MASTER THESIS

ANALYSING AND IMPROVING RISK MANAGEMENT IN AN ENGINEER TO ORDER ENVIRONMENT

TU Delft

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Master Thesis

Huisman

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Analysing and improving risk management in an Engineer to Order environment

Master thesis

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Finishing the thesis means I am at the end of my master journey in Construction Management and Engineering at Delft University of Technology. In collaboration with the manufacturing company Huisman Equipment, with such a nice committee, I really enjoyed the whole adventure! The start was not easy, as previously I have some difficulties finding a graduation opportunity. Until I talked with Marcel Hertogh who is the chairman of my graduation committee later, I got contact with Erfan Hoseini, the first supervisor and involved in part of his risk management research. Afterwards, everything became clear and of course I met so many helpful people I would like to give my gratitude.

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Of course, I have to thank my family, my friends who keep supporting me as always. Another thing I want to mention is that during the period of graduation, as a magic lover, I am also making my own magic act which I considered as my graduation work in this field. I realized that the procedure is exactly the same. You have to start with an idea, find proper ways to achieve that and you need helpful people to guide you. Just two month before the graduation, I did this act in FISM World Championship of Magic and I even use risk management methods to manage my act, I make a “risk log” for this act which helps me to recognize the dangerous parts, mitigate them and prevent me from making mistakes on stage.

Zhipeng (Zippo) Guo

Delft, September 2018

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Summary

The research is aimed to apply project risk management method and the GRMM (Generic Risk Maturity Model) designed by Hoseini (2017) in an ETO (Engineer to Order) environment by using Huisman Equipment as a case study. Based on ABS (2000), four benefits of risk management are: identifying hazards and protecting against them; improving operations; efficient use of resources; developing and complying with rules and regulations. However, on the academic level, study of risk management in an ETO environment is still nascent (Gosling and M. 2009). On the practical level, even though many organizations such as Huisman Equipment, an ETO company understands the importance and benefits of risk management, it is not well implemented in the organization and leaves areas for improvement. Therefore, the main research question of this research is:

How does an Engineering to Order company perform risk management and what are the areas of improvements?

Corresponding sub research questions are:

1. What are the risk management steps for ETO companies based on the literature?
2. How does an ETO company perform risk management in practice?
3. What are the identified improvement areas regarding risk management in the ETO environment?

The first step was to conduct a literature research about ETO and risk management. ETO is defined by Pandit and Zhu (2007) as "*a type of manufacturing process for highly customized products which are required to be designed and engineered in detail as per the specifications in the order placed by customers*." Its main characteristics are low volume, high demand vibrations, custom-made, long lead times, high capital investment and involving various engineering disciplines. Then four commonly used project risk management standards/guidelines together with four supply chain risk management documents were studied and answered the first sub research question with a six-step risk management process:

- Risk management plan – Define the main activities of risk management and depending on the characteristic of project, make guidelines for the team and arrange resources.
- Risk identification – Document possible threat and opportunity of the project and serve as input for next steps.
- Risk analysis – Conduct qualitative analysis to prioritize risks and decide if quantitative analysis is required.
- Risk response plan – Develop actions on certain risks, for a threat, normally it can be avoided, transferred, mitigated or accepted; for an opportunity, it can be exploited, enhanced, shared or accepted.

- Monitor and control – Check the status of risks, and if new risks occur.
- Lessons learned – Evaluate the whole process, update related documents that can be shared across projects.

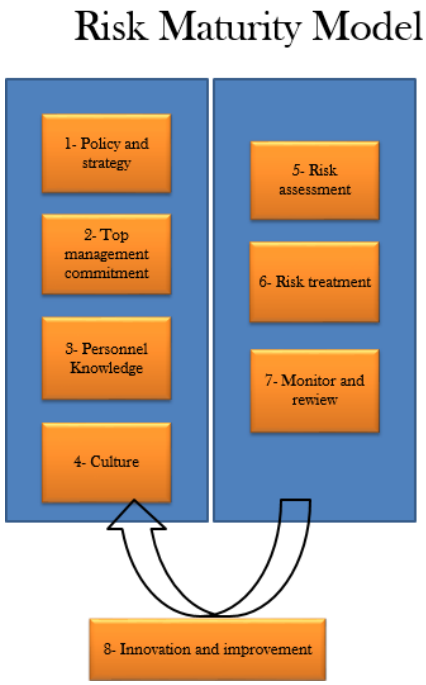

Figure 1 The Generic Risk Maturity Model (GRMM)

After the literature study, the GRMM (see *Figure 1*, further explanation is presented in chapter 1.2) was applied at Huisman Equipment. In total, 23 interviews were done, including 3 pilot interviews to test the applicability of the model in the organization. It turned out that only little adjustments of statements from the GRMM are needed. Nevertheless, due to the innovative characteristic of the company, an adjustment of the original model was the separation of risk into “threat” and “opportunity” so that the users have to think whether they perform better in threat or opportunity side of risks regarding each statement, to make distinctions. Furthermore, 20 representatives of the firm were interviewed. For the individual interview, first a brief introduction of this research and the GRMM was given. Then the respondent started to fill the GRMM, interviewer was present only to give explanations for some terminologies. After the model was fulfilled, questions were asked depending on how they score the statements in the GRMM. The conversation was recorded for transcription and analysis. In the end, two out of the 20 interviewees had not fill the model. Besides, the score from one interviewee was too high comparing with others due to highlighting safety risks which is mentioned in chapter 6.3.3 Recommendations for future research. So finally, 17 results left which were analysed in the following part for answering the second sub research question.

Outcome based on the GRMM shows that overall, the company is currently in a low risk maturity level while the engineering department has a relatively higher maturity level comparing with other departments. On average, there is no significant difference in managing threats and opportunities. As an

innovative company, it was assumed that Huisman Equipment performs better in the opportunity management. For the operation group, it turned out that respondents gave higher scores on opportunities, but for the management and top-management group, threats are higher scored. The reason can be as mentioned by some interviewees in the management group that people in the operation group such as engineers, are intelligent who want challenges but for managers, they want to make sure the work is done with less threats. So that on an organizational level including all groups, there is no distinction between the current situation in managing threats and opportunities. When talking about high ambition score and relatively low score for current situation, it indicates plenty of space for enhancement. Management and top-management group are more positive and have higher ambition than the operation group. Even though the difference is not obvious, it can be seen that threat got higher score for ambition in almost every aspects, which also applied to the majority of respondents who agreed to start with managing the negative side of risks.

As the GRMM was originally designed for the construction industry, the result from Heijmans was compared with the outcome in Huisman Equipment which shows that Heijmans is more mature in risk management. Even though it seems that Heijmans perform risk management much better, both of them share some similar problems:

1) Goals and strategies of risk management from (top) management are not clear. An explanation can be that (top) management commits to them but people have not recognized or be informed properly.
2) Maturity level of risk management differs among roles or even within the project team/same department.
3) Lack of risk awareness, there are people not (actively) involved and the experience of risk management need to be improved.
4) Independent risk department or coordinator is needed, even there are risk managers in Heijmans, people still complained there should be people proactive in making sure everyone is aware of risk and leading risk management.
5) Transformation from sales/tender phase to project execution, risk information gets lost or it is not uniformed.
6) Different maturity level between management and operation group. In Huisman Equipment, operation group lack of awareness and guidance while in Heijmans, the performance quality of risk management is not satisfied.
7) Lack of responsibility, in Huisman Equipment, there is no people responsible to follow up risk management process and in Heijmans, less ownership has negative influence on the risk management quality.

After the analysis of results from all the individual interviews, an expert session was held for validating results and receiving inputs from the experts. Regarding the session, based on analysis of all the individual interviews and discussion with one of the experts, three statements from the GRMM were chosen and adjusted which used as input for the session:

1) Management communicates goals and strategies of risk management;
2) Define control measures to treat risks (reduce, avoid, transfer, accept etc.);
3) Properly manage risks from sub-contractors and suppliers.

Value Proposition Canvas, originally made to transfer customers' needs into products or services (Osterwalder, Pigneur et al. 2014) was used in the session which is explained in chapter 2.3.5. One advantage of the method is that it can give comprehensive solutions from both the positive (gains) and negative (pains) outcome of the input. Moreover, it has been used in Huisman Equipment for several brainstorming sessions. The seven experts gave their individual solutions which can be concluded as:

1) "Process" is the focus – "Set up a uniform, clear, followed up process, start from sales through execution till service, used regularly with lessons learned and based on (top) management governance";
2) "Tooling" is important to the process – "Establish accessible reporting tool with the support of a central database";
3) "Awareness" is lacking – "Demonstrate the benefits of managing risks, compliment actions such as addressing risks";
4) An independent "risk coordinator" or "risk department" is suggested – "Appoint a risk coordinator, he or she can assign risk to its owners, make sure it will be solved, managed or accepted by someone";
5) Managing "external parties" – "Make supplier/sub-contractor evaluation mandatory, enhance involvement of key external parties as well as relation management".

Then the experts were divided into three groups and make their own advice which can be concluded into three phases:

1) Appoint a responsible risk coordinator or have an independent risk department. At the same time, strengthen the supply chain coordinator to better manage suppliers and subcontractors;
2) Make advanced tooling, database, encourage everyone to report potential risks will increase the overall risk awareness;
3) Establish a solid risk management process based on the first two steps.

Advice given by individuals and groups of experts answered the third sub research question. The overall answer to the main research question is listed:

From the literature, a six-step risk management process is suggested for the ETO environment (risk management plan, risk identification, risk analysis, risk response plan, monitor and control, lessons learned). In practice, the ETO company that used as the case is not mature in risk management but the engineering department is more mature comparing with other departments. Besides, even though they cannot manage threats properly, flexible approach is used to manage opportunities. The main areas for improvements are process, tooling, risk awareness, independent risk coordinator/department and managing the external parties.

After finishing the research, three limitations are recognized:

1) The main limitation is that only one ETO company Huisman Equipment is studied. There are other ETO companies that come from another industry which probably lead to different risk management performance;
2) Albeit 20 interviews were conducted, it was realised later that not all the roles are ideal to fill the GRMM so that the number of project manager and process analyst is not enough;
3) The comparison of threats and opportunities is not accurate as 10 out of the 17 people filled both the threat and opportunity part, 7 respondents only gave scores for threat.

Recommendations are given for the company, the GRMM as well as the future research.

Apart from the recommendations from experts in the firm, three other recommendations are listed for Huisman Equipment:

1) Focus on threats prior to opportunities, as interviewees have more ambition on that and also literature supports a flexible way to manage opportunity which is already been done in the organization;
2) Even though managing external parties is an issue, it is suggested to start internally as it is observed that internal people are not active in these meetings.
3) Start from risk identification, make sure everyone is responsible for reporting a potential risk. Then comes the analysis, control and review of risk.

For the GRMM, two recommendations are given:

1) Using “1, 2, 3, 4” instead of “1, 4, 7, 10” when scoring the statements, to speed up the process. As during the interview, people questioned about the reason behind and an algorithm can be added in the model to magnify the final result.
2) Use the words “threat/opportunity” in the statements instead of “risk” as from the literature, “risk” encourages interviewees to think of negative consequences.

For future research, from the view of the research scope, there are two recommendations:

1) Distinguish “process risk” with “safety risk” as safety is the first priority, “risk” in the research should be more process related risk.
2) A meeting including broad members to discuss how to implement the conclusion of the research on a strategic level.

From a broader perspective, two more recommendations are followed:

1) Apply the model in other ETO companies, to make comparisons and see the similarities and differences.
2) Since the result from Huisman Equipment (low risk maturity level) and Heijmans (high risk maturity level) showed common problems regarding risk management, it is interesting to see if those problems exist in most of the organizations. Then future research can be carried on to figure out the reason behind and how to solve them.

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1. Introduction

The AEC (Architecture, Engineering and Construction) industry is one of the most fundamental cornerstones of a country's economy. It involves various parties including designers, engineers, contractors, suppliers as well as other stakeholders working together on a project and includes phases of planning, engineering, building and operation etc. As pointed by Sawhney (1999), due to the adaptation of new project management methodologies, advanced technologies and generation of modern facilities, the AEC industry is developing rapidly.

The contemporary global market is known as high uncertain and turbulent, which tremendously fluctuates the demand and supply. As a result, supply chain in AEC industry is facing more and more challenges such as compressed lead time, complex global stakeholders networking, shorter lifetime of product and technology development etc. (Christopher 2002). Increasingly developed technology, globalization, fierce competitions are all factors making the supply chain in AEC (Architecture, Engineering and Construction) industry exposed to higher risks than ever before (Christopher and Holweg 2017). A survey according to MMC (2005) already revealed that in a sample with 950 European enterprises with a turnover ranging from 30 to 300 million Euros, half of them admitted that they cannot manage the "most significant risks". It is imaginable that at this moment, more enterprises are suffering from managing risks which result in losing money.

In the introduction, background information about the market, ETO (Engineer to Order, one of the supply chain structures) and the GRMM (Generic Risk Maturity Model) designed by Hoseini (2017) further used in the research are introduced. Then this report will be continued firstly by performing literature studies on "engineer to order" and "risk management". A case study is followed and risk management practice in the ETO environment will be learned by utilizing the GRMM through semi structured interviews. After analysing the results, an expert session is going to be held to validate the outcome of the case and help to get solutions to improve the current situation regarding risk management. Finally, current risk maturity level of the case, its improvement areas, feedback of the model, some indications for scientific and practical world will be discussed and concluded.

1.1. Problem Statement

For many companies nowadays, mature in project management becomes one of the fundamental characteristics to achieve success and competitive advantage. As a vital part of project management, risk management is always integrated with project management approach. Organizations understand the importance of risk management, Chapman and Ward (1998) pointed out that risk management is part of the core process for the strategy in an organization. And as stated in ABS (2000), four benefits of risk management are listed: Identifying hazards and protecting against them; Improving operations; Efficient

use of Resources; Developing and complying with rules and regulations. However risk management is not often effectively implemented in these organizations. Additionally, the maturity level of risk management varies in different business lines, organizations and projects.

ETO companies design and manufacture complex products by understanding and translating customer requirements under a wide range of risks. The challenges those companies are facing including: a robust engineering process, high level of customer involvement during the whole process, confusions between company and the client, difficulty in predicting time and cost (mbaskool). However according to a literature review of ETO supply chain management (Gosling and Naim 2009), there is very limited literature regarding problems in an ETO environment. Since then, research on ETO is still very limited let alone ETO risk management.

There are two approaches for learning risk management in an ETO environment. Firstly, products in ETO companies can be considered as projects as they fit the definition of the project "*A project is a temporary endeavour undertaken to create a unique product, service, or result*." (Project Management Institute 2013), which are made in a manufacturing environment (Yang 2013). Besides, most firms in the ETO industry operate in a project environment. Hence, project risk management methods are suitable in an ETO environment. Secondly, ETO belongs to one of the supply chain structures which contain also make to order, make to stock, assemble to order etc. As risk management plays an important role in the operation of present supply chain under various uncertainties, supply chain risk management is studied by many (Ho, Zheng et al. 2015).

1.2. The Generic Risk Maturity Model

Despite the growing of risk maturity model in the literature, most of them are not able to identify the improvement areas of applying risk management (Hoseini 2017). The GRMM (Generic Risk Maturity Model) designed by Hoseini (2017) is a model used in this research that can help to measure the risk management maturity level within project or organization. Moreover, based on the results of the model, strong and weak areas of risk management are able to be identified and can be used as the start point for making improvements. As a result, the GRMM is chosen in this research.

Initially, the model divides risk management into two areas: the "organization area" and the "application and process area". For each area, three aspects are included. In the "organization area", there are "Policy and Strategy", "Top-management Commitment" and "Culture and Personnel Knowledge". As for the "application and process area", it contains "Risk Assessment", "Risk Treatment and Mitigation" together with "Monitor and Review". Furthermore, the aspects consist of several statements, 51 in total, which are

extracted from 12 best risk management practices, 13 risk maturity models as well as 5 lessons learned (Hoseini 2017).

