A Survey on Risk-management and Tooling Support for Procurement Processes in Supply Chains

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Abstract: Managing risks in supply chains is challenging for most companies given that the globalisation process is strengthening production constraints and also introducing more procurements risks. This is difficult for smaller companies in particular as they lack the resources necessary to develop specific expertise or buy expensive tools. Our research aims to address these issues by proposing an easy to use, yet powerful, tool-supported methodology. As a first step, we conducted a survey of the relevant industries, which were mostly based in Germany and Belgium. The goal of the survey was to assess the current state of risk management practices and identify the associated requirements specific to our SME target. This paper presents the outcomes of our survey based on the results collected from a representative sample of 70 participating companies. These results yield interesting observations regarding the characterisation of the people in charge of risk management, their perception of the importance of risk categories, the current ways to manage these risks and the tooling used. We also collected several recommendations for how tools could better support risk assessment and drive the rest of our research.

1 INTRODUCTION

Supply chain risk management (SCRM) is the implementation of strategies in order to manage both everyday and exceptional risks throughout the supply chain. This will be achieved by continuously carrying out risk assessments with the objective being to reduce the number of vulnerabilities, thus ensuring continuity (Wieland and Wallenburg, 2012). Such risks can occur for several reasons, both externally (procurement risks of geographic, political, social nature, etc.) and internally (machine reliability, nature of specific operations, etc.). The Risk management (RM) is performed by either qualitative or quantitative models (Printz et al., 2015). In terms of legal requirements and reporting issues, quantitative risk models are used. An accepted standard of quantitative risk management is the Value at Risk (VaR) standard combined with the Monte Carlo Simulation, which are then adapted according to their application (McNeil et al., 2005)

Helping company managers make the right decisions in the face of risks is not an easy task. Small and medium enterprises (SMEs) are particularly challenged because they have limited resources to devote to this task, despite the fact that failing to address such risks could dramatically affect their business. The ultimate goal of our research is to produce a user-friendly, tool-supported methodology that will guide the user through the whole process of risk assessment, as shown in Figure 1.

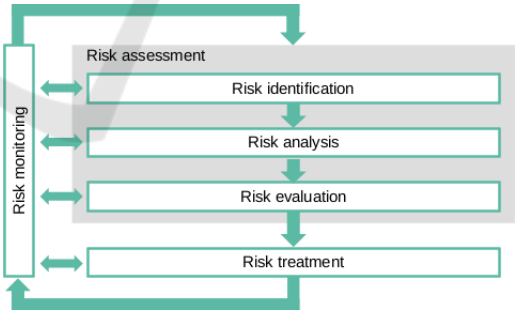

Figure 1: Risk management process according (ISO, 2009).

Initially, it was important to fully characterise

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the current practices of SMEs with respect to supply chain risks:

- What are the risks perceived by companies ?
- How do they rank them in terms of importance, taking into account both likelihood and impact ?
- How do they manage such risks in terms of people and tools ?
- What do they require of methods and tools in order to integrate them into their business?

The paper is structured as follows: section 2 provides an overview regarding risk classification and risk management methods, Section 3 presents the survey process, Section 4 provides an overview of the main characteristics of the participating companies, Section 5 considers specific procurement aspects, Section 6 describes risk perception, Section 7 looks at the current tools and collects the requirements necessary for better tool support. Finally section 8 concludes with an answer to the identified SMEs needs.

2 LITERATURE REVIEW

According to ISO 31000, risk is defined as the impact on uncertainty to objectives (ISO, 2009). The objectives to be assessed are, for instance, strategic, organisational, and related to projects, products or processes. However, Heckmann pointed out that there is no common definition of SCRM (Heckmann et al., 2015). This literature review provides an overview of several classes of risks. In order to reduce complexity, an aggregation of three risk classes was performed, which considers the transportation and warehouse risks in the context of manufacturing. *Quantity risks* are related to how a lack or excess of materials (from raw materials to produces) can affect the manufacturing process. *Quality risks* are related to the good or bad conditioning of materials as well as the respect of specifications for internal quality. Finally, *Delay risks* concern the time aspects, especially for the supplying of materials, the processing time and the transport from/to warehouses. Those classes are shown in Table 1, and they are widely reported in the literature (Blackhurst et al., 2008; Chopra and Sodhi, 2004; Mangla et al., 2015; Manuj and Mentzer, 2008; Oke and Gopalakrishnan, 2009; Punniyamoorthy et al., 2013; Sodhi and Lee, 2007; Sodhi and Tang, 2012; Thun and Hoenig, 2011).

