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RISK ASSESSMENT AND MANAGEMENT LOGISTICS CHAINS

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ABSTRACT. Background: In the context of economic globalization and increasing complexity of economic relations enterprises need methods and techniques to improve and sustain their position on the global market. Integration processes offer business new opportunities, but at the same time present new challenges for the management, including the key objectives of the risk management.
Method: On the basis of analysis tools known from the pertinent literature (Supply Chain Management and Supply Chain Risk Management methods, methods of probability theory, methods of risk management, methods of statistics) the authors of this paper proposed their own risk assessment method and the method of management of logistics chains. The proposed tool is a specific hybrid of solutions known from the literature.
Results: The presented method has been successfully used within the frames of economic-mathematical model of industrial enterprises. Indicators of supply chain risks, including risks caused by supplier are considered in this paper. Authors formed a method of optimizing the level of supply chain risk in the integration with suppliers and customers.
Conclusion: Every organization, which starting the process of integration with supplier and customers, needs to use tools, methodologies and techniques for identification of "weak links" in the supply chain. The proposed method allows to fix risk origin places in various links of the supply chain and to identify "weak links" of a logistic chain that may occur in the future. The method is a useful tool for managing not only risks and risk situations, but also to improve the efficiency of current assets management by providing the ability to optimize the level of risk in the current assets management of the industrial enterprise.

Key words: risk management, supply chain risks, optimization of risks, integration risks.

INTRODUCTION

The paper is devoted to the risk assessment and management of the industrial supply chain. The authors considered indicators of supply chain risks, including risks caused by supplier. Authors formed a method of optimizing the level of the supply chain risk in the integration with suppliers and customers.

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In the context of economic globalization and increasing complexity of economic relations enterprises need methods and techniques to improve and sustain their position on the global market. Integration processes offer business new opportunities, but at the same time present new challenges for the management, including the key objectives of the risk management.

BRIEF METHOD OF ASSESSMENT AND MANAGEMENT LOGISTICS CHAINS

In our view, the integration is a process of creation and the involvement of individual

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parts into a whole, taking into account the ability of their devices to achieve new qualitative state and acquire new capabilities. But the result of such a state can be achieved not only through the integration process, but also in the so-called quasi-integration. Analysis of the literature showed that the consensus on the concept of quasi-integration does not exist. In this regard, we consider it reasonable to offer own definition of "quasi-integration", based on the interpretation of the term by Sheresheva [2010]. The quasi-integration is an association of economic subjects, based on the stable and long-term relationship between them and the management mechanism of their joint activities through transparency, financing (including long-term lending, investment lending, leasing), insurance and other tools to control the behavior of subjects other than legally issued change of ownership [Butrin and Vikulov 2012].

Butrin A. [2012] in his work "Methodical bases chain costs management in integrated enterprise" notes that the participation in the integration process provides participants with the following features:

- higher access to different types of resources (material, financial, labor),
- the opportunity to operate on a broader integration space,
- to create efficiencies,
- to create privileged conditions for integrating subjects and protect them from the competition of other non-interest in the structure of grace,
- an agreed solution.

Modern integration processes were reflected in the risk management. Today, risk management in some industries is carried out on the level of the whole company, and begins to go beyond a single enterprise, taking the form of an integrated process, accompanying the transition of companies to the concept of supply chain management (SCM). In this regard, we note the emergence of scientific papers on supply chain risk management (SCRM). This concept covers all aspects of the activity and serves as a strategically tool of risk management in the integration process [Tsaplin 2011, Vikulov 2011].

In recent years, many papers covering this field have been published by Russian scientists. This work can be structured in the following areas: risk management in integrated structures, strategic risk management, development of risk management system at the enterprise, risk management of certain areas of the company.

The main weaknesses of the current stage of risk management are as folllows:

- lack of theoretical and methodological framework for identifying risks and losses of their intensification,
- no methodology of risk management in the context of growing integration in the industry,
- local management of interacting participants functional without including risk component. It does not permit to achieve the desired synergies and reduces efficiency,
- the pricing based on the classical approach, does not fully take into account the risk of losses in the logistics chain.

Accordingly, the actual tasks are:

- disclosure of organizational and economic nature of the risks and characteristics of industrial enterprises in the context of integration with suppliers and customers,
- development of risk optimization method in industrial enterprises current assets management,
- development of economic and mathematical model for determining the optimal level of risk in logistic chain.

