RELATION RISK IN DISTRIBUTION NETWORKS OF STEEL PRODUCTS

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Abstract

Disruptions generated at the meeting point of cooperating organizations are a special issue in the process of network co-ordination. This paper aims at identifying relation risk in different models of a distribution network of steel products. In order to fulfil this objective literature research was conducted regarding both the co-ordination of supply chains (including distribution channels), network structures and disruptions in supply chains and distribution channels and a methodology for relation risk assessment suggested. In the next stage relation risk in distribution networks of steel products was identified and analysed.

Keywords: Disruptions, relation risk, logistics network, distribution

INTRODUCTION

The literature of management sciences includes research into networks of cooperating enterprises and their subjects, which have been conducted for many years now. Authors analyse many different aspects, including tactical and operating issues connected with flow management, supplies management, the organization of logistic processes, which are included in the research into logistics. It can be noticed that logistic publications include a growing trend concerning disruptions, risk and the resilience of networks, which are complex structures. Simultaneously, while observing the literature on management sciences focused a network paradigm, it can be noticed that there is a problem arising at the meeting point of cooperating organizations and it is called relation risk. Distribution networks composed of many different cooperating organizations combine two types of networks: commercial networks and logistic networks. At the meeting point of those two types of networks, there appear disruptions which affect the growth of sensitivity of the entire distribution network and upset the resilience of such a structure. Therefore, the aim of this paper is to interpret relation risk in distribution networks and perform an analysis of relation risk in a distribution network of steel products against the background of other categories of network risk.

1. RELATION RISK IN THE LIGHT OF MANAGEMENT SCIENCES

A network is a special kind and manner in which relations with the environment, that is interorganizational bonds, are formed, [1]. Numerous authors stress that the winner of the competitive war is the subject which can skilfully establish such network connections that generate a high value added, increase innovativeness and simultaneously allow the growth of adaptability [2]. The formation of interorganizational bonds results from different reasons ranging from aspiration to improving the efficiency of the enterprise and enlarge resources, through aspiration to organizational learning, and finally aspiration to reducing uncertainty [3].

Irrespective of motives for establishing collaboration, the key distinguishing feature of networks of cooperating organizations are: the legal and organizational independence of network nodes, the dynamics of interorganizational relations, relations shaped horizontally and vertically in order to increase the value added from the customer's perspective, the common supply base including the network partners' resources, the features of the network bonds: exchange, commitment, reciprocity. Network relations can be established in order to exchange information, exploit resources, organize processes, perform project tasks with a certain deadline. This recognition indicates virtual networks, based on exchange of information on impermanent relations, in which costs of joining a network and leaving it are relatively small), project networks, in which relations are shaped according to the project objectives and last until it is finished, bearing in mind that in order

to fulfil the project objectives the organizations engage all their own resources; supply networks, in other words distributed networks, in which the organizations shape relations around a determined resource, e.g. the transport, warehousing or production infrastructure and decide to share exploitation of this supply, which indicates a long-term perspective of such collaboration, and integrated networks, which are networks with a long-term perspective, established by organizations sharing the realization of all processes, i.e. marketing, logistic or production processes. This network classification should also include process networks, which refer to relations within subcontracting both of tasks connected with production or postponed production, and logistic tasks.

Distribution networks can be organized via a combination of the above-mentioned types of networks. Simultaneously, distribution networks should include both logistic networks, created by collaboration in the TSL sector and collaboration between organizations from the TSL sector and productive and commercial organizations, and sales networks, created by wholesale and retail commerce networks.

Logistic networks can be classified regarding the degree of centralization, the commitment of resources and the time horizon, and also types of organizations included in the network structure. According to the first criterion, one can indicate dominated networks and equal partners' networks. Dominated networks have a clearly separated flow coordination subject. It can be a logistic integrator (4PL) or a conductor (5PL). They are subjects with high relation competences, having a higher capability of including subjects in networks than other organizations. In equal partners' networks, subjects cooperate on equal rights, and none of the organizations has a dominant position towards others. This type of networks can be organized, e.g. in the form of a logistic cluster [2].

The indicated descriptions of distribution networks, including networks and sales networks, are known in the literature and well recognized empirically. However, the problem of disruptions and flow coordination and also the risk connected with material flows is definitely strongly analysed at the level of supply chains rather than collaboration networks. From this perspective, research into networks should be developed in the area of supplementing the methodology for selecting mechanisms of the multiple co-ordination (network governance): bureaucratic, social and flow, with the aspect of disruptions in material flows [3,4].