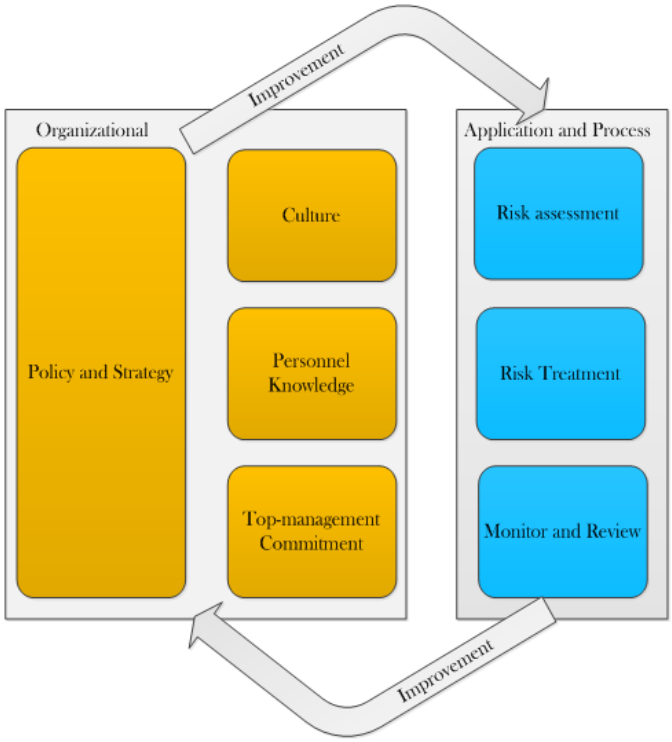


Figure 2 Areas and Aspects of the Generic Risk Maturity Model

For each statement, the user are asked to fill in three scores regarding "value", the current situation of the statement; "importance", how important the user think of the statement in the project or organization; "ambition", how much the user hope to be in the future. Besides, users can only score 1, 4, 7, 10, for instance "10" in "value" means the current situation in project or organization is exact as the statement, "7" in "importance" shows that the person finds the statement is important, "4" and "1" in "ambition" indicates the respondent wants limited application and no application of the statement in the future.

			Threat	
ID	Culture and Personnel Knowledge	Value	Importance	Ambition
1	The personnel's understand the necessity of risk management (risk management is not seen as an additional burden)	7	7	7
2	There is no blame culture and the organization accepts that people make mistakes	4	7	7
3	The personnel's have trust and openness in reporting risks	7	7	10
4	The organization is aware of his risk attitude*	4	7	10
5	The personnel receive training (if needed) to improve risk management skills	1	7	7
6	There is an experienced team/ person responsible for risk management	4	7	7
		Score	4.5	

Opportunity			
Value	Importance	Ambition	Indicator
4	7	7	
4	7	7	
4	7	10	
4	7	10	
1	7	7	
1	7	7	
Score	3.0		

*Risk attitude is the chosen response of an individual or group to uncertainty. Risk attitude can be: risk averse (avoiding risk), risk seeking, or risk neutral. The risk attitude has influnce on the decision making on risks.

Figure 3 Part of the model filled by one of the users

The formulas below are used for the calculation of average score for each aspect (Hoseini 2017):

$$N = \sum_{i=1}^{j} Importance_i \qquad \textit{(Equation 1)}$$

$$Total\ score = \sum_{i=1}^{j} Score_i \times \frac{importance_i}{N} \qquad \textit{(Equation 2)}$$

It is noticed that in *Figure 3*, risk is separated into “threat” and “opportunity”. As will be explained in the literature review, for this research, risk includes both the negative side (threat) and the positive side (opportunity). Originally, the GRMM use “risk” but from Ward and Chapman (2003), the wording “risk” encourages people to think of the negative consequences. Consequently in this research, an adjustment of the original model is the separation of risk into “threat” and “opportunity” so that the users have to think whether they perform better in threat or opportunity side of risks regarding each statement, to make distinctions.

2. Research design

Chapter 2 is about the design of this research. In section 2.1, research objective, main and sub research questions are given. Then in section 2.2, the scope of the research is introduced, and in section 2.3, methods that has been used in this research is discussed. Lastly the outline of the thesis is presented in section 2.4.

2.1. Research Objective and Research Question

As mentioned in the introduction, the topic of risk management has been studied by many but research respecting risk management in an ETO environment is still nascent (Gosling and Naim 2009). This thesis is intended to make contribution to this field.

The goal of this research is to implement project risk management method and apply the GRMM in an ETO environment by using Huisman Equipment as a case study to determine enhancement directions according to the company's characteristics. Additionally, to upgrade knowledge on risk management in an ETO environment and to apply, test the GRMM in practice. So the main research question is:

How does an Engineering to Order company perform risk management and what are the areas of improvements?

Based on the main research question and objectives, the corresponding sub research questions are listed as:

1. What are the risk management steps for ETO companies based on the literature?
2. How does an ETO company perform risk management in practice?
3. What are the identified improvement areas regarding risk management in the ETO environment?

2.2. Research Scope

This research focuses on risk management in ETO companies on the process level. Due to time limit, and to make sure the depth of this research, only the risk management practice in one ETO company will be studied. Huisman Equipment, a manufacturing company experienced in design and product heavy construction equipment is a typical ETO company. Moreover, as the company just implements risk management since 2016 and wants to know how to improve its risk management, it is taken as the representative of ETO companies.

In addition, as the GRMM had not been applied in an ETO company beforehand, the applicability of the model in such environment was tested. In another research, the GRMM was been used to investigate the

risk maturity of Heijmans, a construction company, the overall score of which is going to compare with the result of Huisman Equipment.

2.3. Research Approach

2.3.1. Literature study

Literature study is the first step to learn about the definition of risk, various risk management standards and guidelines, project risk management, supply chain risk management and the current status of the ETO industry. Further in discussion, related studied will also be used as arguments. Thus, literature study is one of the most important and basic approaches in this thesis and will go through the whole research procedure (Kumar 2011).

2.3.2. Single case study

Yin (2017) defined case study as "*an empirical inquiry, in which focus is on a contemporary phenomenon within its real life context & boundaries between phenomenon and its context are not clearly evident*." And according to Dul and Hak (2007), case study is used when there is not many literatures available and "*when the 'context' is very important*". In this research, there is no direct research about risk management in an ETO environment also the case itself is important for the research, so case study, in this thesis a single case study is used.

This method is questioned by some that "*one cannot generalize from a single case*" but an in-depth single case study is appropriate and valuable (Flyvbjerg 2006). Besides, due to the time limit and accessibility of the resources, mainly regarding the interviewees, single case study is the most feasible method.

2.3.3. Interview

Interview helps the researchers to get information via various interactions with people (Kumar 2011). Semi-structured interviews were carried out so that apart from the predefined questions, there are rooms for extra questions and the process can be adjusted depending on the circumstance with different interviewees.

2.3.3.1. Pilot interview

Since the GRMM is primitively designed for the construction industry, in order to see the applicability of the model in the manufacturing companies, three pilot interviews were conducted before the coming interviews that asking respondents to fill the model. The three interviewees were requested to check each statements and make modifications depending on the characteristic and situation of Huisman Equipment. What is more, some general questions related to risk management in the organization, recommended people for interview were asked.

2.3.3.2. Selection of interviewees

The organizational form of Huisman Equipment during the period of interview is a balanced matrix but more towards functional oriented as can be seen as (B) and (C) in *Figure 4*. As it is observed that project managers and discipline managers share the authority over resources such as personnel, finance etc. (Hobday 2000). People value their department more comparing with projects they are involved and mostly report directly to discipline managers.

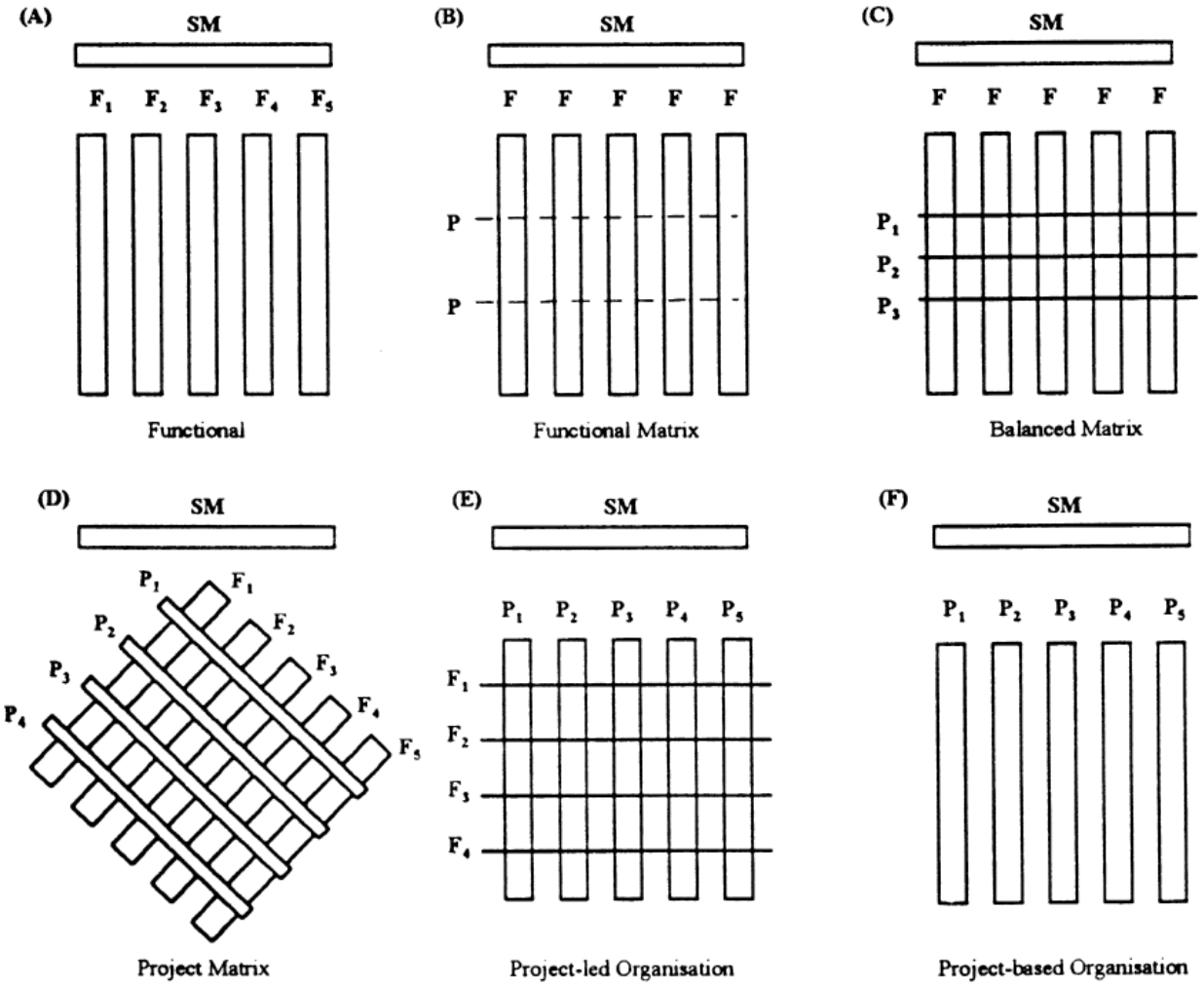


Figure 4 Ideal-type organizational forms (Hobday 2000)

So there are two starting points of selecting the interviewees: on one hand, including people throughout the process of a project, from design, supply chain, production, commissioning and testing to after sales; on the other hand, have people from different levels in the organization, top managers, project managers, directors in each discipline, operation people.

2.3.3.3. Transcription of interviews

The interviews were recorded after the approval of interviewees. By transcribing the recordings, the interview results were able to be better studied afterwards and transcriptions were used as input for analysis and discussion.

2.3.4. Cross case analysis

There are five types of comparison of the results of the GRMM.

1) Comparing the scores among different roles (engineering department, supply chain department, production department, C&T department and after sales department);
2) Comparing the scores among three groups (top-management, management and operation);
3) Comparing the overall result with Heijmans, a construction company;
4) Comparing the scores for threat and scores for opportunity;
5) Comparing the current situation and ambition.

Comparing among departments is needed as the company wants to know the risk maturity level for different roles. By comparing among management and operation, it can reveal to what extend the instructions are conducted. As the model was also used in Heijmans, a construction firm, it will indicate difference between the two industries. “Threat” and “opportunity” are compared as Huisman Equipment considers itself as an innovative company who is able to manage opportunities, not just deal with threats. The GRMM contains score for current situation and ambition which helps to see the area of improvements.

Through different cross case analysis, more detailed outcome can be gained, diverse results can be attained and similarities among the findings can be determined. Conclusion from one analysis is able to be checked from others.

2.3.5. Expert session (Value Proposition Canvas)

In order to validate the result from individual interviews and cross case analysis, experts from the company were invited. Moreover, the experts are capable to help answering the third sub research question which requires to identify the improvement areas. A method called Value Proposition Canvas is chosen to make use of their knowledge and experience.

Value Proposition Canvas is originally made to transfer customers’ needs into products or services (Osterwalder, Pigneur et al. 2014). One advantage of the method is that it can give comprehensive solutions from both the positive (gains) and negative (pains) outcome of the input. Moreover, it has been used in Huisman Equipment for several brainstorming sessions.

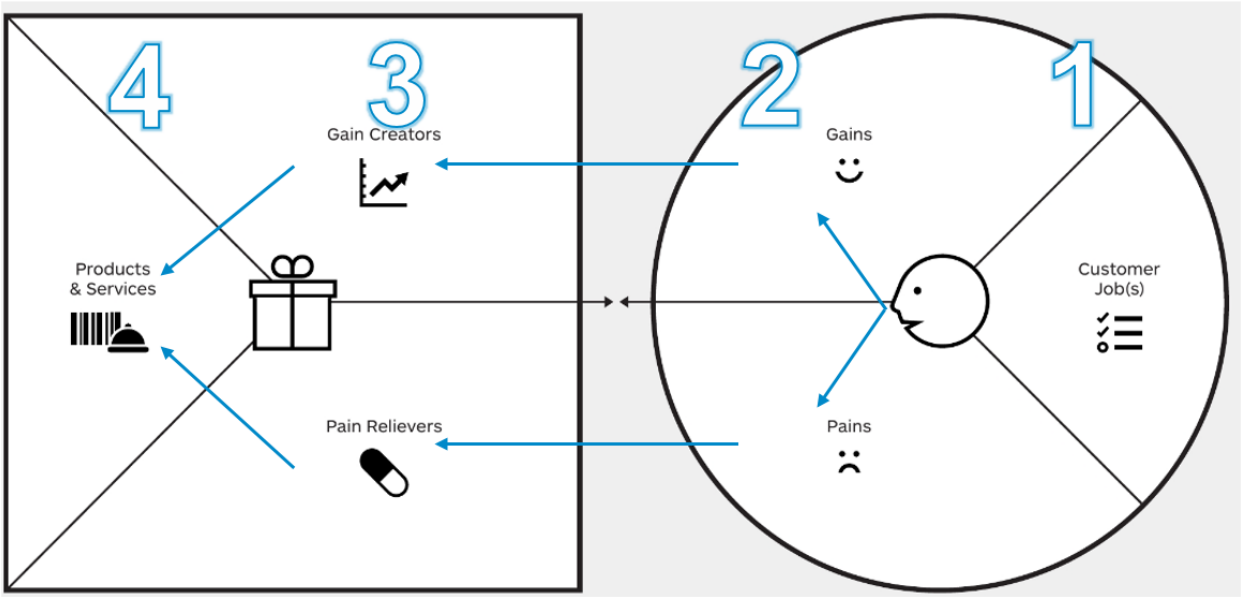


Figure 5 Value proposition canvas (Osterwalder, Pigneur et al. 2014)

From the figure above, this approach consists of 4 steps. The starting point will be conclusions summarized into several statements based on all the individual interviews. Possible gains and pains linked with the statements are presented after discussion with one of the experts and experts have to validate those pains and gains. For the third step, experts are asked to give solutions regarding each pain and gain individually. Finally, experts are divided into groups, discuss over all the solutions, reach to conclusion within groups then brainstorm and make agreements.