We consider the developed method of risk management in current assets management of industrial enterprises in the context of integration. In contrast to existing methods, authors propose method, firstly, based on fixing of sources of risk at their location in the circulation of current assets, which eliminates duplication, secondly, considering various schemes of logistic chain, taking into account the specifics of interaction with contractors, each of which has its influence on the occurrence and size of the risk, and thirdly, based on the intersystem approach and aims to choose the optimal parameters of current assets with the risk component in the quasi-integration.

We offer the following composition of the risks listed in Table 1, in order to fix the source of the risk at their location in the supply chain. It corresponds to the placement of the main sources of risk in the various links of the supply chain [Butrin and Vikulov 2012].

This approach to the risk classification allows to fix the places of risks appearing in specific links of supply chain and identify "weak links" of the supply chain that may occur in the future, in contrast to most existing approaches, where the "weak links" are already determined after the fact. The systematic picture of the potential "weak links" in the chain is a useful management tool not only for the risks and risk situations management, but also for improving of the overall efficiency of management company.

Table 1. The composition of the various risks in the of logistic chain links
Tabela 1. Poszczególne ryzyka w obrębie ogniw łańcucha logistycznego

Group of risks	Composition of risks
Risks associated with supplier	Risk of "care" supplier
	Risk of penalties to the supplier for violations of contract
	Risk of violating the delivery schedule resources
	Risk of buying poor quality resources
	Risk of non-delivery / short delivery resources
	Risk of changes in resource prices
	Risk of leaving the consumer reasons associated with supplier
Risks of the "Procurement"	Risk of failure in transport
	Risk of damage or loss transported values
	Risk of leaving the consumer for reasons, that have arisen in «Procurement»
Risks of the "Warehousing, storage, internal transportation resources"	Risk of improper storage resources
	Risk of loss of resources for internal transport
Risks of the "Production"	Risk of rhythm disorders of manufacturing
	Risk of producing unwanted products (overproduction)
	Risk of downtime production capacity for technical reasons
	Risk of failure in IT-systems of production management
	Risk of downtime for other reasons
	Risk of increase the marriage finished products
	The risk of poor control quality of products
	Risk of environmental losses
Risks of the "Warehousing, storage, internal transportation products"	Risk of improper storage products
	Risk of loss of products for internal transport
Risks of the "Sales and Marketing"	Risk of changes in the planned volume of sales
	Risk of failure of networking sales
	Risks choosing the wrong promotion strategy
	Risk of reduce market prices for finished products
Risks of the "Transportation of finished products"	Risk of failure in transport
	Risk of damage or loss transported values
Risk of the “Finance”	Risk of loss due to the binding of the capital in the functional "Procurement"
	Risk of loss due to the binding of the capital in the form of stock
	Risk of loss due to the binding of capital in the form accounts receivable from buyers
Risks associated with the buyer	Risk of bad debt
	Risk of "care" buyer
	Risk of losses (gains) of default by the buyer

We have to go through several steps in order to solve the optimization problem of finding of the optimal value of the delay (timing) flows.

In the first stage it is necessary to accumulate all the necessary statistical and operational information in order to determine the magnitude of the losses and the probability of their occurrence. This bank of information is easier to form than in the disintegration as under the conditions of quasi-integration in the presence of open information space and its transparency, it is entirely possible to do.

Table 2. The formula for calculating the integral components of the expectation of losses
Tabela 2. Wzór wyliczania składowych przewidywanych strat