The quantitative assessment of supply chain risks is evaluated using the probability of risk and its expected impact. For instance, Ziegenbein extended the approach to the number of suppliers and interruption time. However, this approach is a mathematical model. There is no connection to the process and value added chain (Ziegenbein, 2006).

Table 1: Risk classification.

Risk class	Definition	Root cause
Quantity	risks leading to deviations in the disposed quantity	insolvency, storage, order cycle, sourcing strategy, supplier, order strategy
Quality	risks regarding the quality of supplied goods	processing, sourcing strategy, supplier, logistics
Delay	risks causing unscheduled deviations	processing, logistics, delivery time, transportation capacity, number of brokers / transfer points

3 SURVEY PROCESS

The survey was carried out between October 2014 and mid-2015. It was based on a trilingual form (French, German, English) that was distributed to companies in Wallonia and Germany via different communication channels, such as dedicated mailing lists and social networks. The geographical factors were determined by the collaborative SimQRi project, which involved different industrial partners and focused on risk assessment (Printz et al., 2014).

The survey was composed of about 40 questions in total and had different sections: one to understand the company size and business, one to understand the importance of the procurement process, another to identify the current way in which risks are managed, and finally one to determine the requirements necessary for better tool support. Figure 2 illustrates a typical question, designed to be simple to understand and answer. The indicative time needed to answer the survey is about 15 minutes. The survey was available through a dedicated website for surveys.

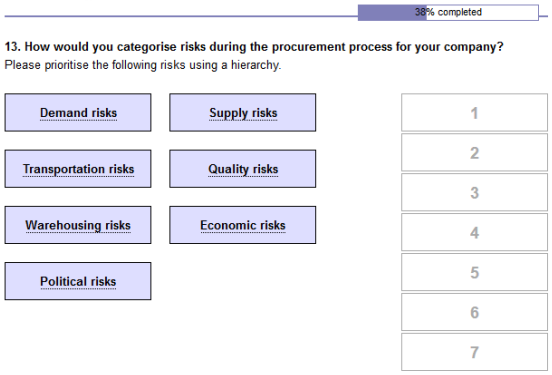

Figure 2: Example of question.

4 CHARACTERISATION OF PARTICIPATING COMPANIES

Around 70 companies answered the invitation and despite their answers being anonymous, we were able to record the contact data of the companies interested in following the project and wanting to get more involved in the process through a user committee. The initial user committee was also the first target group used to fine-tune the survey before it was released to a wider audience. The average age of the participants was 44.84 years, 9 were female and 61 male. The average number of years of professional experience in the sector of risk management was 15.12.

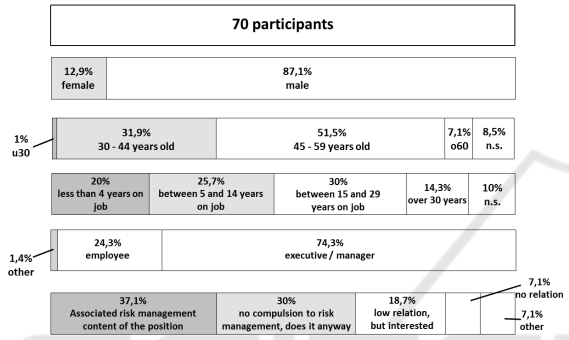

Figure 3: Main characteristics of participating companies.

