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Transportation Research Procedia 54 (2021) 69–75

Transportation Research Procedia

www.elsevier.com/locate/procedia

TransSiberia 2020 Conference

Software for the Application of the Restriction Assessment Methodology in Logistics Chains

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Abstract

The article presents a methodology for evaluating restrictions in logistics chains using intermodal transport. Based on scientific methods and consultations with experts, the methodology determines a set of potential limitations in the logistics chain and makes it possible to compare different variants of the implementation of logistics chains. Based on the definition of conditions, the methodology allows the selection of a suitable variant of the logistics chain with emphasis on the specific conditions of the evaluator. The methodology is processed in the form of a software tool, which allows its wide application in practice in the planning and selection of a suitable variant of the logistics chain with the entry of specific conditions. Logistics operators, forwarders, carriers, shippers or other entities, can use the methodology for logistics chain planning.

Keywords: Logistics Chain; Restriction Assessment; Intermodal Transport.

1. Introduction

The analysis of logistics processes in the implementation of logistics chains shows how problematic it is to determine the optimal level of individual limiting criteria. This is due to the fact that this level depends primarily on the specific needs and capabilities of the entity concerned, the scope of the logistics chain and the characteristics of the commodities transported, the geographical characteristics of the route and other factors. For the effective

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10.1016/j.trpro.2021.02.049

implementation of logistics chains, it is necessary to compare and possibly eliminate potential constraints. The given article will present the methodology of evaluation of restrictions in logistics chains using intermodal transport and describe the developed software for easier application of the given methodology in practice. The methodology defines the relevant constraints, the method of determining the weights for individual constraints and the method of comparing the level of constraints in different variants.

Thanks to software processing, the methodology can be widely applied in practice in planning and selecting a suitable variant of the logistics chain. Logistics operators, forwarders, carriers, transporters or other entities can use the methodology for planning logistics chains with the entry of specific conditions. The specific requirements of the entities concerned directly define and limit the technologies, techniques, processes and procedures that can be used in the implementation of logistics chains. Based on the set conditions, the methodology allows the selection of a suitable variant of the chain with emphasis on the conditions.

2. Materials and Methods

The first step of the research was the collection and analysis of information in the field of intermodal transport and combined transport, logistics and transport chains, the theory of bottlenecks, risks and other constraints. The first step of the research was the collection and analysis of information in the field of intermodal transport and combined transport, logistics and transport chains, the theory of bottlenecks, risks and other constraints.

For this purpose, materials from international organizations operating in the field of international intermodal transport and combined transport, information from logistics operators, international evaluation of logistics indicators from the World Bank were used. After reviewing the obtained data, a draft methodology followed, which took place in several steps.

In the first step of the methodology for the assessment of restrictions in logistics chains in intermodal transport, it is necessary to determine a set of potential restrictions. For this purpose we used scientific methods (FMEA method - Failure Mode and Effects Analysis) and consultations with experts in the field of intermodal transport, academia, logistics operators, shippers, carriers and shippers. (Kudláč et al., 2017) This set of restrictions does not include all possible restrictions, due to the variability of logistics chains, the number of restrictions can be practically infinite. The aim of the methodology was to create a set covering all relevant constraints in logistics chains so that multi-criteria evaluation would be effective in terms of time required to develop it. For better orientation, the set of restrictive criteria was divided into three levels, according to:

I. flows,
II. categories of flows and
III. restrictive criteria.

The final breakdown of the set of restrictive criteria is given in Table 1.

Table 1. Set of restrictive criteria. Source – author.

Level I	Level II	Level III
Flows	Categories of flows	Constraining criteria
Flow of materials	Continuity of a flow of materials	1. Total time of transport
		2. Conditions of customs procedures
		3. Flexibility of operators
		4. References on reliability of operators
	Appropriateness of ITU	1. Structure and capacity of ITU
		2. Technological options of ITU utilisation
	Safety of a flow of materials	1. Accident frequency
		2. Political situation
Financial flow	Level and conditions of a financial flow	1. Total costs
		2. Payment terms
		3. Financial losses securing
		4. Credibility and solvency of operators
	Safety of a financial flow	1. Safety of financial transactions
		2. Illegal charges
Information flow	Level of an information flow	1. Information on exact delivery time
		2. Technologies for information on a process state
		3. Rate of information on changes
		4. Communication with operators
	Safety of an information flow	1. Internal safety of information
		2. Information technologies for information safety

3. Results

The methodology for evaluating restrictions in logistics chains in intermodal transport is processed in the form of a software tool, which is created in Microsoft Excel. The software allows to perform a comprehensive evaluation of constraints and mutual comparison of the suitability of the implementation of various variants of the logistics chain in a user-friendly environment, thus eliminating the need for manual calculations. The basis of the software is an analytical multilevel decision method - Saaty's method, which allows detailed analysis and solution of decision problems using advanced pairwise comparison. It should be mentioned that in the first step, two variants of the logistics chain are always comprehensively compared. In case we need to assess more variants, the variant with a better overall rating is compared with another variant. Such an approach allows the comparison of any number of variants (Majerčák and Kudláč 2016; Nedeliaková et al., 2015).