Integr.R= R(S)+R(P)+R(SR)+R(PR)+R(FS)+R(M)+R(D)+R(F)+R(C)
R(S)= $\min(B_{zp}*Q_{neposp.res}/N_{racx}*T_{proizw}*(1+TAX_{ss}) + T_{zap}*MR_{sztr.pr.post.}*P_{realiz}*Q_{neport.res}/N_{rash}$; $R_{utz}*P_{zakyp}*Q_{nepost}*R_{srocz} +(P_{dr.post}-P_{zakup})*Q_{nepost})*P(S_1)+(MR_{szt.prosr.opl}*C_{neopl}*(T_{oc}-T_{octsr.})+(Q_{post}-Q_{swob})*P_{zakup}*MR_{szt.prosr.prin*}\frac{(Qtreb.res.-Qswob)}{Vwysw})*P(S_2)+$ $\min(B_{zp}*Q_{nepost.resc}/N_{rash}*T_{proizw}*(1+TAX_{ss})+ +T_{zap}*MR_{sztr.pr.port.}*P_{realiz}*Q_{nesw.post.res}/N_{rash} - T_{zap}*R_{sztr.pr.rost.}*P_{zakup}*Q_{nesw.post.res.}$; $R_{utz}*P_{zakup}*Q_{nesw.post.res}*R_{srocz} +(P_{drp.post}-P_{zakup})*Q_{nesw.post.res} - T_{zap}*R_{sztr.pr.post.}*P_{zakup}*Q_{nesw.post.res.})*P(S_3)+ \min(B_{zp}*Q_{nepost.res}/N_{rash}*T_{proizw}*(1+TAX_{ss})+ T_{zap}*MR_{sztr.pr.post.}*P_{realiz}*Q_{nekacz.res}/N_{rash} +\min(R_{utz}*P_{zakup}*Q_{nekacz.res}; (P_{zakup}-P_{zakup.g.})*Q_{nekacz.res})- R_{sztr.nekacz.}*P_{zakup}*Q_{nekacz.res.}$; $R_{utz}*P_{zakup}*Q_{nekacz.res}*R_{srocz} +(P_{dr.post}-P_{zakup})*Q_{nekacz.res} + \min(R_{utz}*P_{zakup}*Q_{nekacz.res}; (P_{zakup}-P_{zakup.g.})*Q_{nekacz.res})- R_{sztr.nekacz.}*P_{zakup}*Q_{nekacz.res.})*P(S_4)+$ $\min(B_{zp}*Q_{nepost.res}/N_{rash}*T_{proizw}*(1+TAX_{ss})+ T_{zap}*MR_{sztr.pr.post.}*P_{realiz}*Q_{nekomp.post.res}/N_{rash} - T_{zap}*R_{sztr.pr.}*P_{zakup}*Q_{nekomp.post.res}$; $R_{utz}*P_{zakup}*Q_{nekomp.post.res}*R_{srocz} +(P_{dr.post}-P_{zakup})*Q_{nekommp.post.res} - T_{zap}*R_{sztr.pr.}*P_{zakup}*Q_{nekomp.post.res})*P(S_5)+ (P_{now}-P_{zakup})*Q_{post}*P(S_6)+ (P_{realiz}-PC_{plan})*Q_{nepost.res}/N_{rash}*P(S_{71})+ (P_{realiz}-PC_{plan})*Q_{nesw.post.res}/N_{rash}*P(S_{72})+ (P_{realiz}-PC_{plan})*Q_{nekomp.post.res}/N_{rash}*P(S_{73})$
R(P)= $\min(B_{zp}*Q_{nenpost.res}/N_{rash}*T_{proizw}*(1+TAX_{ss})+ T_{zap}*MR_{sztr.pr.post.}*P_{realiz}*Q_{nesw.post.res.tr}/N_{rash} - T_{zap}*R_{sztr.pr.post.}*P_{zakup}*Q_{nesw.post.res.tr}$; $R_{utz}*P_{zakup}*Q_{nesw.post.res.tr}*R_{srocz} +(P_{dr.post}-P_{zakup})*Q_{nesw.post.res.tr.}- T_{zap}*R_{sztr.pr.post.}*P_{zakup}*Q_{nesw.post.res.tr})*P(P_1)+ \min(B_{zp}*Q_{nepost.res}/N_{rash}*T_{proizw}*(1+TAX_{ss})+ T_{zap}*MR_{sztr.pr.post.}*P_{realiz}*Q_{powrerzd.res.tr./N_{rash}} + P_{zakup}*Q_{powrerzd.res.tr.}- R_{sztr.pow.post.tr}*P_{zakup}*Q_{powrerzd.res.tr.}; R_{utz}*P_{zakup}*Q_{powrerzd.res.tr.}*R_{srocz} +(P_{dr.post}-P_{zakup})*Q_{powrerzd.res.tr.}+ P_{zakup}*Q_{powrerzd.res.tr.}- R_{sztr.pow.post.tr}*P_{zakup}*Q_{powrerzd.res.tr.})*P(P_2)+ (P_{realiz}-PC_{plan})*Q_{powrerzd.res.tr./N_{rash}}*P(P_{31})+ (P_{realiz}-PC_{plan})*Q_{nesw.post.res.tr}/N_{rash}*P(P_{32})$
