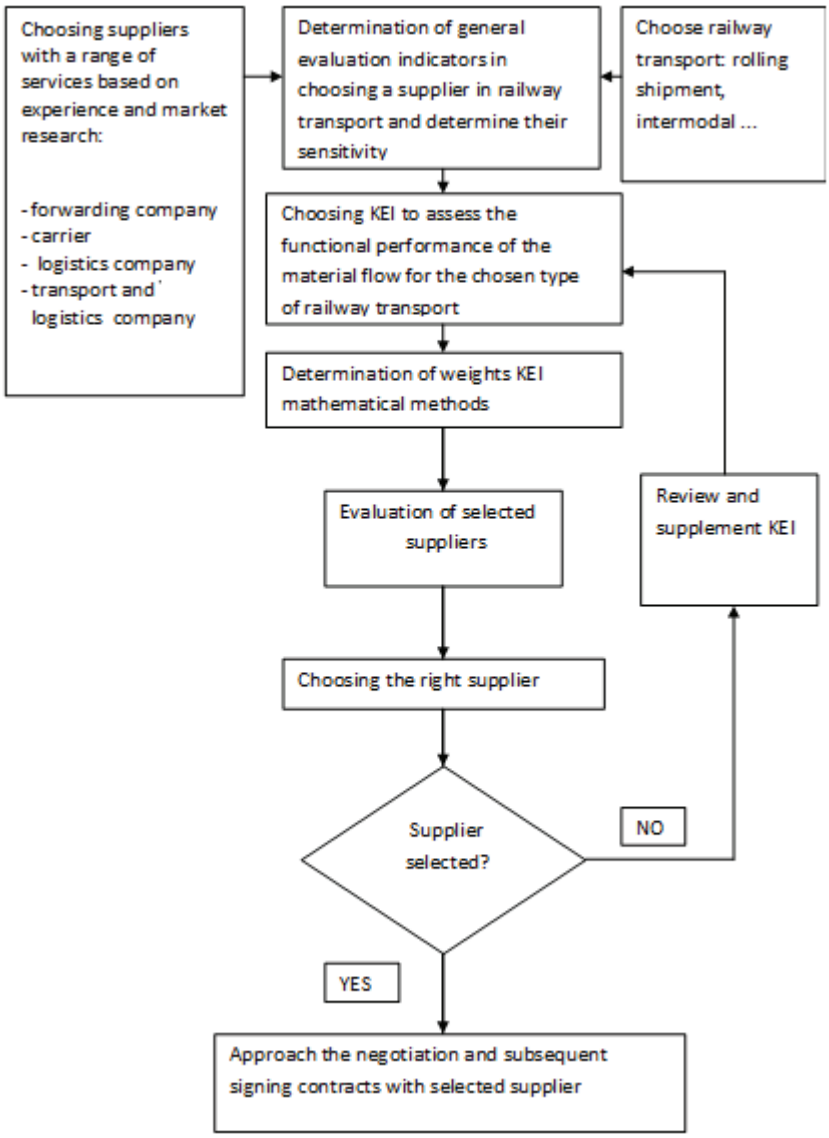

Fig. 1. The procedure for selecting the suitable supplier of logistics services in railway transport. Source: authors

3 Determination of general evaluation indicators in choosing a supplier in railway transport

Table 1 shows the general evaluation indicators used in daily operations. Collection of these of indicators is open and can be added at any time for new indicators. The order of indicator in the table is a random and does not prioritize the individual indicators.

