INTEGRATED SUPPLY CHAIN RISK MANAGEMENT PERFORMED BY LOGISTIC ASSISTANCE SYSTEMS

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ABSTRACT

The occurrence of risks usually leads to damages at relevant enterprise and moreover causes further risks at other partners. Consequently, more and more enterprises need to deal with risks. Especially, small and medium sized enterprises (SMEs) are forced to make statements concerning risks and intended actions, particularly regarding the dynamically fluctuating system load. There are no applicable tools and methods known to assess those risks and possible actions in order to control them profitable. The new SCM-Software generation Logistic Assistance Systems (LAS) opens new application fields in global supply chains. The novel LAS approach is currently being intended to provide a basis for an integrated Supply Chain Risk Management (SCRM) approach. With the aid of LAS, different risk key performance indicators (KPIs) can be obtained which can be used in order to assess risks and actions quantitatively and proactively; additionally to experience to what extend the risks can be minimised.

Key words: Supply Chain Risk Management, Risk Assessment, Logistic Assistance System, Simulation

1. INTRODUCTION

Consequences of the trends in recent years like the application of the lean production philosophy as well as the developing globalisation of the economy are efficient global supply chains, reduced inventory, high capacity utilisation and optimised lead times. Furthermore, increased end customer requirements regarding quality, price and availability as well as the increasing global competition lead many companies to a closer collaboration within their supply chains. Thus, these trends generally lead to significant efficiency improvements on the one hand; contrariwise by the optimisation, e.g. reduction of inventory, number of suppliers and delivery times, companies' interdependencies grow enormously and therefore lead to an increase of the vulnerability of the entire supply chain. Through worldwide interconnectedness, events in countries and continents faraway can affect adding value processes in other regions significantly (Kersten 2008). Ad hoc increases of customer demands, insolvencies of suppliers, malfunctions of information systems, strikes, fluctuating system loads, unexpected high declines in sales, natural catastrophes and other events are examples for risks, which can affect companies. The occurrence of such risks usually leads not only to damages at the relevant company but causes the entrance of further risks with according damages at other downstream or upstream supply chain partners. The understanding of supply chain risk is disruption, quantified with its occurrence probability; the risks' occurrence affects more than one company in the supply chain and the risks' origins are located within one company, its supply chain or within its environment (Kersten 2008).

The imminent loss by unforeseen events discloses the acuteness for companies to deal with their risks from an entire supply chain perspective in order to carry on being competitive, avoid turbulence costs along the entire supply chain and to generate a significant long-term advantage in competition. Though, risk management does not serve to avoid risks but to identify those and to provide a decision basis for strategic considerations.

To face these challenges it is essential for companies to proactively identify, evaluate, control and communicate the risks. Large-scale enterprises have already reacted to these challenges and operate a simple form of risk management in order to get a transparency of their risk situation. Nevertheless, in order to quantify the vulnerabilities in a supply chain context, companies have to consider not only the risks of their own operations but also risks, which are caused by the connections between the organisations; this means they need to consider their supply chain partners' risks.

That is why more and more big enterprises ask small and medium sized enterprises (SMEs) – usually as their key suppliers - to make statements concerning their risk situation regarding the satisfaction of requested demands. Malfunctions of SMEs can have significant effects on their partners. SMEs as partners in a network increase the risk for large-scale enterprises and endanger the stability of the whole supply chain because generally SMEs represent the most fragile partners within a supply chain. For instance, same risks can be serious risks for SMEs by being small or no risks for big enterprises. Consequently, these new challenges often cause trouble in SMEs, which were not confronted

with such problems in the past; and therefore endanger the stability and performance not only in one but in all involved supply chains at the same time.

One of some major risks SMEs are exposed to extensively is the dynamically fluctuating system load. System load arises from the difference between supply and logistical performance object demands. It causes the flow of the logistical performance object through the processes (Jungmann, Kuhn, and Bandow 2007).

This means that demand requests from multiple customers, located in different supply chains, can change frequently in different ranges and affect SMEs enormously so that they may not perform and satisfy the requested transformation performance, for example due to limited capacities or due to missing implementation of risk minimisation actions. Requested transformation performance means that the requested demand is fully satisfied in terms of requested time, quantity and quality in such a manner that the performance of the supply chain is affected in no case. Consequently, the supply chain transformation performance cannot be assured by the SMEs and the fulfilment of requests can be at risk.

