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# Reducing Network Risks in Supply Networks by Implementing Games for Mediating Skills on Risk Management

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**Abstract:** Serious games have proved to be an important tool in supporting the education and training at schools and universities as well as vocational training in the industry. This paper presents an approach how such a game can be used for mediating skills on mediating skills on and understanding of risks in manufacturing networks. Finally, the paper presents first results and further work.

## 1. Introduction

Globalisation of manufacturing has caused an increase of locations with common markets and customers resulting in a harder competition for each of the involved players. Combining this observation with the trends toward more complex products, decreasing product life cycle times, higher customisation of products and higher demand of knowledge, leads to the necessity for companies to produce products in co-operation with other enterprises [6]. On the same time each company has to operate in an increasingly dynamic market and sourcing situation. Even though the ability of serving markets at the right time, is one of the most important indicators for staying competitive. The harder the competition is, the higher the efficiency must be. This leads to cost reduction strategies like out-sourcing, etc. [1,3]. A main result of this development is the emergence of complex and widespread manufacturing networks, which are more vulnerable and more sensitive to external and internal changes [3,4,5]. The reason for this is the interaction between the involved partners which leads to incalculable states on a local and a system level. Often networks react more inflexible since the large number of different entities and their complex interrelations. Thus, the number of risks and the impact these have increases too. There are several reasons for this- like reduction in number of supplier and the tendency to focus on efficiency instead of effectiveness [1].

In order to handle the existing risks of complex supply networks a proactive risk management system seems to be an adequate supplementation of a holistic process management system. Furthermore, it enables the involved partners to prepare risk oriented decisions on their own and realize them. For this reason, the development of a proactive risk management system can be considered as a relevant success factor for supply networks ant the collaboration within the supply network.

The fundamental rationale behind collaboration is that a single company cannot successfully compete by itself. Customers are more demanding; competition is escalating. Thus many firms seek to coordinate cross-firm activities and work reciprocally over time to produce superior performance. Enterprises enter into inter-organisational collaborative arrangements for a while in order to share risks and rewards. Therefore, dynamic systems such as production networks compel their workforce to be faced with ever-changing working environments [7]. This stresses the need of continuous learning, which constitutes

the true competitive advantage for organizations [8]. Moreover, the learning rate of the organization must be higher than that of competitors so that the former can survive [9]. An effective tool for mediating learning is serious computer games [10]. Serious games are mainly based upon the theory of constructivism. Constructivism sees the learner as an active agent, not a passive processing unit, and it sees knowledge as personal and subjective construction, not internalization of external rules. With the learner placed at the center of learning through social interaction, dialogue becomes the main vehicle for knowledge construction. This makes discussion, debate and collective analysis critical to the learning process. Multi-user computer games not only convey hard skills such as the understanding of how complex systems operate, production networks being one of them, but also mediate soft skills like collaboration and communication [21].

A serious game will let the player experience the impact of decisions and events happening in the game in a soft failure environment. This experience can how ever be transformed to the reality. Another advantage of serious games is that they offer the players the possibility to understand how complex systems operate as well as also mediate soft and hard skills needed in a collaboration like supply networks[11].

## 2. Objectives

An important negative side-effect in the operation of global networks is their vulnerability and inflexibility. Many companies have recognised the need to conduct formal risk audits. Suitable standard approaches for Risk Management like the one from FERMA [12] are available, but a lack of an integrated approach in enterprise networks exists. Networks do not use an integrated approach for several reasons. Besides the high organisational effort and the costs, the main obstacle is that different companies and employees are collaborating must closely collaborate and share information. A further obstacle is that organisations often have diverging goals in the collaboration [13]. The risks in supply networks are of complex nature, often originating from organisation entities and humans collaborating with each other. Furthermore, many enterprises see cooperation-specific risks as unavoidable [14]. The risks are often difficult to identify, because they are of complex nature and do not always have a very high negative impact at the beginning. Most of the employees are neither aware of risks nor the impact they might have. Therefore, risk management is often not integrated in daily working operations. Peck [16] states that “corporate risk assessment tends to focus on risk management from a single firm rather than a network perspective, as such it has largely failed to keep pace with the reality of networked global supply chains”.