The software tool is clearly divided into ten sheets of a Microsoft Excel workbook. The division allows the user to be better oriented during the evaluation. Sheet 1 serves as a guide and shows the sequence of steps for carrying out the evaluation, and Sheet 10 presents the final result of the evaluation. The outputs of the software tool are clearly displayed directly during data entry in tabular and graphical form.

Before starting the evaluation process using the software, the user prepares decision tables separately for each variant of the implementation of the logistics chain. For successful evaluation, the user goes through the individual sheets one by one.

In the first step of the evaluation, it is necessary to assess the possibility of implementing the logistics chain and to set the maximum and minimum levels of the following restrictive criteria:

- the possibility of carrying out transport in terms of the characteristics of the transported goods and the capacity of the infrastructure;
- the ability to handle an intermodal transport unit (ITU) at all points of the transport system change;
- minimum capacity of ITU;
- maximum total transport time;
- maximum level of total costs.

If the above criteria are not fulfilled, the implementation of the logistics chain in the given variant is not possible. All other evaluation steps are implemented in the software environment by moving the graphic element (Fig. 1) without the need to enter manual entries and calculations.

Fig. 1. Graphical element of the software tool. Source – author.

The second step in evaluating restrictions using software is to determine the weights of the limit criteria that the user can perform sequentially in Figures 2-4. At this stage, the user must perform a pairwise comparison of all possible pairs of constraints at a given level. The user performs the comparison by moving the slider in the graphic element intended for the given pair. For example, if the user compares material and financial flow, the runner must move closer to a more significant criterion than shown in Figure 1 (in this case, material flow is absolutely more significant than financial flow). In a similar way, the user sets the values of all compared pairs according to their own preferences. The software automatically overwrites the values corresponding to the settings in a table and automatically recalculates the values, which are then graphically displayed using pie charts. The values are then automatically rewritten in the tables in the following sheets and included in the final evaluation.

To check the logical continuity of claims, the software automatically recalculates the consistency value of the claims – consistency index. If the consistency of the statement is at the desired level - the cell is colored green. If the degree of inconsistency exceeds the allowable limit, the cell turns red. In such a case, the claims need to be reconsidered in the context of the comparisons (Máca and Leiter, 2002).

Figure 2 shows the environment of Sheet 2, setting the same weights of the basic logistics flows.