R(SR)= $(B_{zp}*Q_{nepost.res}/N_{rash}*T_{proizw}*(1+TAX_{ss})+ R_{utz}*P_{zakup}*Q_{nekacz.hr.res.}*R_{srocz} + T_{zap}*MR_{sztr.pr.post.}*P_{realiz}*Q_{nekacz.hr.res.}/N_{rash} + P_{zakup}*Q_{n.h.res})*P(SR_1)+ (B_{zp}*Q_{nepost.res}/N_{rash}*T_{proizw}*(1+TAX_{ss})+ R_{utr}*P_{zakup}*Q_{nakcz.tran.res.}*R_{srocz}+ T_{zap}*MR_{sztr.pr.post.}*P_{realiz}*Q_{nekacz.tran.res.}/N_{rash}+ P_{zakup}*Q_{nekacz.tran.res.})*P(SR_2)$
R(PR)= $\min(B_{zp}*Q_{nepost.res}/N_{rash}*T_{proizw}*(1+TAX_{ss})+ R_{utz}*P_{zakup}*Q_{nekomp.post.res.}*R_{srocz}$; $B_{zp}*Q_{nepost.res}/N_{rash}*T_{proizw}*(1+TAX_{ss})+ T_{zap}*MR_{sztr.pr.post.}*P_{realiz}*Q_{nekomp.post.res.}/N_{rash})*P(PR_1)+ +(T_{hran}*C_{hran.}*Q_{perreproizw}+ K_{obescen}*P_{realiz}*Q_{pereproizw})*P(PR_2)+ \min(2*B_{zp}*T_{prost}(1+TAX_{ss})$ $+ T_{zap}*MR_{sztr.pr.post.}*P_{realiz}*Q_{prost}+ 3_{priob.zap.cz.}$; $2*B_{zp}*T_{prost}(1+TAX_{ss})+ 3_{serw.obsl}+ 3_{priob.zap.cz.})*P(PR_3)+ \min(B_{zp}*T_{prost}(1+TAX_{ss})$; $T_{zap}*MR_{sztr.pr.post.}*P_{realiz}*Q_{prost})*P(PR_4)+ \min(B_{zp}*T_{prost}(1+TAX_{ss})$; $T_{zap}*MR_{sztr.pr.post.}*P_{realiz}*Q_{prost})*P(PR_5)+ (B_{zp}*(Q_{braka}+Q_{braka.obor.}+Q_{braka.t.pr.})*T_{proizw}+$ $+B_{zp}*(Q_{braka}+Q_{braka.obor.}+Q_{braka.t.pr.})*T_{proizw}*TAX_{ss}+T_{zap}*MR_{sztr.pr.post.}*P_{realiz}*(Q_{braka}+Q_{braka.obor.}+Q_{braka.t.pr.}))*(P(PR_{63})+P(PR_{64})+P(PR_{65}))+$ $CC_{plan}*Q_{braka.}*P(PR_{63})+ CC_{plan}*Q_{braka.oobor.}*P(PR_{64})+ CC_{plan}*Q_{braka.t.pr.}*P(PR_{65})+ (R_{utz.p.}+MR_{sztr.nekacz.})*P_{realiz}*Q_{nekcz.post}/N_{rash}*P(PR_7)+ 3_{ekol.}*P(PR_8)$
R(FS)= $(T_{zap}*MR_{sztr.pr.post.}*P_{realiz}*Q_{nekacz.hr.gp.}+ CC_{plan}*Q_{n.h.gp})*P(FS_1)+ T_{zap}*MR_{sztr.pr.post.}*P_{realiz}*Q_{nekacz.tran.gp.}*P(FS_2)$
R(M)=$(P_{real}-CC_{plan})*(Q_{plan}-Q_{fakt})*P(M_1)+(3_{form}-(P_{real}-CC_{plan})*Q_{fakt})*P(M_2)+$ $+(3_{prog}-(P_{real}-CC_{plan})*Q_{fakt})*P(M_3)+(P_{now}-P_{real})*Q_{fakt}*P(M_4)$,
R(D)= $(T_{zap}*MR_{sztr.pr.post.}*P_{realiz}*Q_{nesw.post.gp.tr.}+T_{zap}*R_{sztr.pr.post.}*P_{realiz}*Q_{nesw.post.gp.tr.})*P(D_1)+ +(T_{zap}*MR_{sztr.pr.post.}*P_{realiz}*Q_{powrerzd.gp.tr.}+ CC_{plan}*Q_{powrerzd.gp.tr.}- R_{sztr.pow.post.tr}*P_{real}*Q_{powrerzd.res.tr.})*P(D_2)$,
R(F)= $Д3_{post}*R_{god}*\frac{t_{zap}^{part}}{365}*P(F_1)+(P_{zakup}*Q_{res}*R_{god}*(t_{hr.res}+t_{proizw}+t_{hr.gp}+t_{oc})/365+$ $+P_{real}*Q_{gp}*R_{god}*(t_{hr.gp}+t_{oc})/365)*P(F_2)+ (P_{real}*Q_{gp} - P_{real}*Q_{gp}/(1+R_{alt}*\frac{t_{zap}^{pok}}{365}))*P(F_3)$
R(C)= $P_{real}*Q_{gp}*s*P(C_1)+ l*L_u*H_{pr}*P(C_2)+ P_{real}*Q_{neprr.gp}*MR_{sztr.nepr}*t_{nepr.}*P(C_{31})+ +P_{real}*Q_{gp}*MR_{sztr.prosr}*t_{prosr.}*P(C_{32})$

