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RISK MANAGEMENT IN LOGISTICS SYSTEMS

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Abstract:
This article presents a management-approach which has been developed to combine the disciplines of logistics management and risk management, in order to response to rising risk potential in complex logistics systems. Effective and efficient logistics processes rep-resent an imperative necessity in modern supply chains; especially supplier-customer relationships have become more and more important. No matter which level in the supply network is concerned, both, opportunities and risks regarding logistics processes increase along with the complexity of the respective systems. Besides this approach, logistics risk sources, releasers, and amplifiers are described and the term "logistics risk" is discussed. In order to demonstrate how this approach can be realized in reality, selected parts of a practical case study underline achievable improvements in case of application.

Key Words: Risk Management, Logistics, Supply Chain Management, Inventory

1. INTRODUCTION

In the course of time, logistics has developed from a classical support function to a crucial success factor influencing the competitiveness of business. The rising demand for logistics performance together with decreasing costs lead to more complexity and consequently to more uncertainty and risk potential in logistics systems. Since risks can be de-scribed as unplanned events, they can have immense negative effects on a company's overall performance, especially if it is not appropriately prepared for their occurrence.

The opening of London Heathrow's terminal 5 is a recent, impressive incident in terms of logistics risks. Although an airport terminal is not a classical industrial application, it still is a graphic example of underestimated logistical risks. On March 27, 2008, within hours, the opening of the modern airport terminal for 8.6 billion dollars caused an incredible chaos. That day, various airlines had to cancel 34 flights and many passengers did not get their luggage, had to look for other travel arrangements, or were left stranded in the new building. [1]

However, not just events with such a catastrophic impact should be considered in terms of logistics risks. Also unplanned, negative events with less impact still lead to additional efforts and costs. Therefore, this paper has the intention to introduce a management approach helping to understand the logistics risk situation and treat it in an appropriate manner. Moreover, first an appropriate definition and categorization of logistics risk has to be introduced in order to understand the entire context.

2. DEFINITION OF THE TERM "LOGISTICS RISKS"

The term "risk" can be understood as the unexpected, unwanted event or the cause of an unwanted event which may or may not occur. [2] When speaking about logistical risks, the obvious similarity of the meanings on the terms "Logistics" and "Supply Chain Manage-ment" has to be taken into account. Along with that, the similarity on the terms "Supply Chain Risk"

and "Logistics risk" is obvious, what is also underlined by statements like the following of Norrman: "Supply chain risks are risks that are related to the logistics activities in companies' flows of material and information." [3]

In relevant literature, supply chain risk is consequently linked to supply chain disruption. These considerations fit to the definition of logistics in terms of its objectives of having the right material at the right time in the right quality at the right place. They are also known as the "4 Rs" of logistics. [4] Therewith, unwanted events of logistics according to these objectives are to be expressed by not having:

- the right materials,
- in the right quality,
- at the right time, or
- at the right place.

In other words, logistics risks are disruptions of the planned material flow for what ever reason with all its consequences. Unplanned events in logistics processes are directly linked to missing inventory and therefore to the material flow. The information flow, as a necessary "support flow", is needed in order to provide the required logistics performance. When recapitulating all these considerations, logistics risk can be defined the following way:

"*Logistics risks are the unexpected, unwanted event or the cause for this event of not having the right material at the right time in the right quality at the right place at the planned price. Causes can be of physical or of virtual nature due to mistakes or the disruption of either the material flow or the related information flow*." [5]

3. LOGISTICS RISKS CLASSIFICATION

Risk categorization is the first important step towards a successful derivation of risks with-out forgetting important fields during the risk identification stage. Ideally, this categorization is customized to the risks to be addressed, resulting in case-specific risk categories. [6] This paper suggests a logistics risk categorization which consists of three perspectives: Logistics risk sources build the basis of the classification. Strategic product importance – as the amplifier or absorber of risk – massively influences the business impact in case of risk occurrence. Last but not least, logistics risk releasers are the third category which deserves to be listed in the context of logistics risks. Especially in the practical application of logistics risk identification, these classification parameters have shown to be an excellent framework. Together, they provide a convenient basis for the detection and evaluation of realistic logistics risk scenarios (Figure 1).

