THE ANALYSIS OF INTERFERENCES WITHIN THE SELECTED LINKS OF THE LOGISTICS CHAIN IN METALLURGICAL INDUSTRY

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Abstract

The aim of this article is to show the importance of the reliability of the selected links of the logistics chain. For companies operating in the metallurgical market it means a necessity to create new terms for cooperation, based on various segments of customers. Logistics services providers are those links that are included in the structure of efficient logistics chains. In order to meet market demands, metallurgical plants must embrace particular tools to verify individual links being the part of their logistics chains.

To verify this purpose, theoretical research tools were used, such as: analysis, synthesis, generalization and comparison. The scope of practical methods comprised the following: the observation method (to gather information about partners of the logistics chain at Huta Małapanew Sp. z o.o., interviews with employees, determining the interferences within and across the selected links) and the calculation and analytical methods (the analysis of measurement results, determining the acceptable level of interferences).

The tangible benefits of the conducted research include the development of a catalogue of probable interferences, which should be taken into account when managing the logistics chain.

Keywords: logistics chain, metallurgical market, logistics services providers, catalogue of interferences

1. INTRODUCTION

Ensuring a seamless flow of goods and information is the basis for the management of the logistics chain. The aim of this publication is to demonstrate the importance of the reliability of the selected links in the logistics chain. For companies operating in the metallurgical market it means a necessity to create new terms for cooperation, based on various segments of customers. Logistics services providers are those links that are included in the structure of efficient logistics chains. In order to meet market demands, metallurgical plants must embrace particular tools to verify individual links being the part of their logistics chains, due to interferences that appear at various stages of cooperation.

Activities performed in the the logistics chain may be organized in order to reduce the probability of interferences, and at the same time ensure an adequate response to the ensuing interference, to reduce its adverse effects.

An interference can be defined as an expected or an unexpected event, causing unscheduled, negative deviations in the processes of supplying products and services carried out in accordance with organization's objectives [1]. An interference is defined as an undesired event and its undesired consequences. Most of the discussions on distortions, drawn out in the logistics literature, refers to defining the risk occurring in logistics processes. Risk stands for the occurrence of risk factors, specific (typical) for logistics processes, showing particular probability (prevalence) and leading to particular effects (expressed as cost). Risk factors occurring in logistics processes affect changes in the added value pursued in the main processes implemented by an organization. Such a change is usually negative [2].

With an increase of interest in various forms of cooperation in logistics chains, new research studies appear, which present cross-organizational relationships as one of the sources of interferences leading to deviations in logistics and production processes [3].

The implementation of different concepts of management, quality improvement, logistics processes, including the reduction of logistics costs, lead to increased sensitivity of logistics chains to all types of interference.

An interference in the logistics chain can be anything that impacts the flow and supply of raw materials, parts, components and finished products, at each stage of the flow, from sources of origin to the final stages, where we deal with demand. [4]. Handfield R, McCormack K. define an interference as the main delay in manufacturing, distribution or supply nodes which influence the activities of other nodes in the supply chain [6]. Interferences usually form a bottleneck in one of the nodes, which as the result, spreads its impact on the entire supply chain. Each individual event, such as: fire, problems with the quality of the manufactured products, machine breakdowns, delayed customer orders, may lead to significant interferences in the entire logistics chain [6].

In particularly complex supply chains – that is in such, where there are plenty of nodes – the number of possible interferences also increases. Smooth, efficient management and cooperation in such a logistics chain requires, first of all, the identification of those nodes which are most sensitive to the effects of extraordinary events and constitute links that are critical to the entire chain.

2. LITERATURE REVIEW

The task of logistics is tracking the flow of tangible goods in the market environment, being the foundation for creating feedback, which enables – from the perspective of economic effectiveness – appropriate efficiency of such a flow. The original concept, in relation to logistics and the logistics chain, is a distribution channel, which is a mutually related sequence of actions initiated by a source of goods (raw material), and ended with an outfall, where the transported goods are absorbed by their recipient [7].

Logistics chains, functioning within the company's logistics system, combine the area of the manufacturing process with the areas of supply and distribution, and connect the company with other entities via the sphere of supply and distribution. In the macrologistics scale, logistics chains combine the cooperating companies, setting up links of subcontractors which provide components, for example, for a company running a production and assembly process.

As the subject-matter constitutes, a logistics chain is composed of tangible goods purchased on a supply market in accordance with the demand, passed over to production, processed into finished products and made ready for sale.