A global overview of the whole sample is depicted in Figure 3. The number of participating companies was balanced between Belgium and Germany (given the size of the activity sectors in both countries). A great variety of manufacturing industrial sectors were covered, with no predominance of any specific sector. The majority of the companies were medium-sized (between 50 and 250 employees), though Walloon companies tended to be smaller, which corresponds well to their economic make-up. About one third (26 participants) had a position associated with risk management, 21 participants are not compelled to carry

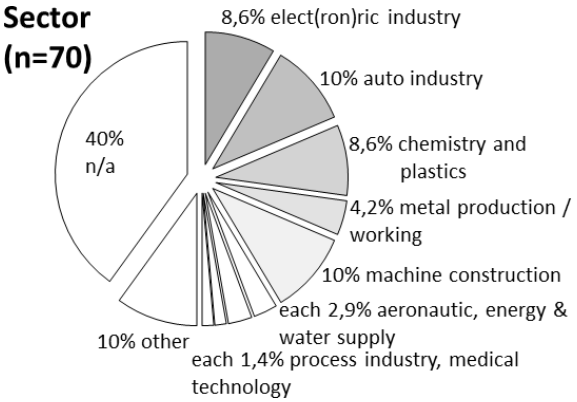

Figure 4: Sectors represented in the survey.

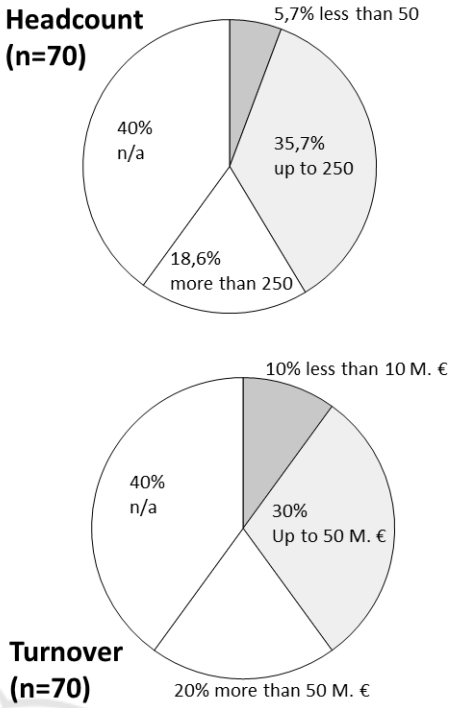

Figure 5: Size and turnover of the participating companies.

out risk management but do so anyway, 13 participants have a little experience with risk management but are interested, and 5 participants have no experience with risk management at all.

The main sectors of activities are shown in Figure 4. The automotive industry (10%) and machine construction (10%) are leading, followed by electric/electronic industry (8,6%), chemistry/plastics (8,6%) and the metal production/working (4,2%). Other sectors are less represented. Over 58 of the companies participating are located in Germany, five in Belgium, one in the Netherlands, and three are from other countries in the European Union (EU). Three other companies are located outside of the EU. Globally this is consistent with the survey area and relative importance of the sectors within that area.

The size and turnover results present quite a similar profile, as shown in Figure 5. Less than four companies have fewer than 50 employees (”small” size), 25 companies have up to 250 employees (”medium” size) and 13 companies are over 250 employees.

Finally, in regards to procurement risks more specifically, for the most part the participating companies were manufacturers of final products (60% of answers), however there was also a significant number of part assembly companies (25%), as well part suppliers (15%), though to a lesser extent. With respect to the number of suppliers for each company, Figure 6 shows the average of suppliers is quite high. Inter-

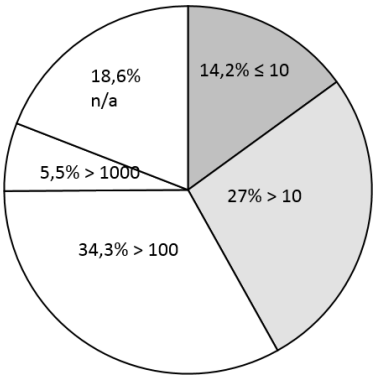

Figure 6: Distribution of the number of suppliers.

estingly, there were as many companies present with fewer than 100 suppliers, as companies with more than 100 suppliers. This calls for methods and tools able to manage an important supplier base.