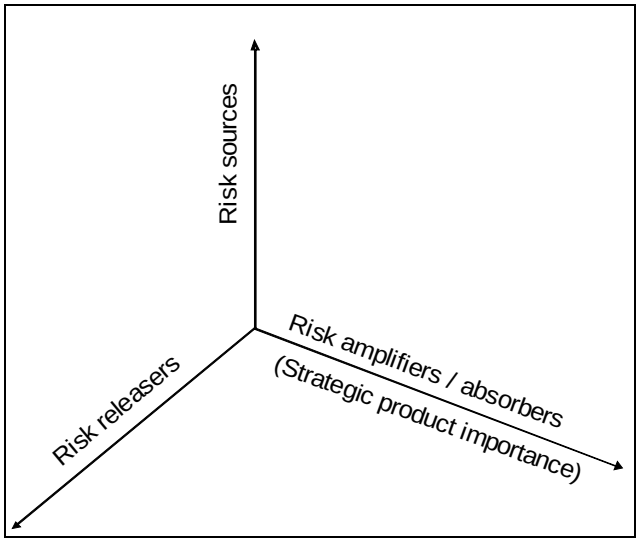

Figure 1: Three dimensional categorization of logistics risks [7].

3.1 Logistics Risk Sources

In order to have a good starting point for logistics risk identification, it is meaningful to structure risk sources according to a well considered framework. The first level is constrained by the system borders, meaning that internal risk sources are separated from external ones. The latter are, according to a well accepted categorization designed by Ma-son-Jones and Towill, either related to the supplier, to the customer or to other environmental circumstances [8]. System-internally, either the material flow system or the information flow system is the root for disturbances. Together, these sources offer a holistic perspective on possible logistics risk scenarios (Figure 2).

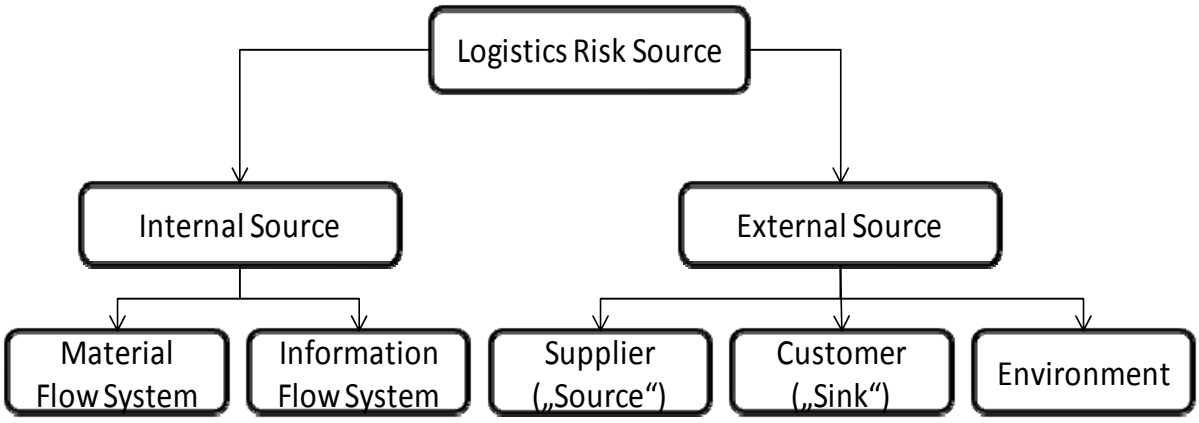

Figure 2: Logistics risk sources [9].

It is definitely possible to break down this tree to some lower levels of system elements and sub-systems. However, abstraction degree of logistics risk sources offer the advantage of not to be too restrictive for required creativity needed for risk-scenario-development stage, what has been well investigated in practical applications [10].

3.2 Logistics Risk Releasers

Independently of the affected logistics risk sources, four direct risk releasers are to be named. In any case of logistics risk occurrence: (Figure 3)

- the happening is either introduced by a human’s mistake, or
- technical appliances did not work as planned, or
- bad organization lead to the risk occurrence, or
- force major could be blamed for the happening.