2.4. Research Outline

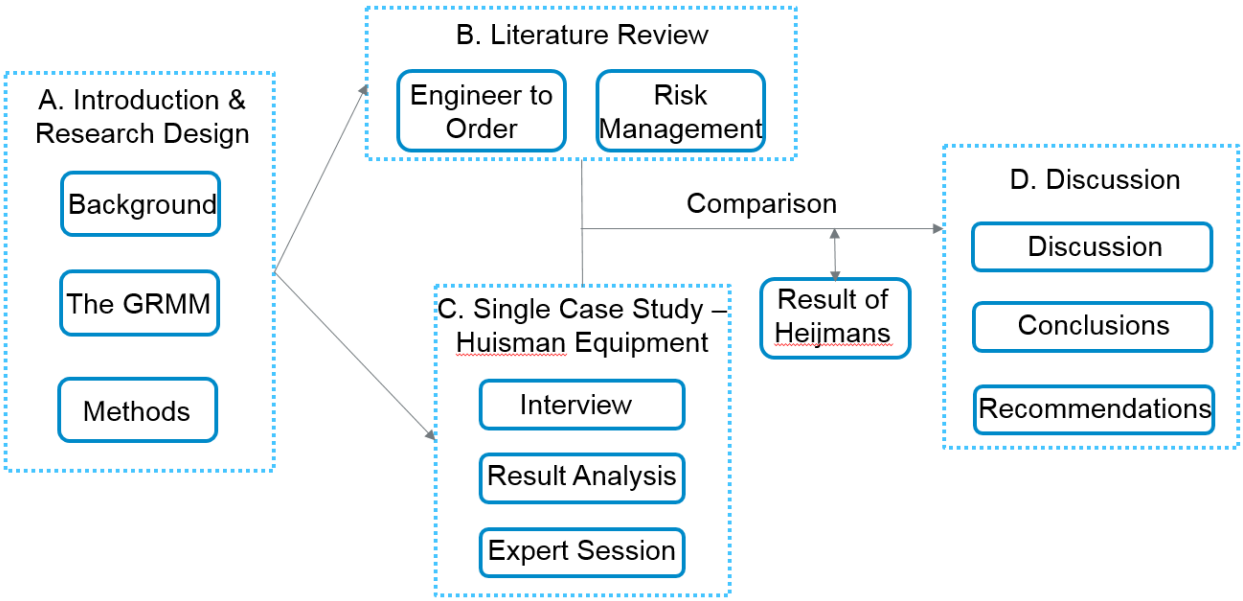


Figure 6 Research outline

Figure 6 describes the methodology of the thesis. Part A is the start which provides basic introduction, the GRMM and methods will be applied during the research. Then in part B, literature on the characteristics

of ETO, project and supply chain risk management are studied, to answer the first sub research question, "*What are the risk management steps for ETO companies based on the literature*". Huisman Equipment, the single case is studied in part C, including interviews with representatives of the company by applying the GRMM, analysis of the results to provide input for the second sub research question, "*How does an ETO company perform risk management in practice*". An expert session was held afterwards to solve the third sub research question, "*What are the identified improvement areas regarding risk management in the ETO environment*". Lastly in part D, results from the single case study is compared with the findings of the literature. Besides, the result from another research using also the GRMM is applied in the discussion followed by conclusions and recommendations.

3. Risk Management in an Engineer to Order Environment

The aim of the chapter is to answer the first sub research question, "*What are the risk management steps for ETO companies based on the literature*". First and foremost, the uniqueness of ETO is researched. Then, risk is learned from the perspective of ETO, supply chain and project. To know the risk management steps in an ETO environment, supply chain risk management and four widely used risk management guidelines/standards are studied.

3.1. An Engineer to Order Environment

3.1.1. Engineer to Order as a basic supply chain structure

The basic supply chain structure includes: ETO, modify to order, configure to order etc. Differences among these structures can be demonstrated by CODP (customer order decoupling point), the point within the value chain where production actions are triggered by customer orders. Products in the upstream of the CODP are driven by forecast while downstream are driven by customer orders (Olhager 2010). The relationship of CODP and the basic supply chain structures are displayed in *Figure 7*.

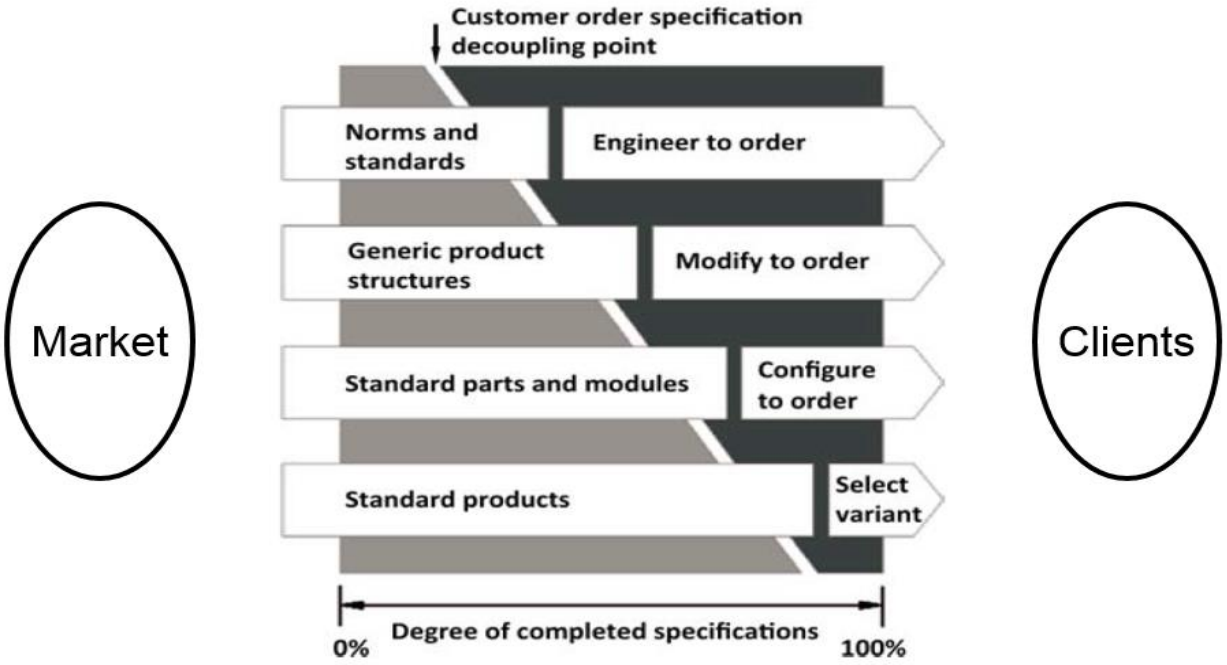


Figure 7 CODP in different supply chain structures modified from Segerstedt and Olofsson (2010)

At the point of CODP, product/system specification will be fixed. Nevertheless it's positioning is a bit tricky as interpreted by Powell, Strandhagen et al. (2014), on one hand, in order to lower lead times (the total preparation and execution time of manufacturing an item) it requires a shift of CODP to the right side closer to the end users; On the other, to be less dependent on forecast of market/customer demands and requirements which is risky, it is desired to move the CODP leftwards closer to the market. For ETO companies, customization is part of the strategy as only norms and standards are defined within the

portfolio which face much higher risks compared with other supply chain structures. However, there is very limited literature regarding problems in an ETO environment (Gosling and Naim 2009).

3.1.2. Characteristics of Engineer to Order

Traditional manufacturing consists of rubber, metal, food, petrochemicals etc. and Bresnen (1996) observes that researches in supply chain management have a tendency to focus on particular industries e.g. automotive industry characterized with large-volume and standardized. Contrary to the industries mentioned above, Engineer to Order manufacturer offers varieties of unique products and ETO is defined by Pandit and Zhu (2007) as "a type of manufacturing process for highly customized products which are required to be designed and engineered in detail as per the specifications in the order placed by customers."

The paper from Hicks, McGovern et al. (2000) provides three general business processes in an ETO environment, 1. Marketing, which means analyse the market trends, potential customers and capacity of the company. 2. Responding an invitation to tender, in which conceptual design, understanding and translation of customer needs, overall lead time and cost are needed. 3. Post awarded contract, where detailed project plan and design are developed, procurement with suppliers, subcontractors and physical steps are followed.

By understanding specific customer demands, ETO companies translate them into several components and create value when integrating those components into products or systems (McGovern, Hicks et al. 1999). Despite the main characteristics of ETO, which involve low volume, high demand vibrations, custom-made, long lead times, high capital investment and involving various engineering disciplines, Mello, Gosling et al. (2017) forward another perspective. It is demonstrated in figure 7 that split an ETO product into ETO parts and MAM parts. ETO parts stand for components specifically designed and manufactured for customers. MAM parts are the collection of all the MTO (Make to Order), ATO (Assemble to Order) and MTS (Make to Stock) components. As a result, only parts of a product are guided under real ETO control. Moreover Bertrand and Muntslag (1993) give three characteristics of ETO control: dynamics, uncertainty and complexity.

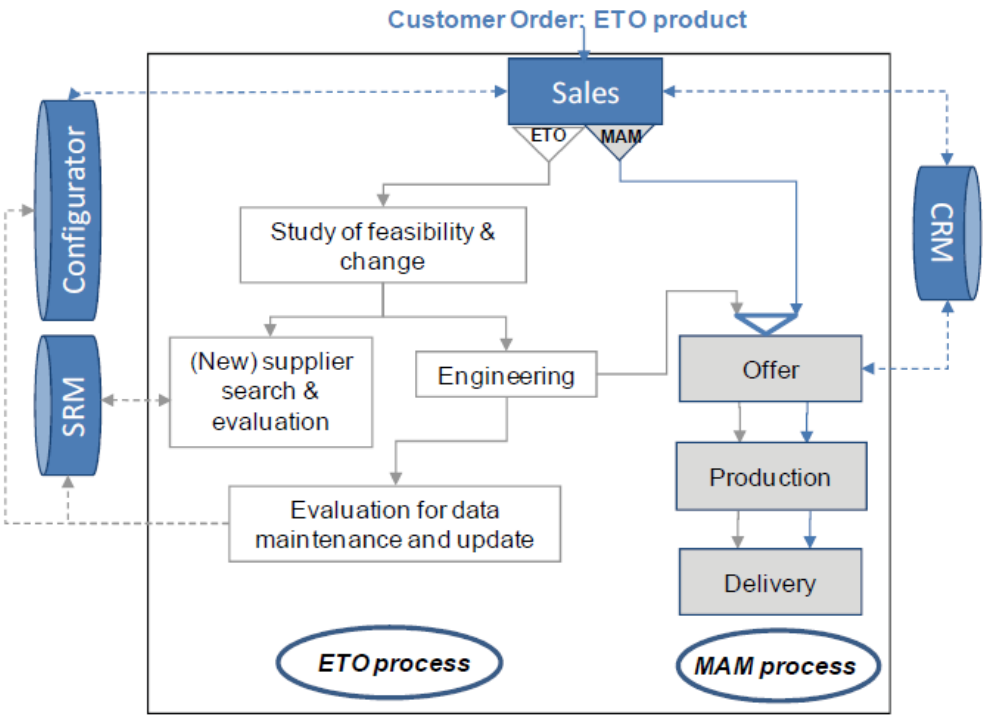


Figure 8 ETO & MAM process in an ETO environment (Amrani, Zouggar et al. 2010)

So main characteristics of ETO can be concluded as low volume, high demand vibrations, custom-made, long lead times, high capital investment and involving various engineering disciplines.

3.2. Risk in Engineer to Order

Few literatures mentioned risks in ETO, Amrani, Zouggar et al. (2010) gave two types of risks in an ETO environment: 1) product risks, related to the successful delivery of products. 2) network risks, which are the uncertainties in searching, selecting, evaluating and interacting with stakeholders. Adrodegari, Bacchetti et al. (2015) listed three risks for machinery-building ETO companies: 1) contractual risk, basically there are two possibilities, tendering means higher risks as time/cost will be lowered while partnering reduces risks; 2) sharing knowledge, risks from competitors offering similar products; 3) capacity utilization, regarding engineering/manufacturing ability.

Therefore, direct sources of ETO risk are too limited. As suggested in the introduction, from one point of view, ETO is a special type of supply chain, from another, ETO products can be seen as projects. Then supply chain risks and project risks are able to be referred to in the next sections.

3.2.1. Project risk

In the project viewpoint, Sanchez-Cazorla, Luque et al. (2016) proposed nine risk categories especially for complex and mega projects out of over 80 articles: design risks, legal/political risks, contractual risks, construction risks, operation and maintenance risks, labour risks, customer/user/society risks, financial/economic risks and force majeure risks. Likewise, Murray, Grantham et al. (2011) identifies 9

project risks: technological and operational risks, financial and economic risks, procurement and contractual risks, political risks, environmental risks, social risks, regulatory and legal risks, safety risks and delay risks. In PRINCE 2,Bentley (2010) classify project risks into: strategic/commercial risks, economic/financial/market risks, legal and regulatory risks, organizational/human/management risks, political risks, environment risks and technical/infrastructure/operational risks.

It can be seen that categorization of project risks covers the whole process within a project from strategy, plan, to execution, operation and maintenance.

3.2.2. Supply chain risk

Supply chain risk is defined by Zsidisin (2003) as "the potential occurrence of an incident associated with inbound supply from individual supplier failures or the supply market, in which the outcomes result in the inability of the purchasing firm to meet customer demand or cause threats to customer life and safety". According to Harland, Brenchley et al. (2003) many studies regarding SCRM focus on purchasing and supply risk e.g. outsourcing, purchasing strategy, buyer/seller behaviour, however they don't extend the standpoint to supply chains and network (inter-organisational relationships) as a company's position in the network belongs to its resources.

There are many ways to category the supply chain risks. Ghoshal (1987) divided sources of supply chain risks into supply, demand, operations, security, macroeconomic, policy, competitive and resource risks. Later, Manuj and Mentzer (2008) argued that some of those risks overlapped with each other so they focused only on risks in supply, operation, demand and security. Zsidisin and Ritchie (2008) categorized risk in supply chain into four dimensions, 1) Disruptions to the supply of goods or services; 2) Volatility in terms of price; 3) Poor quality products or service from both upstream and downstream; 4) The reputation of the firm. They also provide a process-driven approach to classify supply chain risks as demonstrated in the figure below, 1) supplier risks; 2) Internal supply chain risks including plan, source, make deliver risks; 3) customer risks. Christopher and Peck (2004) suggested a similar and simple way of three categories with five risks: 1) risks internal to the company (related to process and control); 2) risks external to the company and within the network of supply chain (supply and demand) 3) risks beyond the supply chain network, the environment.

Figure 9 A process-driven approach to classify supply chain risk (Zsidisin and Ritchie 2008)

The supply chain risk looks into the relationships within and above the supply chain network and highlights risk from suppliers and customers.

3.3. Risk Management Steps

3.3.1. Project Risk Management

Currently there are plenty of risk management standards and guidelines. Four of the most widely used ones, PMBok (Project Management Body of Knowledge), PRINCE 2 (PRoject IN Controlled Environment), ISO (International Organization for Standardization) and ATOM (Active Treat and Opportunity Management) are selected for this research. Initially, definitions of risk from the four standards and guidelines are provided in the table below:

Standard/Guideline	Definition of risk
PMBok	Project risk is an uncertain event or condition that, if it occurs, has a positive or negative effect on one or more project objectives such as scope, schedule, cost, and quality. A risk may have one or more causes and, if it occurs, it may have one or more impacts (Project Management Institute 2013).
PRINCE 2	An uncertain event or set of events that, should it occur, will have an effect on the achievement of objectives. It consists of a combination of the probability of a perceived threat or opportunity occurring, and the magnitude if its impact on objectives Bentley (2010).
ISO	Effect of uncertainty on objectives. An effect is a deviation from the expected — positive and/or negative(ISO 2009).
ATOM	Any uncertainty that' if it occurs, would have an effect on achievement of one or more objectives (Hillson and Simon 2012).

Table 1 Definition of risk

It can be noticed that all of them include negative side (threat) and positive side (opportunity) as "uncertainty" contains both of them. Therefore in the following studies, both sides are taken into consideration.

The process of risk management listed in the PMBok (Project Management Institute 2013) is: 1. Plan risk management, set up the goal and how to comply it in the context of projects; 2. Identify risk, including also documenting the characteristics of different risks; 3. Perform qualitative (and quantitative) risk analysis, in order to prioritize risks for the next steps; 4. Plan risk responses, reduce negative effects and enhance positive ones; 5. Control risks, to manage risks continuously. It highlights that the risk management process is integrated with other project management processes. Besides, it distinguishes individual project risk with overall project risk, which is more than the sum of individual project risks (Project Management Institute 2013).

In another widely used project management method PRINCE 2 (PRoject IN Controlled Environment), Bentley (2010) gives a five-step risk management 1) Risk identification; 2) Risk Assessment; 3) Plan; 4) Implement; 5) Communicate as showed in the figure below. Even not mentioned in its step, Bentley (2010) suggests that risk management strategy should be established before embedding risk management in project management activities.

