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Risk Management in self controlled logistic processes

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ABSTRACT

Modifications of product life cycles, company structures and information flows alter the requirements for logistic processes. Logistic processes are facing new challenges. These developments are caused through the evolution of virtual organisations and the increasing maturity of new ICT technologies like RFID and ubiquitous computing. The rising complexity of organisational structures leads to an increasing utilisation of existing processes [1]. To coordinate all these processes, an increasing demand of required information for just in time deliverables is needed. These requirements exceed the abilities of existing standard logistic processes. To fulfil future needs in logistics, the development of adaptive, self controlled logistic processes is necessary. This can be realised through autonomous, decentralised control systems, which select alternatives autonomously and decide within a given framework of goals. Experiences show, that a high number of autonomously acting objects lead to an increased sensitivity and higher risk. Direct disturbances of the processes caused by anthropogenic risks and natural hazards have to be identified and reduced by a pro active risk management system.

To develop such a suitable risk management system, a holistic risk term has to be defined, which contains technical, economic and sustainability aspects.

KEYWORDS

Risk, Responsibility, Logistic Processes, Requirement, Entity, Autonomous

NEW REQUIREMENTS FOR LOGISTICS

With reduction of the vertical range of manufacturing and the tendency to globally distributed production, logistics and the design of logistic processes gain significance [3]. The changing customer market conditions have considerable effects on planning and the control of logistic processes. An increasing number of transports and as a consequence thereof a smaller packet size leads to a relative shortage of logistic infrastructure as a result of rising utilisation of logistic processes. The changeover from sellers' markets to customers' markets promotes customer orientation as a success factor in competition. Just in time deliveries and traceable packets are also located in close connection to the customer orientation for logistics.

Trough the changing market conditions new organisational are new forms like extended enterprises and virtual organisations supported and established. These temporary alliances lead to an increased complexity of the logistic processes due to their distributed, dynamic structure. As a result of these facts, the importance of logistics grows and new concepts for planning and control of the logistic processes are needed. Because of the former described changes in customer market conditions there are complex and partly conflicting requirements to logistics in future. These requirements cannot be managed by actual logistic planning and control systems. The dynamic development of new information- and communication technologies opens new possibilities for the development of seminal logistic systems. One example for a technology which may support logistic processes is RFID technology. The transponder or Radio Frequency Identification (RFID) technology is a technology, which is capable to trace products and packets piecewise at any place and along the life cycle from the design phase until the final recycling or disposal. It enables units to act as intelligent entities. Typical application fields are e.g. toll collections, baggage handling, animal tracking or identification of containers [5]. Ubiquitous computing and wireless communication networks afford an ongoing localisation and identification of traceable units and give the possibility for communication between the individual units. These technologies offer new options in logistics. However, these technological advantages can only be fully used with new strategies and methods for logistic processes because the complexity of virtual organisations and their dynamic development inhibit the allocation of all relevant information for a central deciding entity.

SELF CONTROL AS A POSSIBLE SOLUTION

To manage the bulk of information adaptive logistic processes with capabilities for decentralised coordination of autonomous logistic objects in a heterarchical structure are required. The ability of self control allows the autonomous adaptation towards changing conditions for each entity in the logistic process. Self control in a narrow sense means the ability of an entity to decide within a given framework of goals. A self controlled entity can be supported by the use of RFID technology because the ubiquitous availability of information accompanying the material flow can be further used in order to realise innovative decision support tools, which can be adopted for various issues within enterprise networks and logistics and the process chains in the field waste and recycling management [5]. One RFID driven advantage is that information can be transmitted in real time to the concerned entities which are able to converse the given information and react within their given framework of goals. Existing approaches of adaptive logistics and supply chain event management (SCEM) consider changes to sub goals or external interferences in logistic processes on management level but it is necessary to combine the new possibilities from ICT and management theory in one concept to fulfil the requirements of self controlled logistic processes. The Collaborative Research Centre (CRC) 637 "Autonomous Cooperating Logistics Processes: A Paradigm Shift and its Limitations" (CRC 637, www.sfb637.uni-bremen.de) is underway at the University of Bremen since January 2004. It is funded by the German Research Foundation (DFG) and the University of Bremen and comprises more than 40 researchers. The CRC 637 uses an interdisciplinary approach to study novel logistics paradigms. This approach encompasses researchers from the scientific disciplines of manufacturing engineering, business studies, computer and information sciences, electrical engineering and mathematics.