where B_{zp} - rate for an additional charge of basic salary, $Q_{nepost.res}$ – quantity of undelivered resources, N_{rsah} – flow rate of the resource per unit of production, T_{proizw} – time per unit of output, TAX_{ss} – fixed rate of social security contributions, R_{utz} – share of transport costs in the total amount of the purchase of resources, P_{zakup} –cost of purchased resources, Q_{nepost} – quantity of undelivered resources, R_{srocz} – increased rate for urgency, $P_{dr.post}$ –cost of resources from another supplier, T_{zap} - duration of the delay of delivery, due to the delay in the search for raw materials (days), $MR_{sztr.pr.post.}$ - value of the contract penalty for each day of delay in the form of interest rate, P_{realiz} - price of product, C_{neopl} – amount of non-payment, T_{oc} - quantity of days equal to the difference between the operating cycle (from the receipt of raw materials to the receipt of the money from customers for manufactured product), Q_{post} –volume of purchased resources, Q_{swob} – free storage space, $Q_{reb.res}$ – quantity of required resources, P_{zakup} –cost of purchased resources, $MR_{szt.prosp.prin.}$ - amount of the fine in the form of interest per day of delay in taking delivery, V_{wysw} - average (speed) of the release of a warehouse for storage which can be time-ship their power to all of the resources could be taken, $Q_{nesw.post.res}$ – quantity of untimely set of resources, $Q_{nekacz.res}$ – quantity assigned resources inadequate quality, $P_{zakup.g.}$ – price of the resource, taking into account the discount, $R_{sztr.nekacz.}$ –value of the fine supplier under the contract for the supply of low-quality resources, $Q_{nekomp.post.res}$ – quantity of undelivered resources, PC_{plan} – planned the cost price of products, $Q_{powrerzd.res.tr.}$– quantity of damaged / lost resources, transportation company, $R_{sztr.pow.post.tr}$ –value of the fine (sum insured) for damage resources transportation company under contract as a percentage rate of the value of goods, $Q_{nekacz.tran.res.}$ – quantity of improperly transported in resource production and unsuitable for the production, T_{hran} – time of storage, $C_{hran.}$ - cost of storage per unit per day, $Q_{pereproizw}$ - quantity of over-produced products, $K_{обесцен}$ – rate of depreciation of products on the market, $T_{прост}$ – downtime due to technical reasons, $Q_{прост.}$ –quantity of units that may make during the down time, $3_{serw.obsl}$ – maintenance costs, $3_{priob.zap.cz.}$ – cost of spare parts, $Q_{braka.}$ – quantity of defective products because of the low skilled personnel, $Q_{braka.obor.}$ – quantity of defective products due to poor condition of the equipment, $Q_{braka.t.pr.}$ – quantity of defective products associated with the process, T_{proizw} – time per unit of output, CC_{plan} – cost of routine, $R_{utr.p.}$ - specific transport costs per 1 ruble of sales of inadequate quality, $3_{ekol.}$ – cost of the environment, $Q_{nekacz.tran.gp.}$ – quantity of improperly transported in the production of finished products, and unsuitable for implementation, Q_{plan} – planned sales, Q_{fakt} – actual sales, 3_{form} – cost of creation / organization of the sales network, 3_{prod} – cost of product promotion, P_{now} – new price realization, $Q_{powrerzd.gp.tr.}$– amount of damaged / lost finished goods transport company, $R_{sztr.pow.post.tr}$ – value of the fine (sum insured) for damage to the transport company resources under the agreement as a percentage rate of the value of goods, $Д3_{post}$ – advanced payment provider for raw materials, R_{god} – annual interest rate on the loan for financing, P_{zakup}- cost resources, P_{real} – cost of the finished product, Q_{gp} – quantity of stocks of finished products, Q_{res} – quantity of resource stocks, R_{god} – annual interest rate on the loan for financing, $t_{hr.res}$ – time of storage resources, t_{proizw} – production time, $t_{hr.gp}$ – time of storage of finished products, t_{oc} – value of the operating cycle, Q_{gp} – quantity of finished products, R_{alt} – alternative rate investment of resources, t_{zap}^{pok} –duration of the period of collection of receivables, S –proportion of bad debts (debt to the value of the delay of more than 2 months) in the structure of receivables, l –average cost of shipment per customer, L_u – quantity of buyers once freed, shih unserviced for the analyzed period, H_{pr} – rate of profit enterprises, $t_{zap.pok}$ – lag time of shipment of products buyers, $Q_{nepr.gp}$ – quantity of delayed introduction of products, $MR_{sztr.nepr}$ – value of fines for non-timely, $t_{nepr.}$ – duration of the breach, $MR_{sztr.prosr}$ – size of the penalty for late payment, $t_{prosr.}$ – duration of the breach of the obligation to pay