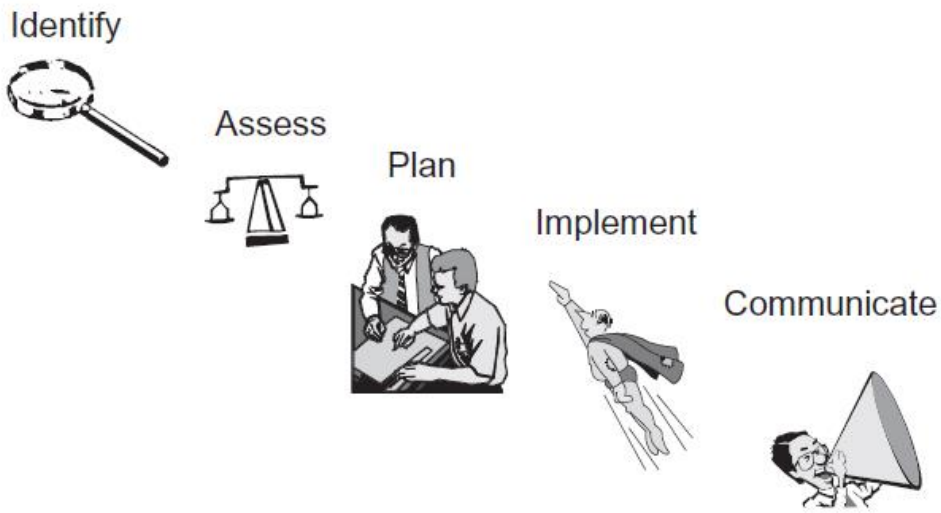


Figure 10 The five risk management steps in PRINCE 2(Bentley 2010)

The well-known ISO(ISO 2009), also presents a risk management with 5 steps, 1) Communication and consultation; 2) Establishing the context; 3) Risk assessment; 4) Risk treatment; 5) Monitoring and review. Moreover, 11 principles (characteristics) and a 5-part framework of risk management are provided (Figure 5). ISO emphasizes an organization-wide risk management, in contrast with a project-wide risk management in other standards or guidelines.

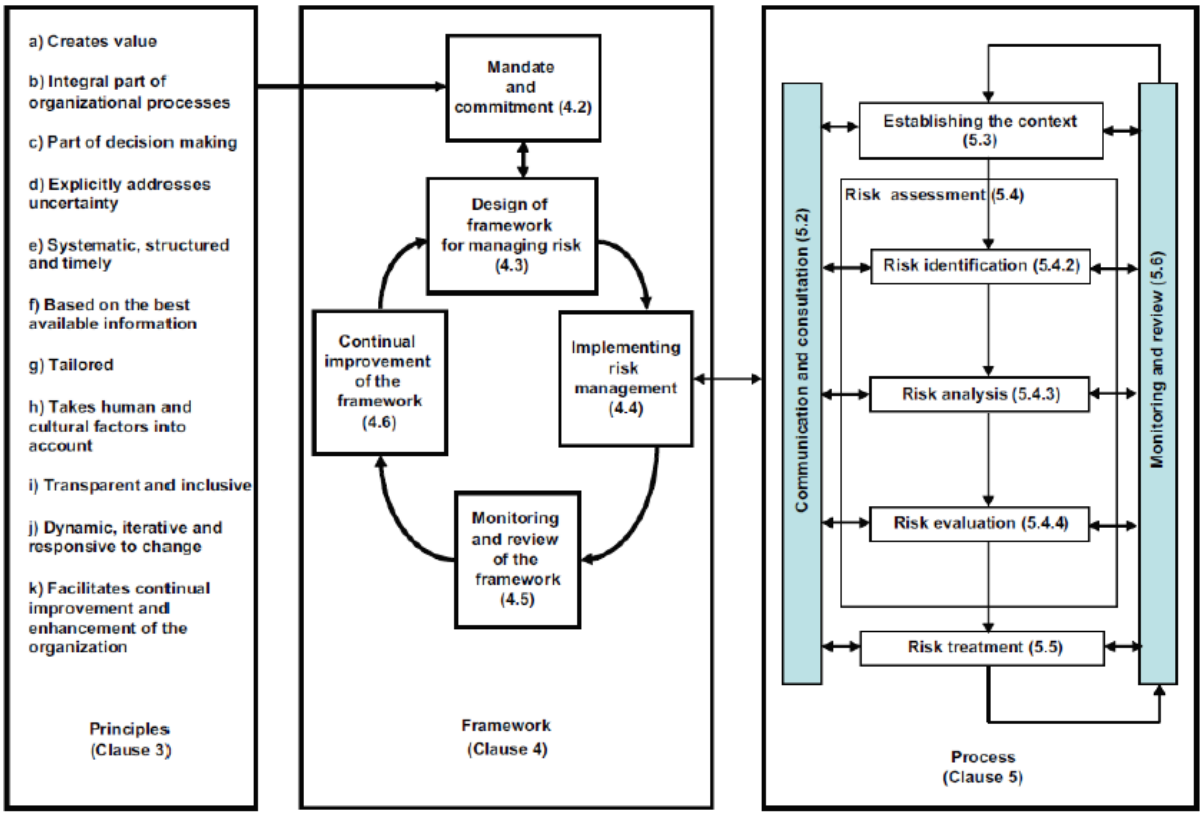


Figure 11 Risk management process in ISO 31000:2009(ISO 2009)

The ATOM risk management process has eight stages: initiation, identification, assessment, response planning, reporting, implementation, major and minor reviews. Moreover, four critical success factors are suggested for an effective risk management: supportive organization; competent people; Methods, tools and techniques; simple scalable process, which is the easiest one to address according to (Hillson and Simon 2012).

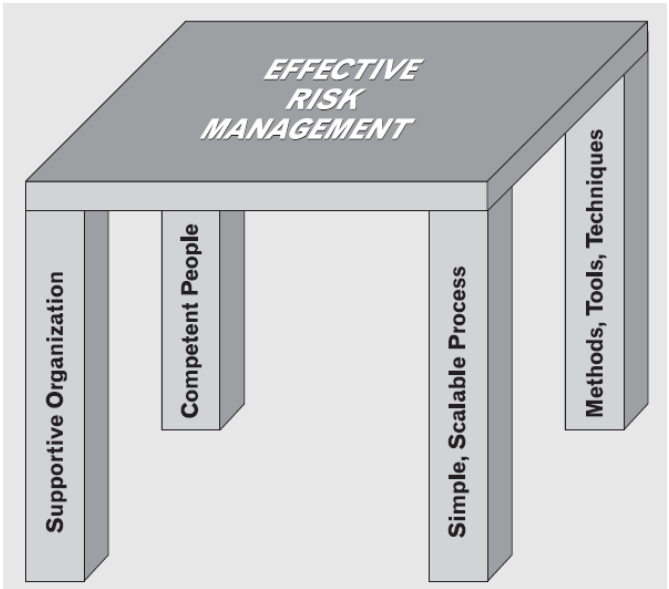


Figure 12 Critical Success Factors to Support Effective Risk Management (Hillson and Simon 2012)

The four chosen project risk management standards and guidelines share similar steps and all of them consider risk management as a continuous process in the project life cycle.

3.3.2. Supply Chain Risk Management

Zsidisin and Ritchie (2008) provided a five steps process of SCRM (Supply Chain Risk Management), 1) Risk identification and modelling; 2) Risk analysis, assessment and impact measurement; 3) Risk control; 4) Risk monitoring and evaluation; 5) Organizational/personal learning and knowledge transfer.

They also displays a three-phase supply chain risk management methodology (risk identification, assessment and mitigation) with 8 sub-phases for small and medium sized enterprises in supply chain as can be seen in the figure below.

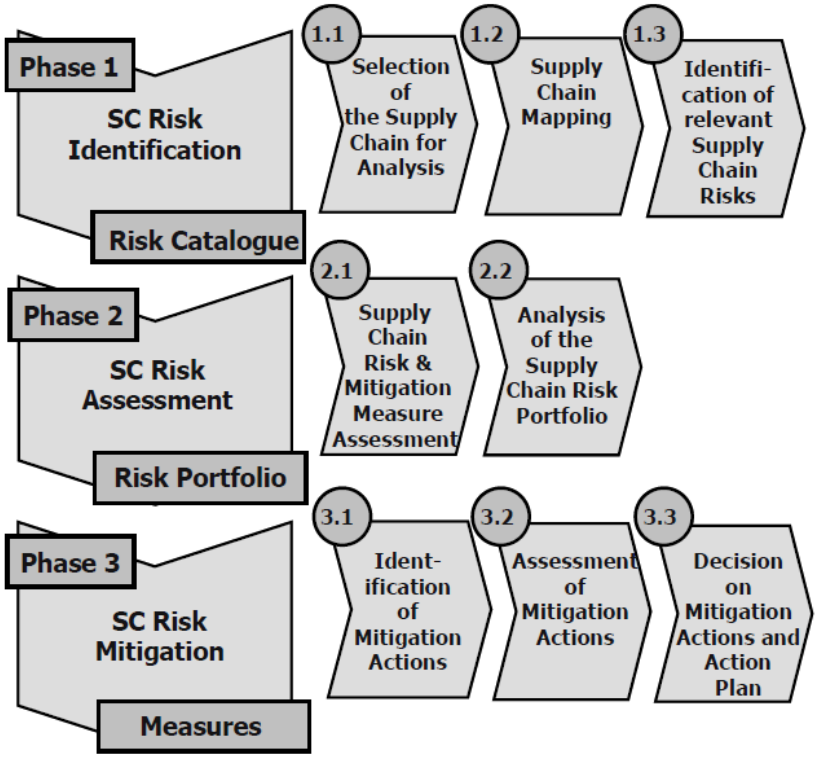


Figure 13 A supply chain risk management methodology for SMEs (Zsidisin and Ritchie 2008)

Jüttner, Peck et al. (2003) gave four basic steps of SCRM, 1) Assessing sources of risk 2) Identifying the risk and defining the risk consequences 3) Tracking the drivers of risk 4) Mitigating supply chain risk.

Harland, Brenchley et al. (2003) explains a repetitive process of supply chain risk management with 6 steps, 1) Mapping supply network; 2) Identifying risk; 3) Assessing risk; 4) Managing risk; 5) Forming collaborative risk strategy; 6) Implementing the strategy.

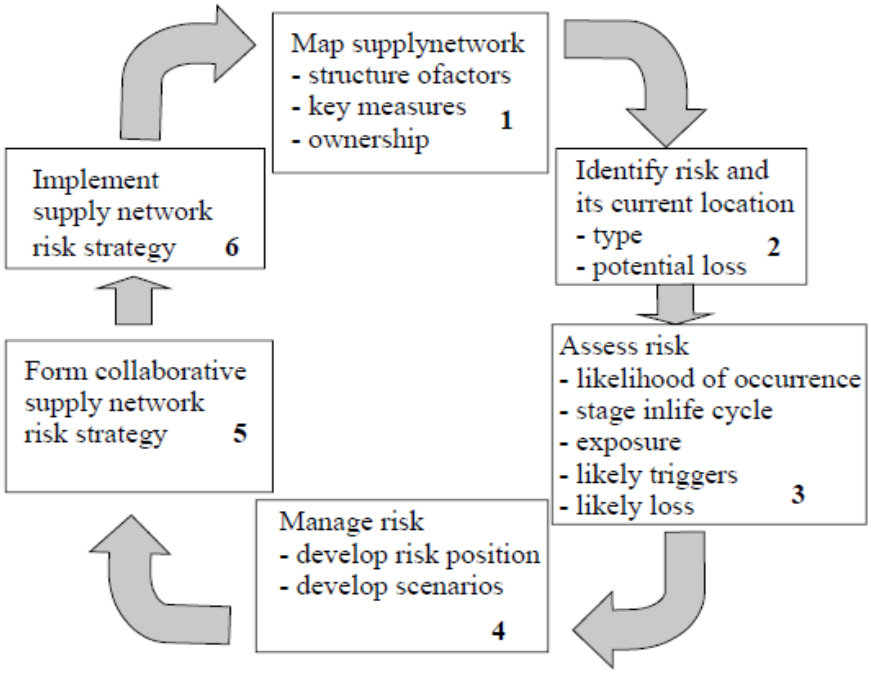


Figure 14 A Supply chain risk management process(Harland, Brenchley et al. 2003)

Not all the authors think the supply chain risk management as a repetitive process, but expect from that, they have similar steps as project risk management.

3.3.3. Similarities and differences between project and supply chain risk (management)

Differences can be found between project risk and supply chain risk. Supply chain risk pays more attention to the relationships within the supply chain network but looks more beyond the organization itself. For instance, risk from suppliers and customers are highlighted from most of researchers. Project risk does include external risks e.g. force majeure risks that are out of control and also from the society. But it concentrates more on the internal process or capability within the company or project team such as technical and operational level.

Even though they don't share the exact same types of risk, the risk management methods are similar. Both start with the initiation and planning of a risk management strategy, then identify, assess, take measures to deal with risks, finally revaluating and reviewing risks. Although the risk from the chosen project risk management methods consider threat and opportunity while the literatures of supply chain risk only concentrate on risk related to failure, the risk management steps in an ETO environment can be extracted from those references.

3.3.4. Risk management steps in an Engineer to Order Environment

Table 2 and *Table 3* below list project risk management steps in different standards/guidelines and supply chain risk management steps from different authors. It serves as input for defining the steps.

Standard/Guideline	PMBok	PRINCE 2	ISO 2009	ATOM
Step 1	Plan	Identify	Communicate & consult	Initiate
Step 2	Identify	Assess	Establish context	Identify
Step 3	Analyse	Plan	Assess	Assess
Step 4	Response	Implement	Treat	Response
Step 5	Control	Communicate	Monitor & Review	Report
Step 6				Implement
Step 7				Review

Table 2 Project Risk Management Steps

Authors	Zsidisin & Ritchie	Zsidisin & Ritchie (2)	Jüttner, Peck et al.	Harland, Brenchley et al.
Step 1	Identify & model	Identify	Assess (sources)	Map
Step 2	Analyze	Assess	Identify	Identify
Step 3	Control	Mitigate	Track	Assess
Step 4	Monitor & evaluate		Mitigate	Manage
Step 5	Learn & transfer			Form (strategy)
Step 6				Implement

Table 3 Supply Chain Risk Management Steps

From the eight processes, all of them contain the identification of risk, analysis and management of risk even though the authors name them differently. Besides, six out of eight possess the lessons learned of risk management. Also, expect PRINCE 2 and second resource of Zsidisin and Ritchie (2008), all other processes have a step before identifying risk. Therefore, a six-step risk management process is demonstrated mainly based on Project Management Institute (2013):

- Risk management plan – Define the main activities of risk management and depending on the characteristic of project, make guidelines for the team and arrange resources.
- Risk identification – Document possible threat and opportunity of the project and serve as input for next steps.
- Risk analysis – Conduct qualitative analysis to prioritize risks and decide if quantitative analysis is required.
- Risk response plan – Develop actions on certain risks, for a threat, normally it can be avoided, transferred, mitigated or accepted; for an opportunity, it can be exploited, enhanced, shared or accepted.
- Monitor and control – Check the status of risks, and if new risks occur.
- Lessons learned – Evaluate the whole process, update related documents that can be shared across projects.

4. Risk Management Practice at Huisman Equipment

With the intention of answering the second sub research question, "*How does an ETO company perform risk management in practice*", firstly, the applicability of the GRMM in the company was tested through three pilot interviews. Further, the GRMM was utilized to test the risk management maturity among the departments (engineering, supply chain, production, commissioning & testing, after sales) and management. Furthermore, results from all the selected interviewees were compared.

After all the individual interviews, an expert session was held with interviewees and other experts in the company, to validate the findings from the interviews and help answering the third sub research question, "*What are the identified improvement areas regarding risk management in the ETO environment*".

4.1. Huisman Equipment as a typical ETO company

Huisman Equipment, founded in 1929, is an ETO company with extensive experience in design and manufacturing of heavy construction equipment. Its product range is subdivided into six main categories: Cranes, Pipelay Equipment, Drilling Equipment, Winches, Vessel Designs and Special Products (Huisman Equipment). A majority of ETO companies hold the ability of design and engineering but outsource their manufacturing activities. Conversely, Huisman Equipment has its own production hall in several locations. Hicks, McGovern et al. (2001) provided 4 ideal types of ETO companies. As project management methods have been used in Huisman Equipment, knowledge from previous projects, reputation and engineering knowledge play a key role in the company's competency, Huisman Equipment can be seen as Type I from the *Figure 15* below.

