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ASSUMPTIONS OF TRUST IN LOGISTICS COOPERATION

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Keywords: cooperation, outsourcing, supply chain, trust, reliance on partner of exchange, dependence on partner of exchange

Abstract: As a result of the need to shorten delivery time and meet customer expectations quickly the interest in supply chain cooperation, as well as the interest in cooperation with providers of specialized logistics service increased. Cooperation in the supply chain is usually of a long-term nature. Assuptions of cooperation with providers of complex logistics service also concern longer period of time. This increases the importance of trust, that the other party will work in the interest of cooperation even if the conditions in environment change and the agreement does not contain detailed provisions concerning such changes. The purpose of this article is to present determinants of trust in logistics cooperation, together with description of the role of trust in development and achievement of expected benefits in logistics cooperation.

1 Introduction

As a result of the need to shorten delivery time and meet customer expectations quickly, the interest in supply chain cooperation, as well as the interest in cooperation with providers of specialized logistics service increased.

Cooperation in the supply chain is usually of a long-term nature and requires frequent adjustments to changing needs of customers. Assuptions of cooperation with providers of complex logistics service also concern longer period of time. This increases the importance of trust, that the other party will work in the interest of cooperation even if the conditions in environment change and the agreement does not contain detailed provisions concerning such changes. Under the influence of the actions undertaken, trust between cooperating units may develop over time. In case of unfavorable, opportunistic actions the trust can be reduced or even eliminated.

The purpose of this article is to present determinants of trust in logistics cooperation, together with description of the role of trust in development and achievement of expected benefits in logistics cooperation *(The publication was financed from the resources allocated to the Management Faculty of Cracow University of Economics, under the grant for the maintenance of the research potential).*

2 Types of relationships in logistics cooperation

Distinguishing relationships in logistic cooperation, exchange of information, scope of cooperation and the attitude of each party to the organizational culture of partner can be highlighted, as general criteria of differentiation. Using these criteria following types of relationship can be distinguished [7]:

- adversarial – based on individual transactions, parties to cooperation share the small scope information, required in each transaction, there is a wide range of cooperation with the competitors of partner, parties are characterized by separate, different organizational cultures,
- informal cooperation – the way of linking parties is difficult to determine, the scope of information exchanged is small (it concerns transactions and occasional cooperative support in activities beyond the scope of cooperation), the range of cooperation with competitors of partner is wide, organizational cultures of partners separate.
- contractual – based on a medium-term contract, the scope of information provided by partners is broader, limited cooperation with competitors of partner (eg. to meet sudden increase of demand in a short period of time),
- formal alliance – long-term contracts between parties, greater scope of information shared, scope of cooperation with the competitors of partner is small, organizational cultures of parties to contract are similar,
- minority investment – based on long-term contracts, on the basis of such contracts one party to contract undertakes minority investment in cooperation, the scope of information shared is higher, than in previous types of relationships, further reduction of cooperation with the competitors of partner, organizational cultures similar,
- joint venture – based on long-term contracts, including mutual involvement of capital, risk and benefit sharing, wide range of information shared, according to requirements of ventures, the scale of cooperation with competitors of partners small (considered in situations of emergency), common organizational culture,
- vertical integration – also based on long-term contracts, full reciprocal access to information held by partner, limited extent of cooperation with the competitors of partner, common organizational culture common.

Concerning selected types of relationships it should be noted, that it is very difficult to indicate the exact boundaries, concerning occurrence of features represented by mentioned criteria. Presented approach can be treated rather as description of way, how features represented by criteria can change, along with the development of cooperation.

From the point of view of the need to describe and analyze the relationship between the principal and the specialized logistics service provider, the above distinction can suplemented by the proposal of outsourcing typology. In this typology, the scope of outsourced services and the need to delegate decision-making powers, concerning implementation and improvement of outsourced tasks to the provider are basic criteria for distinguishing types of cooperation [6]:

- individual outsourcing (outsourcing tasks within a single, specialized workplace where the client needs a knowledge in the unknown area for a certain period of time),
- functional outsourcing (outsourcing a specific functional activity of organization that is costly for principal),
- competence outsourcing (ensuring competent decision-making powers of the service provider for the implementation and improvement of outsourced tasks).

Individual outsourcing may concern specific forwarding service. An example of functional outsourcing may be the cooperation with distribution service provider. The example of competence outsourcing, complex order processing and delivery to customers can be described. As the scope of outsourced service and the acquisition of decision-making competence by the provider increases, the importance of trust in such an entity is emphasized.

Considering detailed guidance on the suitability of these types of relationships in supply chain cooperation it can be stated, that business-to-business relationships should be based on a partnership, understood as creation of relationships based on trust, sharing risks and benefits, resulting in additional, synergic effects and competitive advantage [9]. In detail, the following features of such partnerships in the supply chain can be distinguished [8]:

- collaboration - informal agreements for strategic alliances, common information-sharing links to ensure transparency and understanding of activities undertaken, usually associated with formal contracts, enabling management of inventories by suppliers, joint planning, forecasting and replenishment,
- confidence in partners – concerning quality of delivered goods, delivery skills, delivery times, delivery capacity, financial security, capacity, quality of performance, risk management and risk mitigation,
- visibility of activities and effects across all partners in the chain – information exchange, concerning inventory levels, demand, seasonality, promotions, new product development, conditions of supply and distribution to recipients, production and supply schedules, performance, risk, unpredictable events, lost sales, ensuring immediate flow of current information when new risk factors occur is also important, this allows to adjust the action to new risks and to reduce risks,
- process convergence – it concerns the need to adapt the processes implemented by partners in the chain to common standards, which become accepted as a daily mode of work over time, the example is adaptation of enterprises in supply chain to Just In Time concept, as well as implementation of overall quality management and joint risk management,
- high velocity – it refers to the time when goods move from the first suppliers to the final customer, closely related to the reduction of storage time, time of waiting for production, time for movement of materials, semi-finished products between the manufacturing stages, dependence on the level of integration of the partners is important.

Features presented can be seen as the most important from the point of view of organization and cooperation in the supply chain. Among these features trust (confidence) in partners is considered. From the point of view of the essence of trust and the foundations of cooperation, the use of trust as a condition influencing cooperation has its own limitations.

3 The importance of trust in logistics cooperation

On the basis of presented typology of relationships it can be stated, that together with the integration of cooperation the importance of mutual trust of individuals representing cooperating enterprises increases. Because the cooperation on the market is related to the rational choice of the partner, in description of relationship between companies also the reliance on partner shoud be taken into consideration. Reliance, closely related to trust can be described as a positive expectation of one party, that its specific needs will be met by the partner, taking into account its proven capabilities or existing, proven standards of exchange. Such reliance on partner is derived from the belief and desire to remain in the relationship *(Wide range of features distinguishing the concept of reliance on partner of exchange from trust between the representatives of partners is outlined in: [2]).*

In the area of outsourcing of single, uncomplicated types of work and recipient's focus on detailed control of performance of supplier, trust may play a negligible role. This applies in particular to contract aspect of trust, as well as to trust in the goodwill of suppliers. If particular control of vendor concerns also the performance and results of activity it can be concluded, that trust in the supplier's competence is low. If the recipient of goods and service extends the scope of outsourced service, period of cooperation is longer and the access of the provider to principal's own information increases it can be said, that the recipient relies on his supplier, trust in competence and goodwill of supplier increases.

The ability to create climate for mutual reliance concerns also establishing the relationship, that is based primarily on dependence on the other side of cooperation. The concept of dependence on other party involves the need to enter into a relationship with such entity, due to the lack of other possibilities [1], [2]. However, the basic condition for changing the approach of dependent party (from dependence to reliance) may be the behavior of the supplier avoiding the use of its advantage on dependent party.

Taking into account the classification of outsourcing types, presented in this article it should be noted, that there is assumption for each of these types of cooperation, that the principal uses the service of a specialized company. Therefore, principal should be able to rely on service provider. Considering the trust between cooperating parties it is important to add, that it is emphasized in competence outsourcing. Although there should be mutual trust in all its dimensions in competence outsourcing, from the point of view of the ability to achieve the assumed effects of cooperation, contractual trust and competence trust in service provider should already exist in individual outsourcing and functional outsourcing.

Beside presented types of relationships, there may also be other situations with positive expectations, regarding the ability of partner to achieve results of cooperation. This can be accompanied by contractual trust, confidence in goodwill, and competence trust. It is related to aforementioned rationality of partner selection, often based on a thorough recognition of the experience and achievements in cooperation with existing principals. Taking into account the current importance of logistics in achieving and maintaining competitive advantage, the recognition of the current history of achievements of considered partner and ability to cut the time needed to ensure reciprocal reliance on parties, as well as trust between employees representing those parties is of particular importance.

