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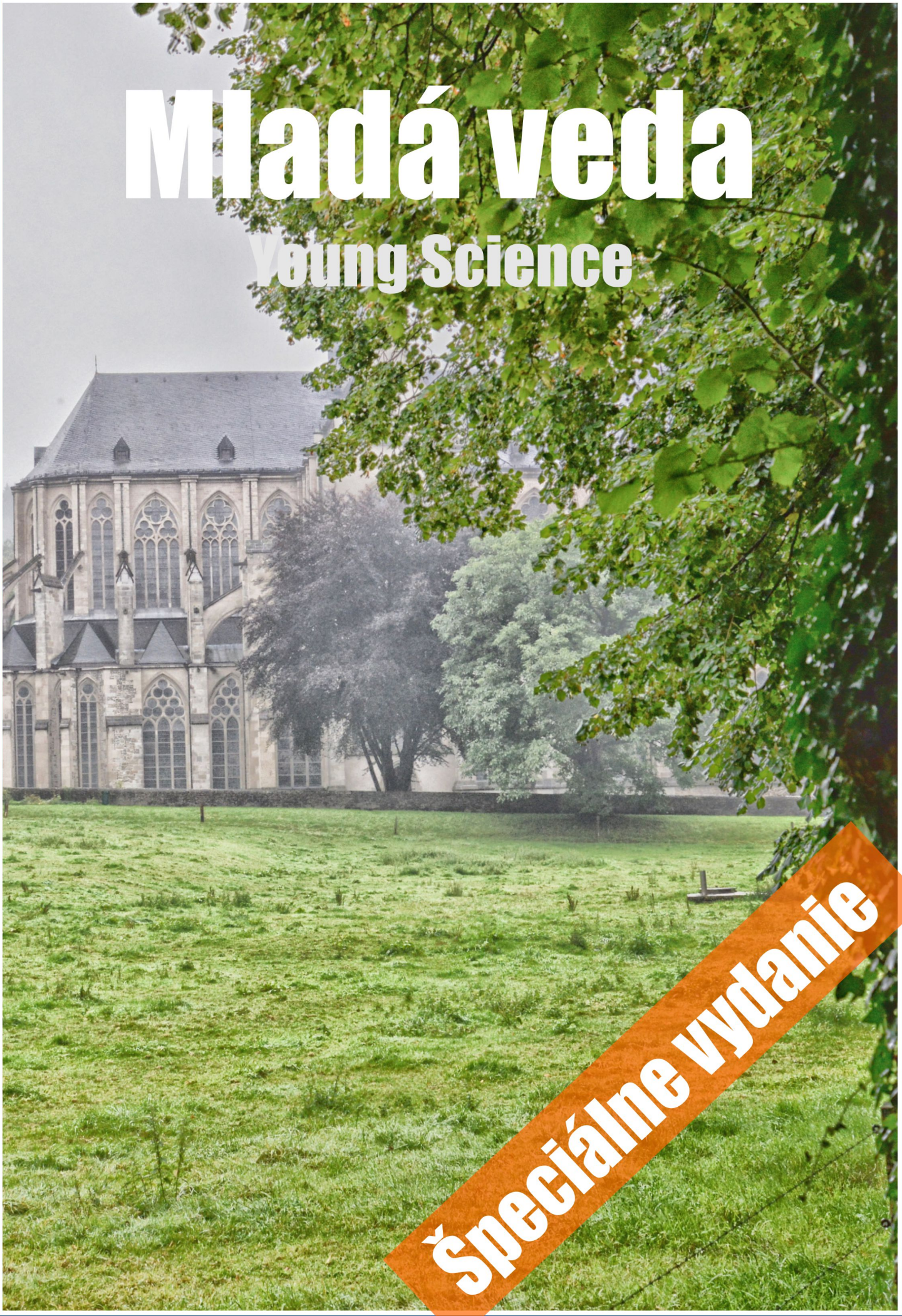

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MODELING THE "CURRENT REALITY TREE" DIAGRAM IN THE CONTEXT OF INDUSTRIAL LOGISTICS FOR DETERMINATION OF SYSTEM CONSTRAINTS

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Abstract
This paper deals with the construction of the "Current Reality Tree" (CRT) diagram, as one of the Theory of constraints methods, to show a system of supply chain model regarding the industrial logistics. The purpose of designing the CRT diagram is to identify undesirable activities (entities) in regard to production processes which have an adverse impact on enterprise costs and the customer service level. In the CRT diagram, links are defined with respect to effects of the production elements on inventory in certain manufacturing enterprise. The more processes are closed to logistics optimum, the smaller quantity of inventory is in the enterprise. It is caused especially due to the fact that inventory acts like compensator for the deficient production and logistics processes organization and management. Effort to integrate the material flows in production, minimize the inventory and maximize the flexibility in meeting customer requirements leads to application of the basic logistics approaches.
Key words: Model, Current Reality Tree, industrial logistics, production, manufacturing, system constraints, undesirable effects, relevant entities, key problems