Including the analysis of disruptions in the co-ordination of supply chains is proposed by Cao, Zhou and Lu [5]. Disruptions analysed by Cao and other researchers are identified on two levels of the supply chain: on the level of deviations from the predicted customer's needs (disruptions connected with demand uncertainty) and on the level of deviations from the planned logistic costs (disruptions connected with collaboration in supply chains). The authors assumed that cost risk and demand risk occur at the same time.

Obviously, flow coordination is strongly connected with demand uncertainty. Planning demand, even if it does not lie completely in the coordinator's hands, is essential for his/her work and decisions. Besides, decisions undertaken by the coordinator and co-ordination mechanisms used by them are affected by the location of material decoupling point, uncertainty of decision making connected with risk, including the risk resulting from the organization of the network itself, and consequently relation risk and process risk. However, disruptions in material flows can be understood considerably more widely than those proposed by Cao et al. Disruptions in supply chains result from influences of endogenous and exogenous factors in relation to the supply chain. Disruptions understood so widely are defined as unexpected events which slow down or stop material flows between organizations participating in production and delivery of goods and services [6]. Chopra and Sodhi [7] stress that risk management in supply chains, which is initiated by identification of disruptions in material flows, is especially difficult because activities which compensate processes and improve deviations in one supply chain can cause disruptions in another chain link. Therefore, it can be assumed that a growth of network relations in supply chains increases this risk. Research by Cao et al. [5] confirms the adopted assumption that relations created within supply chains and especially in the network structure can be themselves a source of interference which are called relation risk in the paper. Therefore, relation risk will be understood as a

probability of disruptions in material flows causing losses resulting from inadequate forms of relations or unreliable internal procedures, errors made by people and systems. Relation disruptions can occur particularly by extending the lead time of logistic and production processes or/and changes of the level of logistic costs. The results of relation risk involve increasing the entire logistic costs or worsening the customer satisfaction indicator. The idea of a risk relation management system (strategic partnership risk) has been discussed in the literature for several years. The idea of strategic partnership risk is based on a perceived probability of potential threats resulting from participation in strategic bonds with other independent subjects, whereas the size of the threat will be the bigger, the bigger losses may be incurred by a given enterprise [8]. The discussed risk refers to the negative results of certain events and decisions and is perceived subjectively, i.e. it reflects an estimation of the objective risk of a person who takes decisions. Relation risk includes all ambiguities concerning future events, perceived by potential partners, which can negatively affect the results of the collaboration. It is defined as a probability and the consequences of failure to achieve satisfying cooperation [9]. It results primarily from the potential of behaviour, harmful for the relationship, occurring on the part of both enterprises, and is influenced by all partner in the part in which each of them places and administers resources which they were committed to transfer for partnership. Therefore, the interpretation of relation risk adopted in the paper matches the ideas of defining relation risk presented before.

2. THE IDEA OF RESEARCH INTO RELATION RIS IN DISTRIBUTION NETWORKS

This paper indicates differences in the sense of relation risk in different types of distribution networks of steel products, taking into account in these networks both sales and logistic networks. As a result of disruptions in material flows are unpunctual and incomplete deliveries, or even worse, unfulfilled deliveries. Consequently, risk in material flows is considered as a probability of disruptions which entail organizational and/or financial effects. Organizational effects involve 5 levels: (1) effects compensated by previous protections, (2) effects requiring slight, short-term changes in the fulfilled processes, (3) effects requiring changes in the process organization, (4) effects causing threat for the realization of the key targets and those requiring long-term changes in the fulfilled processes, (5) effects causing impossibility to fulfil the key target. Financial results are associated with process reorganization and extraordinary transport but also with penalties resulting of non-fulfilment of the contract.