	Type I	Type II	Type III(i)	Type III(ii)
Definition	Vertically integrated	Design and assembly	Design and contract	Project management
Core competencies	Design, manufacturing, assembly, project management	Design, assembly, project management	Design, project management, logistics	Project management, engineering expertise, logistics
Competitive advantage	Product and process knowledge; integration of internal processes	Systems integration; co-ordination of internal and external processes	Systems integration; co-ordination of internal and external processes	Reputation; engineering knowledge
Vertical integration	High	Medium	Low	Very low
Supplier relationships	Adversarial	Partnership	Partnership	Contractual
Environment	Stable	Uncertain	Dynamic	Dynamic
Type of risks	Capacity utilisation, return on capital, under-recovery of overheads	Lack of manufacturing may undermine design capability. Sharing core knowledge with suppliers makes them potential competitors	Overall contractual risk, capability and performance of suppliers	Loss of reputation

Figure 15 Four ideal types of ETO companies

Huisman Equipment has experienced rapid growth in the past years for instance, the employee raised from 200 in the year 2000 to over 2000 (Teerlink 2013). Expansion of the organization resulted in the need for formal project management procedure and risk management was introduced in the company from 2016. The circumstance or culture of a company is indispensable to support the risk management process (Institution of Risk Management 2013). Research done by Ward, C.B. et al. (1991) also proposes that successfully apply a management method e.g. risk management can be strengthened as it fits with the company's characteristics. Huisman Equipment is used to be characterized as entrepreneurial considering its smaller company scale for many years. Yet remain the entrepreneurial strength may conflicts with the introduction of risk management. What's more, the conclusion by Cameron and Braiden (2004) highlights that amongst smaller ETO companies, the success of projects depends much on personal skills so that the high levels of empowerment of individuals could impede the improvement of organizational progress.

Nevertheless, the company realizes they are not satisfied with the current risk management level even though people seem to know the importance of it. As a result, where are they towards a mature risk management and how to improve becomes an interesting topic for Huisman Equipment.

4.2. Applying the GRMM

In total, 23 interviews were done, including 3 pilot interviews. 20 respondents were asked to fill in the GRMM, but one from sales and the other from production did not fill the model. Besides, the score from one interviewee is too high comparing with others due to highlighting safety risks which is mentioned in chapter 6.3.3 Recommendations for future research. So finally, 17 results left which are going to be analysed in the following part. Yet comments from all participants were taken into account.

During the individual interview, a brief introduction of this research and the GRMM was given. Then the respondent started to fill the scores, interviewer was present only to give explanations for some terminologies. After the model was fulfilled, questions were asked based on the statement that the gap between current situation score and ambition score is big. The conversation was recorded for transcription and analysis.

4.2.1. Pilot Interview and selection of interviewees

As the company wants to know where to improve its risk management and mentioned in chapter 1.2, the GRMM is able to identify improvement areas within project or organization, it is going to be applied in the interviews. However as the GRMM was originally designed for construction industry, its applicability in an ETO environment is unknown. To check the applicability of the GRMM, three pilot interviews were executed with one process analyst, group leader of after sales and the COO. Generally from all their viewpoints, the GRMM is very applicable which means it will be applied for the following interviews to test the risk management maturity in the organization.

The pilot interview started with introduction of the research and the GRMM, then got to know more about the interviewees and the current risk management process, practice in their mind. The critical part was to go through each statement whether to keep it, adjust or delete it. Protocol for pilot interview can be found in Appendix A.

Only one statement was considered by one interviewee as inapplicable, “There is no blame culture and the project organization accepts that people make mistakes”. He argues that “no blame culture” is not possible for a company. Since other two interviewees didn’t show similar concern, no statement was removed. Still two wordings were suggested to be modified several times. “Risk register” was substituted by “risk log/topic list” which is normally used in the company. “Contractor” was changed into “supplier/sub-contractor”.

The model was further checked by the technical director of the company and he commented to separate risk into “threat” and “opportunity” so that the users have to think whether they perform better in threat

or opportunity side of risks regarding each statement, to make distinctions. After discussion of the feedback within the committee, this change was applied.

With the help of interviewees from the pilot interview, potential people were invited and in total 20 people participated the interview and the result of 17 were utilized for further analysis which are grouped into top management, management and operation.

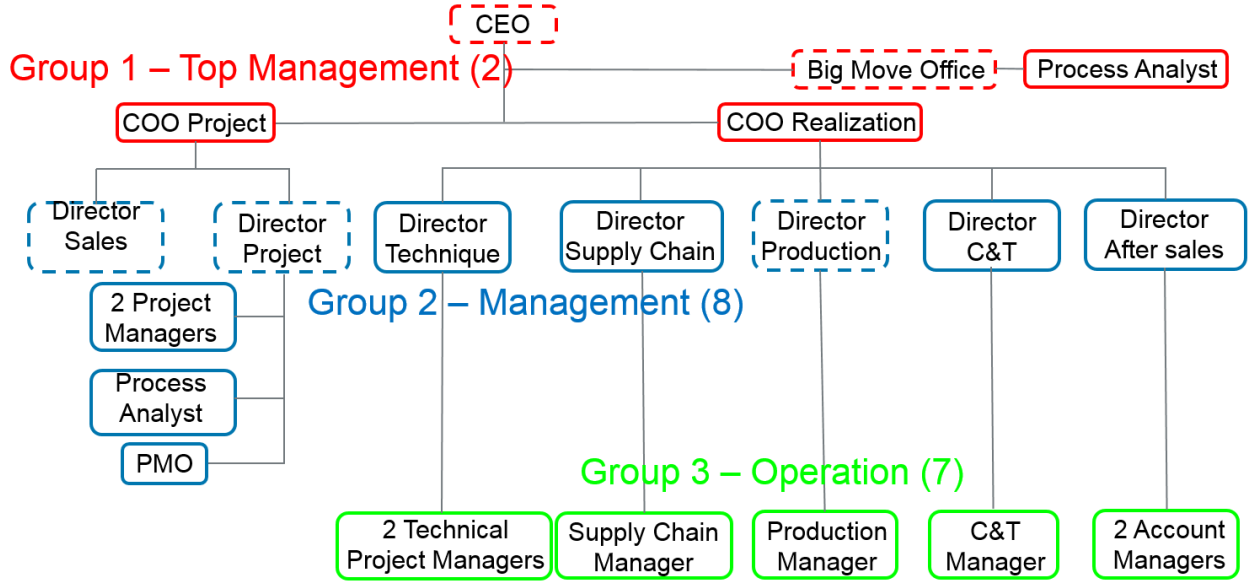


Figure 16 Grouping of Interviewees

The table below covers some detailed information of all the interviewees. 2 interviewees found it difficult to fill the model and one other put a much higher score among all the respondents due to highlighting safety risks which is mentioned in chapter 6.3.3 Recommendations for future research. Therefore, 17 results were taken into consideration.

Interviewee ID	Role and group	If fill in the threat	If fill in the opportunity	Comments
1	Project Management Officer - Management	Yes	Yes	
2	Process Analyst - Management	Yes	Yes	
3	Technical Project Manager - Management	Yes	Yes	
4	Project Manager - Management	Yes	Yes	
5	Account Manager - Operation	Yes	No	

6	Global Discipline Manager C&T - Management	Yes	No	
7	Production Manager - Operation	No	No	Didn't fill the model
8	Production Manager - Operation	Yes	No	
9	Global Manager Supply Chain - Management	Yes	No	
10	Technical Director - Management	Yes	Yes	
11	Supply Chain Manager - Operation	Yes	Yes	
12	Technical project manager - Management	Yes	Yes	
13	Account Manager - Operation	Yes	No	
14	C&T Manager - Operation	Yes	No	
15	(previous) Director Engineering and Projects/COO – Top Management	Yes	No	
16	Director Sales - Management	No	No	Didn't fill the model
17	Group Leader Service Offering, HEU Sales - Management	Yes	Yes	
18	Big Move Office – Top Management	Yes	Yes	
19	Project Manager - Management	Yes	Yes	
20	Manager Operations – Management	Yes	Yes	Scored too high due to highlighting safety risks

Table 4 List of interviewees

4.2.2. Interview within Engineering Department

In total two technical project managers were interviewed and were asked to fill the GRMM. They filled in both the management of threat and opportunity.

4.2.2.1. Results of GRMM

Threat:

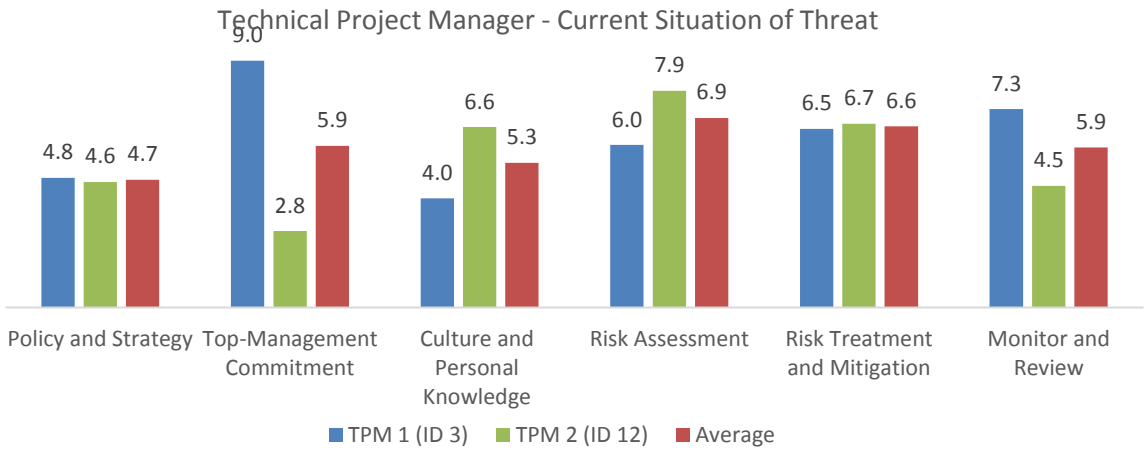


Figure 17 GRMM Result Value - TPM (Threat)

The scores given by each technical project manager are showed in the figure above, there is no big difference except for the aspect “Top-Management Commitment”. On average, the scores for managing threat from the technical project managers are bit higher than 5, “Policy and Strategy” is lower which indicates that the documentation and procedure of risk management is not mature and risk management is not well integrated with project management. The highest scores are “Risk Assessment” and “Risk Treatment and Mitigation”. As a result, threat is often identified and then treated within the department. Since results from the other aspects stay at around “5”, it shows that in the engineering department, people have basic understandings to deal with threats. It is part of their daily working process and is done to a certain extend.

Opportunity:

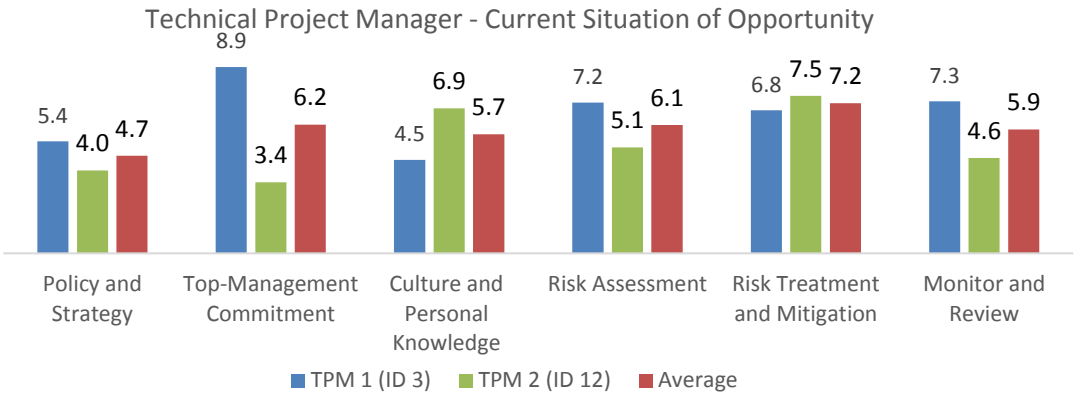


Figure 18 GRMM Result Value - TPM (Opportunity)

Similar to threat, the only big difference is in the aspect "Top-Management Commitment". "Risk Assessment" and "Risk Treatment and Mitigation" are among the highest, which show the identification and treatment of opportunity are good for technical project managers. Besides, the treatment of opportunity is greater than the assessment, so once an opportunity is identified, technical project managers exploit that quite often. Also the lowest score is the "Policy and Strategy". Other scores are over 5, and it reveals that in the engineering department, engineers have the capacity to manage opportunity.

4.2.2.2. Discussion of the Results

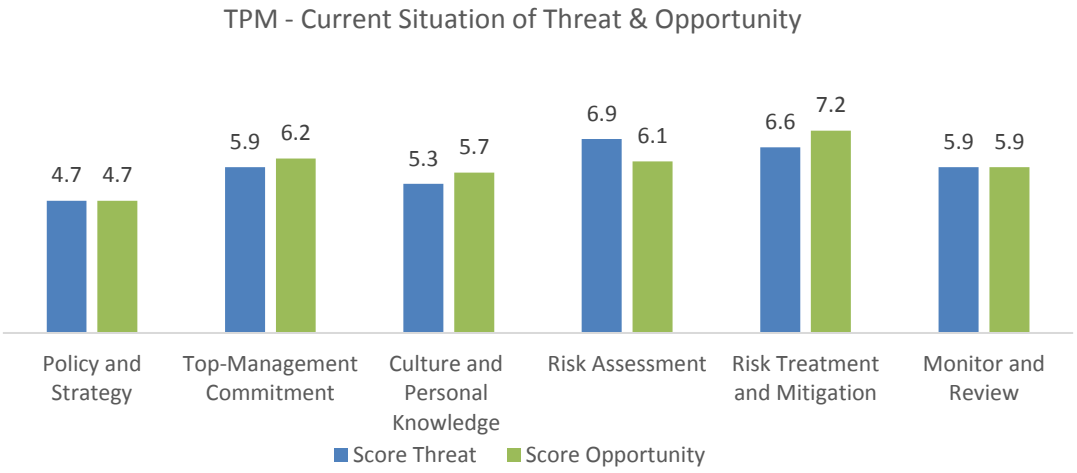


Figure 19 Score on Average - TPM (Threat & Opportunity)

From the figure, technical project managers perform similarly in managing threat and opportunity. It can be assumed that in the engineering department, people agree on mitigating negative risks while exploiting opportunities. The opportunities even got little more scores, as one of the manager in engineering told, "*We are an innovative company, we have a value creating thinking*". From the side view, during another interview, the people from the project management office mentioned, "*We have many smart and*

intelligent engineers in the company and they always try to improve, change and they can see many opportunities".

Overall, application and process (last three aspects) of risk management is better than organizational facet (first three aspects). The weakest aspect is "Policy and Strategy". Some wordings e.g. "risk appetite" is new to them and they agree it is important to know, e.g. one said, "*we can be better on what kind of risk are allowed to take*". A database for collection information is also lacking, actually as one interviewee said, "*It is difficult to have a database, we have some tools, many different ones and they are not integrated together. You can find the information but it takes too much time*". Besides they don't have a procedure to decide the risk reservation. However, when answering why they filled in a low score one just mentioned that "*I don't think there is a reason and no one does it*". As mentioned previously, the two technical project managers score differently in "Top-management Commitment", the one given low scores explained, "*they simply don't use risk management to make decisions, as an organization, we do not have much experience with risk management*". The reason of such difference can be they referred to different managers.

4.2.2.3. Improvement Areas

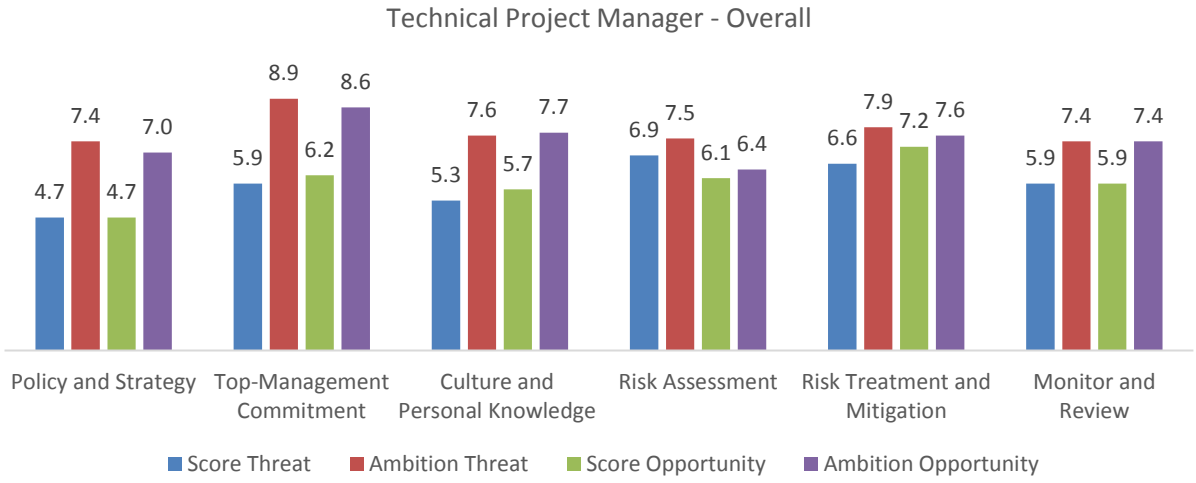


Figure 20 Score with Ambition on Average - TPM (Threat & Opportunity)

As mentioned before, "Policy and Strategy" scores the lowest in the current situation in the Engineering department. Nonetheless, it scores low in the ambition of it, both in threat and opportunity. The ambitions are higher in "Top-Management Commitment" and "Culture and Personal Knowledge". Therefore, they are clear improvement areas. According to one interviewee, "*The management of risk really depends on who is in your project team, e.g. some people do report threat or opportunity, but some not*". Without a supportive company culture and enough push from top-management, people cannot behave in the same direction.