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Introduction

The supply chain within industrial logistics is a complex process of integrating several subsystems regarding manufacturing processes among which numerous links are present. The subsystems are affected by each other and this may have positive as well as negative effects on them ultimately. Therefore, it is necessary to address the optimization of individual production processes within the supply chain. Understanding of current function state and interrelationship of the various elements in the system is the basis for such an optimization (ATWATER and CHAKRAVORTY, 1995), (KALINA et al., 2016).

There are various methods utilized to present the current state and its links in the production system. Current Reality Tree known as CRT diagram belongs among them. It allows for identification of negative impacts and understanding key problems in the whole system. CRT diagram is a method of "Thinking processes" within the Theory of constraints which is used to analyze the adverse effects and identification of causes (BUTTON, 1999).

Data and methods

Construction of the CRT diagram consists of several subsequent steps. Firstly, it is necessary to determine the range of analysis in order to reveal the key problems. If the selected part of the production system is too small, the key problems will not be detected usually. On the contrary, if the selected part of the system is too large, the quality of final results will be decreased (CHAUDHARI and MUKHOPADHYAY, 2003).

Borders of the CRT diagram are represented by suppliers and customers of the production enterprise. Each enterprise creates certain amount of inventory in order to ensure the continuity of production process and adequate customer service. There is a need to take into account the impact of inventory level on the increase in costs. Thus, the purpose of the CRT diagram is to identify the elements of the production system, as a part of the supply chain, that have the most significant impact on the mentioned costs of the enterprise as well as the customer service level (BUTTON, 2000), (RAHMAN, 2002).

Specifying the list of the most significant problems

The basis for construction of the CRT diagram is to define particular entities, i.e. undesirable effects, which limit and restrict the production system functionality. In general, abbreviation "UDE" is common for these entities. Within the examined part of the supply chain, there are three basic subjects (PEREZ, 1997), (RAHMAN, 2002):

- suppliers,
- production enterprise,
- customers.

The supplier affects the production process of the supply chain by its ability to deliver the required material at the exact time period, on the right place and in the required quality (KUBASAKOVA and IVANKOVA, 2010). These attributes have effects especially on the production continuity in enterprise and on provided customer service level. The risk of inventory deficiency is increased due to the unreliability of suppliers. It can be the reason for disruption of the production continuity, customer service level reduction and costs increase.

In case that the minimum amount of one delivery is determined, inventory level in the warehouse and the resulting costs will increase. Otherwise, if the determined amount of one delivery is not fulfilled, unit delivery costs will increase.

Inventory warehousing and inventory maintenance costs increase proportionally with the inventory level increase in the enterprise as well as inventory fixes more capital of enterprise. The increase of capital bound in inventory is also caused due to long delivery times. It results from the need of holding the higher inventory level in the enterprise. The higher inventory level also means a higher risk of unused inventory which also causes generating certain costs (FOSTER et al., 1998), (FRY, 1992), (SCHRAGENHEIM and RONEN, 1991).

Continual production process of the supply chain is also significantly affected by unexpected changes in the consumption intensity which is caused by fluctuations in customer requirements and fluctuations in consumption resulting from a nature of production (LAMBRECHT and DECALUWE, 1988), (LAMBRECHT and SEGAERT, 1990), (SCHRAGENHEIM and DETTMER, 2000).

On the basis of above mentioned, problems, which are able to affect significantly the smooth functionality of the supply chain process, are identified (see Table 1).

UDE
Breach of delivery time
Incorrect delivery amount
Insufficient delivery quality
Risk of inventory deficiency
Costs resulting from the inventory deficiency
Disruption in production
Reducing customer service level
Delivery amount higher than the consumption
High delivery costs
Low delivery flexibility
High inventory level in the warehouse
High costs for inventory storage and maintenance
High capital bound
Long delivery time
Risk of unused inventory
Costs arising from unused inventory
Unexpected changes of consumption intensity
Fluctuations in customer requirements
Fluctuations in consumption

Table 1 - Entities restricting the function of the production processes.
Source: authors

From the list, it is necessary to select 5-10 of the most important problems (relevant entities). Subsequently, the causal links must be created between relevant entities. These entities are the basis for the diagram construction and other specified problems will be used later. The relevant entities are summarized in previous Table 1, indicated by gray color.