The basic objective of the CRC 637 is the systematic and broad research in "autonomy" and a new control paradigm for real-life logistic processes. There are three major goals:

- Scientific research of the “autonomy” concept and the development of a theoretical framework for the modelling of autonomous logistic processes,
- Methods and tools for efficient dynamic control systems as well as their communication and coordination geared towards logistics systems,
- Investigation of the impacts of the autonomy paradigm on logistic systems and their future development using modified control methods and processes.

The autonomy paradigm and its application to logistic processes can only be developed in a holistic and cross-disciplinary approach. Based on a system concept known from systems engineering, there are three task layers to be covered in the CRC 637: material flow and logistics, communication networks and knowledge-based methods, and organisation and management. Research therefore centres around the autonomous physical flow of wares and goods, its realisation by information systems, and the management of autonomous logistic processes [2].

The main feature of self controlled logistic processes is the autonomous acting within a given framework of goals. It is the objective of these processes taking such measures to be successful in reaching the given goals. The use of agent based technology with autonomous entities is a possibility to realise self controlled logistic processes. As a consequence of the development of self controlled logistic processes by using agent-based technology the responsibility for the processes is moving from a central human instance to an autonomous entity. Figure 1 provides an overview:

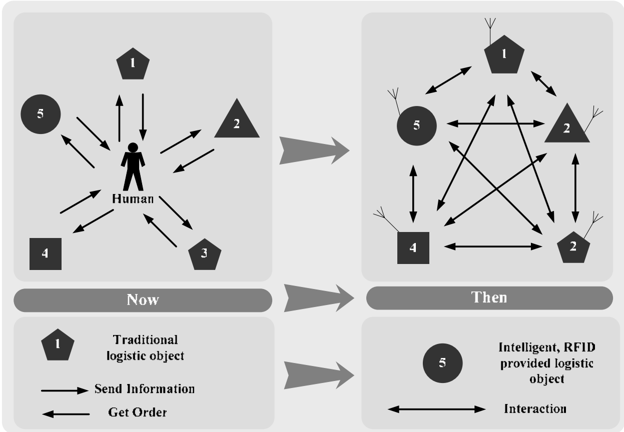

Figure 1: Adjustment of responsibility from a central instance to the logistic process

The self controlled logistic processes are more damageable and the interaction between the amount of autonomous entities leads to non calculable states on local and global level.

It is unrealistic to think that the development of a technology for such a complex and dynamic system can be done without thinking about malfunctions, bugs or related problems. In this context, the existence of possible hazards and chances has to be born in mind. To handle the existing risks of self controlled processes a proactive risk management has to be established as a part of whole system, because it helps to make the processes robust and insusceptible to existing and occurring hazards and supports the entities in decision taking. The development of a proactive risk management system can be considered as a relevant success factor for self controlled logistic processes, as shown in Figure 2:

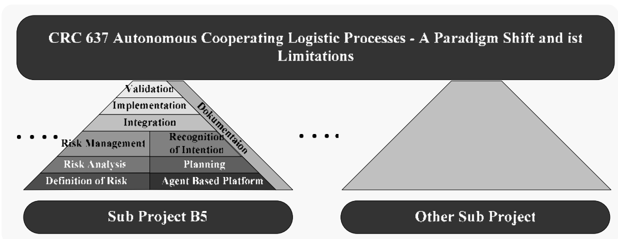

Figure 2: Risk management as bearing column for the CRC 637

An additional advantage caused by the use of a proactive risk management in comparison to a traditional reacting risk management system is the gain of auxiliary scopes. These scopes are pointed out in Figure 3:

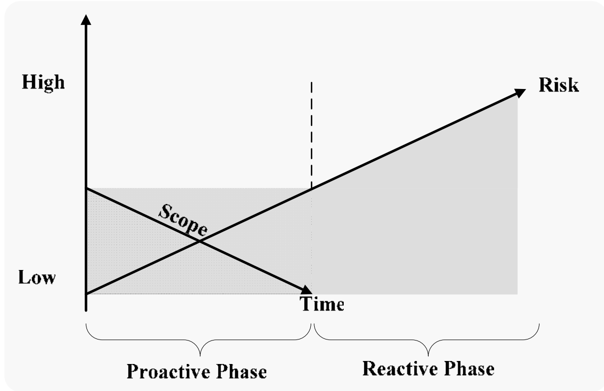

Figure 3: Impact of a proactive risk management on total risk regarding additional scopes

As shown above the existence of a pro active risk management system leads to more opportunities and lower process risk. But how to manage it?