Relation risk is a type of risk in networks, including distribution networks. The proposed methodology of research into relation risk is coherent with ideas of measuring disruptions in networks and supply chains, which were presented before. Therefore, the proposal involves identifying disruptions, measuring their frequency and results and then combining them into risk factors (**Figure 1**). At the stage of identification of potential disruptions, a detailed study of the literature on resilience of supply chains was taken into account. Summing up the results of their research Kramarz [10] indicated a set of endogenous and exogenous disruptions in network supply chains. According to the proposed methodology, disruptions measurement in an organization requires diary studies (participating observation, continuous observation). These studies can be carried out using of disruptions measurement cards, simultaneously these results are combined with the data registered by the computer system, especially in the area of measurement of orders fulfilled incompletely, unpunctually and unfulfilled orders. The observed deviations in material flows in the conducted research translate into the reliability of fulfilled orders. The reliability of fulfilled orders is measured by all organizations cooperating in a distribution network. At the last stage of the research, previous disruptions measurement results forming relation risk, are analysed in different types of distribution networks (virtual, project, supply, integrated and process networks).

The literature and pilot research allow selecting 32 factors causing disruptions in material flows in network supply chains of steel products directed to the motor industry. Factor analysis selected in order to separate risk factors allowed connecting strongly correlated variables. Risk factors, distinguished in this way, were analysed relative to the essential justification of the connection of certain variables in a given risk factor. The

three-stage process separated 6 groups of disruptions named risk factors [11]. The system of the 6 factors provides 67 % of the explanation of variance, and 17 variables have loading above 0.7. Therefore, it can be concluded that the separated 6 risk factors in 67 % represent the variability of disruptions as regards frequency. Accordingly, it keeps a considerable degree of defining the variability of the frequency of disruptions, simultaneously involving as many as 17 separated variables. Therefore, it was accepted that the separated 6 factors sufficiently and relevantly explained the variability of disruptions in respect of the frequency of their occurrence and therefore it is a proper set of risk factors, compatible with the accepted assumptions. When interpreting groups of risk factors, it can be indicated that four of them can be classified as relation risk factors.

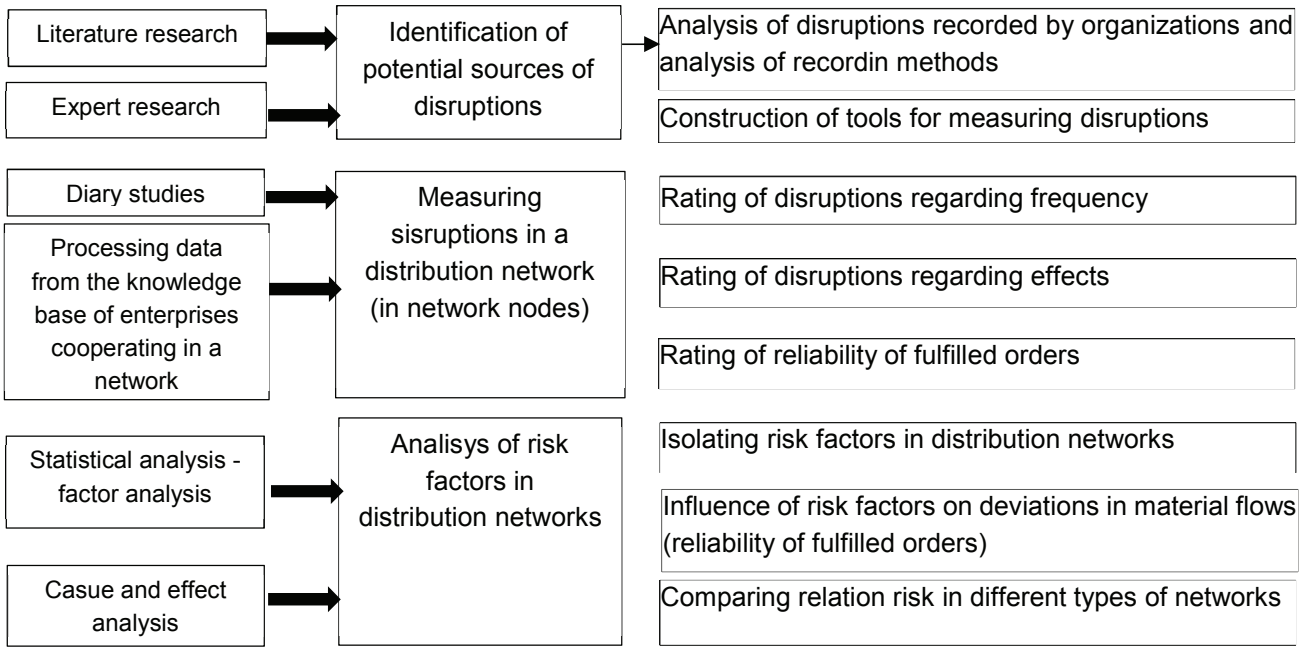

Figure 1 Stages of the research of the relational risk [own study]

