DEPENDABILITY OF DISTRIBUTION SYSTEMS IN THE REALITY OF MASS CUSTOMIZATION OF STEEL PRODUTS

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Abstract

Logistic distribution systems' dependability is a highly significant matter in today's understanding of system's ability to satisfy customer requirements, which usually are excessive and much individualized. A solution to such demands more and more often is the customization of offered goods, due to adapting postponement strategy. Steel products market is characterized by a constant, large fluctuations of demands, as well as by a high degree of requirements' differentiation in terms of products variants. The situation in which a steel products distributor has to face the problem of meeting consumers' specific requirements is getting more and more common. Commonly used service centers are main example of the idea of mass customization, based on postponing the differentiation in the supply chain.

Nevertheless strategy of postponed differentiation is increasingly popular also among trading companies, which are operating without specialized, typical for service centers, technical infrastructure. Lack of adequate production equipment does not prevent the possibility of implementing the strategy of delayed production. Due to condition of owned infrastructure and the presence of qualified personnel specialized in the performance of differentiation operations, enterprises may use different variants of strategy of delayed differentiation and mass customization. The article presents the results of studies designed to compare the benefits of using different variants of postponed production strategy.

Keywords: Distribution systems dependability, mass customization, delayed differentiation, steel products distribution

1. INTRODUCTION

The subject of the distribution systems dependability is a very prevailing issue, insufficiently described in the literature. Combining this with the subject of products' mass customization to the final customers requirements by companies involved in the steel products trade, leads to interesting conclusions. It regards the conjunction between the execution of postponed production tasks by the individual supply chain links and their dependability. To illustrate steel products trading situation, it was explained what exactly mass customization of products is. Additionally, the article presents selected indicators to measure the level of distribution systems dependability. Subsequently, a selection of two units was made applying final product customization strategy. A distinguishing element for those units is the location of postponed production tasks in the supply chain. In the first case, those tasks have been located in the last link of the supply chain -the trading company having the infrastructure necessary to perform the service center function. The service center performs technological products adaptation to customized requirements of clients. The second case involves outsourcing of technological elements by commissioning specific technological operation to external partners. In order to analyze the dependability of two considered systems, the author conducted their observation leading to conclusions in the form of distribution system dependability indicators. An additional element was a survey of customer satisfaction among business partners of two entities taken into consideration. Such a dual approach to the analyzed issue maximizes objectivity of the study and increases their credibility.

2. SYSTEM'S DEPENDABILITY - INTERPRETATION OF THE TERM

Systems' dependability as a term is functioning in many areas and is being described in the literature in many different ways. Considering the term generally, one can say that this is simply "the ability of a system to deliver specified service" [1]. This definition is characterized by huge level of generality, however it allows people to focus on further analysis of the dependability concept in the right way. "Delivering specified service" in relation to the logistic system is simply the supply of a specific product (under the principle of 7R) timely and with ensuring the smooth running of the delivery process [2]. The dependability can (even should) be interpreted in the context of the entire supply chain and understood as the ability of the supply chain to meet the needs of the final consumer. Describing Twaróg's approach, the key aspect of the systems' dependability is the smooth running of delivery. This is main objective of supply chains willing to have a high level of dependability.

Avizienis, Laprie and Randell in their multi-dimensional approach notice the problem of possible disruptions in the distribution process. Authors claim that in order to properly define the concept of dependability, it should be considered from three points of view. The first one is to look at the threats to systems' dependability such as defects, errors and failures likely to occur in the system. Moreover, they recognize the need to define the attributes of a reliable system (availability, reliability, safety, confidentiality, integrity, maintainability) and measures leading to achieve the desired dependability (faults prevention, faults tolerance, faults removal and faults forecasting) [3, 4]. This approach has been shown in **Figure 1**.