5 RISK MANAGEMENT

Asked where risk management takes place in the company, 31 participants named the ”executive board”, 18 participants ”supply chain management”, and 5 participants ”logistics”. Whilst 5 participants chose ”other sections”, 10 did not specify at all. Half of the participants do not prioritise risks, 57% do not even have a system for the categorisation of risks, all of which is depicted Figure 7.

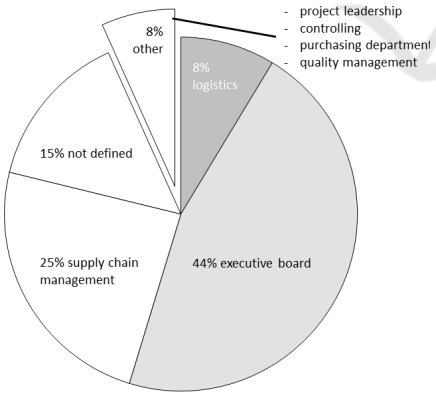

Figure 7: Function in charge of risk management.

To set up a priority hierarchy of risks relevant to global manufacturing processes, we asked the companies to rank their top 3 risks. Figure 8 shows quality risks (products that cannot fulfil quality requirements), supply risks (constraints on the volume and the delays required by the clients), and risks related demands (which are directly related to procurement).

Considering procurement processes (before manufacturing) more specifically, Figure 9 shows a simi-

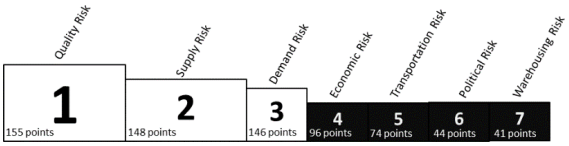

Figure 8: Risk prioritisation in global process.

lar top 3 risks, with procurement risks logically ranking first. Other risks that intervene, though to a lesser extent, are economical risks (e.g. bankruptcy of a supplier), political risks (related to the political situation of a country or region), transport risks (possibility of losses or delays in conveyance) and storage risks (losses or stocking degradation).

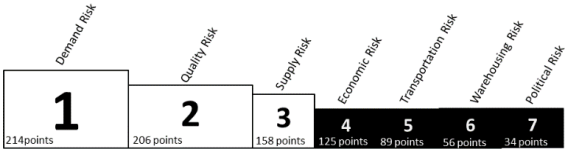

Figure 9: Risk prioritisation for procurement process.

6 EXISTING AND DESIRED TOOLS

The survey reveals that the majority of SMEs do not have any kind of risk management tool or, more precisely, that they rely on standard office tools, like spreadsheets. Barely 10% of companies have dedicated tools for risk management.

Regarding the risks that require more support, Figure 10 shows the same top 3 as those identified in the previous section, which is quite consistent with the importance of those risks. Over 50% chose quality risk and demand risk, while over 80% do not see the benefit in receiving support in assessing political and warehousing risks.

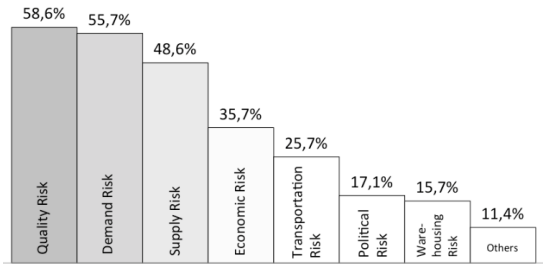

Figure 10: Tool support by risk categories.

A more detailed correlation analysis (Pearson r) was carried out in order to check the significance levels (p) of the SME’s characteristics on the current tools used and in order to identify areas that need bet-

ter tooling. The number of answers (N) is given after each item.