Using the notion of a logistics chain, we should stress the crucial importance of logistics functions associated with customer service, transport, storage, loading works, packing, customs service, organization and safety of the these processes. In conclusion, a logistics chain is a transport and storage chain, being a technological link-up between storage and transshipment points and routes for goods carriage. Individual actions conducted in the framework of the logistics chain represent consecutive stages of the entire flow of goods and services. All operations, procurement and stock policy processes for individual links of this chain are organizationally and financially coordinated. The so understood logistics chain is the subject of this paper's analysis.

We can distinguish four main types of logistics chain links: the link for sourcing raw materials – the source of acquiring raw materials, the link for providing raw materials to the chain – intermediaries selling raw materials and semi-finished products, the production link – manufacturing of finished products, the distribution link – provision of finished products to the customer.

So structured production and logistics systems require increased focus on managing material flows, due to interferences that appear at various stages of cooperation. An example of the logistics chain corresponding to the researched industry is shown in Figure 1.

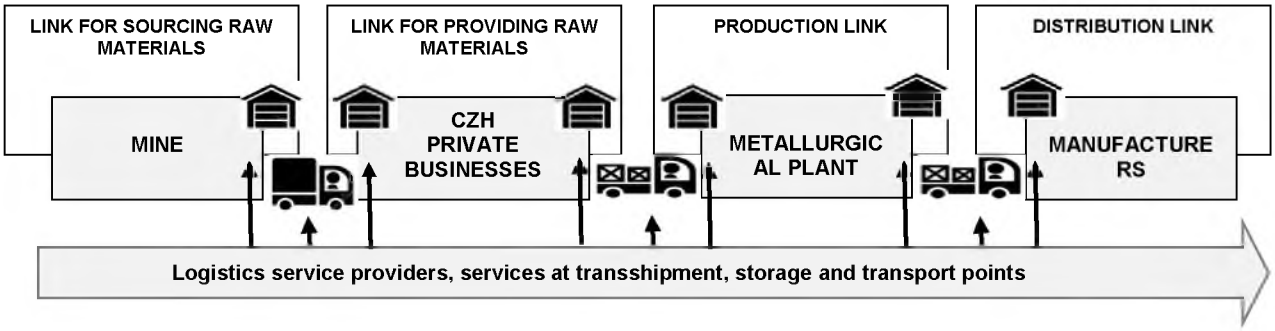

Fig. 1. Diagram of the logistics chain in a metallurgical plan (own elaboration)

The logistics chain extends between the market of sourcing raw materials and the sales market – and being more specific, between: suppliers, manufacturers, logistics operators and end users.[1] Thus, the sources of interference must be searched for mainly in the areas of contact between the individual links in the logistics chain. If we predetermine these places as nodes, they will be represented by transshipment and storage points[2], while taking into account the cooperation with logistics operators.

3. SUBJECT OF RESEARCH

The metallurgical company, Huta Małapanew Spółka z o.o., was established on 1 July 2001 and is the business successor of Huta "Małapanew" S.A. located in Ozimek. It is one of the largest Polish manufacturers of steel castings. The main assortments of products include: raw and processed casts, metallurgical rolls, machine parts (wheels for gantry cranes, rolling fittings). Castings are made from approximately 200 types of cast steel and cast iron, according to the following standards: PN/EN, DIN, ASTM, GOST, BS or on the basis of the requirements set by the contracting entity.

The weight of a single raw casting can be from 5 to 12000 kg. The recipients of the castings are found across all industries, particularly in mining, metallurgy, cement and lime, machinery, energetics, shipbuilding, etc. The plant is capable of handling discrete or mass production. Castings are offered in the raw or manually processed state [8].

4. RESEARCH METHODS AND STUDY RESULTS

To verify this purpose, theoretical research tools were used, such as: analysis, synthesis, generalization and comparison. The scope of practical methods comprised the following: the observation method (to gather information about partners of the logistics chain at Huta Małapanew Sp. z o.o., interviews with employees, determining the interferences within and across the selected links) and the calculation and analytical methods (the analysis of measurement results, determining the acceptable level of interferences).

The publication features the analysis of nodes between the link for providing raw materials to the logistics chain – the metallurgical plant, i.e. the production link – and between the metallurgical plant and the distribution link.

The transport and storage processes at each of the nodes are performed by different logistics operators, but their proceedings and potential sources of interference look similar. Tab. 1 presents an alignment of the identified interferences with a set of stages representing the progress of realization of the researched processes.