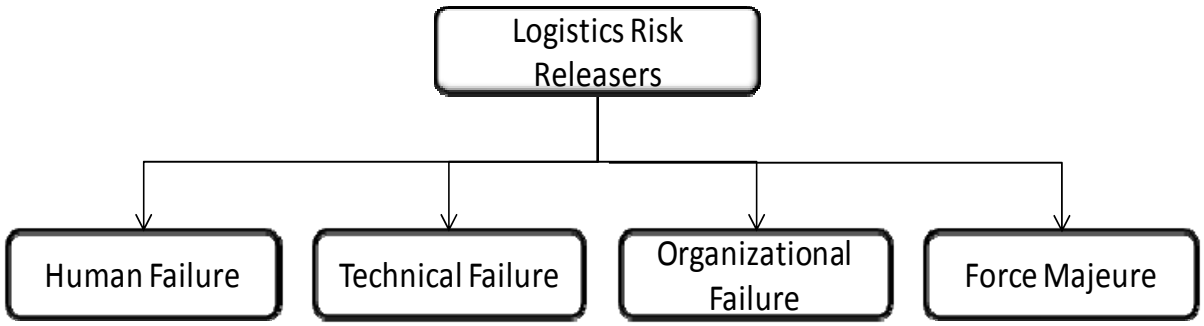

Figure 3: Logistics risk releasers [11].

Humans can cause the occurrence of risks intentionally (e.g. in the case of a terror at-tacks) or unintentionally. Examples for technical releasers are hardware or software defects or

defective machinery like warehouse equipment. Risks caused by bad organization are linked to unclear responsibilities, badly defined workflows, or lack of information due to bad documentation. Force major finally offers a wide spectrum of direct risk releasers such as strokes of lightning, a fire, or floods, just to name a few examples.

Risk releases – in combination with logistics risk sources – are an excellent basis for starting the search on logistical risk potential and support the required creative process to gain appropriate results, although the result's completeness is never guaranteed.

3.3 Strategic Product Importance

While risk identification can be based on risk sources and releasers, the business impact in turn is strongly influenced by the strategic importance of the respective product. The strategic importance is characterized by several factors, described in this chapter. A strategy can be defined as "the plan of the procedure used to reach a predefined goal by considering factors that obviously influence the procedure or goal." [12] Moreover, the strategic product importance significantly influences the supplier-customer relationship. In re-turn, certain market constellations even constrain possible kinds of relationships, which likewise influence the strategic importance of products (Figure 4).

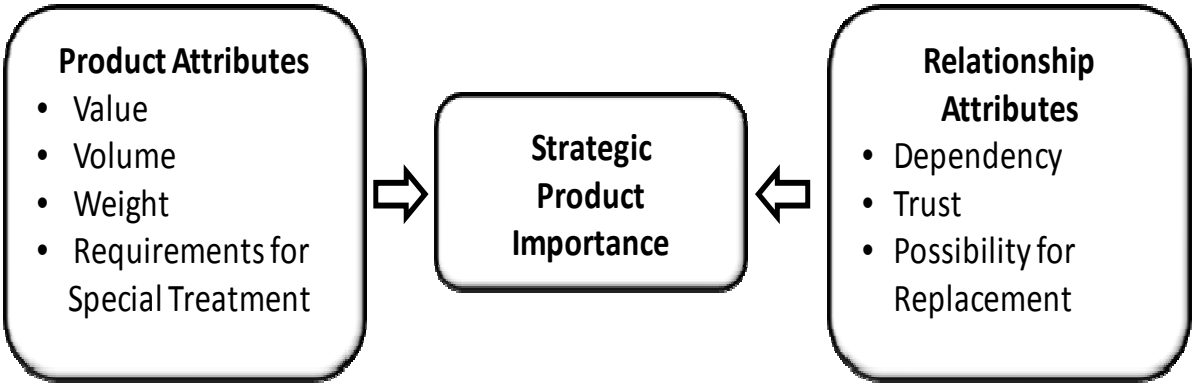

Figure 4: Influencing factors on the strategic product importance [13].

The most important characteristics of a product influencing the related logistics strategy are its attributes. [14] Physical attributes like volume, weight, the number of product variants, or special treatment requirements create the framework and also constrain imaginable logistics strategies which directly amplify or absorb logistics risks. For instance, bulky products combined with restricted storage space restrain the level of inventory, what enforces the possibility of material flow disruption automatically. A product existing in a high number of different variants often requires the delivering strategy "Just-In-Sequence" (JIS), what excludes the possibility of keeping safety stock and what in turn, significantly enhances the danger of material flow disruption. In the automotive industry, especially voluminous modules existing in a high number on variants (e.g. car seats) are being delivered JIS. Also the importance of the product value has to be highlighted in this context. Valuable products cause more risk in terms of theft or damage. Therefore, additional technical requirements like locked sections are necessary. Moreover, special process requirements have to be considered.