Table 1. The general evaluation indicators for choosing a supplier of railway transport. Source: authors

Order (random)	General evaluation indicators
1.	The reliability compliance with the time of delivery (transit)
2.	Total transit time (from border to border)
3.	Total price from sender to recipient
4.	Quality of forwarding services
5.	The possibility of find shipments
6.	Providing regular monitoring of movement shipments
7.	Insurance of transported shipments
8.	Guarantee the protection of goods against loss, damage or breach of
9.	The range and quality of services provided at the state border in railway transport
10.	Possibility to provide customs operations necessary for the further handling of goods
11.	Staff qualifications and competence
12.	Language skills of staff
13.	Economic and financial stability of supplier
14.	The quality of the sale of services, ease to negotiate competitive prices
15.	Possession of the necessary equipment. Ability to ensure the equipment for handling goods
16.	Ability to provide the type or kind of vehicle for further transportation - such as the transshipment
17.	Readiness supplier negotiations on the revision services
18.	The complexity of the order process required services
19.	Readiness supplier negotiations on the revision price
20.	Availability of storage
21.	Secure store against theft
22.	Insurance of goods in the store
23.	Warehouse staff training required for handling the types of goods
24.	The owner of the certificate of quality ISO
25.	A member of FIATA
26.	A member of Association of Logistics and Freight Forwarding of the Slovak Republic
27.	Additional services required for the treatment of goods before delivery to the customer (for example, assembling packages)
28.	Possibility to provide palletizing goods during transshipment
29.	Possibility to provide strapping goods during transshipment
30.	Possibility to provide foiling goods during transhipment
31.	Possibility to provide selection of suitable wagons for loading
32.	Possibility to provide sorting of goods according to specified criteria
33.	Affinity shipment
34.	Supplementary criteria for supplier selection

4 Determination of sensitivity for the assessment of individual indicators

By determining the sensitivity of indicators identifies a threshold when the indicator crosses the border between the two evaluations.

Determination of the sensitivity of indicators:

a - The supplier can arrange the selected indicator accurately according to requirements without the need to use the agreed tolerances the supplier can propose new quality or cost-effective solutions.

b - The supplier can arrange the selected indicator, as required by agreed tolerance without intervention of customer.

c - New supplier with good references.

d - The supplier can arrange the selected indicator, does not respect the agreed limits of tolerance, the intervention of the customer.

e - The supplier can arrange the selected indicator, exceeds the limits of the agreed tolerance and waits for the customer intervention, is required constant monitoring of suppliers to meet contractual obligations.

f - New customer without reference.

g - The supplier cannot provide the selected indicator, despite contractual obligations to the client.

5 The selection of key indicators of evaluation and determination of their weights mathematical methods – model example

In determining the estimated weights KEI, we used more mathematical methods:

- The order method,
- The scoring method,
- Method pairwise comparisons - Fuller method,
- Method of quantitative pairwise comparisons of indicators (Saaty´s method).

We select KEI to test the procedure for assessing the functional performance of the material flows implemented by multiple vendors. From general evaluation indicators (Table 1) we choose the key evaluation indicators.

For example (KEI):

I1. - The reliability compliance with the time of delivery (transit).
I4. - Quality of forwarding services.
I5. - The possibility of find shipments.
I7. - Insurance of transported shipments.
I20. - Availability of storage.

We will consider the following order of importance, KEI: 1,4=5,7,20 which means that I1 indicator will be most important, for it will I4 and I5 indicators as important, then followed I7 and at the end of I20. The indicator that is least important.

For all the methods used to determine the weights we will be based on the same initial assumptions.

We choose weights always so that the total weight of all KEI selected for a specific model example equal to one. If the weight for the i-th indicator I tag vi for i = 1, 2, ...u, where “u” is the number of indicators, then for the relationship will apply:

$$\sum_{i=1}^{u} vi = 1 \,,\; vi \geq 0 \tag{1}$$

When determining the weights of indicators allocate more weight to the criterion which is important. We weight assigned to the selected indicators under the terms of the sum of weights equal to one (as stated above) or by using mathematical methods that were used for the model example.

6 Comparison of the estimated weights for the key evaluation indicators by different methods

In Table 2, we make a direct comparison between different methods of estimating weights. The Saaty´s method the most sensitive assigns appropriate assessment of individual indicators [10,11], so we decided to use the results of this method in further calculations.