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[1] The functioning of logistics chains in metallurgical industry consumes very high costs. One of the ways to reduce them is using logistics service providers. Unfortunately, the high availability of services in this field increases the risk of establishing cooperation with an incompetent operator.
[2] Places of dispatch and receipt of goods

Tab. 1. Interferences in transport and storage processes in the logistics chain of Huta Małapanew

STAGES OF TRANSPORT AND STORAGE PROCESS REALIZATION	*INTERFERENCES IMPACTING INDIVIDUAL STAGES*
Selection of the carrier	picking a disadvantageous offer
Generating a transport order for the carrier	lack of communication; interferences resulting from inappropriate communication; errors in order delivery; errors in understanding information; excessive duration of delivering the order – delays, errors/deficiencies in the submitted order, including changes in the ordered batch; submitting extraordinary orders; a too high, in relation to the projected amounts, number of orders in a given period; human error, for example, an incorrectly entered date of receipt on documents intended for the carrier
Acceptance and order confirmation by the carrier	lack or insufficient communication, errors in delivering order confirmation, refusal to execute the order, excessive time of waiting for reply, breakdown or a theft of the means of transport.
Designation of the means of transport and the driver	selecting a wrong means of transport, selecting a wrong driver, no driver available, no means of transport available
Preparation of the means of transport and the driver	errors when communicating information about the route to the driver, uneconomic route planning, errors associated with the preparation and passing transport documents over to the driver, wrong scheduling of the working time
Loading	accidents during loading, losses in materials during loading, maladjustment of machinery and equipment that allow loading to the means of transport, inadequate load securing
Transport	accidents involving the used means of transport, breakdowns of the means of transport, adverse weather conditions, failure to deliver goods on time, necessary detours, incorrect route selection by the driver, the driver is unable to drive the vehicle, transported load thefts, vehicle thefts
Unloading	accidents during unloading, breakdowns of machinery and equipment, material losses, property damage unsatisfactory service to the recipient of the goods
Settlement	failure to deliver the invoice, issuing an incorrect invoice, lack of financial resources, erroneous delivery of financial resources

Source: own elaboration

Transport, in addition to the price of the product and its quality, is an inherent element affecting the level of satisfaction of the recipient of the delivered goods. The company – when deciding to use an external logistics operator – must be aware of possible interferences associated with outsourcing transport services to external companies.

It is important to determine an acceptable level of interference through risk indicators. The risk indicators dedicated to transport and storage logistics processes are: quality, terms of delivery, lead time and losses [9]. Tab. 2 presents the number of interferences recorded during the planning and realization stages of transport and storage processes in the logistics chain in the period from 1 January 2015 to 31 December 2015 – and on the basis of the interviews with the staff an acceptable level of interference was determined.

On the basis of data collected in Tab. 2, the statistical significance of the structural indicators for individual interferences was analyzed. Let M indicate the number of interferences and let n represent the total number of activities. Let us determine the level of significance. Let H stand for the null hypothesis and let K represent the alternative hypothesis and let W be the critical range of the test.

Tab. 2. Selected interferences recorded in the researched metallurgic plant

No.	Type of interference	Total number of activities	Number of interferences	Percentage share of interferences to the total of activities	Percentage share of correctly performed activities	Acceptable	Enhanced control of an interference	Unacceptable
1.	Incorrect flow of information	128	60	46.81%	53.19%	0–20 %	21-40 %	<40 %
2.	Delays in performed transport	119	45	37.61%	62.39%	0–20 %	21-30 %	<30 %
3.	Wrong scheduling of the working time	111	35	31.47%	68.53%	0-10 %	11-30%	<30%
4.	Wrong route planning	38	10	26.13%	73.87%	0-5 %	6-15%	<15%
5.	Losses of goods	44	6	13.68%	86.32%	0-5 %	6-20 %	<20 %

6.	Breakdowns	18	6	32.68%	67.32%	0-10 %	11-30%	<30%
7.	Accidents	9	1	10.61%	89.39%	0%	1-10 %	< 10%

Source: own elaboration on the basis of the conducted research

Interference: incorrect flow of information

$M = 60, n = 128$.

$H : p = 0{,}4$

$K : p > 0{,}4$

$$Test : U = \frac{M - np_0}{\sqrt{np_0(1-p_0)}} \sim N(0,1)$$

$W = [1{,}64; \infty)$.

After the calculation of the U statistics value, on the basis of the sample, we will get $U_D = 9{,}89$. As $U_D \in W$ we should reject the null hypothesis for the benefit of the alternate hypothesis. Therefore, at the researched company, the indicator of the structure of the incorrect flow of information exceeds 40%.