Over the past years Supply Chain Risk Management (SCRM) has been developed and integrated into the supply chain management (SCM) concept in order to meet the challenge mentioned above. This concept contains the identification, the assessment, the control as well as the monitoring of supply chain risks in order to improve the integration of companies in their supply chain (Kersten 2008). Several companies operate a simple type of risk management. However, the concept of SCRM is still in its infancy (Jüttner 2005). Furthermore, risk management not only serves for dealing with risks but to identify them and exhibit a basis of decision for strategic advisements.

Existing solutions in order to operate a simple form of risk management are predominantly applicable for big enterprises. The literature reveals that a lot of SMEs do not quantify and manage their risks adequately. Risk management should become a core issue in planning and management of every organisation (Finch 2004). An application-oriented methodology for identification, assessment, and control of risks from an intra-company perspective was developed by Ziegenbein (Ziegenbein 2007). For supply chains in practice neither tools nor an integrated application-orientated methodology with an entire supply chain perspective is known; that risk management shows substantial deficiencies regarding dissemination and implementation (Ziegenbein 2007).

For SMEs there is a lack of integrated supply chain risk management tools which systematically and proactively identify, assess and enable the communication of risks.

Regarding dynamically fluctuating system load which is one of the core risks for small and medium enterprises, SMEs are not able to make statements regarding their satisfaction risks of received purchase requisitions. Moreover, instruments for a decision-support are needed regarding which actions could minimise the satisfaction risks to which degree and how those purchase requisitions would influence the risks of existing purchase orders. Furthermore, there is a big need for key performance indicators (KPIs) which allow the measurement, the quantitative assessment, the transparency as well as the communication of the risks.

2. LOGISTIC ASSISTANCE SYSTEMS AS A NEW SCM SOFTWARE GENERATION

For the enhancements of an integrated SCRM concept and its successful widespread implementation in global supply chains by all involved partners there are no tools known which allow process owners and risk managers in enterprises a transparency and an exchange regarding existing risks and their extent. Basic requirements for SCRM instruments are the enabling of acting proactively in order to identify and assess risks, not only in the own company, in advance. Risk assessment needs to take place in a quantitative way, for instance with the aid of KPIs, especially in order to allow the communication of the risks. Furthermore, different possible risk minimisation actions need to be assessed proactively in order to determine the optimum way of risk control. Moreover, the tool handling complexity should not require special expertise by the user.

The new SCM-Software generation Logistic Assistance Systems (LAS) opens absolutely new application fields in the industry in global supply chains. Therefore, the novel LAS approach is being intended to provide likewise a basis for an integrated SCRM approach in global supply chains.

Assistance systems are computer-assisted tools which aim at delivering information and support for decision-makers and experts in order to assist them in terms of decision making and decision realisation in given planning situations (Schneider 2006). LAS offer transparency about all appropriate information and integrate specific decision support systems and planning approaches into one combined planning approach. Based on actual, high quality data LAS consist of additional APS functionality and decision support systems. The LAS concept focuses on relevant and consistent information along the supply chain, transparency about the current process status and planning functionality (Kuhn and Toth 2008). The basic idea of LAS is to plan and assess defined consideration scopes with a clearly specified planning scenario in supply chains, consisting out of several companies and service providers. In order to apply assistance systems in cross-company value added collaborations efficiently, an architecture which makes the technology globally accessible, by protecting the planning competence of the autonomic partners, is needed (Blutner et. al. 2007). The developed approach is based upon a decentralised cooperation of the value adding partners. All partners which are included in the process provide the required data. This data is process-oriented and flow into a central planning logistic, but can be locked for other partners if required.

Within the scope of an integrated SCRM, LAS are being intended to be applied by focusing on the

planning approaches in order to allow quantitative analyses. The assistance system provides services for the available data and for the planning. A planning and simulation component is integrated in the LAS, enabling the analysis and assessment of the logistical network including the structures and processes (Wagenitz 2007; Hellingrath et. al. 2004). The simulation environment OTD-NET has been applied successfully in many projects in the automotive industry and therefore will be applied within the scope of the methodology for an integrated SCRM contribution.

OTD-NET was developed at the Fraunhofer-Institute for Material Flow and Logistics IML; OTD-NET allows very quick simulation runs as they are required for assistance systems. Process logical components are integrated in the simulator and therefore enable a simple modelling and parameterisation of different SCM strategies. Additionally, real demand data out of operational systems can be imported or generated. LAS extend a simulation model including all detail processes by providing a supply chain planning system and an integrated approach for operational and tactical planning of global supply chains.