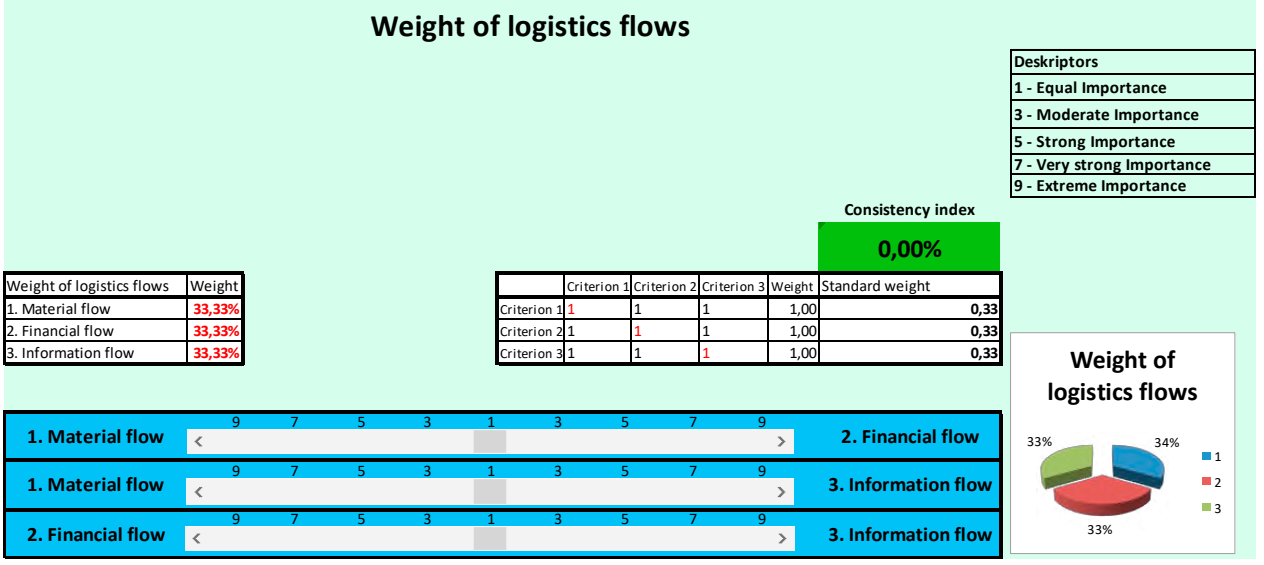

Fig. 2. Graphical environment of Sheet 2. Source – author.

The next step in the evaluation of restrictions using the proposed software is to compare the restrictions in different variants of logistics chains, which the user implements in Sheets 7 - 9. The sheets are designed separately to compare the constraints in material, financial and information flow. Comparison of restrictions in individual variants is performed in a user-friendly graphical environment without the need to manually enter values in tables (Fig.3).

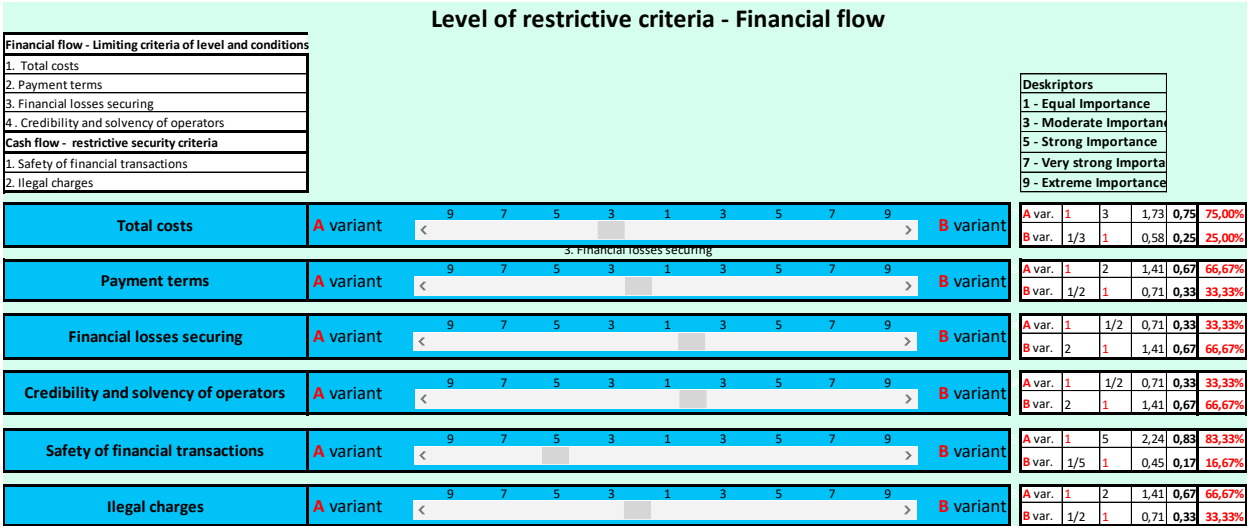

Fig. 3. Graphical environment of Sheet 8. Source – author.

All data entered in Sheets 2 - 9 are automatically processed in tabular form in Sheet 10 (Fig. 4), which shows the overall result of the evaluation of restrictions in two different variants of the implementation of the logistics chain using intermodal transport. The final evaluation of the suitability of the implementation of variants is presented in percentage. A variant is logically suitable for implementation, the limiting criteria of which across the entire logistics chain reach a better level.

In the event that both variants received the same number of percentages in the final evaluation, it is necessary to re-evaluate the previous settings in Sheets 7 - 9. Given the number and specificity of the restrictions considered in practice, such a situation is rather hypothetical.

Thanks to the detailed display of partial results, the software provides an evaluation of the suitability of variants at the level of individual categories of basic logistics flows. This fact allows a deeper analysis of the limiting criteria and provides the user with a detailed overview of the suitability of these variants at individual levels of the logistics chain.