Additionally to product's attributes, the relationship of the supplying to the purchasing party regarding a product strongly influences the strategic importance as well. Not every relationship between supplier and customer has the same intensity. Companies use different kinds of collaboration, ranging from the classical arm's length transaction to the complete in-sourcing of the product's supplier. [15] Especially in the automotive industry, a continuous reduction of the supplier base has taken place in the last years in order to intensify collaboration. Although there are many benefits of intensified relationships, the risk potential

increases as well. The most crucial attribute of tight relationships is that “working together” results in interdependence. That definitely requires trust. Trust and risk are directly linked. [16] Logistics risks are caused by trust as the vulnerability of the material flow is much higher in highly developed forms of collaboration. From the customer’s point of view, an intense collaboration usually requires high investments in IT. In the case of a supplier’s failure, alternatives are difficult to obtain. From the supplier’s point of view, the danger of lost investments and efforts put in a relationship can cause serious problems. [17]

4. SUCCESSFUL LOGISTICS RISK MANAGEMENT: A MODEL-APPROACH

For the successful treatment of logistics risks, they need to be managed. Existing risk management approaches are fragmented, what leads to the situation in which risk is treated as disparate and easily to compartmentalize. [18] Therefore, the management of logistical risks should be part of the entire logistics management process. According to the “St. Galler Management Konzept”, management principally contains three core functions, these are:

- the core function of DESIGN,
- the core function of STEERING, and
- the core function of DEVELOPMENT.

Regardless of the field of activities on which management has to be applied on – or in other words, which field has to be managed – the core functions remain always the same. Consequently, the same core functions are to be applied on logistics management and risk management. However, risk management has been developed as a very specific discipline with specific steps. Usually, risk management contains the steps of: [19]

- Derivation of a corporate risk policy
- Risk identification
- Risk quantification
- Respondence to risk and
- Risk monitoring and control.

Nevertheless, principally these steps are allocatable to the three core functions of management too. The core function of risk DESIGN contains the derivation of a risk policy – including the definition of targets and rules of behaviour in case of risk occurrence – and the identification and quantification of risks. The core function of risk STEERING is basically allocated to the step of risk response, which means defining and applying response measures to meet the pre-defined targets. The core function of risk DEVELOPMENT ensures that risk gets measured. By the observance of risk occurrence and the application of appropriate measures the continuous development of system and processes in respect to logistics risks is ensured.

The developed model is displayed in Figure 5. The centre of this model represents all logistical activities which have to be accomplished in order to satisfy the needs of the served customers. Firstly, these activities can be allocated to the system- and process planning in order to create the appropriate framework for further activities. Secondly, an-other group of activities is required in order to operate the logistics systems by applying predefined processes and to create the logistical performance. Thirdly, there are some activities necessary which are directly linked to performance monitoring. This is a necessity for a company in order to stay competitive in the long run.