3. RELATION RISK IN DISTRIBUTION NETWORK OF STEEL PRODUCTS

When analysing the research findings as regards risk in distribution networks of steel products , it can noticed that the risk factors introduced earlier, generated on the part of the base enterprise, refer to all models of networks (they do not significantly differentiate the five types of network - virtual, project, supply , integrated and process networks), only relation risk is different in each of the examined models. The summary of the results of the factor analysis and the interpretation of individual risk factors were presented in **Table 1**.

The separated risk factors in respect of the frequency not only significantly represent the variability of disruptions in respect of the frequency but also have their own essential justification. The division of factors is compatible with the phasic (systems) depiction. Factors 2-5 of the disruptions group are classified as relation risks. Within the base enterprise itself, two types of risk factors were distinguished. The first one (risk factor 1) depicts disruptions resulting from a bad job organization. Variables forming this factor refer to organization waste factors. The second risk factor generated by the base enterprise (risk factor 6) refers to events happening as a result of maladjustment of the supply base organization and quality control procedures to the real requirements of material flows. Similarly, disruptions generated by the supplier in respect of the frequency constituted two risk factors. Risk factor 2 accumulates events connected with the defective quality of delivered material, which finally extorts additional control, requires returns, and therefore it required organizing extraordinary processes, however, risk factor 5 accumulates events connected with the delivery reliability. The next step deepens the inference process with the details of the results for 5 types of distribution networks (see **Table 2**).

Table 1 The interpretation of risk factors [own study]

Risk Factor	Representation of disruptions	Interpretation
Risk factor F1	D30 - using improper procedures in production and/or logistic processes, D31 - long periods of stoppage (idle time of people, material, information) , D32 - improper worksite organization,	Disruptions generated by the base enterprise in the area of the organization of production and logistic processes - waste
Risk factor F2	D3 - defective delivery, D4 - bad quality of delivered materials,	disruptions are generated by suppliers (quality of materials)
Risk factor F3	D12 - unpunctual transport processes, D20 - badly selected business partners, D24 - damage while loading/stockpiling,	disruptions at the stage of fulfilment of logistic processes between the base enterprise and the customer
Risk factor F4	D10 - insufficient subcontractor's production capacities, D11 - delays in fulfilment of processes by the subcontractor	disruptions generated by the subcontractor
Risk factor F5	D1 - unpunctual delivery, D2 - incomplete delivery, D5 - unfulfilled delivery	disruptions generated by the supplier regarding delivery reliability
Risk factor F6	D18 - maladjustment of conditions of order fulfilment to the possibilities of the base enterprise, D23 - bad quality control on the part of the base enterprise	disruptions generated by the base enterprise in the area of order fulfilment including order processing and inspection

Table 2 Relation risk in distribution networks of steel products [own study]

The type of a distribution network	Dominant disruptions	The hierarchy of risk factors of relation risk (1- the least essential, 4 the most essential)	The risk relation (small/average/large)	Results of disruptions
virtual	D12, D24	(1)F 4, (2) F5 (3) F2 (4)F3	small	small
supply	D20, D24, D30	(1)F 4, (2) F2 (3) F5 (4)F3	average	small
project	D4, D1, D2	(1)F5, (2) F4 (3) F3 (4)F2	average	large
process	D10, D11, D12	(1)F2, (2) F5 (3) F3 (4)F4	large	average
integrated	D30, D24, D23	(1)F5, (2) F4 (3) F2 (4)F3	average	small

Risk factors depicted in groups 1 and 6 are characterized with strong variability and are independent from the network type. In detailed research in virtual networks relation risk was generally rated on a low level. This is associated with the impermanence of network relations, dynamic changes of these networks and slight network entry and exit barriers. The level of relation risk was rated high in process networks. These networks are especially complex because they are based on subcontracting of postponed production tasks performed in the distribution channel (on the level of service centres and steel works). Simultaneously, realization of postponed production tasks in enterprises based on partnership is associated with the need for additional organization of transport processes. Consequently, in this type of network, what is especially distinct is the effect of overlapping relation risk in sales and logistic networks. Moreover, in the examined process networks the forms of collaboration between the base enterprise and its partners was also differentiated (both formal and informal relations). In other types of networks, the level of relation risk one rated as average.