In “Risk Assessment” and “Risk Treatment and Mitigation”, the current score is higher. Besides, the scores are close to their ambitions which mean less effort or resources can be put on the improvement in these two aspects. Nevertheless, as one interviewee mentioned, “*If we define a risk in a project, we will take care of it. But the process to identify the risk, that is difficult. We handle risk during the project process meeting, go through the planning, check the steps and ask ourselves if we see any risk or delay*”. As a result, it is better to have a more formal procedure of identifying the risk instead of just thinking about it during other project meetings.

Considering the differences between current score and ambition are bigger in the first three aspects (organizational area). One manager in engineering provided a reason why he gave lows scores in organizational related statements, “*We are currently a line organization instead of a project driven organization. We should grow in that direction, then implement risk and opportunity from the whole, broad perspective, as a complete system, involving all the disciplines. The gap among the departments can be closed if you put more effort on the project side, then they start working as a team and solve the biggest risk together instead of cutting it in engineering/supply chain problems*”. The other interviewee stated that “*When I fill in the different types of risk assessment we made, like FMECA, it causes us a huge amount of time and discussion. Some outsourcing is essential as we do not have much experience with risk management. We need independent people to do that, also training so that maybe in the future projects, we can do by ourselves and better*”, which also suggests the change in the organizational level.

4.2.2.4. Summary of the Outcome (Engineering Department)

Table 5 summarizes the outcome of the engineering department. Almost all aspects were scored over “5”, the application area got higher scores than the organization area. They treat threat and opportunity equally. There exists a risk based approach in the department, tools such as FMECA (Failure Mode Effect & Criticality Analysis) are been used. Respondents showed high ambition in the "Top-Management Commitment" aspect.

Engineering	Organization Area			Application Area		
Aspects	Policy and Strategy	Top-Management Commitment	Culture and Personal Knowledge	Risk Assessment	Risk Treatment and Mitigation	Monitor and Review
Threat	4.7	5.9	5.3	6.9	6.6	5.9
Ambition	7.4	8.9	7.6	7.5	7.9	7.4
Opportunity	4.7	6.2	5.7	6.1	7.2	5.9
Ambition	7.0	8.6	7.7	6.4	7.6	7.4
Overall results	Current situation: Application area > Organization area; Opportunities and threats are treated equally. Ambition: High ambition in "Top-Management Commitment"					
Statements in GRMM	Low in: Risk appetite; Database; Procedure risk reservation	Low in: Management communicating goals and strategies of risk management	Low in: Personal training	High in: Identifying risks (threats)	Low in: Defining different strategies for treatment (reduce, avoid, transfer, accept)	
Comments interviewees	Risks are treated within departments instead of in the project; Tools also stay in departments	Improvement area; People behave differently	Performance of risk management depends on who is in the project (people behave differently)	Too much time to assess the risks (e.g. FMECA)	Better at treating than analysing risks	
Reason behind	Organization structure, need to change to project driven organization	Lack of communication	No push from the top; No formal process	No independent team to do that	No formal procedure	

Table 5 Summary of outcome – Engineering department

4.2.3. Interview within Supply Chain Department

One supply chain manager was interviewed and he filled both the threat and opportunity.

4.2.3.1. Results of GRMM

Threat:

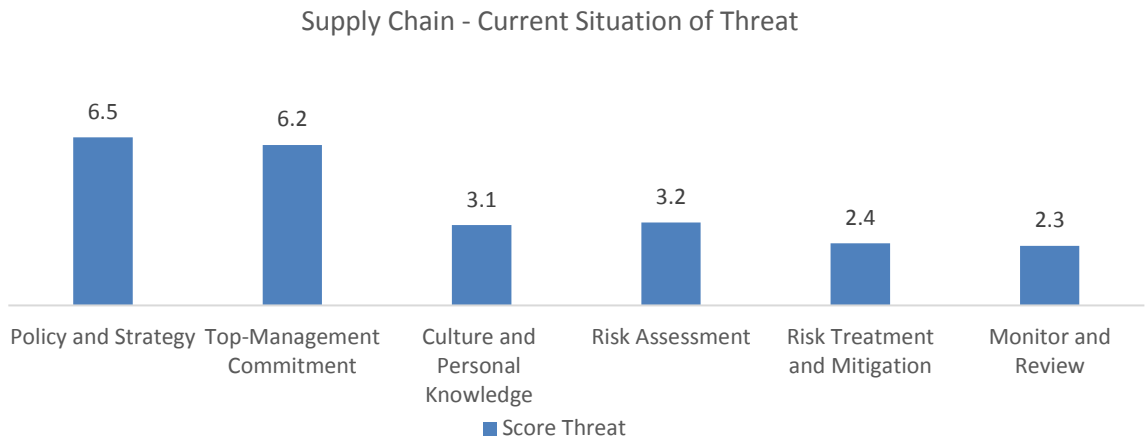


Figure 21 GRMM Result Value - Supply Chain (Threat)

Four out of the six aspects have low scores, especially in the application area (last three aspects), the interviewee gave scores around 2 and 3 so that in the supply chain department, the process to manage negative risk is performed very limitedly. “Culture and Personal Knowledge” also got a low result so for the department, they lack of the understanding of managing the threat. However, “Policy and Strategy”, “Top-Management Commitment” score much higher so actually there is procedure, managers encourage and support it.

Opportunity:

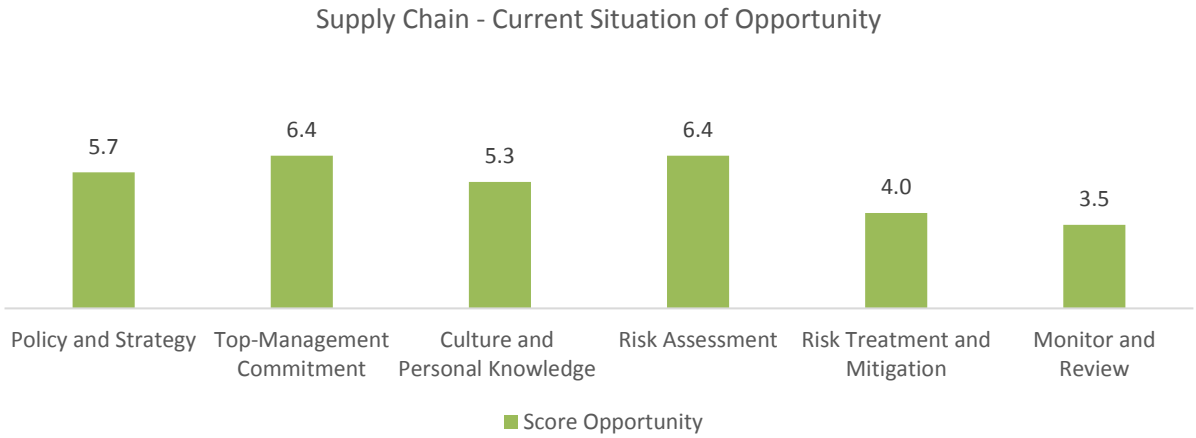


Figure 22 GRMM Result Value - Supply Chain (Opportunity)

Organizational area (first three aspects) of opportunity management get higher scores comparing its application. It indicates that supply chain managers have basic understanding of opportunities and management has support on opportunities. “Risk Assessment” is rated the highest, but “Risk Treatment

and Mitigation", "Monitor and Review" follow after have the lowest scores. Therefore, opportunities are identified but they are not often chased and controlled.

4.2.3.2. Discussion of the Results

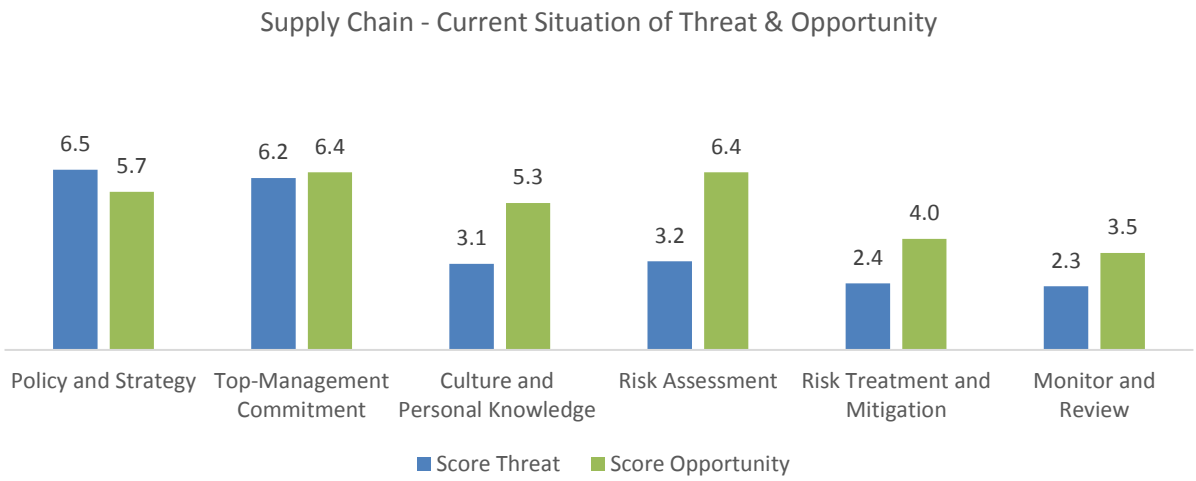


Figure 23 Score – Supply Chain (Threat & Opportunity)

From the chart, organization area (first three aspects) is rated higher than the application of risk management (last three aspects). The interviewee acknowledged that, "*the process is there, but there is also lots of work to do, then you skip risk management first*". It reflects that people tend to pay more attention to their own department rather than projects they are involving. Risk management is not part of their daily work.

There is a clear difference for supply chain department regarding managing threat and opportunity, especially in its process and application. It indicates that in the department, people know and manage opportunities better than threat. The reason can be generally, the (negative) risk management is performed badly within the department based on the comments by interviewees from other departments. An interviewee from engineering said, "*We need to find a way to also give our suppliers part of our risks (threat), give them also hard targets and give them pressure*". Also from interviewees in commissioning & testing, "*We have some problems but should be suppliers', we need to do more with contracts*". On the other way, normally, opportunities are stayed within the organization, less effort is required as no third party involves.

"Risk Treatment and Mitigation", "Monitor and Review" are the lowest in both sides of the risk while the earlier step "Risk Assessment" is better. As stated by the supply chain manager, "*We have project meetings, and when you don't show up, you will miss a lot of information. Project managers think you know where to find them but there is misunderstanding and lack of communication*". In all, the whole

process of risk management is not followed and the project team needs more collaboration among departments.

4.2.3.3. Improvement Areas

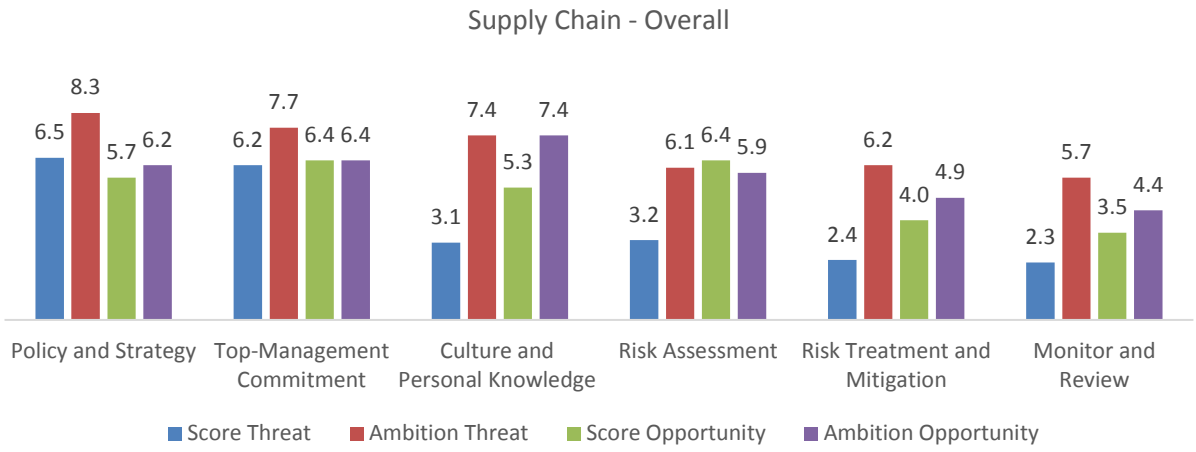


Figure 24 Score with Ambition– Supply Chain (Threat & Opportunity)

Contrary to the current situation, the interviewee has a higher ambition on dealing with threat, he suggested to focus on threat first. In general, higher ambitions appear to be in the organization area (first three aspects). A project based organization was mentioned again, "*We keep changing roles over the years, so it is difficult to communicate who is responsible for what. We changed too much in the past years, each director of supply chain has his/her own opinion, so we keep redesigning our department. We should not depend on the supply chain head, we need a solid base, clear policy, not affected by a specific person*". In short, the change within the department should not have big influence on the behaviour of people working on projects.

There is a big gap between current situation and ambition in "Culture and Personal Knowledge". The interviewee highlighted the statement that talks about "blame culture", "*We always have to blame somebody for the problem but we need to solve the problem before we blame someone, otherwise we don't go to those meetings anymore*". On the other hand, team members are not obligatory to attend these meetings. What's more, according to the interviewee, many low scores in the later statements are caused by lack of communication, e.g. lack of communication between the project manager and supply chain managers lead to less control measures on identified risks. Hence, People need to be feel like working in a team and solve problems all together which goes back to the transformation into a project based organization. He used the buyer as an example, "*Right now the buyers don't have the feeling that they are in projects, they just have to buy and deliver at a certain time*". Without standing on a project view, risks arise.

4.2.3.4. Summary of the Outcome (Supply Chain Department)

Table 6 is the summary of the interview in the supply chain department. So the result is indicative as only on supply chain manager filled the GRMM. Application area got very low score so that risk management process is not followed. Opportunity were scored higher but the interviewee put more ambition over managing threat.

SC	Organization Area			Application Area		
Aspects	Policy and Strategy	Top-Management Commitment	Culture and Personal Knowledge	Risk Assessment	Risk Treatment and Mitigation	Monitor and Review
Threat	6.5	6.2	3.1	3.2	2.4	2.3
Ambition	8.3	7.7	7.4	6.1	6.2	5.7
Opportunity	5.7	6.4	5.3	6.4	4.0	3.5
Ambition	6.2	6.4	7.4	5.9	4.9	4.4
Overall Results	Current situation: Application area of threat is very low; Opportunity > Threat; Ambition: Higher ambition in threat					
Statements in GRMM	Low in: Risk management objective; Risk appetite; Database; Procedure risk reservation		Low in: blame culture; Personal training, and most of statements	Low in: External stakeholder involvement, and most of statements	Low in: Defining different strategies for treatment (reduce, avoid, transfer, accept), and most of statements	Low in most of statements
Comments interviewees	Process is there but often skip it; Too much changing and redesign within department		More attention to the own department than the project; Tend to blame before solving the problem, people are not feeling like working in a team	Not aware of the outcome of risk sessions; People are not active in risk related meetings.	Have to learn to transfer some risks to suppliers; Risk Management process is not followed	
Reason behind	No formal procedure and push from the top; Need to change to project driven organization		Lack of communication, need to change to project driven organization	Lack of communication; Need to change to project driven organization and pressure from the top	For control measures of risk, "transfer" is not included; Lack of collaboration among departments	Similar reasons

Table 6 Summary of outcome – Supply Chain department

4.2.4. Interview within Production Department

Two production managers were interviewed, one didn't fill in the model and admitted that, "*Risk management is something completely new for me*". However, he is confident in his experience, "*For production, I think without being actively involved in risk management, we can do our job. We try to avoid risks of course, e.g. when there is a risk we deliver too late, just add resources. But I don't need to study about it and I think of solutions instead of risks*". The other only filled the scores for threat, a second round to validate some of the aspects ("Risk Treatment and Mitigation", "Monitor and Review") was done with the help of the supervisor from the big move office. As previously he said, "We never use the word 'risk', we think of four pillars, quality, time, budget and safety. I find it bit difficult to discuss, when I was filling the model."