- The support of assessing and simulating external effects and risks (Pearson r=0.429**) is very important (p=0.007) according to the position in the supply chain (N=38).
- The importance and impact of warehouse risks (Pearson r=0.328**) is significantly correlated (p=0.005) to the risk management (N=70).
- The professional experience is correlated (Pearson r=0.766*) significantly (p=0.045) with less expenditure regarding software usability (N=7).

In addition to the survey questions, companies could provide further requirements through comments or via their involvement in the user committee. The requirements were sorted according to software engineering criteria (Sommerville, 2011). First, the functional requirements were evaluated (table 2).

Table 2: Functional requirements.

Recorded risks	Usability	Supported methods
Internal and external (Suppliers)	Clear interface	quantitative and qualitative
Status production line (machine downtime)	Indication and Correction of input errors	Decision support
Material accounting	Partially-automated analysis	Scenario analysis
Failure according production volume	prioritisation of risks	Definition of Key Performance Indicators

Summarising the functional requirements, the user wishes for a tool to support risk management activities. The tool should provide qualitative and quantitative RM approaches and recommendations for risk treatment. The input time interval should be as short as possible and very simple. With regards to an industrial application of the tool we gathered non-functional requirements as well (see table 3).

Table 3: Non-Functional requirements.

Integration	Others
rapid alert system	Confidentiality (protect company data)
Solution Center (AV, Prod, technology)	Collaboration (sharing analysis)
Traceability of measures (initiation and pursuance)	Partially-automated analysis
Interface supplier ratios (SAP, Oracle)	Prioritisation of risks

Non-functional requirements are summarised in Table 3. They do not need to be fully integrated into the tool in the short term, but they will help create an efficient and standard application method for industry.

7 CONCLUSIONS AND NEXT STEPS

Based on this enquiry and its recommendations, the SimQRi project is currently developing a tool prototype, which will allow for assessments to be made of the impact of different risks. The next steps should provide the following functionalities:

- A simplified model of procurement and manufacturing processes that is based on a web-graphical editor. This interface should be designed with usability and ease of installation in mind and it will fully operate in ”Software as a Service” mode. This will support collaborative work, however it could result in some threats and barriers occurring as a result of confidentiality requirements. In order to address the needs of more advanced users and their confidentiality, a desktop-based interface relying on Eclipse has been planned as a second phase.
- An efficient discrete-event simulation based on Monte Carlo methods with the inference of probability distributions for different types of risks. This work is relying on the OscaR library (OscaR, 2012). A version of the simulation engine has already been produced and benchmarked on small scale examples (De Landtsheer et al., 2016).
- Support for the risk analysis process, starting with risk identification, and also the elaboration of a risk-oriented model that can be simulated using the Monte-Carlo simulation. During the simulation, specific probes are used to compute risk related queries into the model in a statistical way. The simulation results can be analysed in direct relation to the risks, all of which is presented on a dashboard. The effects of specific measures can then be considered and simulated again in order to control the significant risks.

The current prototype is depicted in Figure 11. Its interface is structured across different tabs, which clearly show the risk management process: edition, risk identification, simulation and analysis.

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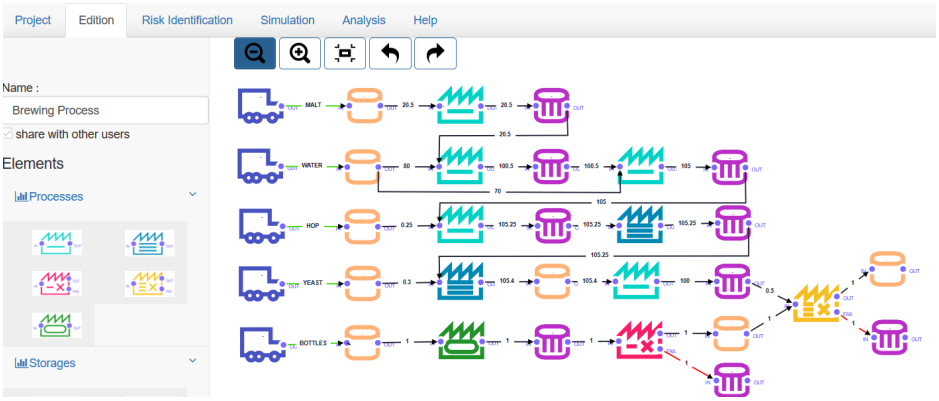

Figure 11: Current prototype.