Considering the nature of the relationship and the place of trust between companies in the supply chain, the essence of this form of cooperation should be taken as a starting point. As a result of integration of partners' activities, often combined with far-reaching commitment to the core business of suppliers and customers, reliance on partner, as well as ensuring trust in all dimensions between individuals representing parties in the supply chain are key factors of success of cooperation. The fulfillment of these conditions is considered as the basis for ensuring the stability of relations between partners *(Taking into account the trust between employees representing parties to contract and the reliance on partner as main dimensions of the relationship, together with presented, stable relationship, one can also distinguish: personal relationship (high trust and low reliance on partner), unstable relationship (low trust and low reliance on partner) and ad hoc relationship (low trust and high reliance on partner) [5])*.

The need to develop trust in all dimensions is confirmed by results of research presented in sources of literature on the importance of trust in interorganizational management *(Wide range of results of research on the role of trust in inter-organizational management is presented in: [3], [4])*. These studies concerned primarily alliances. Taking into account the characteristics of relationships in supply chains, as well as the characteristics of long-term, bilateral cooperation with suppliers of complex logistics services, the mentioned results may also be considered in logistics cooperation. According to these results, confidence in a partner's goodwill is more important in the sharing of material resources, while competence trust plays a greater role in the sharing of intangible assets. Developing trust in all dimensions between partners as well as sharing mechanisms (tangible and intangible) increases the likelihood of meeting the objectives of cooperation. Trust between organizations is positively influenced by interpersonal trust. Trust between organizations has a positive impact on engagement, knowledge sharing and specific investment in relationships. On the other hand, opportunistic behavior (of suppliers) have a negative influence on inter-organizational trust [4].

There are also companies with unique resources which might potentially have a tendency to influence excessively on dependent parties in the supply chain. However, the specificity of cooperation in the supply chain requires a significant mutual alignment between partners. As a result, the tendency of companies with unique resources to influence other partners can be significantly reduced. The limitation for such units may be the cost of resigning from cooperation in the supply chain, acquiring new customers and adapting to its requirements.

It is also important to take into consideration relationships with logistic service providers, along with relationships between companies, that are main partners in supply chain. The entire chain can be managed by the company, acting as Supply Chain Management operator. Such operator can influence all activities in the chain, as well as all dyadic relationships.

4 Conclusions

The content of the article has been developed to a great extent on the study of literature sources. Presented considerations are of preliminary character. From the point of view of the need for analysis and assessment of existing relationship, an attempt should be made to identify coherent set of criteria allowing to assess levels of trust of employees, that represent collaborating companies, the reliance of each party on the partner and possible dependence on partner. It may also be interesting to isolate the key criteria particularly useful in assessment of the relationship between companies cooperating in logistics area and determining the influence of trust between individuals representing partners to ensure the stability of the relationship between these partners. Mutual influence of bilateral relations, shaping the supply chain is also important.

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A UNIFIED MACHINE FOR TECHNOLOGICAL ELECTRIC TRANSPORT LADDER-BACKBONE LOAD-BEARING SYSTEM

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Keywords: load-bearing system, ladder-backbone, technological electric transport, comparative analysis
Abstract: Frequently in a process of developing new specialized models of wheeled vehicles, the task of integrating a multitude of design criteria for parts, assemblies and mechanisms arises. Using a comparative analysis of various design solutions allows to determine the most optimal options for their design. The authors compare two possible layout drawings of the UMTET load-bearing frame: a simple ladder frame and a combined ladder-backbone load-bearing system. Based on the presented design and layout and weight characteristics, as well as the results of the estimated numerical strength analysis, it is concluded that there are certain advantages of using a combined ladder-backbone frame for the UMTET design.

1 Introduction

The article is a continuation of the previous article with the title *"A UNIFIED MACHINE FOR TECHNOLOGICAL ELECTRIC TRANSPORT LOAD-BEARING SYSTEM"*. The UMTET load-bearing system like any other wheeled vehicle has a whole range of static and dynamic loads during operation [1-10].

2 UMTET standard rolled profile combine ladder-backbone frame

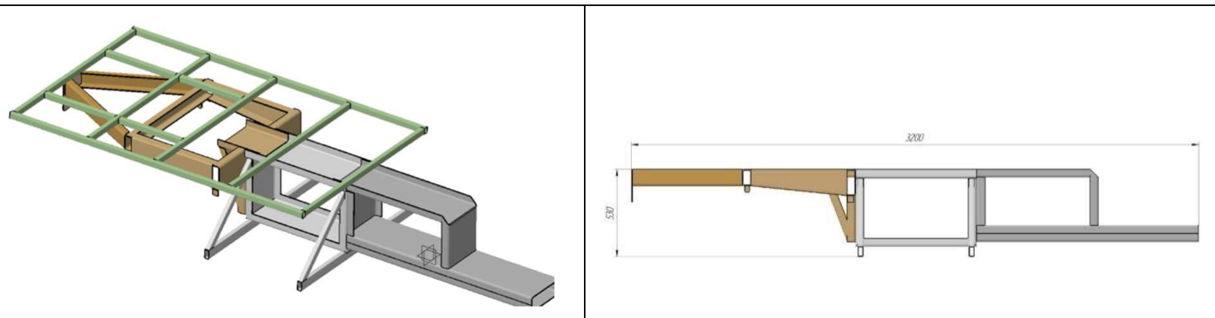
The construction (Figure 1) is a complex space system consisting of a main frame and the subframe that are designed to provide the basing and assembly of all parts and assemblies of UMTET.

The advantages of combined ladder-backbone frame:

- Providing the required geometric dimensions (width - 1180 mm, length - 3200 mm, height - 530 mm);
- the design is developed from standard steel profiles (St40), which significantly reduces the cost of production;
- the possibility of assembly and basing most of the UMTET units and assemblies (Figure 2) and mounting traction batteries of various sizes;
- relatively small mass of the load-bearing system (170 kg).

Disadvantages:

- Specialized equipment is required for the manufacturing, which increases its cost.



a) b)

Figure 1 UMTET ladder-backbone load-bearing system a) geometric model b) overall dimensions

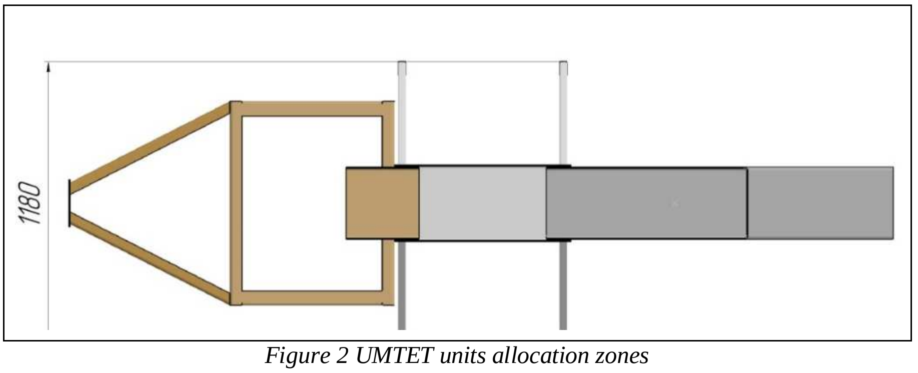


Figure 2 UMTET units allocation zones

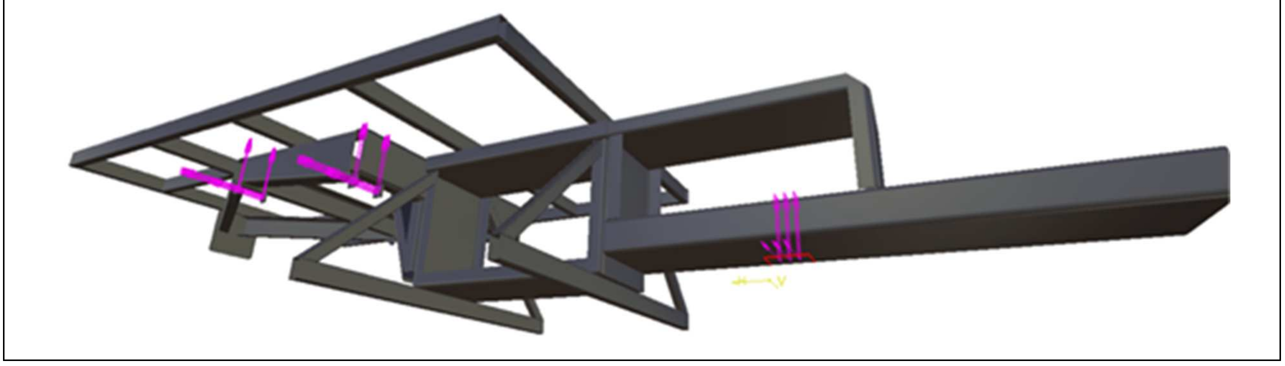
3 UMTET Workload Impact Numerical Strength Analysis

The principles and characteristics of the structure numerical strength analysis are similar to the simple ladder system described above but due to the fact that the geometry, material and layout characteristics are significantly different, Figure 3 shows the relevant material characteristics of the structure under consideration, the mounting zones and the application of forces.