Reviewed literature presents several guides, tools and measurement techniques are developed to help companies assess their risks, and foresee possible disruption to their processes [17,18,19,5]. However, the review of these existing tools for risk management in supply networks clearly shows that the understanding of risk is based on a functional view of the company and not capturing the context of supply chains. Available tools for risk management are also adopted from traditional risk management and for this reason disregard supply chain specific aspects such as engineering, innovation and collaboration.

It is clear that risks in supply networks are complex and diverse, and that will hardly be possible to identify, assess and manage all risks in a supply network with one tool and that the problems resulting from collaboration in supply networks can hardly be solved by using a tool, but more by decreasing the negative impact of them. Due to previous experience on mediating soft skills through gaming, the authors expect that the use of serious games could decrease the lack of awareness by offering the players a soft failure environment in which they will recognise their collaboration processes and in which the impact of decisions and events will be shown. Hereby, the awareness and understanding of risks in supply network will increase.

The main research problems to be addressed in this paper are therefore:

- How to identify and assess all risk factors of a global supply network
- How to reduce the reaction time of a global supply network on occurring risks within the operations stage?

Through the careful design of the gaming concept, gaming can prepare managers and employees for identifying, analysing, and evaluating specific types of risks that can occur within a global supply network.

Thus, this paper presents a concept and results of a computer game applied as training aid for companies involved in supply networks covering the issue of risk management.

## 3. Research Methodology and Approach

A key characteristic of supply network management is the coordination of activities between interdependent partners and actors. Therefore, any approach to managing risks from a supply network perspective must have a broader scope than that of a single organisation. To assess risk and vulnerabilities in a supply network context, companies must not only identify direct risks to their operations but also the risks to all other entities as well as those risks caused by the linkages between the organisations. Risks in supply network centre on the disruption of "flows" between organisations [1].

In organizational learning there exist tools, like games, that enable organisations to learn from past errors and disasters, within their own or other organizations [20]. This fits into what we want to achieve with risks in supply network.

According to Straka, an individual does only learn what he can perform and convert and implement [2], so it is important that this is considered in the game.

In a first step we analysed the collaboration processes at nine different industrial users, all being involved in supply chains. Secondly, in order to get a better overview of what the industry required and where they found a lack, a questionnaire were designed and distributed to a wide range of industrials as well as researchers. Around 250 questionnaires were completed and returned. The analysis shows that this is especially important for soft skills and for complex situations involving collaboration risks. This implies that in order to train students and young professionals to face new situations and to deal with risks in a dynamical environment, curricula need to be developed, which allow active. However, the questionnaires also showed that there is not enough to only increase the sensibility of risks, but that it is also a need for more methodological competences on risk management.

After analysing different gaming approaches and games comparing these with the user requirements, it was decided to develop a game engine, so that the player can get an individual adapted user scenario. A gaming engine allows the generation of different games and levels of games without having the need of re-programming. It also reduces the time required for changes in the games depending on user feedback and the score of learning outcome. This is the reason for separating the engine from the underlying model. The engine reads and executes game models providing an advanced user interface for players.

The architecture of the simulation game consists of an underlying business model, a simulation engine and a user interface, which allows to examine the model elements and to apply game specific actions.

The structure of the game is process driven i.e. it simulates the processes mainly running in a working environment of engineers. It is a collaborative game, since this is the main working situation. It is a role based game played sequential. Each game consists of a game scenario describing the environment, the situation, the topic as well as the role description, so that the players can get a common understanding at the beginning of the game. These elements are all adaptable. Within the game, there are several processes in which the players need to set an action – like choosing how to retrieve information or to complete a design document structured way. Additionally, in order to support the player to discover different risks as well as to increase the motivation factor in the game it is possible

for the facilitator to set different kinds of events. The events are not predictable, but are mainly events having an impact on the development process. At the moment KPI like quality performance, the time and the costs within the game is implemented, because this is a necessary element in order to achieve the competing effect which often works as a motivation factor in games.

