Logistic evaluation of the choice of service provider in transport under different conditions

Jozef Majercak¹, Peter Majercak¹, Anna Kurbatova², Ekaterina Kurbatova²

¹University of Zilina, Faculty PEDAS, Department of Railway Univerzitna 1, 010 26 Zilina, Slovakia
²State University of Management, Ryazanskiy prospect, 99, Moscow, Russia

E-mail: jozef.majercak@fpedas.uniza.sk

Abstract. Article is about a proposal 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.

1. Introduction
Theories on the logistical evaluation of material flows in rail transport are given attention to all stakeholders, i.e. carrier, shippers, shipper, manufacturer and trader [11]. Within Slovakia, we are currently trying to apply foreign knowledge and find the best solutions for our transport sector in order to offer a methodology for selecting a service provider in the transport sector while accepting various indicators, often contradictory. And in this tangle of requirements to find the best possible solution for the one who chooses a supplier for their transport services.

In the literature [7, 8, 9] we find various names and applications of methods that could be used for such an analysis [2, 13]. Examples are the methods of key evaluation indicators, methods of evaluating logistics performance, etc. For our methodology of evaluating the selection of a provider of logistics services in transport, we used the term evaluation of functional performance in the transport process. By this term we mean the selection of a suitable supplier and service provider in transport so that the transport fulfills its purpose, for which it was used [5, 6]. Within Slovakia, we are still trying to apply foreign knowledge and find the best solutions for our region (e.g. methods KPI, KPD, LPI, VDA 17, MS 9000 or MMOG).

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 the following breakdown figure 1 [12].
Choosing suppliers with a range of services based on experience and market research:
- forwarding company
- carrier
- logistics company
- transport and logistics company

Determination of general evaluation indicators in choosing a supplier in railway transport and determine their sensitivity

Choosing KHU to assess the functional performance of the material flow for the chosen type of railway transport

Determination of weights KHU mathematical methods

Evaluation of selected suppliers

Choosing the right supplier

Supplier selected?

Approach the negotiation and subsequent signing contracts with selected supplier

Choose railway transport: rolling shipment, intermodal ...

Review and supplement KHU

Figure 1. The procedure for selecting the suitable supplier of logistical services in railway transport.
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 indicators is open and can be added at any time for new indicators “U”. The order of indicators in the table is random and does not prioritize the individual indicators [4].

| 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 finding 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 transhipment |
| 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 transhipment |
| 29.           | Possibility to provide strapping goods during transhipment |
| 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. Model example of selection of key evaluation indicators (KHU) and determination of their weights by mathematical methods

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

For example KHU:
- U1. The reliability compliance with the time of delivery (transit)
- U4. Quality of forwarding services
- U5. The possibility of find shipments
- U7. Insurance of transported shipments
- U20. Availability of storage

We will implement the mentioned selection of KHU in two ways:
1) Based on the definition of the order of importance weights.
2) Without determining the order of importance weights.

The sum of the weights of all KHUs selected for a particular model example must be equal to one. If the weights for the i-th indicator are denoted $v_i$, for $i = 1, 2, \ldots, u$, where $u$ will be the number indicators, then the relationship (1) will apply to the scales:

$$\sum_{i=1}^{u} v_i = 1, \quad v_i \geq 0$$

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.

4.1. For the first case, on the basis of the choice of the order of importance of the KHU

We will consider the following order of importance, KHU: 1,4=5,7,20. Which means that U1 indicator will be most important, for it will U4 and U5 Indicators as important, then followed U7 and at the end of U20. The indicator, which is least important.

4.2. Determination of sensitivity for the evaluation of individual indicators

By determining the sensitivity of indicators, we determine the limit at which a given indicator crosses the boundary between two evaluations. The more this sensitivity will be determined (greater range of options), the greater the significance of the result.

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 customer intervention,
- 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 can not provide the selected indicator, despite contractual obligations to the client.

4.3. Evaluation of selected key indicators and assignment of sensitivity

For the evaluation of KHU we will use a scale with a range from 1 to 5, while the higher the evaluation, the more the supplier will meet the needs of individual KHUs and the higher the position will be occupied in the final order of candidates - suppliers.
Evaluation of selected key indicators:
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.