- Vertical load of 30000 N (nominal load-bearing capacity of UMTET) is applied to the framework area of the load platform;
- on the mounting zones of the battery in the middle of the load-bearing system, the load is 6500 N (battery weight);
- The load of 2500 N is applied to the front of the load-bearing system.

Figure 4 shows the results of a numerical analysis, from which it is concluded that there are no failure stresses when specified loads are applied.

Mounting zones



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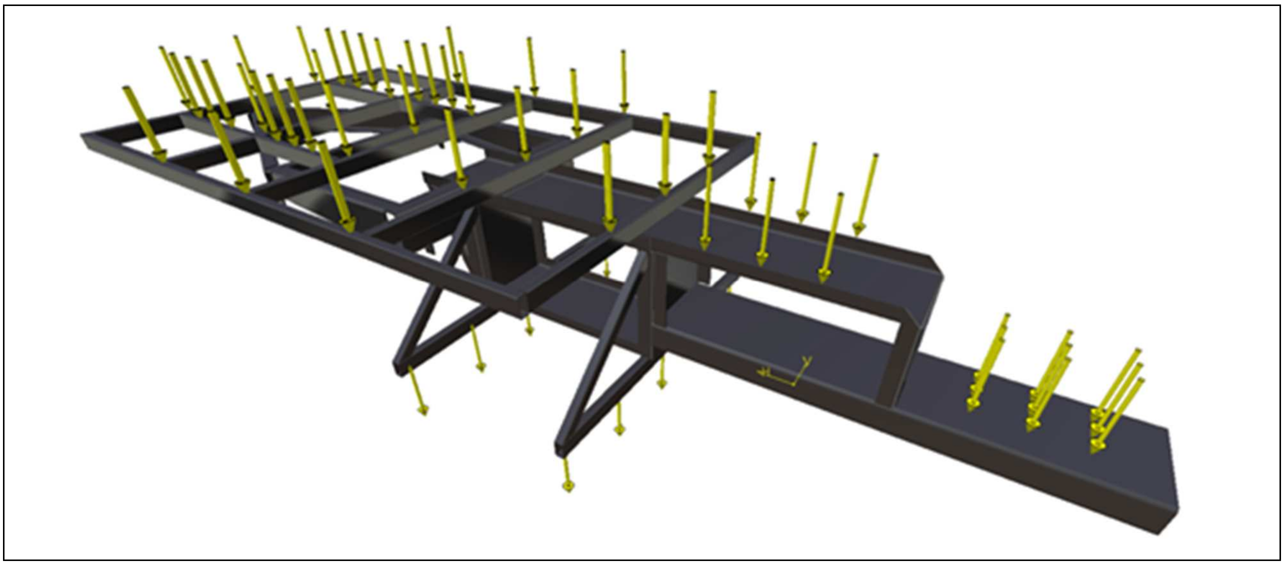

Figure 3 UMTET ladder-backbone load-bearing system calculated numerical model characteristics

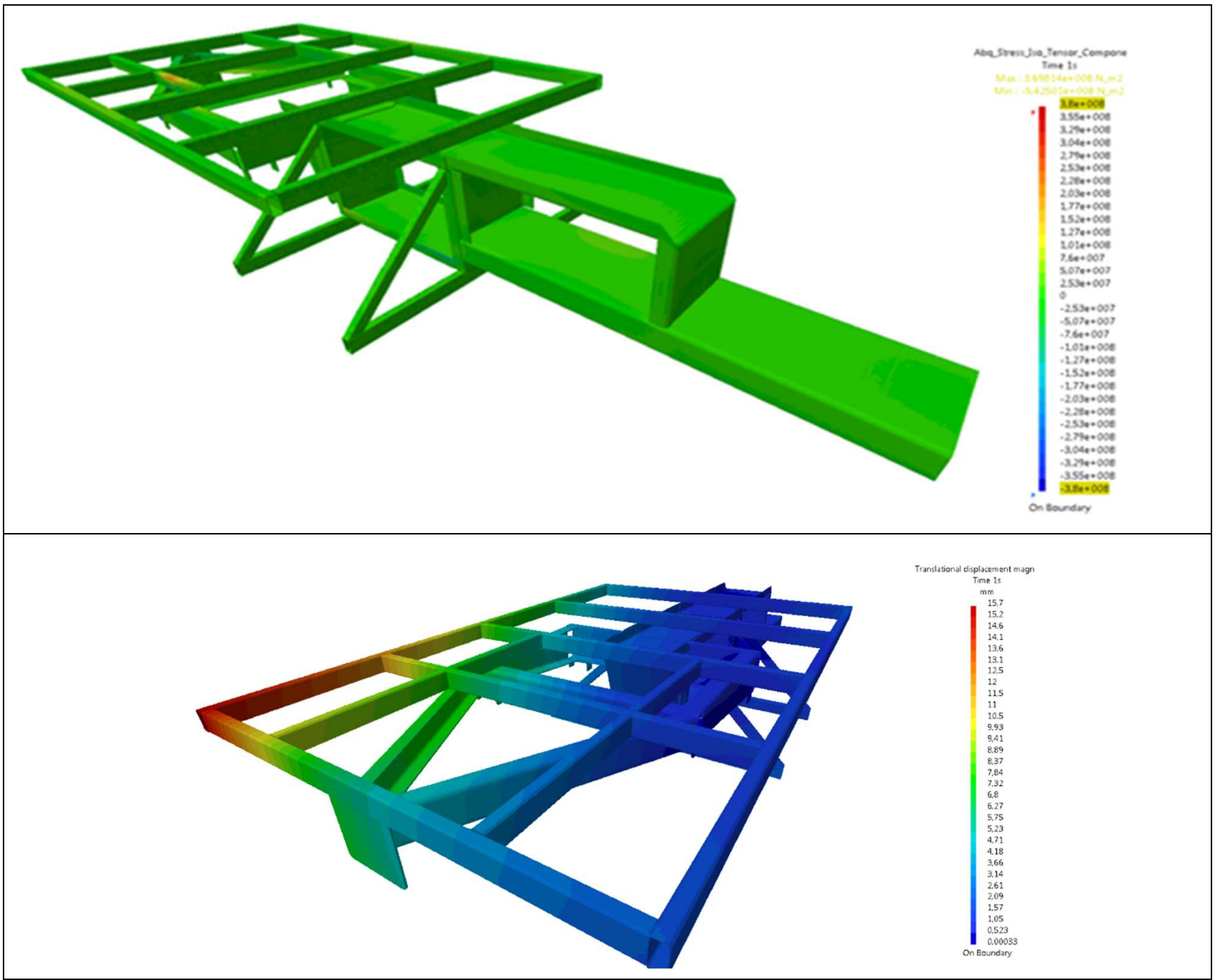

Figure 4 The results of the numerical analysis of the UMTET ladder-backbone load-bearing system under the influence of vertical static loads

4 Conclusion

Estimating and comparing the UMTET ladder and ladder-backbone schemes of load-bearing systems characteristics, the following conclusions should be drawn. With a certain assumption, both options can be used. However, the variant with the combined ladder-backbone load-bearing system is preferable for a vehicle equipped with an electric motor since with sufficient strength characteristics the combined ladder-backbone scheme has more possibilities for the power unit location due to the smaller weight of the construction and the versatility of the battery mounting both with variability of basing of other units and aggregates.

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LACK OF STOCKS RISK REDUCTION

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Keywords: costs, stocks, price, average, standard deviation
Abstract: Within the present market conditions, stock control is ranked among very complicated spheres. Stocks not only cover possible outages in deliveries but also mean cost burdens for the company. Lately, a number of companies makes effort to determine exactly the amount of the buffer stocks which can protect them against negative effects of the surrounding. Logical conceptions offer a possibility of the use of different instruments for the determination of the buffer stock. However, a number of them uses a complicated mathematical apparatus, which is unsuitable for the practical usage under the industrial conditions. This article deals with an analysis of the use of a simple operative instrument for the determination of the amount of the buffer stock. For the analytic part, data from selected industrial enterprises in the Czech Republic were used.

1 Stocks and their meaning for competitiveness

Stocks bring significant expenses for the company related to their keeping. We consider the stocks to be an immediate natural element in manufacturing organizations. Stocks are considered to be such a part of the utility values which were already manufactured but were not consumed yet [1]. Stocks keeping means not only benefits for the enterprise but also negative effects.

The main benefits of the stocks can be classified by the following points:

- continual production process,
- quick reaction to the customer's requirements,
- stability of all processes.