Flows		Weights	Flow category	Weights	Restictive criteria	Weight of criteria		Level of criteria		Partial results		sults of flow categori		Overall rating	
						Relativ	Absolute	A variant	B varian	A varian	B variant	A variant	B variant	A variant	B variant
Logistics chain	Material flow	33,33%	Continuity of material flow	54,77%	1. Total time of transport	25,00%	4,56%	75,00%	25,00%	3,42%	1,14%	52,08%	47,92%	61,84%	38,16%
					2. Conditions of customs procedures	25,00%	4,56%	33,33%	66,67%	1,52%	3,04%				
					3. Flexibility of operators	25,00%	4,56%	66,67%	33,33%	3,04%	1,52%				
					4. References on reliability of operators	25,00%	4,56%	33,33%	66,67%	1,52%	3,04%				
			Appropriatenes of ITU	21,10%	1. Structure and capacity of ITU	50,00%	3,52%	50,00%	50,00%	1,76%	1,76%	58,33%	41,67%		
					2. Technological options of ITU utiisation	50,00%	3,52%	66,67%	33,33%	2,34%	1,17%				
			Safety of material flow	24,12%	1. Accident frequency	50,00%	4,02%	25,00%	75,00%	1,01%	3,02%	52,50%	47,50%		
					2. Political situation	50,00%	4,02%	80,00%	20,00%	3,22%	0,80%				
	Cash flow	33,33%	Level and conditions financial flow	33,33%	1. Total costs	51,49%	5,72%	75,00%	25,00%	4,29%	1,43%	58,02%	41,98%		
					2. Payment terms	9,68%	1,08%	66,67%	33,33%	0,72%	0,36%				
					3. Financial losses securing	14,48%	1,61%	33,33%	66,67%	0,54%	1,07%				
					4 . Credibility and solvency of operators	24,35%	2,71%	33,33%	66,67%	0,90%	1,80%				
			Safety of financial flow	66,67%	1. Safety of financial transactions	75,00%	16,67%	83,33%	16,67%	13,89%	2,78%	79,17%	20,83%		
					2. Ilegal charges	25,00%	5,56%	66,67%	33,33%	3,70%	1,85%				
	Information flow	33,33%	Level of information flow	33,33%	1. Information on exact delivery time	43,86%	4,87%	66,67%	33,33%	3,25%	1,62%	63,07%	36,93%		
					2. Technologies for information on a process state	15,51%	1,72%	33,33%	66,67%	0,57%	1,15%				
					3. Rate of information on changes	28,86%	3,21%	66,67%	33,33%	2,14%	1,07%				
					4. Communication with operators	11,78%	1,31%	80,00%	20,00%	1,05%	0,26%				
			Security of information flow	66,67%	1. Internal safety of information	25,00%	5,56%	33,33%	66,67%	1,85%	3,70%	58,33%	41,67%		
					2. Information technologies for information safety	75,00%	16,67%	66,67%	33,33%	11,11%	5,56%				
Checksums		100,00%					100,00%			61,84%	38,16%			100,00%	

Fig. 4. Graphical environment of Sheet 10. Source – author.

4. Discussion

For efficient organization and management of logistics chains using the intermodal transport system, it is necessary to identify and evaluate all relevant constraints that may negatively affect the implementation of logistics chains. The presented methodology sets out precise procedures for selecting a suitable variant for the implementation of logistics chains in intermodal transport. The methodology comprehensively evaluates restrictions in logistics chains in intermodal transport on the basis of a set of restrictive criteria, taking into account the specific requirements of the evaluator. The evaluation of restrictions is carried out on the basis of the specific needs, requirements and possibilities of the entities concerned in real-time evaluation. The entities for which the evaluation is carried out can be logistics operators, forwarders, carriers, but also the shippers themselves.

Thanks to the software solution, which eliminates manual calculations and data entry into tables, which would otherwise be necessary due to the complexity of the analytical multilevel method of multicriteria evaluation, the methodology can be used effectively in practice. Thanks to the software, the user can conveniently and clearly evaluate any number of variants of logistics chains, taking into account their specific conditions and requirements.

5. Conclusions

The methodology for evaluating restrictions in logistics chains using intermodal transport comprehensively evaluates restrictions in logistics chains, allows the selection of a suitable variant of the implementation of the logistics chain, taking into account the specific needs of the client. In addition, thanks to software processing, it can be widely used in practice. The software can be used by logistics operators compiling the logistics chain, shippers, carriers implementing the evaluation of restrictions for the selection of a suitable transport route, carriers on behalf of employees responsible for the logistics processes of the organization.

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