4.2.4.1. Results of GRMM

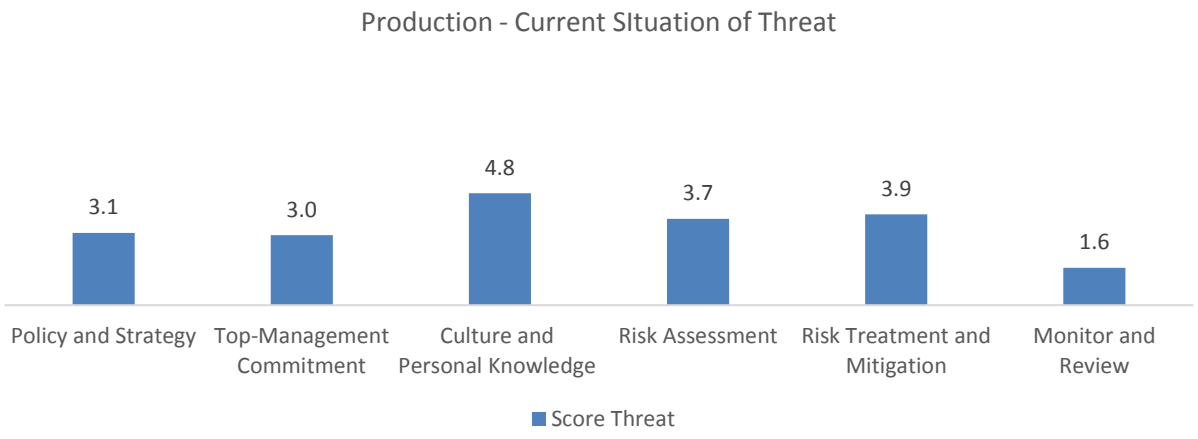


Figure 25 GRMM Result Value - Production (Threat)

On the whole, all aspects got a low score expect for "Culture and Personal Knowledge" which lies in the middle. So in reality, people in the production department do understand risk. But it can be presumed that at the same time, not enough resources (people, training, tools etc.) are committed to risk management, risk is not managed on document or in a proper way.

4.2.4.2. Discussion of the Results

In "Policy and Strategy", statements linked with procedure or documentation have low scores. The interviewee just simply mentioned, "*There is no document and I don't know why they are not available*". For "Top-Management Commitment", he answered, "*We approach everything in a practical manner and we don't fix it on paper, if it is not on paper, then it is not shared, as we don't have the responsibility to put it on paper. We don't have good guidelines*". It can be seen that the goal and strategy regarding risk management are not clear from the top. As to "Culture and Personal Knowledge", it shows people don't understand the necessity of risk management, the production managers don't have any risk management trainings and he didn't know the reason behind. From another interviewee among the top-management,

the interviewee provided his opinion, "*I don't think people in each department should know about the risk management, people should first focus on their own job. Of course we have to share information in a project team*", which may applies to some roles as risk management is not their priority, but sharing information is essential.

For the last three aspects about risk management application, the production manager repeated that they barely have the risk register which brought about the low scores in these aspects.

4.2.4.3. Improvement Areas

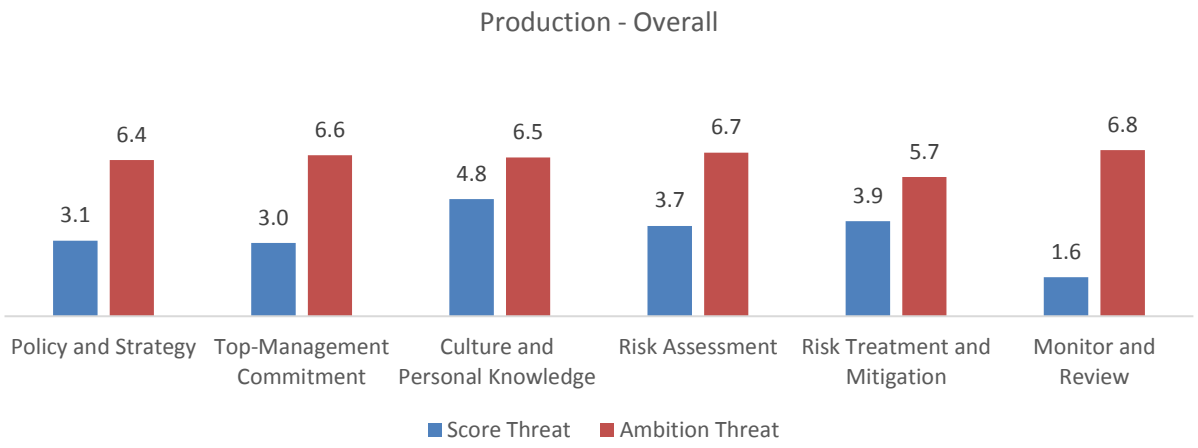


Figure 26 Score with Ambition – Production (Threat)

The ambitions are not high and they are similar for each aspect. The gaps between current situation and ambition are high in "Policy and Strategy", "Top-management Commitment". The interviewee expressed the hope for a better and clear top-down strategy, "*I think in the past few years, we have been guided by external influences, focus too much on satisfying the clients and lost a bit of ourselves*".

In regard to the application area, he told that the organization is good at making processes of how something should work, in a high level manner, but they are not instructed in details and how should people behave. Additionally, he highlighted, "*There are risk management for sure and other people may involve RM more in another level then they will give a higher rating. But I believe it is not shared among the departments. For sure it is not formally structured, in another word, departments are not working in the same way*". Consequently, the risk management process could be more mature in some departments but there are gaps among the departments. As a result, clear explanation of process/standard, follow-up, control and check if people are working accordingly is an essential improvement area. He proposed the top-down approach, "*Head of each department should agree with the procedure in advance, not only just informing people, but also put on the working instruction and evaluation level*".

4.2.4.4. Summary of the Outcome (Production Department)

Table 7 is the overall result in the production department, only the scores for threat are included. Similar to supply chain, the outcome is indicative as only the result of one production manager is used. All the aspects got low score and the respondent gave also lower ambition compared with other interviewees so that he is not positive and believes there are many problems of risk management within the organization.

Production	Organization Area			Application Area		
Aspects	Policy and Strategy	Top-Management Commitment	Culture and Personal Knowledge	Risk Assessment	Risk Treatment and Mitigation	Monitor and Review
Threat	3.1	3.0	4.8	3.7	3.9	1.6
Ambition	6.4	6.6	6.5	6.7	5.7	6.8
Result	Current situation: Low in all the aspects Ambition: Not very high ambition					
Statements in GRMM	Low in: Risk appetite; Database; Procedure risk reservation, and most of statements	Low in: Management communicating goals and strategies of risk management, and most of statements	Low in: Understanding the necessity of risk management; Personal training; Risk management team	Low in most of statements	Low in most of statements	Low in most of statements
Comments interviewees	Practical manner, no documentation, no responsibility to put things on paper	We don't have good guidelines	We don't receive any trainings; Departments have different risk management maturity level	We barely have risk register	Same as before	Same as before
Reason behind	No formal procedure	Lack of instructions of processes	A top-down approach is lacking	No formal procedure	Same as before	Same as before

Table 7 Summary of outcome – Production department

4.2.5. Interview within Commissioning and Testing Department

One C&T (Commissioning and Testing) manager was interviewed, but three people from the department were involved when filling the GRMM as the interviewee found it difficult to fully understand the academic wording. Also, they only fill in the scores for the threat.

4.2.5.1. Results of GRMM

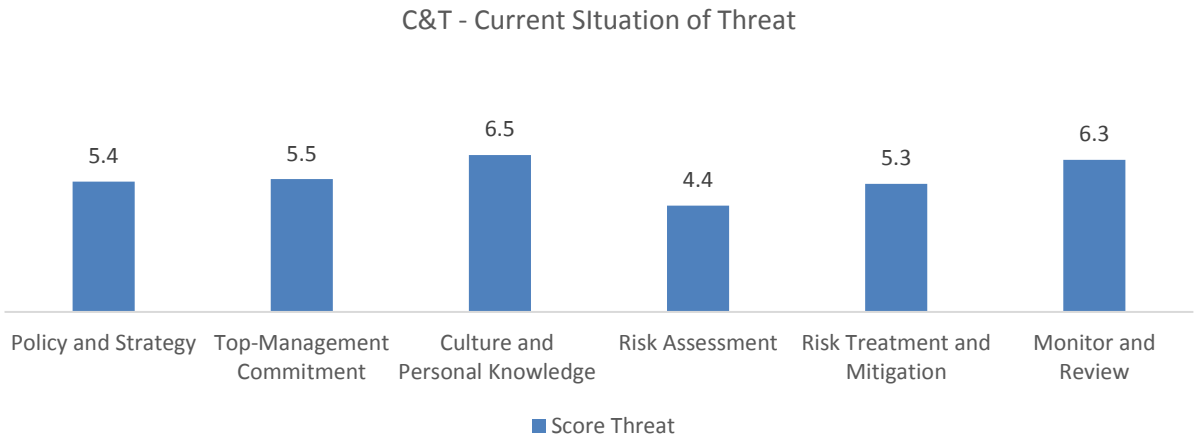


Figure 27 GRMM Result Value – C&T (Threat)

From the figure above, all aspects score around 5, which shows in C&T, there exists basic level of risk management. "Culture and Personal Knowledge" received the highest rate so people within the department have a good understanding of threat. "Risk Assessment" has the lowest score, risks are not defined on a satisfactory level. "Risk treatment and Mitigation", "Monitor and Review" are higher so they execute better on treating and controlling identified risks.

4.2.5.2. Discussion of the Results

For the first aspect "Policy and Strategy", interviewees put low scores on statements connecting with process, they pointed out, "*I think probably there is risk management process on a project management level but that is not really known or communicated to our level. We think there is but we are not involved enough*". During the interview, it can be felt that they are not very familiar with those procedure and actions being taken because of less involvement in risk session or the outcome of those meetings. In the "Top-Management Commitment" aspect, they answered that the management doesn't ask for risk management report or use it to make decisions, "*Risk management is not among the highest priority for the managers, they focus more on time, cost, man power etc*." With respect to "Culture and Personal Knowledge", they don't have risk management training, they also consider themselves as technicians.

As for the application of risk management, in "Risk Assessment", key external stakeholders are not involved in risk identification or notified about the outcome of risk assessment e.g. suppliers. For the risk matrix and quantification of risk, interviewees said they are not done good enough, "*It is not in high*

priority as we want to save time, so we take some shortcuts which will bring new risks ultimately". For the statement regarding "risk owner of each risk", they deemed that the (technical) project managers don't take enough responsibility and say, "*I am responsible for it*". They explained, "*This is not their job, maybe we lack of requirement so more ownership is needed*". Statements related to "secondary risk, residual risk" got low score in the aspect "Risk Treatment and Mitigation" and they repeated, "*they just take more time but people want to save more time and money*". For the "Monitor and Review", interviewees admitted that for statements about updating, they are not involved enough.

4.2.5.3. Improvement Areas

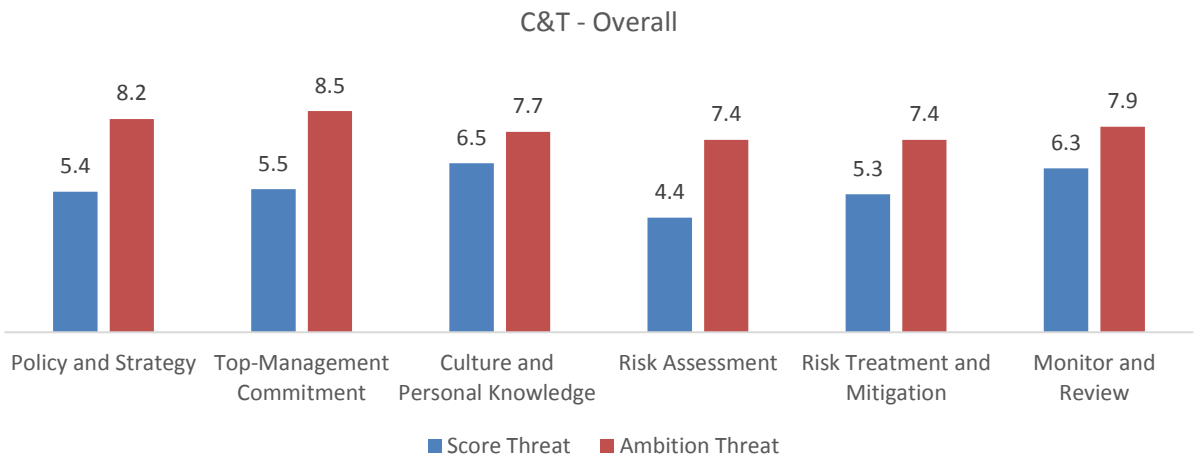


Figure 28 Score with Ambition – C&T (Threat)

Ambitions are higher in the organization area (first three aspects). The gaps between current situation (score) and ambition are big in "Policy and Strategy", "Top-Management Commitment". As interviewees consider the project managers when they were filling the second aspect, they revealed that the project managers are not working under the same procedure, "*There is too much difference on that level, they are not in lined and have different ways to do the projects. We need a more uniform way of working*". It is interesting to mention here that in another meeting with a project manager, he talked about the differences within the same role, "*Everyone is as mature as they are, for project managers, e.g. we have 5 things to do, for me, risk management may be the 2nd priority but for another, it can be the last*". It reflects that for procedure as risk management, project managers don't use the same criterion which confuses the project team members.

"Risk Assessment", "Risk Treatment and Mitigation" are improvement areas especially for statements require extra effort e.g. involvement of external stakeholders, quantification of defined risks, secondary and residual risks etc., interviewees put high ambitions on these statements. They also emphasized on the ownership of both internal and external stakeholders, the (technical) project managers and suppliers. Thus, besides the risk management procedure within the organization, contracting with the external parties has to be upgraded.

4.2.5.4. Summary of the Outcome (Commissioning & Testing Department)

Table 8 presents the outcome within the C&T department, only the scores for threat are given. The scores for current situation were all around “5” so risk management was at a basic level. High ambition could be seen in the organization area.

C&T	Organization Area			Application Area		
Aspects	Policy and Strategy	Top-Management Commitment	Culture and Personal Knowledge	Risk Assessment	Risk Treatment and Mitigation	Monitor and Review
Threat	5.4	5.5	6.5	4.4	5.3	6.3
Ambition	8.2	8.5	7.7	7.4	7.4	7.9
Result	Current situation: Basic level Ambition: Higher ambition in organization area					
Statements in GRMM	Low in: Process/procedure; Database		Low in: Personal training	Low in: External stakeholder involvement; Owner of the risk; Quantitative analysis and most of statements	Low in: Secondary/residual risk treatment; Communication of risk treatment outcome; Sub-contractor/supplier risks	
Comments interviewees	The process stays in the project management level and we are not involved enough	Risk management is not the priority for management; Project managers work differently	We focus more on technique	Not priority for the project team	People don't understand putting more effort now saves time and cost later; Bad at managing e.g. suppliers	We are not involved in these steps, so we assume there is something related
Reason behind	Lack of communication, need to change to project driven organization	Management understands the importance of risk management but people cannot feel it, lack of communication even in the same department	The culture of the company, concentration on innovation, technology	Don't have a uniform way of working	Lack of training and people haven't got benefit from risk management; No good contract management	Lack of communication

Table 8 Summary of outcome – Commissioning and Testing department

4.2.6. Interview within After Sales Department

Two account managers were interviewed and they filled only the management of threat. One of them didn't fill some statements in "Risk Treatment and Mitigation", "Monitor and Review" as he is not really involved in the risk management procedure.