# 4. Business Case Description

## *4.1 Case Description*

In a first step, the characteristics, processes and potential risks and challenges of a network were identified and analysed. The momentarily version of the first level is based on real business processes from four different companies. In order to reduce the complexity and the interdependencies, only processes dealing with collaboration or being essential for the product development were modelled in the game. The first level describes the collaboration within a company. The main tasks which the players need to perform tasks are to specify, design and produce an ordinary product (a jet ski). As they play, risky situations and risks will occur, which the players need to identify and reduce. Each department has to carry out and complete different tasks. The organigram is illustrated in Figure 1.

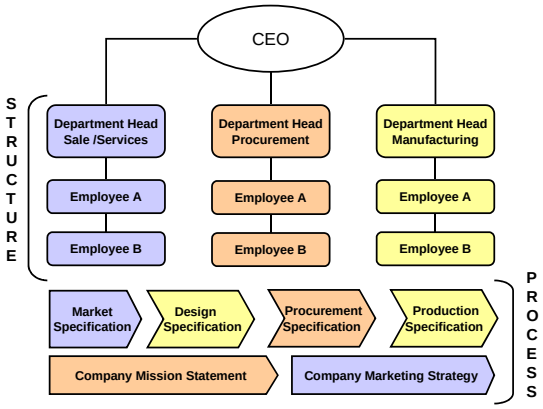


*Figure 1 Structure and process in level 1*

In the second level is based on an aggregated process model of eight different enterprises. There are three different companies, with three departments each. The product they are supposed to produce is a complex extended product- a cell phone with services in collaboration, thus they need to start with negotiating a consortia agreement, in which they need to decide upon risk sharing, communication and collaboration rules etc. Also here the players have a role description, which is designed in such away that the collaboration will not lead to any suitable result if the players do not communicate with each other. Furthermore, in order to design and produce the product, the different companies need to collaborate. The performance of the different companies is measured at a function of the time used in a processes step as well as a function of the percentage deviation of target value of each entry in documents belonging to a process step. The owner of the document does not have the needed information himself, but can retrieve it from other players by communicating with them.

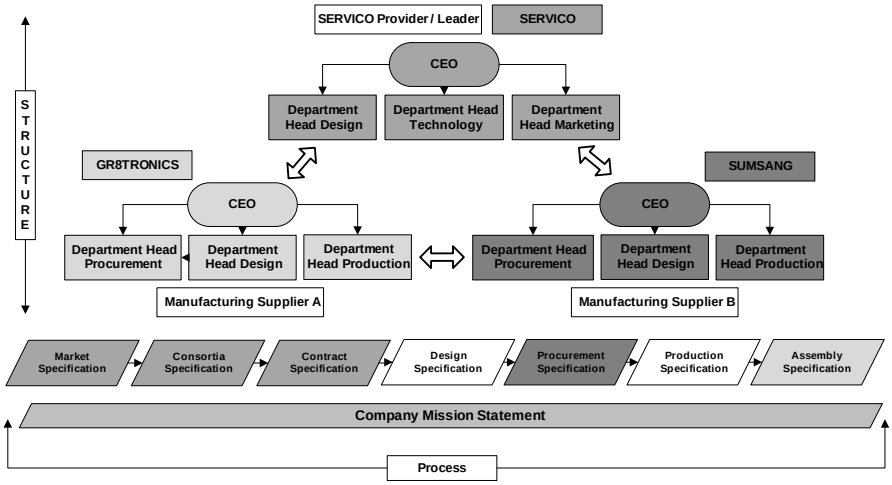


*Figure 2: Structure and process in level 2*

### *4.2 Workshop Setting*

The Beware game is a multi-player online game. It is played by nine players, organised in three groups with different locations. Each player uses an individual web interface to accomplish his given tasks within the simulated product development process. Communication is possible via an inbuilt chat function as well as by phone.