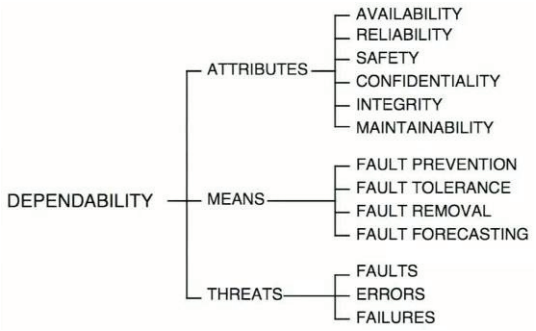

Figure 1 The dependability tree. Threats, attributes and means of dependability [3]

To summarize approaches described above and applying them strictly to the logistic systems, we must recognize that the most important element of the definition is the fact that the dependability is a measure of task realization in time. Paying attention to the primary objective of logistic systems, which is to provide the product to consumer in accordance with the 7R principle, we can tell what exactly the logistic distribution system dependability is and build the appropriate definition. A connection between elements of 7R principle elements and logistic system dependability definition elements is presented in **Table 1** [5, 6].

Table 1 Logistic system dependability definition elements

7R principle element	Logistic system dependability definition element
Right product	Ensuring the availability of appropriate products
Right quantity	Completeness of the delivery
Right condition	The delivery without damages
Right place	Delivery realization to the appropriate destination
Right time	Timely execution of tasks
Right customer	The accuracy of the order
Right price	Payment documents compatibility

From the above consideration appears the definition of systems' dependability in relation to their fundamental objectives. Thus, ***the dependability of the logistic system is system's ability to execute customer orders according to factors arising from the 7R principle, with particular emphasis on the completeness, timeliness and accuracy of ongoing deliveries.***

Regarding to the assessment of the logistic system, the literature contains a number of ways and methods of evaluation. Usually they are not perfect and there are some problems associated with their use. For example there is often the lack of consistency between the measures of the individual areas quality. Operational metrics are often ignored, for the widespread use of economic measures. It also focuses on the evaluation of measures for each unit of the supply chain instead of applying proper attention to a holistic approach and optimizing the supply chain as a whole. Due to the need to focus on the distribution systems' dependability, the author focuses on measures based on previously constructed definition. The table of selected indicators of considered distribution systems is placed in further part of this article.

3. MASS CUSTOMIZATION OF STEEL PRODUCTS

Steel products market is characterized by a constant, large fluctuation in demands, as well as by a high degree of differentiation of product variants. There are situations in which a distributor has to face the problem of meeting specific requirements. This need leads trading companies to seek solutions for mass customization of products.

Literature sources defines the phenomenon of mass customization as "the capability, realized by a few companies, to offer individually tailored products or services on a large scale" [7]. Zipkin defining the mass customization mentions three parts of the customization process: elicitation, process flexibility and logistics. The same author also mentions numerous problems possible to encounter while trying to use mass customization strategy. They can be recognized as the requirements to be met by a company willing to conduct mass customization. These requirements are: highly flexible production technology, an elaborate system for eliciting customers' wants and needs, a strong direct-to-customer logistics system and a potential mass market for custom features. For this publication's purposes, Zipkin's approach is adequate and allows the understanding of basic assumptions of mass customization, which is the occurrence of technological operations of adjusting the final product to specific customer requirements in one of the last supply chain links. Due to the state of existing infrastructure and qualifications of personnel specializing in adjusting operations, entities may use different variants of postponed production strategy. Research subjects of this publication have been selected deliberately and represent the two most commonly occurring variants of that strategy. These versions differ in location technological tasks of postponed production in supply chain.