CRT diagram construction

When constructing the CRT diagram, subsequent steps must proceed from top to bottom. As for the first step, two entities, between which a relationship of cause and effect is present, are selected. CRT diagram is gradually extended by relevant entities in order to help to understand what links are between undesirable effects and what combinations have consequences (BUTTON, 2000), (SCHEINKOPF, 1999).

Then, CRT diagram needs to be read from bottom to resulting undesirable effect by the formulation "if ...then…". In Figure 1, the relevant entities by blue are shown and other entities, which were subsequently added to the CRT diagram, are identified by black.

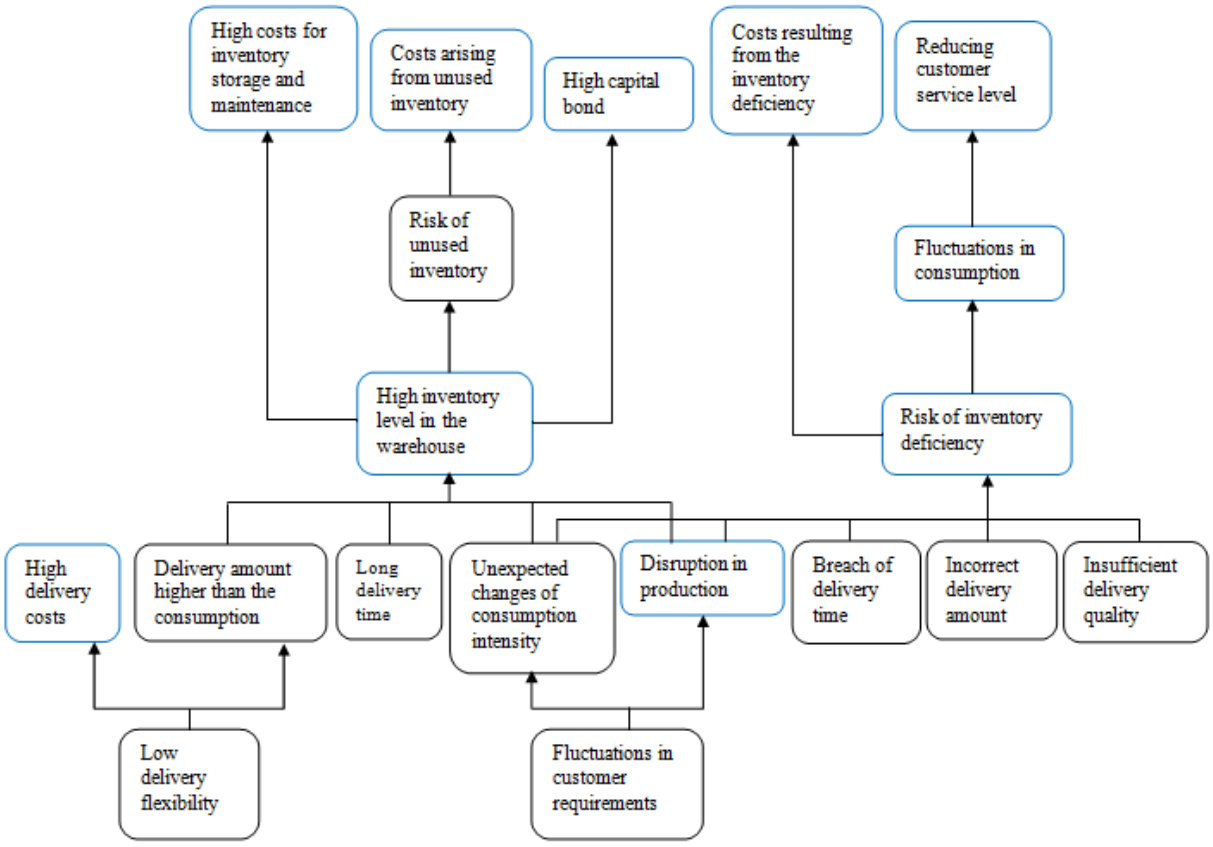

Figure 1 - Construction of the CRT diagram regarding production processes
Source: authors

Results and duscussion

As for the first step in regard to system constraints identification, there is a need to specify those entities which need to be removed from the system. These entities are undesirable itself in the system (see Figure 2 – they are marked by yellow color).