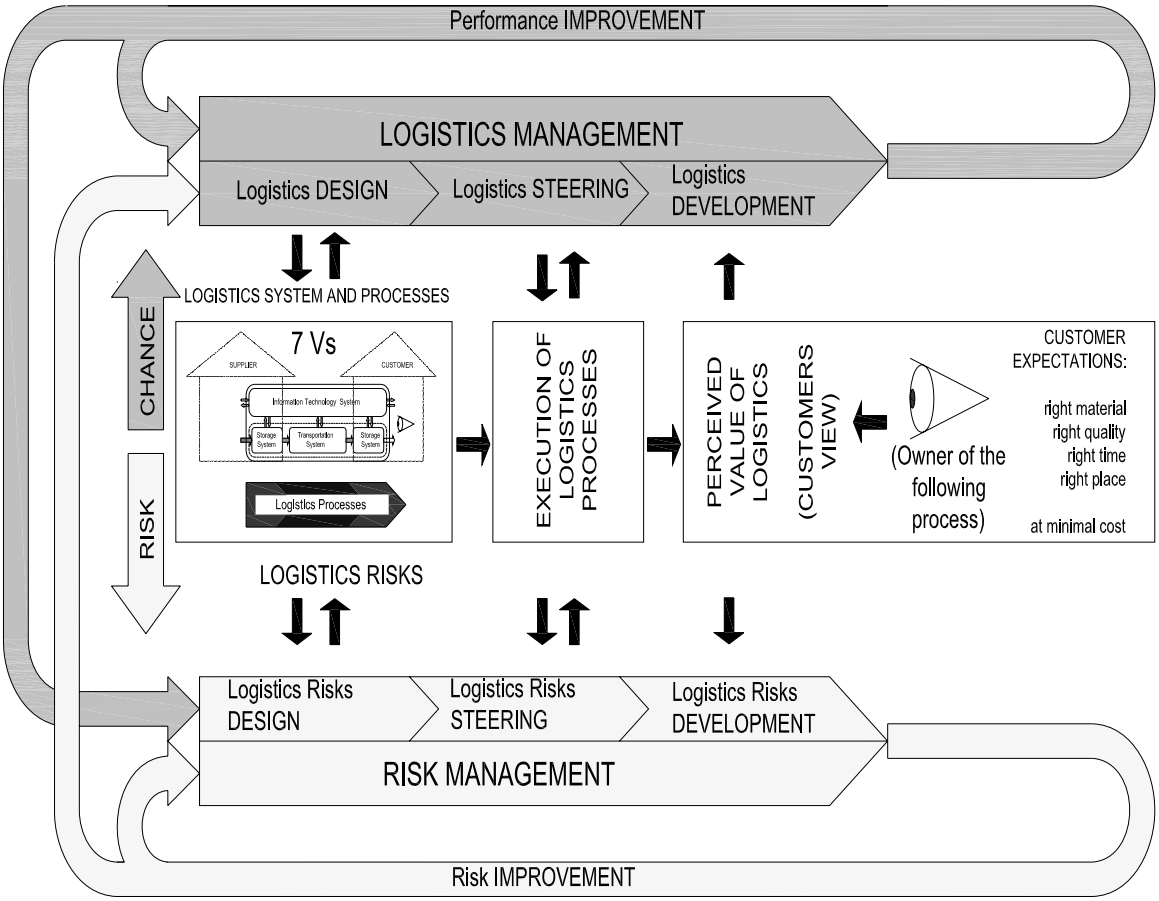

Figure 5: A model approach for risk treatment in logistics systems [20].

All those activities, required for successful logistics performance delivery are guided by the two management processes of logistics management and risk management. Logistics design and logistics risk design ensures the generation of an appropriate framework consisting of the system and it sub-systems as well as pre-defined processes. Therefore, all objectives regarding logistics performance and logistics risk have to be defined and documented. Afterwards, the creative design process builds the centre of this stage. During the whole logistics design procedure, performance- and risk objectives have to be kept in mind and evaluated continuously until an appropriate constellation ensures the possible achievement for performance- as well as risk goals.

Figure 6 shows an example of such a risk map. Business impact as well as likelihood of occurrence is divided in 5 classes. Moreover, the different areas are marked according to a traffic light system. Therewith, the strategy of logistics risk treatment is already de-fined: Risks in red fields have to be replaced in any case, green marked fields indicate acceptable risks, and logistics risks scenarios in yellow coded fields have to be investigated more detailed in order to decide on the course of action.