Table 2. Comparison of estimated weights for KEI the various mathematical methods. Source: authors

Indicators	Weights indicators			
	The order method	The scoring method	Fuller method	Saaty´s method
I1. The reliability compliance with the time of delivery (transit)	0.33	0.31	0.40	0.38
I4. Quality of forwarding services	0.23	0.25	0.25	0.22
I5. The possibility of find shipments	0.23	0.25	0.25	0.22
I7. Insurance of transported shipments	0.14	0.13	0.10	0.12
I20. Availability of storage	0.07	0.06	0.00	0.06

7 Data collection to assess

- Own database (experience),
- The references,
- Inquiry (agency).

8 Evaluation of selected key indicators

I use for the evaluation of KEI scale ranging from 1 to 5. The higher will be evaluation, more supplier will meet the needs of the individual KEI.

Evaluation:
5 - Meets my needs, I don´t have further comments.
4 - Still meets my needs but with some minor reservations.
3 - Still meets my needs but with substantial reservations.
2 - Meets my needs minimum, but I don´t have to choose, now.
1 - Totally satisfying for my needs and is unacceptable.

Assignment to the sensitivity of evaluation:
5 - a.
4 - b, c.
3 - d.
2 - e, f.
1 - g.

We consider about six suppliers of services in the model example [12]. We evaluated KEI for each supplier selected on experience while respecting of sensitivity assigned the evaluation.

Overall evaluation of the individual KEI for the particular supplier:

$$C_{i,d} = v_i \,.\, H_{i,d}, \quad for\ i = 1\ to\ u \tag{2}$$

where :

$C_{i,d}$ - An overall assessment of the i-th key indicator (I) d-th supplier where $d = 1.2 \ldots .z$ and z - means of the number of suppliers.
u - Numbers of indicators.
v_i - The weight of the i - th KEI.
$H_{i,d}$ - Evaluation of i - th KEI , d - th d supplier.
$\sum C_{i,d}$ - The sum total evaluation KEI - final evaluation d - th supplier.

The supplier with the highest sum of evaluations KEI will head order suppliers and I give him 1st place [13]. A detailed overview of our assessment of suppliers Table 3 provides.

Table 3. Evaluation of suppliers Source: authors

	Indicators					**The order suppliers**
	I1.	**I4.**	**I5.**	**I7.**	**I20.**	**∑ Ci,d – final evaluation suppliers**
Weight vi	0.38	0.22	0.22	0.12	0.06	
Hi, evaluation 1st supplier	5	4	4	2	5	1.
Ci,d, overall evaluation I	1.90	0.88	0.88	0.24	0.30	4.20
Hi, evaluation 2nd supplier	4	5	1	2	5	5.
Ci,d, overall evaluation I	1.52	1.10	0.22	0.24	0.30	3.38
Hi, evaluation 3rd supplier	4	3	5	4	1	2.
Ci,d, overall evaluation I	1.52	0.66	1.10	0.48	0.06	3.82
Hi, evaluation 4th supplier	3	4	4	5	5	3.
Ci,d, overall evaluation I	1.14	0.88	0.88	0.60	0.30	3.80
Hi, evaluation 5th supplier	2	4	4	3	5	6.
Ci,d, overall evaluation I	0.76	0.88	0.88	0.36	0.30	3.18
Hi, evaluation 6th supplier	5	2	3	5	1	4.
Ci,d, overall evaluation I	1.90	0.44	0.66	0.60	0.06	3.66

9 Conclusions

In further work we will elaborate in more detail using entropic methods [3, 10] to determine the weights of individual indicators for cases where we do not clearly identified priorities between individual KEI. In further work we will elaborate in more detail using entropic methods [3, 10] for determining weights of individual KEI in cases where we do not clearly identified priorities between indicators. In this case, individual KEI assigns different probabilities. Preliminary calculations show that the process is very sensitive to the objectivity of input information, which then affects a significant degree of uncertainty (entropy) and thus the weight of the selected KEI. Higher sensitivity could this method ever closer to objective evaluation weights the key evaluation indicators (KEI).

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