"The principal element involved in managing risks can be boiled down to a single sentence:

Good process risk management results in perfect containment and safe handling of the hazard [7]."

This single sentence has to be enhanced for self controlled logistic processes:

…and in perception of existing and future options for the autonomous entities.

Kenney exemplifies the fundamentals and principles for a functioning risk management system in three predications:

1. The hazards of a process must be capable of being defined at any time.
2. The risks resulting from these hazards must be controllable by equipment, by procedures, or by some combination thereof.
3. Management must uncompromisingly maintain control over the equipment and procedures that are identified to control the risks

How these simple tasks can be realised in a risk management system will be research object of the subproject B5 "Risk Management for Robust Logistic Processes" of the CRC 637. The first steps of the development of a proactive risk management system, the definition of a risk concept, will be described on the following pages.

EXISTING APPROACHES AND THEIR INFLUENCE ON A DEFINITION OF RISK FOR THE CRC 637

The beginning in research of this sub project is to develop a holistic risk definition for the whole CRC. For this reason, existing approaches of risk management have been analysed and many definitions of risk, hazard and uncertainty have been examined. The first step was the differentiation between uncertainty and risk because in some cases risk and uncertainty are used in the same context.

Nescience of the future and future developments are called uncertainty in wide sense. If an impartial occurrence probability can be allocated to a future incidence it is called risk. If it cannot be allocated to a future incidence, it is called uncertainty. This differentiation was developed by Frank Knight and is deemed to be the economical standard approach [11].

The main difference between engineering oriented and other approaches is the declaration of the meaning of the term risk.

Most engineers consider risk as a negative term, where only a possibility of loss is included.

Two examples for engineering oriented approaches are:

- Risk is the hazard of the negative deviation between plan and reality [6].
- Operational Risk is the risk of loss resulting from inadequate or failed internal processes, people and systems or from external events [9].

These approaches of risk definition are called asymmetric approaches because the appearance of risk is only expected in a way with negative consequences. Most of these approaches are used in different forms of safety analysis like FMEA (**F**ailure **M**ethod **E**ffect **A**nalysis, developed in the 1960’s) or for example HAZOP (**HAZ**ard and **OP**erability Studies, developed in the early 1970’s and extended to software development in the 1990’s). These kinds of safety analysis were originally developed to reduce the error probability in engineering or chemical research and development (R&D). An exception is the approach of Haindl, who defines that risk (especially delivery risk) is the hazard of loss caused by external disturbances within the field of the supplier as well as in communication between supplier and customer [4].

If a definition of risk comprises additional positive possibilities it can be allocated to the symmetric approaches of risk. The differentiation between symmetric and asymmetric can be found in Pfohl [PFO] p. 11.

Financial and entrepreneurial approaches as well as approaches on project management are in the majority of cases symmetric approaches and differentiate between downside risk (negative development) and upside risk (positive development). Downside risk is the also called hazard while upside risk is referred to as chance. An overview to this differentiations can also be looked up in Pfohl [10]. The mathematical approach on risk (Risk = probability * impact) can also be treated as a symmetric approach because the impact can be positive or negative.

The next differentiation in relation to the definition of risk is the differentiation between action risk, which may result from a wrong decision and precondition risk which results from changing conditions of the relevant environment. A determination of these two risk differentiations was made by Haller and can be found in Mikus “Risikomanagement” [8]. This differentiation is insofar interesting because the process can not be exactly divided in action risk and precondition risk, but it is helpful for a first step in building the risk management system.

A risk management system for robust logistic processes will be affected by the following tenors and approaches:

1. It has to work with risk not with uncertainty because the total and the individual risk will be assessed by autonomous intelligent entities who need the mathematical risk approach to asses the risk. Only uncertainty is not enough for an adequate risk assessment. (-> Knight approach).
2. By the use of risk, the influence of the mathematical approach can not be neglected (-> Mathematical approach).
3. Action risk and precondition risk have to be considered. (-> Haller approach)

After examining existing approaches of risk definition and analysing their advantages as well as their disadvantages it can be said that they provide interesting input but they are not sufficient for the necessary purpose. For this reason, a new definition of the term risk has to be developed. This will be done in the following part.