In the second stage, we calculate and group losses in the supply chain that are possible when operating the focus of each of the types of risks identified in Table 1.

In the third stage, we calculate the probability of loss, based on the availability of statistical information.

In the fourth stage, we calculate the intermediate indicators of the expectation of losses for each type of risk by the equations given in Table 2.

The fundamental equation (1) of calculation of these indicators, which is the sum of the product of the probability of loss is shown below.

$$R(N)= \Sigma\ N_i*P(N_i), \quad (1)$$

where R(N) is the mathematical expectation of loss of the circuit of specific stage of current assets, N is group of risk type, N_i is loss value of specific type of risk, $P(N_i)$ is probability of loss of specific type of risk.

In the fifth stage, we calculate to the integral expectation of loss of focus company, which is calculated as the sum of pairwise products of the value of losses in each of the links in the supply chain for their probability. It is as follows:

$$Integr.R=R(S)+R(P)+R(SR)+R(PR)+R(FS)+R(M)+R(D)+R(F)+R(C), \quad (2)$$

where:

Integr.R - integral expectation of losses on all stages,
(S) - expectation losses caused supplier,
R(P) - the expectation stage loss "Supply",
R (SR) - expectation loss in " Warehousing, storage and internal transport resources",
R(PR) - the expectation of loss under "Production",
R(FS) - the expectation of losses in the process of "Warehousing, storage and internal transportation of finished products",
R(M) - the expectation of the loss of the "Sales. Sale. Marketing",
R(D) - the expectation of losses on the stage of "The transportation of finished products",
R(F) - the expectation of loss of the "Financing",
R(C) - the expectation of losses caused by the buyer.

In the sixth stage, we define the values $t_{del}^{supp}, t_{del}^{cons}$ that provide the minimum value of the integral of the expectation of losses.