Negative consequences of the stocks are linked, firstly, to that they bind capital, consume other work and resources and bring with them a risk of devaluation, inapplicability and non-saleability. Increasing competition on the markets together with a high interest rate for short-term loans can bring to that the capital invested in stocks is missing for financing technical and technological development, and threatens liquidity (financial solvency) of the enterprise and decreases its trustfulness during its negotiation on loans [2]. Without question, they are a factor which fundamentally effects competitiveness of each company. A high level of the stocks causes allocation of the financial resources in the stocks, but at the same time optimizes adequate flexibility of supplies. Both these effects are, however, antagonistic, and it will be always important to find out a certain compromise. In case of manufacturing companies, stocks are ranked among financially bulkiest categories. That's also why decisions related to the stocks control system are often essentially strategic.

Japanese Material Flows Management Systems consider the stocks to be a strong negative factor. At present, the Japanese already consider the thought that stocks are necessity as wrong and harmful; that's why they constantly fight against their creation [3]. Stocks are considered to be a cause of hiding a series of operational problems. Where there are no stocks, there is no need to control their amount and movement. Storage areas are being saved; due to decreasing the waiting times, production cycles are also being decreased; a risk of inapplicability and non-saleability of the stocks is being eliminated [4]. Small stocks don't also enable us to significantly suddenly increase disproportionately a production cycle because they don't allow the increase of the working pace. Accordingly, no ripple effect occurs when the company tries to catch up a delay and losses within an extremely short time. Within this conception, the overall quality of production is naturally significantly being decreased. Thus low production stocks support a sufficient level of the production speed.

Stocks both bind a significant capital and also decline the enterprise's profit. Since they - being a part of the current assets - are mostly financed by a borrowed capital, the interest costs influence company's economy as well as storage costs and other expenses related to the stocks. By this, profitability is burdened by the stocks twice. Till this time, an opinion is very widened that stocks secure smooth and economic production, a constant level of loading and a high level of service for customers. Just hesitantly there is being promoted knowledge that stocks hide uncoordinated capacities and processes predisposed to failures and that they bind available means [5].

2 Risk of lack of stock

A lack of stocks can mean threatening of smoothness of production, or even loss of a customer. A lack of raw materials, then, can be given by unpredictable material consumption or by an outage in supplies. In case of companies dealing in the sphere of production of motor-cars, possible penalties resulting from breaching suppliers' relationships can be liquidating for the company. In this sphere, penalties for undelivered components can reach thousands of EUROs per minutes [6], [7]. One of the ways which enables prevention of the above-mentioned problems is keeping a supplementary, i.e. buffer stock. In this case, it is necessary to consider costs for keeping a buffer stock against a risk and loss linked to the depletion of stocks. A concrete amount of the buffer stock can be determined either by means of simulative or statistical methods. Maintenance of the buffer stock at such a level which should prevent from a lack of reserves for all cases would be uselessly expensive for the company. Impacts of a lack that occurs once a year can be much less that costs for year-round maintenance of sufficient stocks. By this reason, it is usual in practice that a company will make a decision to maintain a buffer stock which will protect it not in all cases but, for example, in 90 % of all cases. A percentage of cases when a lack of stock doesn't occur is called an operating level. In other words, it means a probability of that a size of demand in the course of the of order realization cycle will not be higher than the available stock [2]. The higher this operating level is, the higher the required buffer stock and connected with it costs linked to the maintenance of stocks are, but the lower a possibility of a lack of stock and its impact are. The hundred-per-cent operating level then means that the probability of a lack of stock is zero and the entire demand will be satisfied [8]. To determine a suitable amount of the buffer stock, we can use a series of logistic procedures. A very simple and practically easy applicable concept represents a model of determination of the buffer stock with help of a formula (1)

$$PZ = k\sqrt{\overline{R}\cdot(\sigma_d)^2 + \overline{D}^2\cdot(\sigma_R)^2} \qquad (1)$$

Separate variables in the formula mean:
K - coefficient of provision,
R - average durability of the order realization cycle,
σ_D - standard deviation of the daily sale,
D - average daily sale,
σ_R - standard deviation of the order realization cycle.

This model enable determination of the buffer stock by means of an analysis of data about consumption and delivery times. Arithmetic average and standard deviation values are specified for these indicators.

3 Experimental determination of the buffer stock amount

Within the performed analysis in company Hahn Automation, (hereunder referred as Company A) and in company Humpolecké strojírny (hereunder referred as Company B), experimental determination of the buffer stock amount were performed. As input data, there were used data about thirty-days consumption. For analysis of data, a month was chosen in which consumption complies with the average consumptions during the entire year.

Table 1 shows development of consumption in tons. At the same time, data about delivery times are recording into the table. On the basis of these data, we can determine an amount of the buffer stock. For the data about consumption, we will determine the chosen statistic indicators that we need for the determination of the buffer stock (the simple arithmetical average, the standard deviation). Values of these statistic indicators are displayed for the above-mentioned data within Table 1.

Table 1 Development of consumption of Company A

	Company A	
	Consumption	Delivery time
Day	(t)	(day)
1.	25	6
2.	6	6
3.	14	7
4.	14	6
5.	2	8
6.	2	5
7.	20	
8.	21	
9.	1	
10.	16	
11.	18	
12.	6	
13.	10	
14.	32	

15.	12	
16.	25	
17.	10	
18.	12	
19.	8	
20.	12	
21.	17	
22.	20	
23.	6	
24.	90	
25.	20	
26.	10	
27.	10	
28.	17	
29.	16	
30.	10	
Average	16.06	6.33
σ	15.48	0.94

To determine an amount of the buffer stock, we have to use - together with above-mentioned statistical indicators - coefficient of provision. Its value in principle shows us a risk level which the enterprise is willing to accept during creation of the buffer stocks. Concrete values of the coefficient of provision are specified in Table 2. Then, the operating level of 15 % means that the enterprise is willing to accept a risk of a lack of stocks in the amount of 15 %. A higher level of provision then naturally means a higher volume of stocks in storehouse and thus also higher cohesion of the capital in stocks. The determination of the buffer stock will be performed for all values of the coefficient of provision that is specified in table 2.

Table 2 Values of coefficient of provision

Operating level (%)	Coefficient of provision (k)	Risk of lack of stocks (%)
85	1.036	15
86	1.08	14
87	1.126	13
88	1.175	12
89	1.227	11
90	1.282	10
91	1.341	9
92	1.405	8
93	1.476	7
94	1.555	6
95	1.645	5
96	1.751	4
97	1.881	3
98	2.054	2
99	2.326	1

The calculation of the buffer stock for the consumption and delivery times specified in Table 1 can be written as follows:

$$PZ = k\sqrt{\overline{R}\cdot(\sigma_d)^2 + \overline{D}^2\cdot(\sigma_R)^2}$$

$$PZ(99\%) = 2,326\sqrt{6,33\cdot 15,48^2 + 16,06^2\cdot 0,94^2} = \underline{\underline{97,13}}$$

$$PZ(98\%) = 2,054\sqrt{6,33\cdot 15,48^2 + 16,06^2\cdot 0,94^2} = \underline{\underline{85,77}}$$

$$PZ(97\%) = 1,881\sqrt{6,33\cdot 15,48^2 + 16,06^2\cdot 0,94^2} = \underline{\underline{78,55}}$$

$$PZ(96\%) = 1,751\sqrt{6,33\cdot 15,48^2 + 16,06^2\cdot 0,94^2} = \underline{\underline{73,12}}$$

$$PZ(95\%) = 1,645\sqrt{6,33\cdot 15,48^2 + 16,06^2\cdot 0,94^2} = \underline{\underline{68,69}}$$

$$PZ(94\%) = 1,555\sqrt{6,33\cdot 15,48^2 + 16,06^2\cdot 0,94^2} = \underline{\underline{64,93}}$$

$$PZ(93\%) = 1,476\sqrt{6,33\cdot 15,48^2 + 16,06^2\cdot 0,94^2} = \underline{\underline{61,63}}$$

$$PZ(92\%) = 1,405\sqrt{6,33\cdot 15,48^2 + 16,06^2\cdot 0,94^2} = \underline{\underline{58,67}}$$

$$PZ(91\%) = 1,341\sqrt{6,33\cdot 15,48^2 + 16,06^2\cdot 0,94^2} = \underline{\underline{56,00}}$$

$$PZ(90\%) = 1,282\sqrt{6,33\cdot 15,48^2 + 16,06^2\cdot 0,94^2} = \underline{\underline{53,53}}$$

$$PZ(89\%) = 1,227\sqrt{6,33\cdot 15,48^2 + 16,06^2\cdot 0,94^2} = \underline{\underline{51,23}}$$

$$PZ(88\%) = 1,175\sqrt{6,33\cdot 15,48^2 + 16,06^2\cdot 0,94^2} = \underline{\underline{49,07}}$$

$$PZ(87\%) = 1,126\sqrt{6,33\cdot 15,48^2 + 16,06^2\cdot 0,94^2} = \underline{\underline{47,02}}$$

$$PZ(86\%) = 1,080\sqrt{6,33\cdot 15,48^2 + 16,06^2\cdot 0,94^2} = \underline{\underline{45,10}}$$

$$PZ(85\%) = 1,036\sqrt{6,33\cdot 15,48^2 + 16,06^2\cdot 0,94^2} = \underline{\underline{43,26}}$$

The highest degree of provision then represents by a buffer stock for the operating level of 99 %. In this case, the monitored company accepts only a 1 % risk of a possible lack of stocks. The determined value of the buffer stock for this degree of provision is 97.13 tons. By comparing this value with the statistic indicators specified in Table 1, we can determine that it is a consumption multiply higher than the average consumption.