When analysing the results of disruptions, disruptions in project and process networks were rated 4.5. A high frequency of disruptions in integrated networks does not translate into high effects of those disruptions. These networks are definitely adapted the best for compensation of disruptions in the system and for not transferring them on subsequent links. A weak aspect of the presented inference is the differentiation of observation in

individual types of networks. In the examined distribution networks of steel products, the total of 17 coordinators revealed as follows: 17 coordinators revealed participation in virtual networks, 4 coordinators in supply networks, 10 coordinators in process networks, 7 coordinators in the project network and only 2 coordinators in integrated networks. One coordinator participates in many different types of networks.

4. CONCLUSION

The special complexity of the distribution network is transferring itself into problems of logistic managing the such structure. The cooperation of the organization in the distribution network requires the assortment of appropriate coordination mechanisms. Special problem in the network governance are disruptions generated on the joint of cooperating organizations. In the article I identified the problem of the relational risk in the coordination of flows in the distribution network. I showed assumptions for the research on its problem. The designed methodology for analysing risk relation in distribution networks is universal. The empirical research was conducted in a distribution network of steel products which is a very complex system and allows observing different types of networks regarding a given category of products. The obtained results indicate the differentiation of relation risk among types of networks. The differentiation concerns both frequencies of the occurrence of disruptions and their results. Considering a weak aspect of the empirical research, i.e. a small representation in two groups, it is advisable to extend the research on other sectors. Risk relations isn't homogeneous in examined types of the network. It is possible so to conclude that the coordinator should apply the different combination of coordination mechanisms in individual types of the network. Conducting further research above the influence of the type of the relational risk on the effectiveness of individual coordination mechanisms is significant.

REFERENCES

[1] NIEMCZYK J., STANCZYK-HUGIET E., JASIŃSKI B. *Sieci międzyorganizacyjne. Współczesne wyzwania dla teorii i praktyki zarządzania*. Warszawa: C.H. Beck, 2012.

[2] KRAMARZ M. Sieci logistyczne w naukach o zarządzaniu, *Studia Ekonomiczne, Zeszyty Naukowe Uniwersytetu Ekonomicznego w Katowicach*. 2015. vol. 251, pp.79-91.

[3] CZAKON W. *Sieci w zarządzaniu strategicznym*, Warszawa: Wolters Kulwer, 2012.

[4] NEWIG J., CHALLIES E., JAGER N., KOCHSKAEMPER E., ADZERSEN A. The environmental performance of participatory and collaborative governance: a framework of casual mechanisms, *Policy Studies Jour*nal. 2018. vol. 46, no. 2, pp. 269-279.

[5] CAO E., ZHOU X., LU K. Coordinating a supply chain under demand and cost disruptions, *International Journal of Production Research*. 2015. vol. 53, no. 12, pp. 3735-3752.

[6] HENDRICKS, K.B., SINGHAL, V.R. Supply Chain Disruption and Corporate Performance in: Gurnani, H., Mehrotra, A., Ray, S. (eds.), *Supply Chain Disruption: Theory and Practice of Managing Risk*, London: Springer-Verlang, 2012.

[7] CHOPRA, S., SODHI, M. Managing Risk to Avoid Supply Chain Breakdown, *MIT Solan Management Review*. 2004. vol. 46, no. 1, pp. 53-61.

[8] ŚWIATOWIEC-SZCZEPAŃSKA J. *Ryzyko partnerstwa strategicznego przedsiębiorstw: ujęcie modelowe*, Poznań: Wydawnictwo Uniwersytetu Ekonomicznego, 2012.

[9] DAS T.K, TENG B. Risk Types and Inter-Firm Alliance Structures, *Journal of Management Studies*. 1996. vol. 33, pp. 827-843.

[10] KRAMARZ W. *Modelowanie przepływów materiałowych w sieciowym łańcuchu dostaw. Odporność łańcucha dostaw wyrobów hutnicz*ych, Warszawa: DIFIN, 2013.

[11] KRAMARZ M., KRAMARZ W., The identification of zones of amplification of disruptions in network supply chains of metallurgic products, *Metalurgija*. 2015. vol 54, no. 1, pp 279-282.