Table 3. The sample values in the search area in the short term decisions
Tabela 3. Wartości próbek uzyskanych w badanych obszarze dotyczące decyzji krótkoterminowych

Duration of the period of repayment of the debt, days	Duration of the period of collection of accounts receivable, days	The expectation of losses in the stages of the current assets circuit, rubles.									Integr.R, rubles.	K_{eff}
		S	P	SR	PR	FS	M	D	F	C		
-5	10	12760.24	2247.78	71.44	4348.31	105.78	15349.12	-998.76	6597.71	35.42	40517.04	0.842
-5	11	12784.00	2247.78	71.44	4348.31	105.78	15349.12	-998.76	6655.21	35.42	40598.30	0.841
-5	12	12807.76	2247.78	71.44	4348.31	105.78	15349.12	-998.76	6712.67	35.42	40679.52	0.839
-5	13	12831.52	2247.78	71.44	4348.31	105.78	15349.12	-998.76	6770.10	35.42	40760.71	0.837
-5	14	12855.28	2247.78	71.44	4348.31	105.78	15349.12	-998.76	6827.49	35.42	40841.87	0.836
-5	15	12879.04	2247.78	71.44	4348.31	105.78	15349.12	-998.76	6884.86	35.42	40922.99	0.834
-4	10	12736.48	2247.78	71.44	4348.31	105.78	15349.12	-998.76	34444.53	35.42	68340.11	0.499
-4	11	12760.24	2247.78	71.44	4348.31	105.78	15349.12	-998.76	36823.91	35.42	70743.24	0.483
-4	12	12784.00	2247.78	71.44	4348.31	105.78	15349.12	-998.76	39133.68	35.42	73076.77	0.467
-4	13	12807.76	2247.78	71.44	4348.31	105.78	15349.12	-998.76	41376.86	35.42	75343.71	0.453
-4	14	12831.52	2247.78	71.44	4348.31	105.78	15349.12	-998.76	43556.29	35.42	77546.90	0.440
-4	15	12855.28	2247.78	71.44	4348.31	105.78	15349.12	-998.76	45674.65	35.42	79689.02	0.428
-3	10	12712.72	2247.78	71.44	4348.31	105.78	15349.12	-998.76	177932.03	35.42	211803.84	0.161
-3	11	12736.48	2247.78	71.44	4348.31	105.78	15349.12	-998.76	179330.53	35.42	213226.10	0.160
-3	12	12760.24	2247.78	71.44	4348.31	105.78	15349.12	-998.76	180513.44	35.42	214432.77	0.159
-3	13	12784.00	2247.78	71.44	4348.31	105.78	15349.12	-998.76	181527.05	35.42	215470.15	0.158
-3	14	12807.76	2247.78	71.44	4348.31	105.78	15349.12	-998.76	182405.28	35.42	216372.13	0.158
-3	15	12831.52	2247.78	71.44	4348.31	105.78	15349.12	-998.76	183173.55	35.42	217164.16	0.157

For example, consider the distribution of the integral of the expectation of losses in a manufacturing enterprise JSC "Clean Ural", which are engaged in the production of detergents and is closely associated with its suppliers and customers. The selection of calculations results in performed expectation of losses on the basis of statistical and expert enterprise data presented in Table 3.

Thus, we see that the best solution to optimize the level of risk is the duration of the period of repayment of the debt equal to -5 days, and the period of collection of receivables is 10 days. Under these conditions, the interaction in quasi-integration: supplier of material resources and the buyer of finished products manufacturer is to reach lower values of the expectation of losses up to 40,517.04 rubles, which will reduce the rate to 83.55% from the current one. In this case, the data values can be effectively achieved in the short term, as the decision has been selected, subject to certain limits.

CONCLUSIONS

The proposed method allows us to fix risk origin places in various links of the supply chain and to identify "weak links" of logistic chain that may occur in the future. The method is a useful tool for managing not only risks and risk situations, but also as a tool to improve the efficiency of current assets management by providing the ability to optimize the level of risk in the industrial enterprise current assets management.