A high value of the buffer stock in this case is also given by a relatively high standard deviation, which shows a measure of variability of the statistic set. Higher variability will be then mean a higher value of the buffer stocks and a higher cohesion of the capital in stocks.

Table 3 Development of consumption of Company B

	Company B	
	Consumption	Delivery time
Day	(t)	(day)
1.	6	8
2.	10	10
3.	8	7
4.	14	10
5.	8	9
6.	8	8
7.	11	
8.	9	
9.	12	
10.	6	
11.	14	
12.	10	
13.	9	
14.	12	
15.	16	
16.	13	
17.	13	
18.	9	
19.	12	
20.	11	
21.	10	
22.	11	
23.	9	
24.	9	
25.	9	
26.	8	
27.	14	
28.	12	
29.	12	
30.	13	
Average	10.60	8.67
σ	2.43	1.11

An amount of the buffer stock for the data from Company B specified in Table 3. It will be performed by the same method. Again, there were determined values of the statistic indicators for the analyzed data. In this case, it is clear that the consumption has significantly steadier character. The average consumption and the standard deviation value is significantly lower.

On the basis of these values and the coefficient of provision, we can determine values of the buffer stock as follows:

$$PZ = k\sqrt{\overline{R}\cdot(\sigma_d)^2 + \overline{D}^2\cdot(\sigma_R)^2}$$

$$PZ(99\%) = 2,326\sqrt{8,67\cdot 2,43^2 + 10,60^2\cdot 1,11^2} = \underline{\underline{32,02}}$$

$$PZ(98\%) = 2,054\sqrt{8,67\cdot 2,43^2 + 10,60^2\cdot 1,11^2} = \underline{\underline{28,28}}$$

$$PZ(97\%) = 1,881\sqrt{8,67\cdot 2,43^2 + 10,60^2\cdot 1,11^2} = \underline{\underline{25,90}}$$

$$PZ(96\%) = 1,751\sqrt{8,67\cdot 2,43^2 + 10,60^2\cdot 1,11^2} = \underline{\underline{24,11}}$$

$$PZ(95\%) = 1,645\sqrt{8,67\cdot 2,43^2 + 10,60^2\cdot 1,11^2} = \underline{\underline{22,65}}$$

$$PZ(94\%) = 1,555\sqrt{8,67\cdot 2,43^2 + 10,60^2\cdot 1,11^2} = \underline{\underline{21,41}}$$

$$PZ(93\%) = 1,476\sqrt{8,67\cdot 2,43^2 + 10,60^2\cdot 1,11^2} = \underline{\underline{20,32}}$$

$$PZ(92\%) = 1,405\sqrt{8,67\cdot 2,43^2 + 10,60^2\cdot 1,11^2} = \underline{\underline{19,34}}$$

$$PZ(91\%) = 1,341\sqrt{8,67\cdot 2,43^2 + 10,60^2\cdot 1,11^2} = \underline{\underline{18,46}}$$

$$PZ(90\%) = 1,282\sqrt{8,67\cdot 2,43^2 + 10,60^2\cdot 1,11^2} = \underline{\underline{17,65}}$$

$$PZ(89\%) = 1,227\sqrt{8,67\cdot 2,43^2 + 10,60^2\cdot 1,11^2} = \underline{\underline{16,89}}$$

$$PZ(88\%) = 1,175\sqrt{8,67\cdot 2,43^2 + 10,60^2\cdot 1,11^2} = \underline{\underline{16,18}}$$

$$PZ(87\%) = 1,126\sqrt{8,67\cdot 2,43^2 + 10,60^2\cdot 1,11^2} = \underline{\underline{15,51}}$$

$$PZ(86\%) = 1,080\sqrt{8,67\cdot 2,43^2 + 10,60^2\cdot 1,11^2} = \underline{\underline{14,87}}$$

$$PZ(85\%) = 1,036\sqrt{8,67\cdot 2,43^2 + 10,60^2\cdot 1,11^2} = \underline{\underline{14,26}}$$

The calculated amount of the buffer stock for the degree of provision of 99 % in this case is 32.02 tons. Thus, it is approximately one third of the value of the buffer stock compared to the previous company. In case of this degree of provision, the company will have therefore a significantly lower value of the tied financial means in the stocks. At selection of a suitable degree of provision, it is necessary to evaluate a series of factors, first of all, a risk of possible outages, but also its possible consequences. In case of big economic impacts resulting from a lack of stocks, it will be therefore more suitable to use a higher degree of provision. Provided the eventual risk of a possible lack of stock and their consequences is small, from the economic point of view, it is more suitable to use a lower degree of provision.

4 Conclusion

The determination of the correct value of the buffer stock can fundamentally contribute to the competitiveness of the enterprise. High quantity of stocks brings a possibility of a quick reaction to the customer's requirements, but at the same time means increasing the costs. In case that within a longer period of time the company keeps an above-limit quantity of stocks, it can influence their economic results. In a series of industrial branches however it will be necessary to maintain a certain level of the buffer stocks by technological reasons. The key aspect then will be the setting of a suitable level of the buffer stocks which will enable you to minimize risks resulting from a possible lack, but also will not mean the costs increasing.

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DATA STRUCTURE OF INBOUND AND OUTBOUND MATERIAL FOR PLANNING AND LOGISTIC STREAMLINING IN COMPANIES

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Keywords: data, structure, material, PFEP, inventory, calculation
Abstract: An accessible and streamlined data structure is a prerequisite for the proper and efficient operation of all activities related to each department in each company. In the case of production and logistics, it also fulfills the support function for planning changes or optimizing the current state in the light of easily and rapidly available data on materials found in the company. Such structured data is also referred to in the foreign literature by the abbreviation PFEP, which is the name of the Plan for each part, and in translation into Slovak, a plan for each part.

1 Introduction

The article was created on the basis of a case study from practice. The topicality of the article is also illustrated by the situation in the industry where there is a demand for ever greater energy savings and thus a saving of money while preserving the same price of products. It is precisely for this demand that the number of competing companies offering products for the same purposes is growing. That's why the goal is to make all processes more efficient across the company. The way the data structure, its updating, availability and method of processing should be effective as well. Efficient data management in production and logistics is important because logistics is able to influence the part of the costs that are taken into account in product pricing and therefore directly influences the competitiveness of the company. Waste and no value adding activities in processes today are not only in production or logistics activities, it can also be seen from data and table sharing, availability, upgrading and data integration in one place for their availability in the shortest possible time.

2 Data and methodology

For possible optimization of supply, it is necessary to have complete information on the materials and parts for production used in the manufacture and assembly process (Figure 1). The flow of information in the logistics system is as important as the flow of material, information is considered to be the main source in the logistics system [1]. This is the structure of data with the “plan for each part” (PFEP shortcut) (Table 1). It is essential that information is divided into elementary parts, e.g. pack sizes on separate column length, width, height, so it's easy to filter individual information. It is a great help in planning new racks, warehouses and also in the calculation of the load of supply tuggers, forklifts, or when designing the workplace.

An important part is also the PFEP section of the supplier's data sheet, delivery times, distance and supplier availability. These data can later be used to reduce inventory in the production process. Inventories address the time gap between production and consumption, local mismatch between production and consumption, capacity mismatch between downstream production and transport systems [2].

This is possible based on filtering and ordering of suppliers according to the distance and time of delivery of the material. With local suppliers, it is possible to use the principle of increasing the frequency of supply and reducing the supply of material.

By integrating the supplier rating column into the PFEP table, it adds importance to this data when defining the feed-in strategy for certain processes and also defining the supplier frequency of supply. It is necessary to determine the maximum and minimum size of inventory in the process and in the company's warehouses. Suppliers can be divided into reliable, sufficiently reliable or unreliable on the basis of a point assessment that takes into account the reliability of supplies and the reliability of the quality. Based on these criteria, it is possible to determine which suppliers are allowed to reduce inventories in stock because they have proved reliable in the long-term monitoring and evaluation.