THE DEFINITION OF RISK

For the development of an adequate definition of risk in self controlled logistic processes additional requirements have to be considered.
These requirements in the context of self controlled logistic processes in the CRC 637 are:

1. The total risk and the individual risks are connected to the system “self controlled logistic processes”.
2. The risk term includes upside risk **and** downside risk
3. Risk is connected to the goals and /or aims of the system (this is important for an automated evaluation and assessment of risk).
4. Risk has to be regarded in connection with endogenous and exogenous influences or malfunctions.

From this requirements and the examined definitions and approaches of risk the following definition for the CRC 637 was built in these steps, shown in figure 4 :

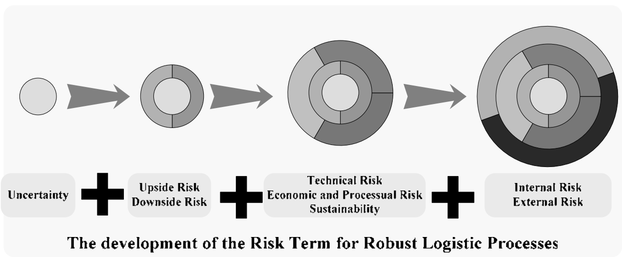

Figure 4: The development of the definition of risk in the CRC 637

The result of this process is the following definition:

“Risk is the contingency, that the result does not correspond to the goals of the system due to differences.”

This definition is a rudimentary basis definition for the research of the other sub projects of the CRC 637 in future and will eventually be enhanced.
Reasons for an enhancement are possible future inputs from other sub projects which may have a different understanding of risk. Therefore, the existing definition might be further elaborated through their input. This could happen in the next steps in research.

OUTLOOK AND CONCLUSION

The definition of risk in the CRC 637 is the basis for the development of a risk management system for robust logistic processes. To develop this risk management system the research on methodical concepts on risk analysis in the context of autonomous systems in agent based environments and related applications is the next step in realisation. Scientific examination of existing methods and approaches of risk analysis and their possible influence on the development of risk management will be done in close cooperation with the other sub projects of the CRC 637 because an insulated advancement can not lead to sufficient results for the research process of the whole CRC.

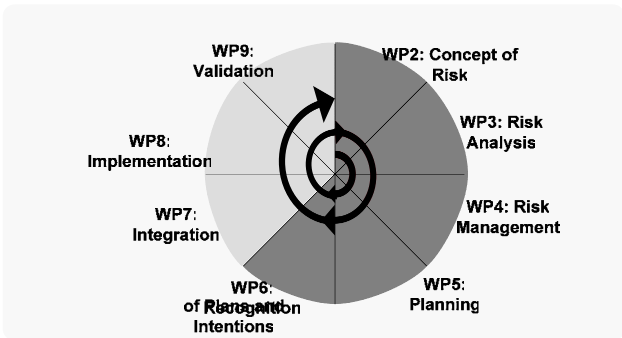

Figure 5: Course of research actions in sub project B5

The development of methodical aspects of risk will be implemented into a specified agent based system. The development of procedures and an approach of a risk management system will be done afterwards. The ascertained requirements of risk management for robust logistic processes will be conversed in the agent based system and checked with respect to their effectiveness and efficiency. This risk management system will be enhanced by methods for recognition of plans and intention on competing logistic processes as shown in figure 5. Afterwards, the methods of risk management, recognition of plans and intention will be integrated and implemented into an agent based platform. The implemented risk management system will be validated in the end and possible modifications will be integrated. A persistent documentation will guarantee a high quality and comprehensible research results.
It seems to be obvious that the use of autonomous logistic objects will play an important role in logistics. Traditional logistic system will be obsolete and not be adequate for the future needs in logistic processes. The subtitle of this CRC (A Paradigm Shift and its Limitations) offers the possibility to combine both approaches (traditional logistics, logistics based on autonomous cooperating

processes) in logistics, because fully autonomous logistic objects may not become reality: Some factors can only be managed by human or other central entities. But if ICT develops as fast as within the last ten years, the last sentence may become obsolete. With the development of this concept of risk for the CRC, a first successful step to a pro active risk management is done but the next steps will show how enduring and realisable this term will be.

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