REFERENCES

Blackhurst, J. V., Scheibe, K. P., and Johnson, D. J. (2008). Supplier risk assessment and monitoring for the automotive industrynull. *Int. Journal of Physical Distribution & Logistics Management*, 38(2):143–165.

Chopra, S. and Sodhi, M. S. (2004). Managing Risk To Avoid Supply-Chain Breakdown - By understanding the variety and interconnectedness of supply-chain risks, managers can tailor balanced, effective risk-reduction strategies for their companies. *MIT Sloan management review.*, 46(1):53.

De Landtsheer, R., Ospina, G., Massonet, P., Ponsard, C., Printz, S., Härtel, L., and von Cube, J. P. (2016). A Discrete Event Simulation Approach for Quantifying Risks in Manufacturing Processes. In *International Conference on Operations Research and Enterprise Systems (ICORES16), Rome*.

Heckmann, I., Comes, T., and Nickel, S. (2015). A critical review on supply chain risk Definition, measure and modeling. *Omega*, 52:119–132.

ISO (2009). DIN ISO 31000 : Risk management - Risk Assessment Techniques.

Mangla, S. K., Kumar, P., and Barua, M. K. (2015). Prioritizing the responses to manage risks in green supply chain: An Indian plastic manufacturer perspective. *Sustainable Production and Consumption*, 1:67–86.

Manuj, I. and Mentzer, J. T. (2008). Global supply chain risk management strategies. *International Journal of Physical Distribution & Logistics Management*, 38(3):192–223.

McNeil, A. J., Frey, R., and Embrechts, P. (2005). *Quantitative risk management: concepts, techniques and tools*. Princeton series in finance. Univ. Press, Princeton, NJ.

Oke, A. and Gopalakrishnan, M. (2009). Managing disruptions in supply chains: A case study of a retail supply chain. *International Journal of Production Economics*, 118(1):168–174.

OscaR (2012). OscaR: Scala in OR. https://bitbucket.org/oscarlib/oscar.

Printz, S., von Cube, J. P., and Massonet, P. (2014). SimQRi - Simulative quantification of procurement induced risk consequences and treatment impact in complex process chains. http://www.simqri.com.

Printz, S., von Cube, J. P., Vossen, R., Schmitt, R., and Jeschke, S. (2015). Ein kybernetisches modell beschaffungsinduzierter störgößen. In *Exploring Cybernetics - Kybernetik im interdisziplinren Diskurs*. Springer Spektrum.

Punniyamoorthy, M., Thamaraiselvan, N., and Manikandan, L. (2013). Assessment of supply chain risk: scale development and validation. *Benchmarking: An International Journal*, 20(1):79–105.

Sodhi, M. S. and Lee, S. (2007). An analysis of sources of risk in the consumer electronics industry. *Journal of the Operational Research Society*, 58(11):1430–1439.

Sodhi, M. S. and Tang, C. S. (2012). *Managing Supply Chain Risk*, volume 172 of *International Series in Operations Research & Management Science*. Springer US, Boston, MA.

Sommerville, I. (2011). *Software engineering*. Pearson, Boston.

Thun, J.-H. and Hoenig, D. (2011). An empirical analysis of supply chain risk management in the German automotive industry. *International Journal of Production Economics*, 131(1):242–249.

Wieland, A. and Wallenburg, C. M. (2012). Dealing with supply chain risks: Linking risk management practices and strategies to performance. *International Journal of Physical Distribution & Logistics Management*, 42(10):887–905.

Ziegenbein, A. (2006). *Supply chain risk assessment: a quantitative approach.* ETH-Zentrum für Unternehmenswissenschaften, Zürich.