Information can be physically collected and verified directly in production, but an effective way is to request this data from its suppliers. Logistics and the supply chain relate to physical and information flows, and storage from raw materials to final distribution of the finished product [3]. Each supplier should know his product, so filling this table should be a matter of purchasing staff. To update this spreadsheet on a regular basis, it is necessary to instruct the responsible person or multiple persons to update the spreadsheet after each change. This is the only way to maintain the integrity and veracity of the data in the table. Essential is table flexibility, speed, ease of operation and data tagging, and PFEP table readability.

The PFEP table can be created:

- MS Excel or another spreadsheet editor,
- In database software.

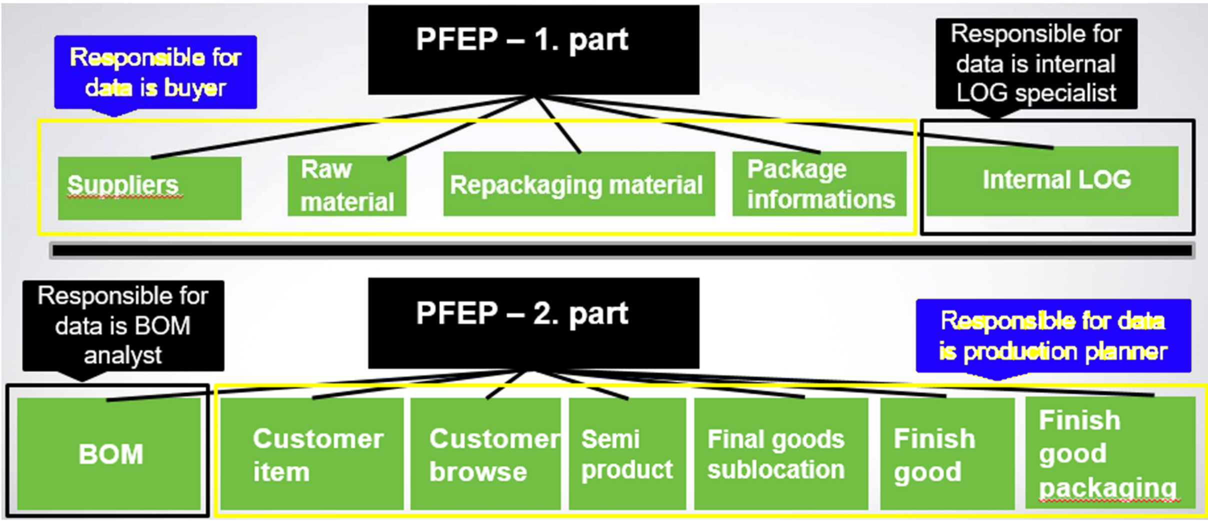

Figure 1 Draft staff responsibility for updating data

Table 1 Content of the basic data structure to create PFEP [4]

Article number	The number used to identify the material internally
Article description	Name of the material (e.g. frame, bolt, nut)
Daily consumption	Average daily material consumption
Place of consumption	Process / zone where material is consumed (e.g. cell 14)
Place of storage	Address (location) where the material is stored
Intensity of ordering	Frequency of order from the supplier
Supplier	Name of the material supplier
Supplier - city	The city where the supplier resides
Supplier - region	Region where is supplier allocated
Supplier- country	Supplier's country of origin
Type of transport unit	Type of packaging (e.g. single, reversible)
Weight of the transport unit	Weight of empty package
The weight of one piece	The weight of one piece
Weight of the whole package	Weight of full packing material
The Length of the transport unit	Length or depth of pack
The width of the transport unit	Packaging width
The height of the transport unit	Packaging height
Consumption for 1 product	The number of parts needed for 1 final product
Hourly consumption	Maximum number of units used per hour
Number of units per transport unit	Number of packages in one package
The need for packaging per hour	The maximum number of packs needed per hour
Transport dose	Standard delivery size in days (1 week = 5 days)
Shipper	The company providing transportation services
Delivery time	Transport time required for shipment from supplier to plant (in days)
Number of cards in circulation	The number of tensile signals that are in the system
Vendor rating	Supplier performance evaluation that includes timeliness of delivery, quality

A decisive condition for determining how data is integrated into a spreadsheet or database software is the amount of data the user wants to manage in this way. In case a large amount of data, the database software can be up to 60 times faster when searching for data as a spreadsheet editor. The amount of data affects the size of the production and the variation of the products produced.

In Table 2, creating a PFEP table merged and integrated data from 12 files, which can bring benefit in the form of shortening the time to search for information.

3 Results

In the case study, the measurement of all types of packaging in all partial warehouses was carried out in the company in order to quantify the amount of material required to store the material and the volume offered by the shelf available to centralize the material from the partial warehouse to the shelf. The measurement was focused on:

- Length of packaging.
- Width of packaging.
- Height of packaging.

The data about the actual dimensions of the packaging for individual parts used in the production can subsequently be converted to cubic meters to calculate the volume required for the storage of all parts. The formula (1) used to calculate the volume is as follows:

$$PV = LP \times WP \times HP \tag{1}$$

PV - Packaging volume (m^3)
LP - Length of packaging (*m*),
WP - Width of packaging (*m*),
HP - Height of packaging (*m*).

All three dimensions of packaging for used parts are necessary due to the height of the packaging, it is necessary to dimension the shelves and the height of the individual traverses placed in the racks. The tables containing the volume calculations for each zone look like this:

The calculation of the required volume for the storage of parts and materials from the current state was set on cubic meters. This table represents the approximate required volume, because during the measurement, all the material has not had to be in the sub-zones, which means that the future storage place has to be dimensioned with a certain reserve of space, and the growing production must also be taken into account, which in the future will mean the increase in inventory and the areas where it will be necessary to store the material. Production can be understood as the conversion of inputs into another production process into tangible products or services [5].

Table 2 Calculating the amount of space required for the material

CELL 1 TL			SUM	
1,2	0,8	1,12	1,0752	m3

CELL 2			SUM	Pieces
0,6	0,8	0,33	0,1584	
0,4	0,6	0,16	0,0384	
1,2	0,8	0,34	0,3264	
1,2	0,8	0,34	0,3264	
0,4	0,3	0,16	0,1728	9
0,38	0,38	0,38	0,164616	3
0,18	0,18	0,09	0,011664	4
0,36	0,21	0,14	0,010584	
0,86	0,66	0,76	0,431376	
0,86	0,66	0,38	0,215688	
			1,856328	m3

CELL 3 TL			SUM	
1,2	0,8	0,75	0,72	
1,2	0,8	0,75	0,72	
			1,44	m3

CELL 4 ASSY			SUM	Pieces
0,15	0,18	0,09	0,02916	12
0,15	0,18	0,09	0,00486	2
0,15	0,18	0,09	0,02916	12
0,23	0,24	0,16	0,017664	2
0,22	0,23	0,16	0,008096	
0,22	0,15	0,07	0,00231	
0,4	0,3	0,16	0,1344	7
0,5	0,31	0,25	0,89125	23
			1,1169	m3

BT4			SUM	Pieces
0,4	0,3	0,16	0,1536	8
0,19	0,18	0,14	0,02394	5
0,35	0,31	0,25	0,027125	
0,31	0,5	0,25	0,03875	
0,25	0,2	0,15	0,0075	
			0,250915	m3

BT2			SUM	
1,2	0,8	0,35	0,336	m3

CELL 7			SUM	Pieces
0,6	0,4	0,16	0,6528	17
0,3	0,4	0,16	0,096	5
0,39	0,23	0,15	0,08073	6
0,3	0,39	0,28	0,03276	
0,38	0,3	0,3	0,0342	
0,4	0,3	0,16	0,0576	3
0,6	0,4	0,16	0,0768	2
			1,03089	m3

SUM	7,1	m3

In the next step, the volume of the rack no. 1 was counted in terms of multiplying the length, width and height of the rack in cubic meters, resulting in the total volume of the rack. To clarify the space available in Shelf No 1, it is necessary to deduct the volume of traverses provided by the shelf and creating individual height levels therein.

Table 3 Calculation of available rack volume 2

Regal 1			SUM	
2,7	4,5	1,12	13,608	m3

Traverza			SUM	Pieces
0,11	2,7	0,05	0,0891	6

Regal 1 - Traverzy	
13,5	m3

Regal 2			SUM	
0,5	2,7	1,1	1,485	
0,5	2,7	1,1	1,485	
0,5	1,8	1,1	0,99	
0,5	1,8	1,1	0,99	
			4,95	m3

The volume of traversers was calculated in the same way as when calculating the rack volume, and the same formula for volume calculation was used. For the calculation of the final area, it is necessary to deduct the sum of the volume of all traverses in the shelves no. 1. The calculation of the total usable area of the rack no. 1 is as follows:

$$13.608\ m^3 - 0.0891\ m^3 = 13.5189\ m^3 \cong 13.5\ m^3$$

The same volume calculation was also used for rack no. 2 (Table 3). The volume calculation formula did not differ, with the difference that the method of design and use is planned only on one shelf, which means that it is not necessary to integrate deduction of traverse volume when calculating the total usable volume, as was the case for shelf no. 1.