We will now assign sensitivity to the above-mentioned evaluation. Assign sensitivity to rating:
5 – a
4 – b,c
3 – d
2 – e,f
1 – g

In the model example, we considered six interested parties - service providers. For each supplier, we evaluated the selected KHU separately based on experience in maintaining the sensitivity associated with the evaluation. Subsequently, we used the weights that were determined by the Saaty method (the largest range of options) for selected key indicators and by their product we obtained the overall rating $C$ of a specific key indicator $U$ for a specific supplier $d$.

$$C_{i,d} = v_i \times H_{i,d}$$

where $i=1$ to $u$ (2)

$C_{i,d}$ - an overall assessment of the i-th key indicator (U) d-th supplier where

$u$ - number of indicators

$v_i$ - the weight of the i-th KHU

$H_{i,d}$ - evaluation of i-th KHU, d-th d supplier

$\sum C_{i,d}$ - sum total evaluation KHU - final evaluation d-th supplier

A detailed overview of the evaluations of individual suppliers is provided by Table 2, where the suppliers are ranked. The supplier with the highest sum of KHU ratings will be at the top of the ranking of suppliers and we will award him 1st place.

5. Evaluation of results, selection of suppliers

By comparing the final evaluations of suppliers, we obtain the order of suppliers. The higher the value of the sum of the final evaluation $\sum C_{i,d}$, the more successful the candidate is. For a better overview, we have added the order in the evaluation order in Table 2. We decided to use the results of determining the weights of KHU because with this method (two ways) we reached the same result and the method itself provides the widest range of points of matrix elements, which is closest to the real evaluation of key weights [4].

| Indicators | The order suppliers |
|------------|---------------------|
| Weight $v_i$ | 0.38 | 0.22 | 0.22 | 0.12 | 0.06 | $\sum C_{i,d}$ - final evaluation suppliers |
| H, evaluation 1st supplier | 5 | 4 | 4 | 2 | 5 | 1. |
| C, overall evaluation U | 1.90 | 0.88 | 0.88 | 0.24 | 0.30 | 4.20 |
| H, evaluation 2nd supplier | 4 | 5 | 1 | 2 | 5 | 5. |
| C, overall evaluation U | 1.52 | 1.10 | 0.22 | 0.24 | 0.30 | 3.38 |

Table 2. Evaluation of suppliers.
Note: For the second case, on the basis of not defining the order of importance of the KHU.

The order of importance of KHU will not be determined, which means that none of the selected indicators is more important than the other KHU. We will use the Entropic method to determine the weights of KHU estimation of weights.

5.1. Supplier’s ability to meet KHU conditions
For the ability to fulfill the KHU, we will use a scale with a range from 3 to 1, while the higher the rating, the more the supplier will meet the needs of individual KHUs.

Rating:
- 3 - still meets our needs, but with significant reservations,
- 2 - even if it meets our needs at least, we currently have no choice,
- 1 - absolutely unsuitable for our needs and is unacceptable.

5.2. Allocation of points and determination of KHU sensitivity for individual suppliers
By assigning points, we evaluate the supplier’s ability to meet the requirements of KHU and by determining the sensitivity, we determine when a given indicator crosses the boundary between two evaluations. The more detailed this sensitivity is determined (the greater the range of options), the more informative the result will be. Allocation of points and sensitivity of indicators:
- 1,00b. the supplier can provide the selected indicator exactly as required without the need to use the agreed tolerance (never used the tolerance), the supplier can design new qualitatively or financially advantageous solutions,
- 0,75b. the supplier can provide the selected indicator as required in advance
- agreed tolerance (it is enough to use the tolerance once) without the intervention of the customer,
- 0,60b. new supplier with good references,
- 0,50b. the supplier can provide the selected indicator, but exceeds the agreed limits tolerances (it is enough to use the tolerance once), which triggers the intervention of the customer,
- 0,35b. the supplier is able to provide the selected indicator, exceeds the limits of the agreed tolerance and waits for the intervention of the customer to take further action, it is necessary constant supervision of the supplier in order to fulfill the contractual obligations,
- 0,25b. new customer without references,
- 0,00b. the supplier is unable to provide the selected indicator despite the contractual obligations against the customer.

In the model example, we considered six interested parties - service providers. For each supplier, we evaluated the selected KHU separately and, based on experience, we assigned points with respect to the sensitivity assigned to the point rating multiplied by 100. Subsequently, we used weights, which were determined by the Entropic method for selected key indicators and their product, we obtained the overall rating $C$ of a particular key indicator $U$ for a specific supplier $d$ [3, 10].

| Supplier | 1 | 2 | 3 | 4 | 5 | Overall Evaluation U |
|----------|---|---|---|---|---|----------------------|
| 3rd      | 4 | 3 | 5 | 4 | 1 | 2.00                 |
| 4th      | 3 | 4 | 4 | 5 | 5 | 3.00                 |
| 5th      | 2 | 4 | 4 | 3 | 5 | 6.00                 |
| 6th      | 5 | 2 | 3 | 5 | 1 | 4.00                 |

$H_e$ evaluation 3rd supplier: 4 stars.
$C_{i.d.}$ overall evaluation U = 1.52.
$H_e$ evaluation 4th supplier: 3 stars.
$C_{i.d.}$ overall evaluation U = 1.14.
$H_e$ evaluation 5th supplier: 2 stars.
$C_{i.d.}$ overall evaluation U = 0.76.
$H_e$ evaluation 6th supplier: 5 stars.
$C_{i.d.}$ overall evaluation U = 1.90.