Generally, every partner is able, according to his part in the planning process, to use the input data of other participants to accomplish his planning on real and current data. The planning components are provided as service adequate to the planning case. In case of disposition the planning component is a simulation tool, which displays the dynamic processes of the network, which has to be planned. Furthermore, it is able to simulate the supply chain's future performance of the based on program and flow data as well as on sales figures, by taking risks into account. Furthermore, risk minimisation actions can be simulated and different extent can be presented. The program planer of a distributor as well as the risk manager are able to make adjustments and to simulate in the planning domain (program data) which impact it has by given demand of the customer and reception of distributors. Here the demand is the input variable and the simulation model uses the actual plan data and also the process data (transports, inventory) to assure the validity of a demand adjustment within an available-to-promise-verification (Toth and Wagenitz 2009).

An important target of the planning component in an assistance system is the forecast of the supply chain's future performance. Besides the structure of the supply chain the considered parameters contain real time data with respect to demand situation, ship positions, inventory data, product capacity, etc. By the use of this new alternative of planning and decision assistance in a decentral-organised network, the planning quality as well as the risk transparency can be improved extraordinarily. Risk managers can simulate different system loads as well as the risks which affect them.

Based on the real data a simulation model is designed and integrates the actual status of the supply chain as well as the planed transports and the production volumes as load data which is the basis for a dynamic quantification of the future system development. This function establishes very accurate, adaptive plan scenarios for the expeditor as well as for the risk manager or process owner. The simulation structure, consisting out of modules is comparatively simple (without interference into the source code) and in most parts independent to diversify from the real data. This allows the user to diversify high complex simulation models with simple planning tables and to run simulation studies. By simulating the real data expeditors and risk managers can predict the future transformation performance and therefore the risk situation of the disposed supply chain considering all actual data. Furthermore, it is possible to manipulate single data systematically which offers possibilities for evaluating different scenarios (Deiseroth et. al. 2008).

In recent projects in cooperation with the Fraunhofer IML, LAS were successfully applied for several available-to-promise planning activities. It could be proved that LAS are absolutely capable for different planning challenges. Therefore, the LAS approach is being intended to act in the scope of SCRM.

3. INTEGRATED SUPPLY CHAIN RISK MANAGEMENT WITH THE AID OF LOGISTIC ASSISTANCE SYSTEMS

A novel application-orientated methodology approach for an integrated SCRM contribution is currently being developed at the Fraunhofer IML with the aid of the new SCM-Software generation LAS.

The novel LAS approach includes all specific supply chain structures, resources and processes which need to be considered and presents all relevant data information along the supply chain, delivering transparency about the current status. Besides those specific supply chain characteristics the simulation model contains all further information regarding the supply chain constraints.

The outcome of those given detailed information about the supply chain is that not only program planers of a distributor but also risk managers are able to make adjustments and to simulate in the planning domain in order to see the impact of changes. Risk managers are able to diversify high complex simulation models by implementing risk minimisation actions and to run simulation studies. By simulating the real data risk managers can predict the future performance as well as the risk situation of the disposed supply chain considering all actual data. The possibility to manipulate single data systematically allows an evaluation of different scenarios; therefore, for instance, implementations of different actions for system load fluctuations can be simulated evaluating the satisfaction risks for requested performances in advance.

In terms of system load fluctuations LAS are also able to deal with those risks which affect the system load. Multiple unexpected purchase requisition or increases of existing purchase orders (POs) by different

individual customers can be evaluated regarding their fulfilment by taking into account implementing performance-enhancing actions; the risks and threats for non-fulfilment as well as possible implementation of actions can be evaluated and demonstrated in the LAS. Thus, alternatives for the control of critical risks can be shown by the LAS while demonstrating the impact of the potential delays or cancellations. The developed simulation component is capable to handle the complexity of multiple customer demands and multiple risks considering their occurrence probability and mutual impact, to forecast the supply chain behaviour in case of occurrence. Complex simulations can be run without any need for special IT expertise. Simple handling of the simulation runs which are based on actual, high quality data, allows users to create different risk scenarios which can be assessed for different possible actions. The extensiveness of the proved information covers current data of the supply chain as well as an intelligent concept in order to forecast future dynamic behaviour and is not limited to individual enterprises. Highly important supply chain partners' safety requirements are ensured by role based access limitations to critical data (Deiseroth et. al. 2008).