Volume of rack no. 2. = 4.95 m^3

Sum of available volume in storage racks:

$$13.5\ m^3 + 4.95\ m^3 = 18.45\ m^3 \cong 18.5\ m^3$$

Total volume area per warehouse: 18.5 m^3

Approximate requested volume: 7.1 m^3

4 Conclusion

The data structure in one table, respectively in table editor allows using the formulas to update all the necessary input and after transformation also output data about material for each company, whether the areas needed for storage for a particular material, a material consumption calculation that influences saturation and balance of logistics, or ABC and XYZ analysis. A PFEP table with this structure allows these data to be calculated and updated on a daily basis without the need to manage and browsing in other tables. Its added value is time saving and integrated data with secure update as well as flexibility. Correct information is necessary for correct decisions.

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SITUATION ON INTERMODAL TERMINALS IN THE SLOVAK REPUBLIC

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Keywords: intermodal, terminal, transport, analysis, Slovakia

Abstract: The aim of the article is to describe the current situation and the possibilities of development of intermodal transport in the Slovak Republic (SR) with the potential to link the Slovak Republic better to the inter-modal transport corridors in the countries of the European Community. The construction and operation of a publicly accessible network of intermodal terminals and the installation of non-discriminatory service providers are the main parts of the national development strategy, particularly in continental transport SR. The aim of this transport is to replace road freight transport with using environmentally acceptable rail and water transport together with flexible road transport. To meet this objective, it is necessary to build a comprehensive and progressive of network of public intermodal transport terminals in the places where the different types of transport systems come together.

1 Introduction

The Central and Eastern European region has grown dynamically over the past decade, starting its development even before the accession of many of the leading economies to the European Union.

Infrastructure shapes mobility. No major change in transport will be possible without the support of an adequate network and more intelligence in using it.

The geographical position predestines Slovakia to pass through commodity flows between eastern and western Europe and in direction north - south, northwest – southeast and southwest - east [1].

In order for the Slovak Republic to know and to engage as much as possible in international transport, the essential prerequisite for the efficient operation of combined transport is the precondition.

Intermodal transport, which includes combined transport, represents an environmentally friendly and energy-efficient freight transport system in freight transport logistics chains. In the transportation of goods, it effectively exploits the advantages of particular modes of transport, especially in the Slovak Republic, especially railways, inland waterways and road freight.

In particular, the geographical location of the SR should be used as an advantage for present and future logistics services. Stimulating demand from the world's leading manufacturers of goods for the use of logistics services and the subsequent creation of a range of quality services, the SR offers a chance for an advantageous operation and networks of logistics centers in Europe, including intermodal terminals. The fact that the Slovak Republic is at the crossroads of two different common and wide gauge gauges gives huge potential for the transport of goods from Russia, Japan, Korea and China to the EU countries and is a prerequisite for their reprocessing in the SR. Another strategic advantage of Slovakia is that the three main transport corridors of the pan-European transport network and the track are combined (AGTC) pass through Slovakia and create the possibilities of linking and separating the intersections of these routes.

2 Status of intermodal transport in Slovakia

The Slovak Republic is not currently using a public intermodal transport terminals (hereinafter TIT) in the true sense. All six active TIT are currently operated by private companies, usually operators of the intermodal transport. The construction and operation of the public accessible and non-discriminatory network services provided through the intermodal terminals is one of the main elements supporting the development of the combined transport, but mostly continental transport in the Slovak Republic. The purpose of this combined transport is to replace the road freight as much as possible, using environmentally acceptable railroad and waterways transportation, along with the flexibility of the road transport. To achieve this goal it is necessary to develop a fully-fledged and progressive public terminal for intermodal transportation in places where the different types of transport systems are interfered.

2.1 The framework conditions for the terminal of intermodal transport

The framework conditions for the ideal terminal of intermodal transport can be described as follows:

- length of the railroad for loading and unloading 750 meters,
- the length of the marina is at least 110 meters,
- depth of docking area for a 2.80 meter dive, desirable for a dive of 3.50 meters,
- handling equipment capable of handling any standardized and loaded intermodal cost unit (ISO

containers, swap bodies, manipulative semi-trailers),
- 100% backup of handling equipment,
- load capacity of handling equipment so that it can handle any intermodal load unit. The manufacturer's recommendations are 40 to 42 tonnes on the hanging device (spreader and claw),
- the capacity of the terminal set up to allow a combined train (600-750 meters) or inland waterway vessel to be processed within 1 hour, and road freight delivery vehicles not expected more than 20 minutes [2].

All these requirements, except for the loading and duplication of handling equipment, stem from international agreements and European law, best described in the AGTC.

The requirement for duplication of handling equipment results from the practice of manipulation. Part of the combined transport offer includes terminal parameters, which are also carefully studied by the bidder. Few shippers or combined transport operators are in danger of "blocking" the shipment due to a technical failure of the transporter. Consequently, intermodal terminals without back-up handling equipment are not accepted in practice because of the possibility of "blocking the carriage" in case of failure.

The requirement for the load-carrying capacity of the handling equipment follows from UIC 599 OR Technical Specification "Suitable Loading and Unloading Equipment for Combined Transport Containers or Wagons" and manufacturer's recommendations. Ultimately, however, the recommended load is based on the total maximum weight of the intermodal load unit, which can be loaded onto the road vehicle, and the so-pure intermodal, a combination of water and rail, without a path [2].

2.2 Technical features of the Slovakian terminals

Intermodal terminal Dobra (CTT Dobra) (Figure 1)
Operator: Trans Container – Slovakia, a. s.
CTT Type: Rail traffic – road transport
Rail traffic – rail traffic (change of gauge, 1 435 mm/1 540 mm)
Area: 180 750 m^2
Storage area: open: 2 640 m^2
covered: 245 m^2
Technical equipment: Rail mounted gantry crane (50 t) - 2 pieces
Container handler LUNA RLS - 45 – CT
Number and length of rails: 8 pieces (170 m, 802 m)

Intermodal terminal Bratislava (CTT Bratislava) (Figure 1)
Operator: SPaP, a. s. Bratislava
CTT Type: Rail traffic – road transport
Inland navigation
Area: 21 000 m^2
Storage area: 11 000 m^2
Technical equipment: Gantry crane (2 pieces – 16t, 2 pieces – 20t, 1 piece – 36/32t)
Front compiler LUNA 45t – 2 pieces
Stable ramp RoRo – 1 piece
Number and length of rails: 2 pieces (150 m, 300 m)

Intermodal terminal Kosice (CTT Kosice) (Figure 1)
Operator: SKD INTRANS, a.s.
CTT Type: Rail traffic – road transport
Area: 14 820 m^2
Storage area: 2 600 m^2
Technical equipment: 2 pieces - Tire crane (19t, 12t)
2 pieces - Side loader 35t
Number and length of rails: 2 pieces (2 x 180 m)

Figure1 Map of intermodal terminals in the Slovak Republic

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Currently there are two intermodal transport terminals in use (CTT), one in Dobra and another in Dunajska Streda. Other, pure container terminals are situated in Kosice, Zilina, Bratislava UNS, Bratislava - port (Palenisko) and in Sladkovicovo.

The Container terminals in Bratislava UNS, Bratislava-port (Palenisko), Zilina and Kosice were built during the 70ties to the 80ties in the last century as container transhipment centers for needs of economic group of the socialist countries.

They were primarily designed and facilities for handling 20-foot (6 m) ISO containers 1C. The current trend aims for using larger 40-foot (12 m) ISO 1A containers and other types of cargo units. The private terminal in Dunajska Streda mainly serves as an ending terminal and longterm storage of inland shipping containers.

2.3 Terminal capacity problem in Slovak Republic

Between most important terminal problems in Slovak Republic belong:

- lack of handling equipment
- too small area for storage
- insufficient ultimate load of the foundation 3.1
- too small area for transhipment 3.2
- no free space for future terminal expansion
- insufficient capacity of road connection
- insufficient capacity of railway connection
- too short rail tracks
- insufficient capacity of inland waterway connection (if any)
- opening hours too short
- other (connection to the logistics centrum).

The biggest shortcoming of TIT in the Slovak Republic is the fact that TIT does not comply (with the exception of terminal Dunajska Streda and Dobra) with requirements for intermodal transport terminals related to the technical equipments according to the international AGTC agreement. These requirements include:

- length of at least one railway line to load and unload: 750 m,
- wharf length: min. 110 m depth to dock dive: 2.80 m - 3.5 m,
- handling equipment able to handle any standardized and established Intermodal transport unit,
- load handling equipment so that they can handle any intermodal transport units - 40 to 42 tons of hang equipment (spreader and collets)
- wholly deposit handling equipment,
- capacity of terminal is set so that it could be block train combined transport (600-750 m) or inland waterway vessel processed to one hour and the road trucks for dispatches did not expect more than 20 minutes.