Note: For the second case, on the basis of not defining the order of importance of the KHU.
\[ C_{i,d} = v_i \ast (H_{i,d} \ast 100) = v_i \ast K, \ (v \%), \] (3)

where \( i = 1 \) to \( u \)

\( C_{i,d} \) – overall evaluation of the i-th key indicator (U) of the d-th supplier, where

\( d = 1, 2 \ldots z \) and \( z \) denote the number of suppliers

\( u \) – the number of indicators

\( v_i \) – weight of the i-th KHU

\( K \) – coefficient expressing the degree of reliability of compliance with the requirement

\( H_{i,d} \) – point rating i-th KHU of the d-supplier

\( \Sigma C_{i,d} \) – sum of total KHU ratings – final evaluation of the first supplier

The supplier with the highest percentage of KHU ratings will be at the top of the supplier ranking and we will award him 1st place. Detailed overview of evaluations of individual suppliers provided by Table 3.

6. Evaluation of results, selection of suppliers

By comparing the final evaluations of suppliers, we obtain the order of suppliers. The higher the percentage value of the sum of the final evaluation \( \Sigma C_{i,d} \), the more successful the candidate is. For example, the first supplier meets the requirements under the KHU at 67% out of a possible 100%, therefore exceeding the percentage rating of the other suppliers. Conversely, the 3rd supplier meets the requirements of KHU only 4.20% of the possible 100% and therefore placed in the last sixth place. For a better overview, we have added the order in the evaluation order in Table 3.

| Table 3. Evaluation of individual suppliers. |
|---------------------------------------------|
| Indicators | Order of suppliers |
| U1. | U4. | U5. | U7. | U20. | \( \Sigma C_{i,d} \) final evaluation of individual suppliers in% |
| Weight \( v_i \) | 0.44 | 0.12 | 0.00 | 0.00 | 0.44 |
| \( H_{1.100} = 1st \ supplier \) | 50.00 | 100.00 | 100.00 | 100.00 | 75.00 | 1. |
| \( C_{1,d} \) overall rating U | 22.00 | 12.00 | 0.00 | 0.00 | 33.00 | 67.00 |
| \( H_{1.100} = 2nd \ supplier \) | 100.00 | 75.00 | 75.00 | 100.00 | 0.00 | 4. |
| \( C_{1,d} \) overall rating U | 44.00 | 9.00 | 0.00 | 0.00 | 0.00 | 53.00 |
| \( H_{1.100} = 3rd \ supplier \) | 0.00 | 35.00 | 100.00 | 75.00 | 0.00 | 6. |
| \( C_{1,d} \) overall rating U | 0.00 | 4.20 | 0.00 | 0.00 | 0.00 | 4.20 |
| \( H_{1.100} = 4th \ supplier \) | 0.00 | 100.00 | 75.00 | 50.00 | 100.00 | 3. |
| \( C_{1,d} \) overall rating U | 0.00 | 12.00 | 0.00 | 0.00 | 44.00 | 56.00 |
| \( H_{1.100} = 5th \ supplier \) | 60.00 | 60.00 | 60.00 | 60.00 | 60.00 | 2. |
| \( C_{1,d} \) overall rating U | 26.00 | 7.00 | 0.00 | 0.00 | 26.00 | 59.00 |
| \( H_{1.100} = 6th \ supplier \) | 25.00 | 25.00 | 25.00 | 25.00 | 25.00 | 5. |
| \( C_{1,d} \) overall rating U | 11.00 | 3.00 | 0.00 | 0.00 | 11.00 | 25.00 |

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7. Data collection for evaluation
Without knowing the appropriate data, further evaluation would be virtually impossible. Much of the appropriate data is collected gradually, by creating your own database. Such a database is created on the basis of (most often) one's own experience and it lasts certain period. Of course, the database is constantly being supplemented and changed. In certain circumstances, the necessary data can also be collected through references. However, it should be taken into account that the evaluation may be influenced by the opinion of the provider and may in extreme cases be misleading. Another way to obtain data can be a survey [1].

8. Conclusion
The calculations show that the process is very sensitive to the objectivity of the input information, which significantly affects the weight of the selected KHU in both cases. that is, whether or not the priority of the key evaluation indicators is determined. It is precisely with this increased sensitivity that this method could be closest to the objective evaluation of the weights of key evaluation indicators and, consequently, to the objectivity in determining order in the selection of suitable suppliers for individual business cases.

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