For other interferences similar calculations were carried out. And so, for the delays in performed transport. After the calculation of the U statistics value, on the basis of the sample, we will get $U_D = 1{,}86$. As $U_D \in W$ we should reject the null hypothesis for the benefit of the alternate hypothesis. Therefore, at the researched company, the indicator of the structure of the delays in performed transport exceeds 30%. For the interference concerning wrong scheduling of the working time, after the calculation of the U statistics value, on the basis of the sample, we will get $U_D = 0{,}35$. As $U_D \notin W$ we cannot reject the null hypothesis for the benefit of the alternate hypothesis. Therefore, at the researched company, we cannot reject the hypothesis that the indicator of the structure of wrong scheduling of the working time is equal 30%. For the interference concerning wrong route planning, after the calculation of the U statistics value, on the basis of the sample, we will get $U_D = 1{,}69$. As $U_D \in W$ we should reject the null hypothesis for the benefit of the alternate hypothesis. Therefore, at the researched company, the indicator of the structure of wrong route planning exceeds 15%. For the interference concerning losses of goods, after the calculation of the U statistics value, on the basis of the sample, we will get $U_D = -1{,}06$. As $U_D \notin W$ we cannot reject the null hypothesis for the benefit of the alternate hypothesis. Therefore, at the researched company, we cannot reject the hypothesis that the indicator of the structure of losses of goods is equal 20%. For the interference concerning breakdowns, after the calculation of the U statistics value, on the basis of the sample, we will get $U_D = 0{,}28$. As $U_D \notin W$ we cannot reject the null hypothesis for the benefit of the alternate hypothesis. Therefore, at the researched company, we cannot reject the hypothesis that the indicator of the structure of breakdowns is equal 30%. For the interference concerning accidents, after the calculation of the U statistics value, on the basis of the sample, we will get $U_D = 0{,}1$. As $U_D \notin W$ we cannot reject the null hypothesis for the benefit of the alternate hypothesis. Therefore, at the researched company, we cannot reject the hypothesis that the indicator of the structure of accidents is equal 10%.

From the calculations made, the percentage share of the selected interferences nearly coincides with the unacceptable level.

5. CONCLUSION

The carried out research resulted in developing a catalogue of probable interferences, which should be taken into account when working with logistics operators in the framework of the logistics chains of metallurgical industry, the selected ones have been presented in the publication. The occurrence of interferences in a supply chain is indissociable. The problem of occurring interferences is extremely important, which has been proved by the research. The indicator of the structure of the incorrect flow of information exceeds 40%, the

indicator of the structure of the delays in performed transport exceeds 30%, we cannot reject the hypothesis that the indicator of the structure of wrong scheduling of the working time is equal 30%, the indicator of the structure of wrong route planning exceeds 15%, we cannot reject the hypothesis that the indicator of the structure of losses of goods is equal 20%, the indicator of the structure of breakdowns is equal 30%, the indicator of the structure of accidents is equal 10%.

The more complex the logistics chain is, the greater is the risk of events that could lead to the escalation of interferences within all its links. Companies should cooperate with one other in a way that allows building resistance to interferences across the entire supply chain.

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REFERENCES

[1] Steps to BS 25999 Registration, Perry Johnson Registrars Inc., Southfield, Michigan USA, 2008, p. 8.

[2] Kulińska E., AWZR procesów logistycznych. Modele i eksperymenty naukowe., Printing House of Opole University of Technology, Opole 2011.

[3] Min S., Roath A., Daugherty P., Genchev S., Chen H., Arndt A., Richey R., Supply Chain Colaboration: What's happening?, The International Journal of Logistics Management, Vol. 16 no 2 2005.

[4] Macdonald, J. R., 2008, Supply Chain Disruption Management: A Conceptual Framework and Theoretical Model, The University of Maryland, College Park, http://drum.lib.umd.edu/bitstream/1903/8803/1/umi-umd-5824.pdf [w:] Konecka S., Ryzyko zakłóceń w zarządzaniu łańcuchami dostaw, a doctoral dissertation, Poznań 2015.

[5] Handfield R., McCormack K., Supply Chain Risk Management. Minimizing disruptions in global sourcing. Auerbach Publications Taylor & Francis Group, New York 2008.

[6] Kramarz, M., Kramarz, W., Analiza zakłóceń w wybranym ogniwie łańcucha dostaw branży motoryzacyjnej, Logistyka, no 4, 2012, p. 435

[7] Grajnert J., Kwaśniowski S., Nowakowski T., Miejsce transportu kolejowego w łańcuchach i sieciach logistycznych, Edit. of Wrocław University of Technology, Wrocław 2002

[8] Huta Malapanew Sp. z o.o. http://www.malapanew.com.pl/

[9] Kisperska-Moroń D., Pomiar funkcjonowania łańcuchów dostaw, Academy of Economics, Katowice 2006, p. 52