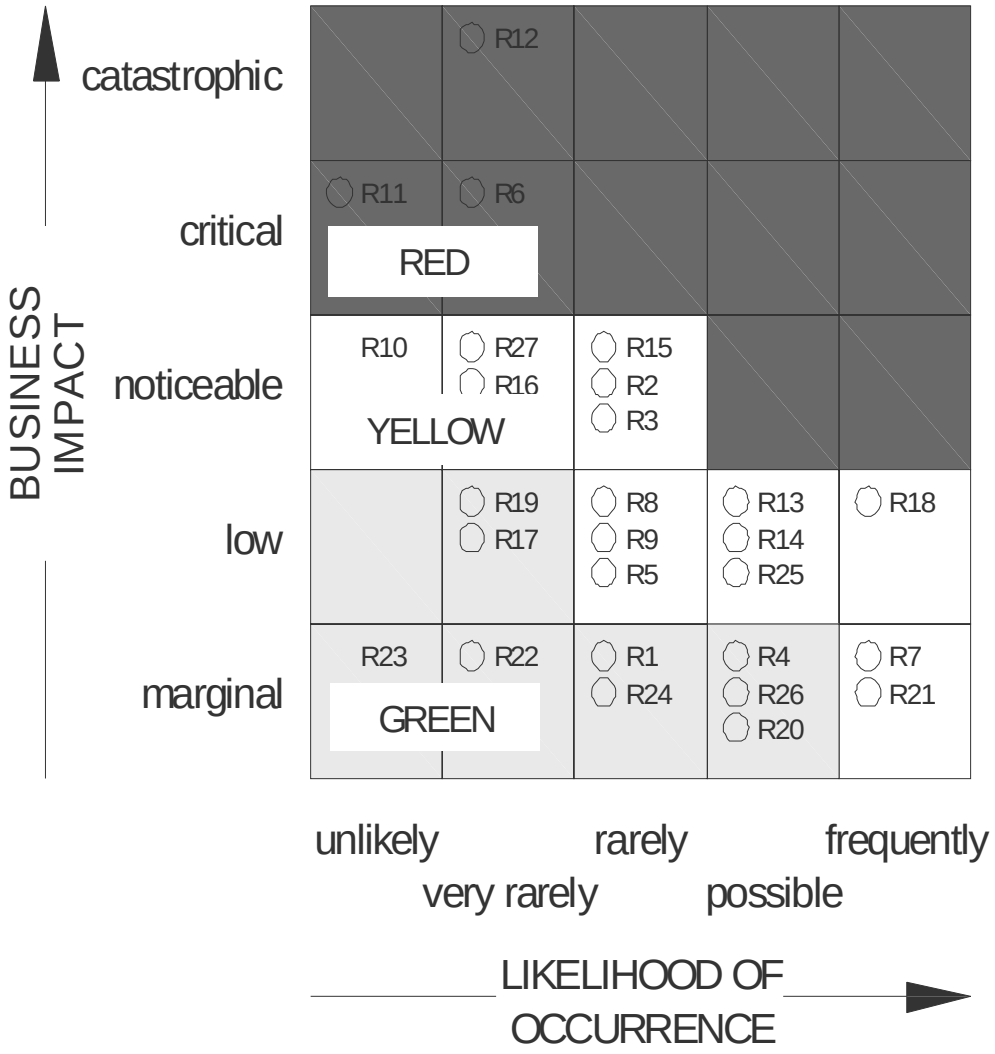

Figure 6: Logistics risk map (example) [21].

Additionally to the judgement on single logistics risks, it is meaningful to consider the cumulated impact of risks for a certain period of time. Since risks occur to a certain probability and its impact varies form case to case, it is necessary to allocate probability distributions to the classes of business impact and likelihood of occurrence. Definitely, this is a very challenging task, because especially when this model approach is introduced the first time, people usually don't know very well about existing risk, but by the time, they become familiar with their risks. Long-time risk documentation helps to adapt assumed possibility distributions. Just like in any other mathematical model, the quality of the results depend on the quality of the input data, which demands professional judgment and helps to understand the logistics risks better. Therefore, the creation of a distribution function by the help of Monte Carlo is not absolutely required, but strongly recommended.

Figure 7 displays an exemplary result, created by an appropriate Monte Carlo Simulation (MCS). The x-aisle displays the quintiles, the y-aisle displays the cumulated business impact, which is negatively influencing the overall result of the company. In this example, the 50% quintile (median) is allocated to a yearly impact of 123.300 Euro, what means that in 50% of the simulated cases, the yearly impact was less. Here, the pre-defined tar-get for this value is 150.000 Euro, what means that the assessed risk situation can be accepted.