Applying LAS within the scope of integrated SCRM allows companies, especially SMEs, a common understanding and transparency by assessing risks in their supply chain. Optimum actions for dealing with risks can be identified. Finally, supply chain partners obtain a decision support for making strategic decisions, either in order to take actions proactively for the purpose of reducing risks and to avoid disruptions or in order to take no actions by knowing the potential extent of damage in advance.

In order to meet especially the requirements of SMEs, usually representing the most fragile partners within a supply chain, it has to be taken into account that due to limited resources for used tools the modelling duration and effort is to be kept as low as possible, which is an essential requirement and challenge. The duration of simulation studies varies by the level of complexity, the data availability and the assigned resources. Generally, for SMEs ideally durations more than a few weeks should not be extended for modelling efforts since quick and cheap results are required, which may not to be as detailed as for large-scale enterprises. In order to decrease the modelling effort, the creation of application-oriented libraries, predefined modules, is very profitable to minimise the implementation and modelling effort, compared to conventional simulation studies. Input and edit masks are available immediately and have only to be integrated into the new model. LAS integrate the following main characteristics and functions: information transparency, collaborative planning, decision support, risk management, process orientation and software flexibility (figure 1).

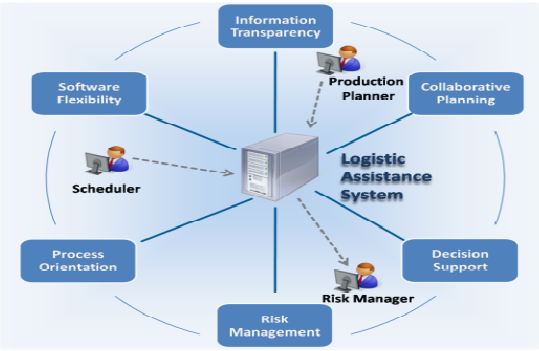

Figure 1: Logistic Assistance Systems

Currently, at the Fraunhofer IML LAS are being developed further in such a way that especially demands mentioned above, regarding dynamically fluctuating system load relevant to SMEs, can be met. First developments of an integrated SCRM approach with LAS have been approached and show promising results.

4. KEY PERFORMANCE INDICATORS FOR INTEGRATED SUPPLY CHAIN RISK MANAGEMENT

In the context of a SCRM approach, focusing on affected system load, LAS need to deliver different key performance indicators in order to enable the assessment and the communication of risks intra-company as well as with supply chain partners. Recent industry projects, managed by the Fraunhofer IML, show the benefits and the potentials of KPIs, which were delivered by LAS. By using components of the tool OTD-NET, presented in chapter 2, a simulation model of a production network was generated; due to the detailing, multifarious questions could be answered quantitatively with high quality (Motta et. al. 2008). The aim of using risk KPIs is to manage and adjust the risks in such a manner that companies keep being sufficiently robust to handle fluctuating system loads by performing requested transformation performances and by keeping costs as low as possible at the same time. This means, risks need to be opposed to costs which would become due by implementing actions or which would become due by taking risks without implementing any actions. Core questions which need to be answered by the aid of the risk KPIs are:

- Which extent do risks have regarding the company transformation performance due to system load fluctuations?
- Which impact do interactions between different supply chain demands have on company's transformation performance?
- Is it efficient to implement any actions in order to decrease the occurrence probability of the risks? If yes, which actions need to be implemented?
- What is the decrease of risks' occurrence probability and the residual risk extent by implementing actions?

In order to answer the questions mentioned above a detailed modelling of the network is essential. The products with variants and bill of material have to be part of the model like demand development within the given period as well as transport relations and supplier on multiple network levels. Besides the network structure the processes are essential. Rules for the planning of orders in factories, the selection of alternative means of extra transportation (e.g. plane) in case of shortages but also the selection of suppliers in case of multiple-sourcing have to be defined. Apart from that, combined used resources and stochastic influences e.g. fluctuation in transport times, have to be considered. Variant part changes have powerful impact on the network because advised variant parts and devices cannot be used anymore on the one hand, and on the other hand a doubling in demand of already produced obsolete variant parts occurs for the supplier.