The biggest shortcoming of TIT in the Slovak Republic is the total obsolescence and lack of the sufficient number of handling equipment, insufficient operating time of the manipulation tracks necessary for downtime minimizing of the trains block formation and for loading and unloading of the ITU, underused business opportunities related to the number of strategic companies in the automotive industry, either directly oriented to the production of cars or parts for their production or repair, and what is the main weakness in comparison with the Czech terminals, their linkage with logistics centres.

Increasing of the terminal capacity and complement of the provided services means that everything is offered in one place. Such like services may be forwarding and banking services, but also providing of the accommodation and refreshment for waiting customers, as well as fuelling, sealing and weighing road vehicles etc.

3 Terminal development in Slovak Republic

The main limiting factors of the container terminals in Slovakia are:

- lack length of transhipment rail tracks,
- inconvenient handling devices in terms of their number, load, speed of handling and the possibility to manipulate all intermodal units - containers, swap bodies and trailers
- lack of storage areas within reach of handling equipment, requiring an increased number of manipulations with shipping intermodal units.

From the existing terminals (name and location of operator in brackets), container transhipment center Bratislava UNS (SKD INTRANS, Zilina), Bratislava - port Palenisko (SPaP, Bratislava), Kosice (SKD INTRANS, Zilina), Zilina (SKD INTRANS, Zilina) and Sladkovicovo (Lörincz Ltd.) do not comply with the AGTC (European Agreement about Important International Combined Transport Lines and Related Installations).

The terminal in Dobra (ZSSK Cargo, Bratislava) fulfills the requirements partially and the terminal in Dunajska Streda (METRANS/Danubia) meets the requirements to the greatest extent. Necessary publicly accessible infrastructure is not yet built in Slovakia for intermodal transport. There are roads, railways and ports in Slovakia, but at the moment no public terminals are existent with the necessary technical parameters which offer a non-discriminatory approach.

3.1 Public intermodal transport terminal Bratislava

The main objective is to build the technical infrastructure for multimodal intermodal transport, which will meet the requirements of the AGC and AGTC (European Agreement on Main International Railway Lines). The terminal is proposed in the area of the port in

Bratislava poolside Palenisko. Required performance limit of the terminal is being prepared for 105 000 units / year. The trimodal part of the terminal is proposed of not less than 300 m to cover three river vessels Danube Europe II, nearby dock edge of pool Palenisko. The bimodal part is an extension of the trimodal part in length 450 m, so the total usable length of the crane track will be 750 m. The Public intermodal transport terminal Bratislava construction consists of the following basic parts:

- reconstruction of the existing connecting rail to the railway station Bratislava – Central Freight Station - Railway Station Bratislava-Palenisko, while maintaining the existing line,
- reconstruction of the existing rail infrastructure in the port Bratislava, so that it can operate on rail the proposed terminal and other existing port traffic, railway station Bratislava-Palenisko with arrival and departure group of tracks,
- construction of public intermodal transport terminal, operating in mode water - rail - road, which is proposed on the west bank of the pool area in Palenisko in VI. SPaP position.

3.2 Public intermodal transport terminal Leopoldov

The public intermodal transport terminal Leopoldov is proposed as the main terminal for SR, the core of international importance HUB type. That is, as a central terminal for redistribution throughout Slovakia, with using loads of other public intermodal transport terminals not only in Slovakia (Bratislava, Zilina, Zvolen, Kosice), but also to create a train load to Hungary, Poland or Austria and the Czech Republic.

The terminal will perform as a bimodal transshipment node: rail - road transport. Its main task will be to redistribute long-distance load transported by trains from ports to local trains and vice versa. The main activity of the terminal is expected in transshipment of intermodal transport nits railway - railway with possible short-term intermediate storage on paved surfaces.

The location of the proposed terminal is in the village of Sulekovo near the railway station Leopoldov. At the terminal, it is planned to work with two rail gantry cranes and a mechanical handling device. The range of the rail cranes has to be provided that they can serve all tracks, paved areas for short-term storage, and roads for loading and unloading road vehicles. Areas for long-term storage shall be operated with mechanical handling device.

The trains used for the intermodal transport terminal before departure and after arrival are processed in their own departure/arrival group of tracks, located in the space between the rail tracks in the direction from Leopoldov to Trnava and terminal intermodal transport terminal 1.

Departure/arrival group of tracks will be part of the railway station Leopoldov.

In the case of building the Terminal 2, the intermodal transport terminal will be built up the departure/arrival group of tracks for the needed number of tracks for both terminals. In the terminal TIP 1 proposes to be placed five service tracks underneath the cranes in length of 750 m and in direct reach of gantry crane. One of these tracks can be used as a track Ro-La.

In the future, while increasing volumes of intermodal transport can be expected, a second mirror terminal is planned. In the vicinity of the terminal it is envisages construction of logistics centers, which is not part of the project preparation.

3.3 Public intermodal transport terminal Žilina

Intermodal transport terminal Zilina is one of the terminals of international importance, which considering the principle of the development of combined transport by the Ministry of Transport, Posts and Telecommunications of the Slovak Republic. The proposed Intermodal transport terminal Zilina is situated between the railway track Zilina - Vrútky and hydro-electric plant of Žilina in the immediate vicinity station Teplicka nad Vahom, which begun to build in the years 1976-1992, but none of its critical parts has building acceptation. The competition is currently underway on the building renovation contractor for station Teplicka nad Vahom.

The planned construction of the terminal will be connected to the capping piece between directional and exit a group of the station, so the designing is based on the state that the station Teplička is a functional station. Terminal will serve to load the ITU from road to rail and vice versa, as well as the storage of the ITU. It is planned to build five tracks, which 4 of them will be operated by two gantry cranes with load capacity 45 t, transshipping goods between vehicles (train / train, train / truck and vice versa), or from means of transport to a storage area and vice versa. One track will be also used for RoLa transport (trucks using front ramp loaded on a special railway wagon platform and continuing the journey on the train). In addition to cranes, it is recommended that the terminal possessed at least one additional reloading mechanism that could be moved to areas outside their reach. As an additional mechanism for the transport of empty containers a mobile device will be used with a capacity of approximately 15 tons.

Terminal will provide ITU handling of Žilina region and the northern part of the region of Trencin, or will eventually help with lines RoLa in the north - south. Terminal is located at the intersection of the line AGTC C - C E40 and C - E63 and its catchment area with 80 km range allows the terminal to serve the region Zilina, the north districts of Trencin region, the region Ostrava in the Czech Republic and the southern part of the Katowice Voivodeship in Poland. The terminal will have the ability to be a input terminal for traffic in all directions and in the future to be part of a logistics center for the area of northern Slovakia.

3.4 Intermodal transport terminal Košice

Company Interport Servis, Ltd. offered in the metropolis of eastern Slovakia, Košice, comprehensive logistics and transportation services since 1996. The area in which the company operates was built in 1970 and originally served as a central transship centre of cars with an annual turnover of up to 50,000 pieces. Nowadays the Interport Servis ranks among the modern European type of logistics companies and in its area equipped with state of the warehouse, logistics and IT systems. It operated the national railway transship center and the network of wide tracks with a direct connection to the Ukrainian railways.

The company is a certified by quality system ISO 9001. In the area of Interport Servis there are a center “Haniska and Customs branch office Kosice” which is designed in compliance with anticorruption programs, and to transparently and equitably for freight forwarding company located in leased offices in the administration building of Interport Servis company.

With outer transshipment is possible to load goods of any kind from wide gauge track to normal gauge or vice versa. Ramps makes also possible to combine transportation systems, which set another degree of freedom, road transport - railway or truck - wagon. Two ramps also allow interleaving goods immediately upon landing and after a period of time secondary loading the desired vehicle. Capacities of unloading ramps are 25 wagons, which in terms of max. Tonnage is about 1,250 tons of material. Capacity of wide gauge and normal gauge is identical. To tracks of European dimension we must include a system of train-formation track. The Interport company has five train-formation track directly connected with the station Velka Ida.

4 Conclusion

Support for the development of intermodal transport is crucial in order to develop intermodal transport and stabilize the transportation system equal to other modes of transport. The existing intermodal transport operation highlighted some distortions at the domestic transport market, which do not create an equal field for competition. For this reason, it is necessary in addition to the gradual levelling of competition conditions for each type of transport in the market, it is also a support for creating infrastructure of intermodal transport, which, unlike the infrastructure of other types of transport, which is built systematically over many decades, is lagging behind.

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