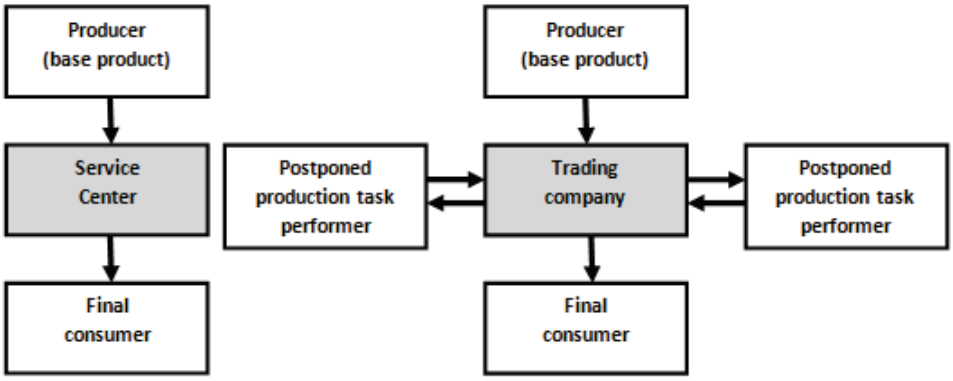

Figure 2 Postponed production strategy variants in distribution of steel products

The first entity is the service center which possesses the necessary infrastructure to carry out technological operations of postponed production on his own. This possibility results in shortening the path leading from the place of product differentiation to the final consumer. Postponed production strategy variant assumes the realization of technological operations inside the trading company and has been presented on the left side of **Figure 2**. The second entity - trading company which doesn't possess the infrastructure dedicated to postponed production tasks realization. This situation makes it necessary to involve external contractors

in each case which requires the use of the postponed production strategy. This decides on using another variant of the strategy. This variant has been presented on the right side of **Figure 2**.

4. TWO-STEP COMPARATIVE DISTRIBUTION SYSTEMS OF STEEL PRODUCTS ANALYSIS

In order to evaluate the level of systems' dependability their comparative analysis consisting of two phases was carried out. The first one is the analysis of entities current activities leading to determine pre-set indicators. The second is customer satisfaction survey analysis using the Customer Satisfaction Index (see **Figure 3**).

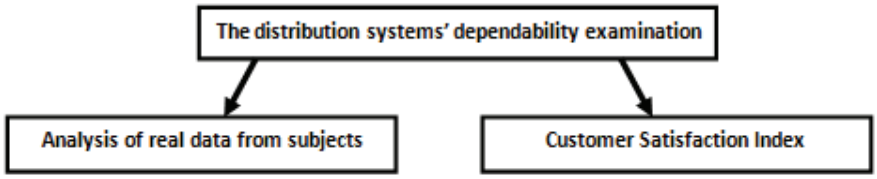

Figure 3 Researches structure

In the first stage, distribution systems of steel products were evaluated using the form which allows registration of the planned orders in comparison with realized orders [8]. It also made possible to indentify disruptions of the system performance by using a detailed spreadsheet of disruption measurement [9]. Assessment of the timeliness and completeness of orders was made by using a set of indicators relating to distribution systems features mentioned before. Data recorded during observation gave the possibility to present calculated indicators in the form of **Table 2**. The table presents selected indicators only.

Table 2 The results of the calculation of completeness and timeliness of deliveries

	Indicator	Trading company	Service Center
1.	$\frac{\text{Number of deliveries with a size equal ordered x 100}}{\text{Total number of deliveries}}$	45 %	**70 %**
2.	$\frac{\text{Number of incomplete deliveries x 100}}{\text{Total number of deliveries}}$	55 %	**30 %**
3.	$\frac{\text{Number of deliveries in time x 100}}{\text{Total number of deliveries}}$	50 %	65 %
4.	$\frac{\text{Number of deliveries realized after the deadline x 100}}{\text{Total number of deliveries}}$	40 %	**35 %**

In the second stage of dependability evaluation a survey was conducted to assess the satisfaction of customers using the services of both analyzed companies. The evaluation was carried out in four areas concerning the overall assessment of the company, pre-sales service, service during order realization and after-sales service. Interpretation of the data coming from the survey was made with use of the CSI method, which assumes the use of a five point Likert scale (1-5) as a way of assessing the level of satisfaction. After determining the ratings and relevance of the features, CSI indicators are calculated using the formula [10, 11]:

- i - number of requirement
- N - number of requirements included in the analysis
- w_i - factor of importance i-th requirement (0-1)
- c_i - Customer Satisfaction rating of the i-th requirement

$$CSI = \sum_{i=1}^{N} w_i * C_i \quad (1)$$

The sheet measuring disruptions used in the study allowed the specification of the most important factors enhancing disturbances that occurred in the observed entities in the course of research (see **Table 3**).