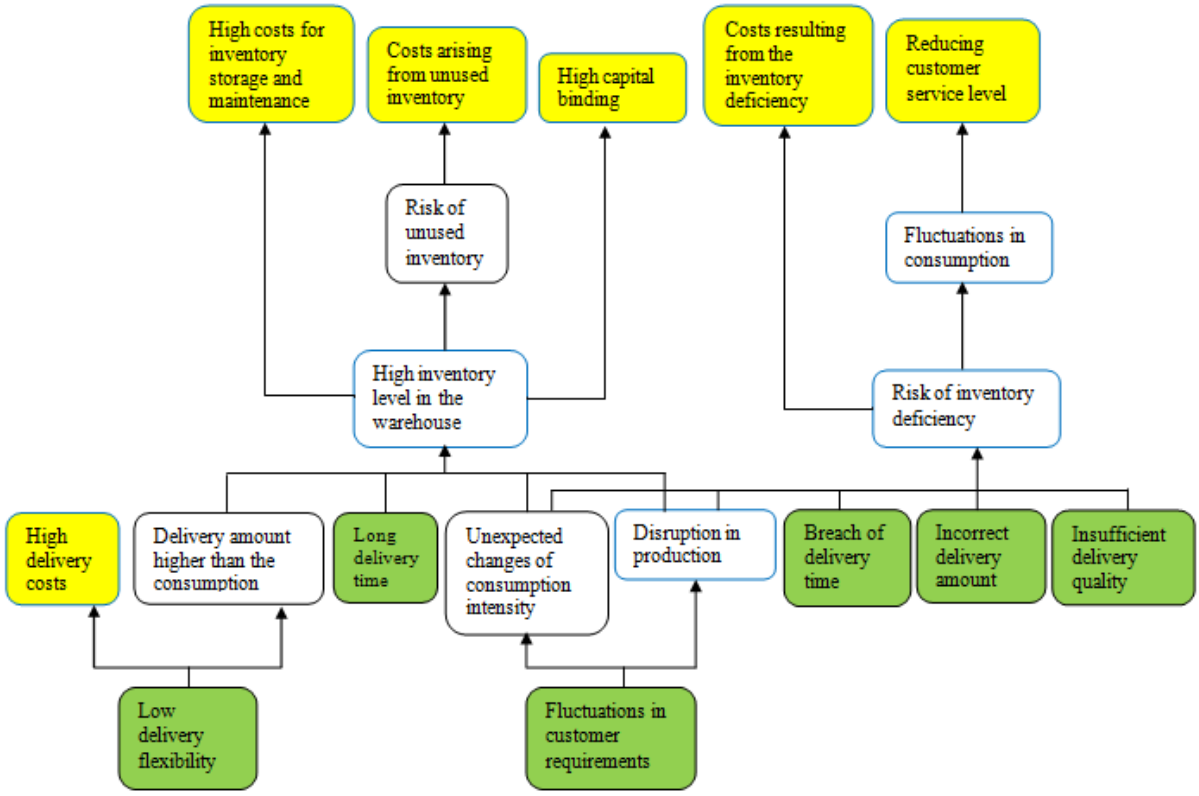

Figure 2 - Resulting CRT diagram regarding production processes
Source: authors

Selected entities are used to create a table. Based on the table, key problems (system constraints = the most significant deficiencies) are identified. In the top line of Table 2, entities indicated by yellow in the previous CRT diagram are summarized. In the left column, entry entities (in the CRT diagram, they are marked by green) are shown. Table 2 shows the effect of entry entities on relevant entities as follows (FOGARTY et al., 1991), (PEREZ, 1997):

- if the entry entity causes some of the relevant entities, value 1 is inserted in the table then,
- if the entry entity does not cause some of the relevant entities, value 0 is inserted in the table.

Such entity, reaching more than 80%, is considered to be the key entity.

		Relevant entities							
		High costs for inventory storage and maintenance	Costs arising from unused inventory	High capital binding	Reducing customer service level	Costs resulting from the inventory deficiency	High delivery costs	Sum	%
Entry entities	Breach of delivery time	0	0	0	1	1	0	2	40
	Incorrect delivery amount	0	0	0	1	1	0	2	40
	Insufficient of delivery quality	0	0	0	1	1	0	2	40
	Long delivery time	1	1	1	0	0	0	3	60
	Low delivery flexibility	1	1	1	0	0	1	4	80
	Fluctuations in customer requirements	1	1	1	1	1	1	5	100

Table 2 - Impact of entry entities on relevant entities in terms of production processes
Source: authors

The Table 2 shows that low delivery deficiency and fluctuations in customer requirements have the most significant impact on the functional production processes. For this reason, it is necessary that the enterprise also puts emphasis on demand forecasting, in particular when considering the variability over time. And also, given the fact that everything depends on changing customer demand, flexible deliveries are a great benefit to operation of the whole production system.