Currently, Beware is designed with two disparate and independent levels, but their numbers can be increased if necessary. In the first level, the participant experiences risks within the organization. A main problem in dealing with risks in a supply network is the large number of risks occurring. This is typical in all dynamical environments, but makes it difficult for the involved people since, people, according to Miller only can handle seven plus or minus two [15] different factors simultaneously while evaluating a problem. So, for each decision in the game we needed to make sure that there were not too many factors having an impact. Thus, the game cannot comprise all types of risks which can arise in detail, but it will comprise the main risks, and specifically be focused on collaboration and communication risks. Additional to these risks, the game does also address supplier and production risks, but on a higher level. Communication risks also include all information flow risks. Collaboration-specific risks include the risks resulting from the actions of cooperation partners differing to the actions explicitly or implicitly agreed upon. Consequently, not all partners are able to reach their goals to the extent planned [13]. Cooperation-specific risks have been classified by Seiter [13] into conflicting behaviour of a partner, opportunistic behaviour of a partner, and the withdrawal of a partner.

Using a blended learning concept with both theoretical foundation and the possibility to experience the impact of risks would fulfil the identified needs. The concept foresees that the participants receive the theoretical material on the risk management process as well as on different types of risks and risk management methods in a script two weeks before the laboratory starts. Then there will be two days of workshop with one week in between. The workshop starts with an introduction on the game, risk management and the collaboration in general. Afterwards, the participants play the first level. The first scenario shows an intra-organisational collaboration between three departments. The main task is the identification of various risks as well as the application of suitable methods to assess and reduce these risks. If the game is played by users familiar with risk management and only interested in experiencing the impact of cooperation risks, the first level may be skipped. Each scenario lasts about three hours. Some indicators, such as time, quality and costs, are supplied to the user as feedback during and after the game. The level of difficulties and the task each player becomes depends to a certain degree of the level of R.M knowledge the player has.

This is based upon the outcome of a pre-test he has to complete before he starts. Each player does have individual tasks to fulfill, which they will present and discuss with in the group in the debriefing phase. This debriefing phase is important for all players, because it allows him to reflect upon his own performance as well as on the overall performance. Furthermore, this task allows the group to discuss about different risk management aspects. An important part of the game is the internal and external communication. In order to receive the needed information, the players often need to argue with the other players and convince them that he really needs them. For this he may use the telephone or the chat which is implemented in the game.

The second game level, is actually the most interesting for supply networks, is more complex than the first one. It is an inter-organisational scenario with an extended product. Still they will need to cooperate in order to finish and to perform the tasks as they are supposed to and they will meet again in plenum. Within debriefing phase, they identify problems and initiating events that occurred in the areas of communication, collaboration, and trust. They develop problem solutions together in order to improve their communicative- and cooperative skills. Again, the players come together physically in order to reflect on what has happened and why certain events took place. It is the intention of the game to stress on specific situation. Therefore, each player gets a role characteristic describing how he or she should behave.

## 5. Results

In order to evaluate the outcome of the class as well as to be able to track changes caused by changes implemented in the course, all students completed a questionnaire at the end of each classes to be used for the evaluation. The questionnaire comprises questions on the involvement, skills gained and past experiences. Furthermore the questions on risk management asked in the pre-test are asked again in order to measure the learning outcome. The students could also add comments and give feedback during a session in each class. This feedback resulted in changes in the workshop setting as well as in the game, so that we registered a continuously improvement in students' ability to identify problems. The ability to develop strategies for reducing the problems was only slightly improved. A more detailed analysis showed that there were mainly four problems which needed to be solved:

1. The range of knowledge on working in distributed environment and on risk management is too large.
2. It was difficult for the beginners to identify the risks and the problems.
3. Esp. for those without any previous knowledge, it was hardly possible to develop suitable strategies.
4. Only players with a good command of English were able to apply the methods in the game and to develop strategies.

A more detailed analysis showed that even though they theoretically knew how they should proceed, they lost the overview of the situation and communication quite early in the game, and did not manage to decide which information they did or did not need. To structure the process in more detail in the first level of the game, additional processes reminding them and forcing the players to use a structured approach for identifying problems and risks were introduced. The new process steps deal with specific, clearly defined tasks on risk management and are mostly carried out by one to two players. A typical task comprises information on the method to be used and additional information which the player needs to process, before he can solve the task. The outcome of these tasks are presented and discussed in the debriefing and reflection phase after each game level.