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ZARZĄDZANIE RYZYKIEM I ŁAŃCUCHAMI DOSTAW

STRESZCZENIE. **Wstęp**: Wobec narastającej globalizacji gospodarki oraz wzrostu złożoności i kompleksowości wzajemnych powiązań gospodarczych przedsiębiorstw, konieczne jest wypracowanie nowych metod i technik w celu poprawy i utrzymania pozycji rynkowej. Procesy integracji stwarzają nowe możliwości, ale jednocześnie stwarzają nowe wyzwania dla zarządzających, w tym również w obrębie zarządzania ryzykiem.
Metody: Na podstawie analizy znanych narzędzi (zarządzania łańcuchem dostaw, zarządzania ryzykiem w obrębie łańcucha dostaw, zastosowanie teorii prawdopodobieństwa, metod zarządzania ryzykiem oraz metod statystycznych) autorzy zaproponowali nową metodę zarządzania ryzykiem oraz metodę zarządzania łańcuchem dostaw. Zaproponowane narzędzie jest specyficznym hybrydowym rozwiązaniem stworzonym na podstawie narzędzi dostępnych w literaturze.
Wyniki: Prezentowana metoda została z powodzeniem zastosowana w ramach ekonomiczno-matematycznych modeli przedsiębiorstwa przemysłowego. Uwzględniono wskaźniki związane z ryzykiem łańcucha dostaw, w tym powodowane przez dostawcę. Autorzy sformułowali metodę optymalizacji poziomu ryzyka łańcucha dostaw we współpracy z dostawcami i klientami.
Wnioski: Każda organizacji, która rozpoczyna proces integracji z dostawami i klientami, potrzebuje narzędzi, metodologii oraz technik do identyfikacji "słabych ogniw" w obrębie łańcucha dostaw. Zaproponowana metoda pozwala na opanowanie ryzyka w różnych miejscach łańcucha dostaw oraz zidentyfikowanie zagrożeń, które mogą się pojawić w przyszłości. Metoda ta jest dobra nie tylko do zarządzania ryzykiem, ale również dla poprawy efektywności obecnych metod zarządzania poprzez optymalizację poziomu ryzyka w przedsiębiorstwie.

Słowa kluczowe: zarządzanie ryzykiem, ryzyka łańcucha dostaw, optymalizacja ryzyka, integracja ryzyka.

MANAGEMENT VON RISIKEN UND LIEFERKETTEN

ZUSAMMENFASSUNG. Einleitung: Angesichts der wachsenden Globalisierung der Wirtschaft und der Zunahme von Kompliziertheit und Komplexität der gegenseitigen wirtschaftlichen Zusammenhänge zwischen Unternehmen ist es unentbehrlich, neue Methoden und Techniken zwecks der Verbesserung und der Aufrechterhaltung der Marktpositionen auszuarbeiten. Die Integrationsprozesse schaffen einerseits neue Möglichkeiten, andererseits generieren für die Manager neue Herausforderungen, darunter auch im Bereich des Managements von Risiken.
Methoden: Auf Grund der Analyse der bekannten Tools (Management der Lieferkette, Management des Risikos innerhalb der Lieferkette, Anwendung von Wahrscheinlichkeitstheorie, von Methoden des Risk Managenment und von statistischen Methoden) haben die Autoren eine neue Methode des Managements von Risiken und Lieferketten vorgeschlagen. Das vorgeschlagene Instrument ist eine spezifische Hybriden-Lösung, die anhand der in der Literatur vorhandenen Werkzeuge geschaffen wurde.
Ergebnisse: Die präsentierte Methode wurde mit Erfolg im Bereich der ökonomisch-mathematischen Modelle eines Industrieunternehmens in Anspruch genommen. Dabei hat man die mit dem Risiko der Lieferkette, darunter dem vom Lieferanten verursachten Risiko, verbundenen Indikatoren berücksichtigt. Die Autoren haben danach die Methode für die Optimalisierung des Niveaus des Lieferkette-Risikos im Rahmen einer Kooperation zwischen den Lieferanten und Kunden formuliert.
Fazit: Jede Wirtschaftsorganisation, die den Integrationsprozess mit den Lieferanten und Kunden anbahnt, bedarf der Werkzeuge, Methodologie und Techniken für die Ermittlung von "schwachen Gliedern" innerhalb der Lieferkette. Die vorgeschlagene Methode erlaubt eine weitgehende Beherrschung des Risikos an verschiedenen Stellen der Lieferkette sowie eine Ermittlung von Gefahren, die in Zukunft auftauchen können. Die Methode ist brauchbar nicht nur für das Risiko-Management, sondern auch für die Verbesserung der Effektivität der gegenwärtigen Verwaltungsmethoden durch Optimalisierung des Niveaus des Lieferkette-Risikos im Unternehmen.

Codewörter: Risk Management, Risiken der Lieferkette, Optimalisierung des Risikos, Integration des Risikos.

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