Analyses showed that for a holistic risk management and risk assessment of risks affecting the system load following risk KPIs are required and can be gained by using Logistic Assistance Systems:

Dependability of delivery reliability in terms of time: This risk KPI gives information regarding the feasibility of the agreed delivery time, for each existing PO. A variance to the agreed delivery time results directly in noncompliance with the requested transformation performance.

Dependability of delivery reliability in terms of quantity: This risk KPI gives information regarding the feasibility of the agreed delivery quantity, for each existing PO. A variance to the agreed delivery quantity results directly in noncompliance with the requested transformation performance.

Dependability of lead times: This risk KPI gives information regarding the feasibility of the planned lead times, for each existing PO. A variance to planned lead times does not necessarily result directly in noncompliance with the requested transformation performance.

Dependability of supply availability: This risk KPI gives information regarding the supply availability, for each existing PO. A supply disability results directly in noncompliance with the requested transformation performance.

Availability of parts: This risk KPI gives information regarding the availability of the parts, for each existing PO. An unavailability of the parts does not necessarily result directly in noncompliance with the requested transformation performance.

Number of existing POs, affected by delayed deliveries: This risk KPI gives information regarding the number of existing POs which have been accepted or are already in progress and are affected by delivery delays due to incoming purchase requisitions. The occurrence of delayed POs results directly in noncompliance with the requested transformation performance.

Number of existing POs, which are affected positively: This risk KPI gives information regarding the number of existing POs which have been accepted or are already in progress and could be affected positively by taking actions. The occurrence of positively affected POs results directly in an increase of compliance with the requested transformation performance.

Degree of risk minimisation: This risk KPI gives information regarding the degree of risk minimisation due to taking actions. The occurrence of a degree of risk minimisation results directly in an increase of compliance with the requested transformation performance.

Costs by taking actions: This risk KPI gives information regarding the costs which would turn up for taking actions in order to minimise risks and increase the compliance with the requested transformation performance. This KPI always needs to be opposed to the risk KPIs “potential costs” and “degree of risk minimisation”. The actual quantitative risk assessment can only be meaningful when this comparison has taken place.

Potential costs: This risk KPI gives information regarding the costs which would turn up by not performing the required transformation performance, either by taking or not taking any actions in order to minimise the risks. This KPI always needs to be opposed to the risk KPIs “costs by taking actions” and “degree of risk minimisation”. The actual quantitative risk assessment can only be meaningful when these comparisons have taken place.

In terms of an integrated SCRM the risk KPIs listed above can be used as a communication medium in order to get a transparency and expose the actual situation. Furthermore, the communication of risk KPIs with downstream supply chain partners can be highly useful as a starting point for the partners’ risk management and risk assessment.

Missing risk KPIs, which cannot be communicated among the supply chain partners, there will be always a falsification of the supply chain’s actual state. The basic assumption for further risk assessment would draw wrong consequences. The usage of risk KPIs within the SCM context, obtained by LAS, leads to a new dimension of detailing in terms of risk assessment.

Usually, risks can be minimised by taking actions. Nevertheless, actions may not always be profitable. Apart from the risk KPIs mentioned above, recent projects showed that cost KPIs can be gained by using LAS. Thus, the risk KPI “potential costs” need to include cost KPIs obtained by LAS. The actual quantitative risk assessment can only be meaningful when this consideration is not neglected in order to have an accurate decision support in terms of taking actions.

Currently, at the Fraunhofer IML the risk KPIs as well as their implementation into the LAS is being investigated. The implementation of the interdependency between supply chain partners’ risks and costs is one of the challenges which are being met.

5. CONCLUSIONS & OUTLOOK

The new SCM-Software generation LAS allows large-scale enterprises as well as SMEs to get a transparency regarding their actual risk situation, especially for risks which are affecting the system load. Though, risk management does not serve to avoid risks but to identify those and to provide a decision basis for strategic considerations. LAS are able to deliver highly useful KPIs. For an integrated SCRM contribution a number of risk KPIs are introduced in this paper. On the on hand enterprises can use these presented KPIs as a communication basis in order to exchange risks. Benefits of the exchange of risk KPIs may be, for instance, the simple identification of potential win-win-situations. Enterprises can share costs for taking actions commonly to increase the compliance with requested transformation performance. On the other hand enterprises can use KPIs intra-company in order to analyse their actual situation and consequently to take actions purposeful.

For future research work it is imaginable to investigate the extension of the presented KPIs and to implement those into LAS which may act for further risk areas and SCM concepts.

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