Table 3 Disruptions enhancing factors - cumulative research results table

	Disruptions enhancing factors	The number of occurrences		Average impact on disruptions occurrences (0; 1)	
		Trading Company	Service Center	Trading Company	Service Center
1.	Short lead time (imposed by the consumer)	1	4	1	0.5
2.	Lack of qualified staff	0	4	-	1
3.	Significant fluctuations in demand for the final product	0	6	-	0.2
4.	Communication problems between the supply chain links	3	4	1	0.6
5.	Limited capacity of the basis enterprise	0	8	-	1
6.	Insufficient capacity of the logistics infrastructure	0	4	-	1
7.	Limited number of suppliers	6	0	0.8	-
8.	Limited production capacity of the supplier and its flexibility	4	0	0.6	-

The research and analysis of the figures drawn from the questionnaires have enabled the presentation of the final results of CSI analysis (see **Table 4**).

Table 4 Customer Satisfaction Index evaluation of researched steel distribution companies

	Trading Company	Service Center
CSI_A	4.15	4.55
CSI_B	4.24	4.44
CSI_C	4.42	4.58
CSI_D	4.41	4.50
CSI avarage	4.305	4.52

CSI_A -CSI Index for overall assessment of the company

CSI_B -CSI for pre-sales service

CSI_C -CSI for service during realization the delivery

CSI_D -CSI for after-sales service

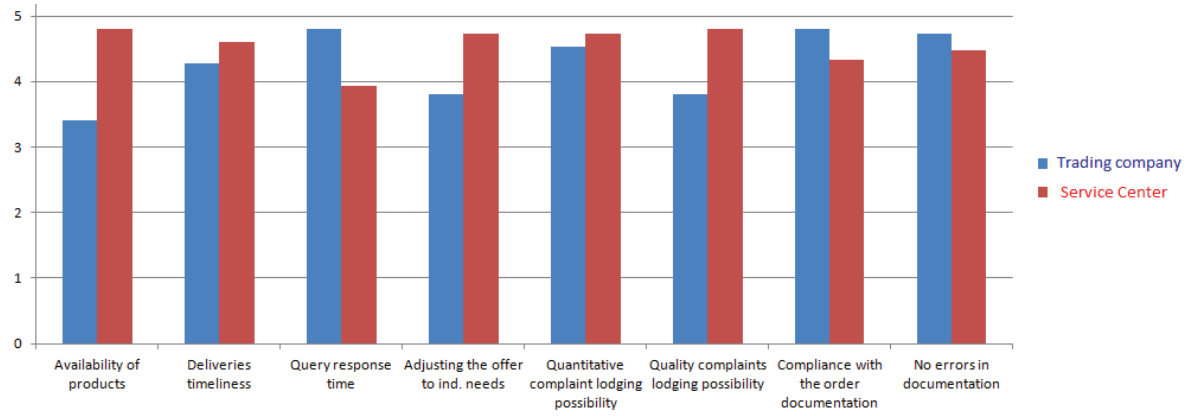

Figure 4 The average level of customer satisfaction index for parameters with a high level of significance

The list of average customer satisfaction index for parameters which significance was defined as high (more than 0.15) lead to some interesting conclusions. This data is presented in **Figure 4** (skipping parameters for which average satisfaction index is equal for both entities).

5. CONCLUSION

This article presents several approaches to one of the key features of steel products distribution systems which is their dependability. Research aimed to reveal the dependability characteristics was conducted on the ground of increasingly popular customization of steel products. Conclusions from the analysis of the literature and primarily from empirical studies carried out in two entities suggest a strong correlation between strategy implemented by company and dependability of its distribution system. In addition, it has been shown that the variant and configuration of the strategy is of huge importance. Both examined subjects use a postponed production strategy, but realized products customization occurs in a different way. This discrepancy significantly affects the satisfaction of customers, as well as the objectively measurable indicators to assess the dependability of the analyzed system.

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