Conclusion

The objective of the paper was to identify entities and links within production processes which have an adverse impact on manufacturing enterprise costs and customer service level. The aim was achieved by creating CRT diagram. Based on an analysis of the particular production processes and activities in the specific enterprise using CRT diagram, it was found that two factors (undesirable effects) have the most significant impact on this enterprise costs and the customer service level.

As for the first one, fluctuations in customer requirements were specified. The bigger fluctuation is, the higher need for inventory holding in the warehouse is, and outcome consists in increased costs. In case of insufficient inventory level in the enterprise, the continuity of production system is disrupted. Ultimately, it results in the decreasing customer service level.

The second factor, which significantly influences the production processes functionality, is related to the flexible deliveries, i.e. suppliers delivering material into the manufacture. If the delivery amount is explicitly determined, e.g. truck or loading unit capacity, the inventory level in the warehouse is expanded and this results in increased operating costs.

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References

1. ATWATER, J.B. and S.S. CHAKRAVORTY, 1995. Using the theory of constraints to guide the implementation of quality improvement projects in manufacturing operations. In: *International Journal of Production Research.* Vol. 33, No. 6, pp. 1737–1761.
2. BUTTON, S.D., 1999. Genesis of a communication current reality tree— the three cloud process. In: *Constraints Management Symposium Proceedings*, APICS, Alexandria, VA.
3. BUTTON, S.D., 2000. The three-cloud process and communication trees. In: *Constraints Management Technical Conference Proceedings*, APICS, Alexandria, VA.
4. CHAUDHARI, C.V. and S.K. MUKHOPADHYAY, 2003. Application of theory of constraints in an integrated poultry industry. In: *International Journal of Production Research.* Vol. 41, No. 4, pp. 799-817. DOI: 10.1080/0020754031000065548.
5. FOGARTY, D.W., J.H., BLACKSTONE and T.R. HOFFMAN, 1991. *Production and Inventory Management*. 2nd ed. South-Western Publishing Co., Cincinnati, OH. 870 p. ISBN 9780538074612.
6. FOSTER, B.P., M.C. SULLIVAN, M.C. and T.J. WARD, 1998. An empirical test of the view of inventory as a liability in explaining financial distress. In: *Journal of Applied Business Research*. Vol. 14, No. 2, 83-94.
7. FRY, T.D., 1992. Manufacturing performance and cost accounting. In: *Production and Inventory Management Journal*. Vol. 33, pp. 30–35.
8. KALINA, T., M. JURKOVIC, H. BINOVA and B. GARDLO, 2016. Water transport - The challenge for the automotive industry in Slovakia. In: *Communications: scientific letters of the University of Zilina*. Vol. 18, No. 2, pp. 6-29. ISSN 1335-4205.
9. KUBASAKOVA, I. and K. IVANKOVA, 2010. Constraint management system – optimized production technology (OPT). In: *Logi - Scientific Journal on Transport and Logistics*. Vol. 1, No. 2, pp. 35-39. ISSN 1804-3216.
10. LAMBRECHT, M.R. and L. DECALUWE, 1988. JIT and constraint theory: the issue of bottleneck management. In: *Production and Inventory Management Journal*. Vol. 29, No. 3, pp. 61–65.
11. LAMBRECHT, M.R. and A. SEGAERT, 1990. Buffer stock allocation in serial and assembly type of production lines. In: *International Journal of Operations and Production Management*. Vol. 10, No. 2, 47–61. DOI: 10.1108/01443579010000736.
12. RAHMAN, S., 2002. The theory of constraints' thinking process approach to developing strategies in supply chains. In: *International Journal of Physical Distribution and Logistics Management*. Vol. 32, No. 10, pp. 809-828. DOI: 10.1108/09600030210455429.
13. PEREZ, J.L., 1997. TOC for world class global supply chain management. In: *Computers and Industrial Engineering*. Vol. 33, No. 1/2), pp. 289–293.
14. SCHEINKOPF, L.J., 1999. *Thinking for a Change: putting the TOC thinking processes to use*. St. Lucie Press, Boca Raton, FL. 268 p. ISBN 9781574441017.
15. SCHRAGENHEIM, E. and H.W. DETTMER, 2000. *Manufacturing at Warp Speed: Optimizing Supply Chain Financial Performance*. St. Lucie Press, APICS, Boca Raton, FL. 376 p. ISBN 9781574442939.
16. SCHRAGENHEIM, E. and B. RONEN, 1991. Buffer management: a diagnostic tool for production control. In: *Production and Inventory Management Journal.* Vol. 32, No. 2, 74–79.