In the reality, they will never occur explicit, so since the player should be able to be aware of such risks later, we decided that in a first step we would only change the numbers of processes at the first level, then letting the player solve their tasks as earlier at the second

level. Due to the large increase in the process of numbers, it was also necessary to change from a sequential model to a model allowing for parallel processing. There are two reasons for this, first of all, it simulates how a risk management process should be carried out- i.e. identify potential risks before they occur, and secondly, it is also a question of motivation- players who do not have anything to do loose the motivation and attention to what is happening in the game

The first four workshops after adding the new processes and changing the model were carried out in January and February 2008 with 36 participants. Even though the software still had several bugs and did not execute the game optimal (some documents were not available as they should, some of the events set were not showed on time), the results shows a significant improvement in the students ability to identify risks and problems within the communication in the network as well as in their ability to develop suitable strategies. In the summer term 2008, 45 participants played the game (five workshop groups). The version used this term was more stable and executed as it should. The learning outcome based upon a comparison of the pre and post-test were mainly the same as in the workshops in January and February. The presentation of the task as well as the written lab-protocol including the risk management tasks as well as the task on identifying communication and collaboration problems and strategies for solving them showed in more than 70% a high level. Additional to the pre- and post tests on risk management which we have used the last three terms, every participant has been asked to evaluate his ability of identifying communication and collaboration problems with in the game as well as his ability to develop strategies to cope with such problems. The figure below shows how the players' subjective assessment of their ability to identify communication problems (figure left) and their ability to find strategies to reduce problems related to interpersonal relations in distributed environment have been improved over the years. We assume that these improvements are mainly due to the improved game and it is measured by using anonymous questionnaires.

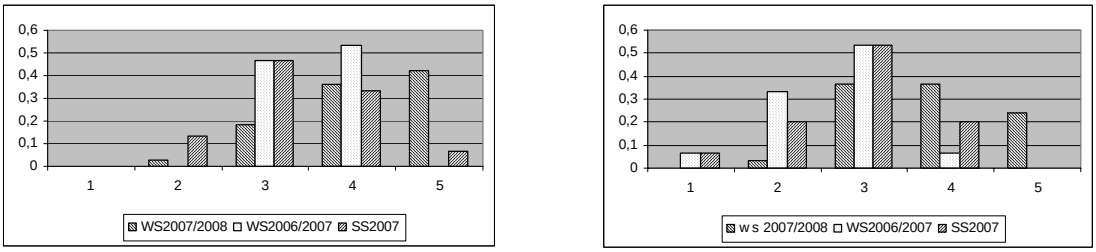


*Figure 3: Students' Assessment on Their Ability to Identify Communication Problems (Left) and Their ability to Find Strategies for Dealing With Interpersonal Relations/Trust Problems in Distributed Environments (Right) (1= Not Improved, 5= Very Much Improved)*

Further more a comparison of the results of the pre-test and the post-tests showed the attendees had increased their knowledge on different risk management methods and also that the understanding and awareness of risks in manufacturing networks were improved.

## 6. Conclusion and Outlook

The results show that it is possible to use a game in order to increase the awareness of collaboration risks in supply network. The learning outcome depends on both the motivation of the attendees as well as on that workshop level matches the level of theoretical knowledge the attendees have in the topics dealt with by the game. Therefore, the success of a game is based upon its adaptability and portability, so that the game always fits the requirements of the target group. Clearly, the results showed that esp. for students without or with little knowledge of a specific topic, it is important to make their task more visible at the first level. Furthermore, it was illustrated that the process of playing one

game, debriefing it, and then implementing another game level helps increase the performance on the second level because of the transfer of knowledge from one scenario to another through debriefing. The participants identified the risks as well as developed strategies for reducing the collaboration risks to much higher degree. The continuous evaluation of the learning effect demonstrates that the time requested to transfer information into knowledge not only depends on the essential debriefing phase, but also relies on the experience that the participant already has.

The game has been implemented and in use in the current version since end of 2007. It is still prototype, since there are still some bugs which need to be fixed and some features which need to be implemented. One process step does not execute as it should. A new version will be available by November 2008 and used in workshops in December 2008.

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