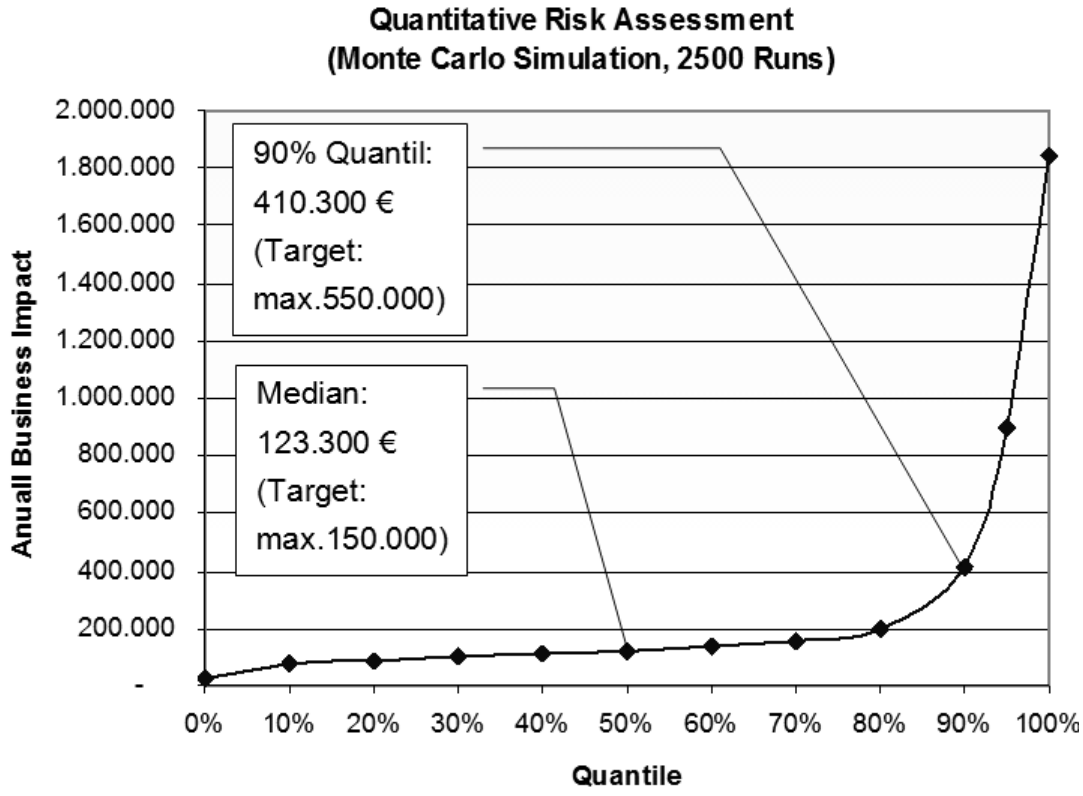

Figure 7: MCS result (example) [22].

The second step of both, logistics management and risk management, is steering. Within this stage, the goal-orientated setting of activities has to be triggered in order to ensure the achievement of short-term objectives. In case of logistics risk occurrence, predefined goals have to be released in order to limit generated negative business impact to the pre-defined levels formulated by the risk strategy. Steering processes are short-term orientated, although short term targets must be in line with the formulated performance targets gathered in the design stage. Basically, four types of risk response can be distinguished, these are: [23]

- Risk acceptance
- Risk reduction
- Risk transfer to a third party
- Risk avoidance

Thirdly, logistics development and logistics risk development are accomplished by long-time measurement of both, performance and logistics risk introduced costs. Ideally, the direct customer serviced gives feedback and supports those measurement processes. While performance can be interpreted as function of costs, quality and time related indicators, logistics risks basically are to be quantified by the cumulated negative business impact created by risk occurrence.

Both, performance- and risk-measurement are the basis for system and process improvement. In the long run, documented logistical risk scenarios are becoming more and more complete, what leads to an improved awareness on logistics risks, and what more-over supports the impact assessment. Finally, improvement potential detected must lead to improvement activities. Therefore, the implemented model approach automatically sup-ports the continuous system- and process-improvement, similar like quality management standards (e.g. ISO 9001) do. For the model implementation, an appropriate procedural method has to be chosen. As one very well fitting approach, Plan-Do-Check-Act (PDCA) [24] can be named since those steps fit to the proposed management approach ideally.

5. CONCLUSION

Today, logistics processes represent an imperative necessity in supply networks. More-over, supplier-customer relationships have become more and more important. In the last decades, logistical developments like Just in Time (JIT), Just in Sequence (JIS), Vendor Managed Inventory (VMI), and other sophisticated strategies have been developed in order to increase logistical performance in terms of time, quality, and costs. Furthermore, logistics systems connecting separated entities within a supply network can be interpreted as interfaces. Interfaces offer potential for optimization, what is well known among managers and scientists.

Thus, improvements in this area (not least due to new achievements in IT) are of interest. At the same time, a large number of possible sourcing strategies in combination with numerous possible (worldwide) suppliers enhance the complexity and logistics risks consequently. Therefore, along with these newly achieved opportunities, risks regarding logistics processes have increased along with the complexity of the applied logistics solutions. However, these risks are often forgotten.

Therefore, an appropriate definition of the term “logistics risk” as well as an appropriate categorization, needed for logistics risk scenario analysis is provided by this paper. Furthermore, a management approach has been developed in order to combine the disciplines of both, logistics management and risk management. Underlined by selected, introduced parts of a practical application, it is shown how the introduced approach can be applied in industrial organizations in order to allow the achievement of objectives and continuous improvement of logistics systems and processes.

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