4.2.6.1. Results of GRMM

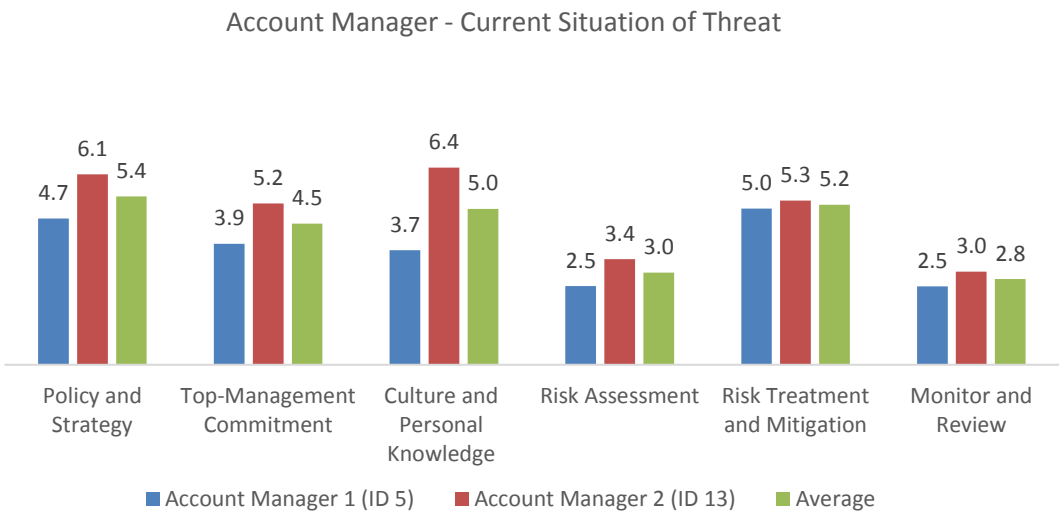


Figure 29 GRMM Result Value – After Sales Department (Threat)

Scores from each account manager are presented in the figure above, only in "Culture and Personal Knowledge" there is bigger difference. The organization area (first three aspects) received more score compared to the application area (last three aspects). Accordingly, account managers understand the necessity of managing threat. Nevertheless, the risk management procedure is not mature, threat are not being taken care formally.

4.2.6.2. Discussion of the Results

In parallel with many other departments, for "Policy and Strategy", low scores were given to the statements about tools or procedure. As one account manager said, "*We don't have a risk matrix and I don't think there is a structured procedure for risk management*". In "Top-Management Commitment", both of them felt management doesn't use risk management reports for the decision making, "*They just decide with their knowledge and experience, this is because of our culture*". "Culture and Personal Knowledge" got different scores and they rated 1 and 10 for the statement related to "blame culture". The account manager who talked about the blame culture answered, *"People don't want to take responsibility, they are afraid of the consequences"*. Throughout the interview, people have diverse opinion on this question, a reason can be in some project teams or within some department, there is blame culture, so some interviewees have experienced that, some haven't. They both agreed that account managers don't receive training for risk management skills but one of them responded, "*I don't know why*

we don't receive training on these topics. Basically what we do is that we try to alert each other on the daily basis, that's how we keep each other sharp".

Very low scores were given to "Risk Assessment", comments included, "*I don't think we have any risk registration or I am not aware of the procedure*". Subsequently, it lower the score in the application area (last three aspects). Ownership was mentioned again, "*there is not a risk owner, I believe everyone should be responsible for their own risks but it doesn't feel like they are really the risk owner. That's something I find missing a bit, the ownership. The reason is maybe the culture of us*". Respecting the outcome of risk assessment, one account manager replied, "*We have to ask a lot, there are lots of meetings but I don't know*".

4.2.6.3. Improvement Areas

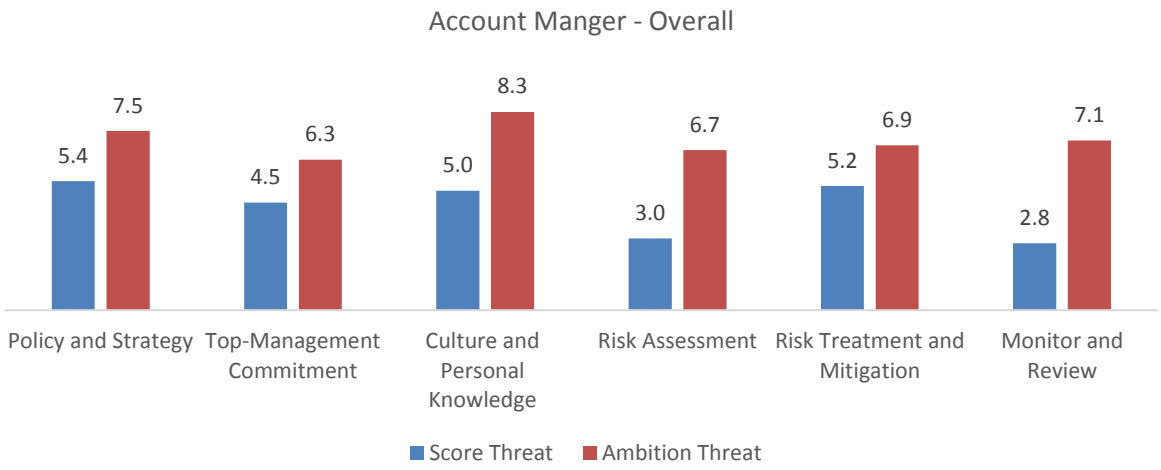


Figure 30 Score with Ambition – After Sales Department (Threat)

Ambitions are higher in the organization area (first three aspects). One account manager talked about lacking a general way of doing project in Huisman Equipment, top-down approach once again was mentioned. Seeing that in general, risk management is not mature, the other respondent complained, "*Sometimes we make things too complex, making it less complicated lowers the risk*". This comment can be linked with opportunities, as it is being considered an important characteristic of the company and bringing more opportunities may cause more threat. Sense of responsibility was being referred to, "*Everybody should know his/her own responsibility, owning a piece of the puzzle. In the meantime, look at the bigger picture, besides my own responsibility, what I will receive and give away*". To achieve this, better information sharing among departments is obligatory. As talked by a technical project manager previously, there exists too much tools/database in the company which are not integrated so that sharing lacks efficiency.

For the application of risk management, interviewees expressed their hope to be actively involved as they revealed, "*We want to be involved because a new build project takes one or two years to finish, but the life cycle is 20 to 30 years*". As they are in the end step, account managers depend on all other parts in the organization and see risk within the complete line. Nonetheless, the situation is becoming better now as one mentioned, "*Since last year, we can get input from other departments but prior to that, not at all*".

4.2.6.4. Summary of the Outcome (After Sales Department)

Table 9 shows the interview results for after sales department and both the two account managers gave only scores for the threat. On average, the organization area were rated higher than the application area and they had higher ambition also in the organization area.

After Sales	Organization Area			Application Area		
Aspects	Policy and Strategy	Top-Management Commitment	Culture and Personal Knowledge	Risk Assessment	Risk Treatment and Mitigation	Monitor and Review
Threat	5.4	4.5	5.0	3.0	5.2	2.8
Ambition	7.5	6.3	8.3	6.7	6.9	7.1
Result	Current situation: Organization area > Application area Ambition: High ambition in organization area					
Statements in GRMM	Low in: Risk management tools and techniques; Procedure risk reservation	Low in: Management use risk management for decision making	Low in: Personal training	Low in: Identifying risks; Owner of the risk; Communication of risk assessment outcome	Low in: Defining different strategies for treatment (reduce, avoid, transfer, accept)	Low in most of statements
Comments interviewees	There is no structured procedure for risk management, even we do not have a general way of doing projects	We feel that they decide based on their knowledge and experience	We need to have trainings on risk	We lack ownership also we are not aware of the procedure	We are not putting enough resources on risk management	Same as before
Reason behind	No formal procedure	The culture of the organization, not used to processes		No formal procedure; Lack of communication	No formal procedure	Same as before

Table 9 Summary of outcome – After Sales department

4.2.7. Interview within Project Department and Process

Two project managers, one project management officer and one process analyst are interviewed and they all filled in the threat as well as opportunity.

4.2.7.1. Results of GRMM

Threat:

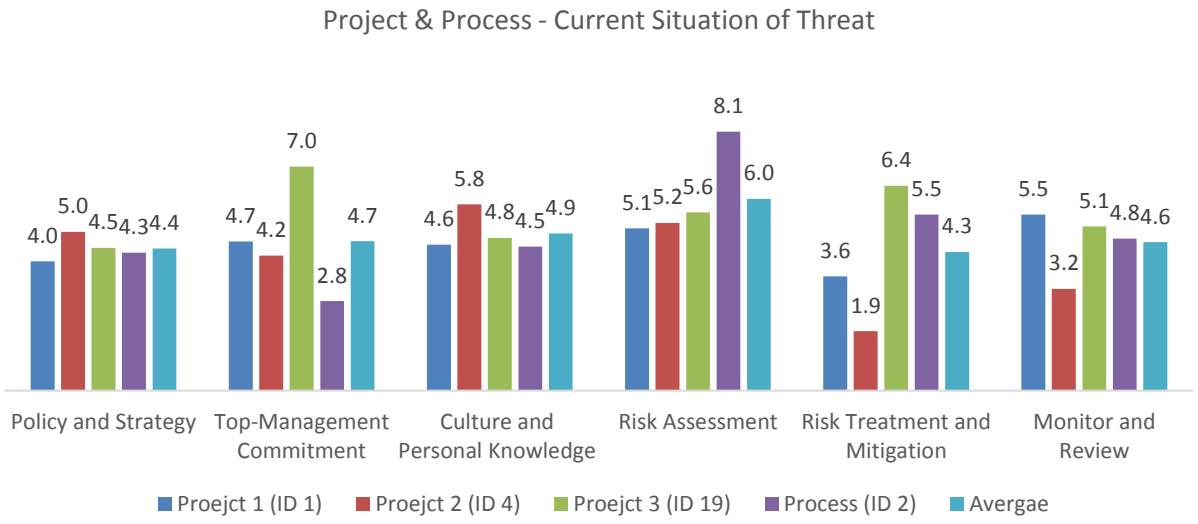


Figure 31 GRMM Result Value – Project and Process (Threat)

The differences among the four interviewees are small, only in “Top-Management Commitment” and “Risk Assessment” stand two higher rates which is acceptable. Apart from “Risk Assessment”, the averages for all other aspects are lower than 5 so threat is not being managed maturely in the projects. “Risk Assessment” is better operated than “Risk Treatment and Mitigation”, “Monitor and Review”, so the process is not followed.

Threat:

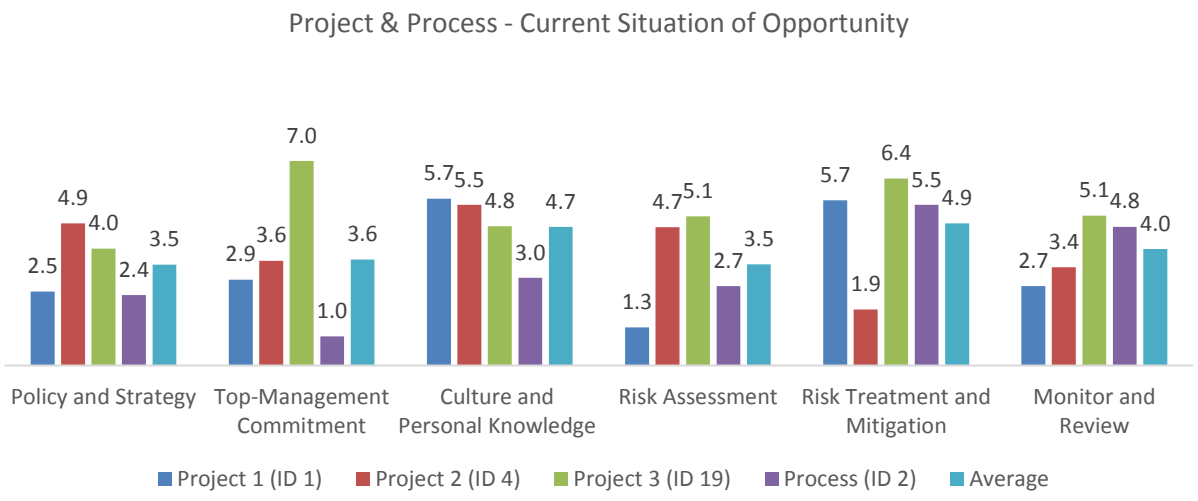


Figure 32 GRMM Result Value - Project and Process (Opportunity)

Comparing with threat, more differences appear in the score for opportunity. Nevertheless, e.g. for "Top-Management Commitment", a high and low score exist at the same time so it doesn't have impact on the average. "Culture and Personal Knowledge", "Risk Treatment and Mitigation" scored higher than other aspects but the average results for all aspects are below 5. Therefore, opportunities are not often managed for them.

4.2.7.2. Discussion of the Results

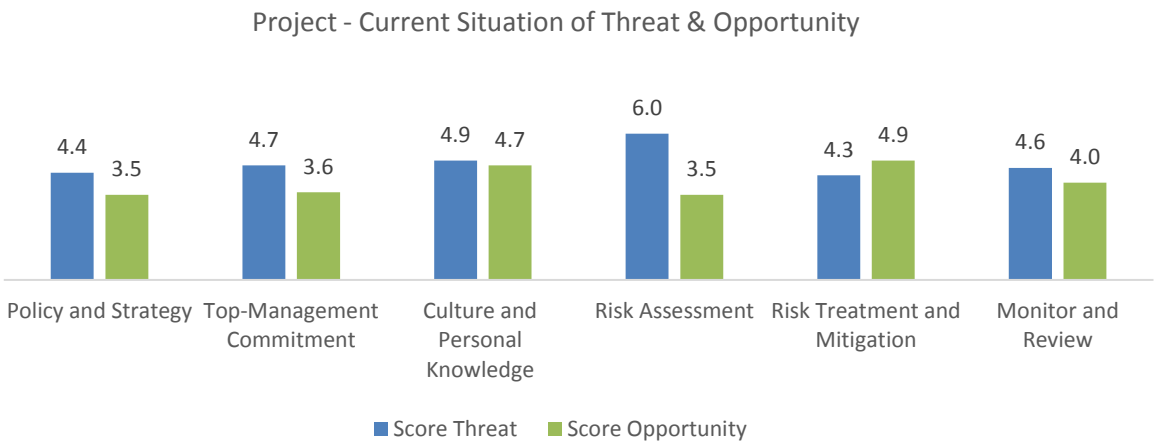


Figure 33 Score on Average – Project and Process (Threat & Opportunity)

Threat gained higher score in most of the aspects which can be concluded that project managers and process analysts put more importance to threat, especially for the identification (big difference in the "Risk Assessment"). According to one project manager, "*In general, when we talking about risk management, we focus more on threat, the negative side, we forgot often in this process to also look at the opportunities. We don't give lots of attention*". To be more specifically, as the project management officer said, "*There is no specific process or documentation during project execution regarding opportunity but for threat there is*". Meanwhile, the risk matrix only has the negative side. In spite of that, he added, "*Not only engineers, but also sales, project managers etc., they see lots of opportunities and contact client and try to sell more. They do it already, so I give high for its importance and ambition. But there is no documented process*". In general, his idea is there is informal way to treat some opportunities.

In "Policy and Strategy", the process analyst pointed out, "*Even though we have process, due to there is no clear objective and strategy, it doesn't work. But it is important to have a clear process. Right now, documents and process are there, but people just don't work accordingly, e.g. they do risk assessment in their heads, they have their own standards but not based on the risk management procedure*". Similarly, she mentioned the risk management tools are there but they are not implemented enough. The project management officer said mostly (technical) project managers are organising meetings related to risk management but most of the other people in the organization are not really involved. All the statements

related to “risk appetite” are scored “1” or “4” by all the respondents and one replied, “*We stay at a lower level for risk management*” so it is understandable that such wording is new for other departments. Simultaneously, they thought risk management approach is not integrated in project management approach, “*At this moment we see the risk sessions separately, we do the risk sessions and take the knowledge to our head, but that’s only in the project managers’ heads. We see the risk session as a brainstorm in the beginning of the project. Not often the link is made to cost and schedule management*”.

For “Top-Management Commitment”, three out of four respondents felt that the management doesn’t use risk management reports to make decisions, “*The RM result stays within the project and top-management they don’t ask for that or we don’t supply it. If the management start to use that, it can be improved*”. An explanation can be the fact that risk management has just been implemented in the organization since 2016. And they sensed that the roles performing risk management process within the organization are not defined, “*There is limited roles only in project management, but the rest of the organization, so for engineering, supply chain, commissioning etc. there is no real authority or accountability there*”. It also connects with the statement “There is an experienced team/person responsible for risk management” in the next aspect.

In “Culture and Personal Knowledge”, “1”or “4” is given by all interviewees about “risk attitude, as the process analyst said, “*Only a few people is aware for example I think the technical director knows his risk attitude, but he cannot represent Huisman Equipment. And if you ask me whether the management is aware of their risk attitude, I think it will also be limited because I am sure in the same management team, the previous CEO has completely different attitude (risk seeking) with the previous COO (risk avoiding)*”. So there are people don’t have such knowledge or people have the knowledge but don’t make agreement on it.

From the perspective of the project management officer, “*Only few projects we have the formal risk management session. As I am working in the PMO (project management office), I push project managers really to organize that and if I don’t push, they probably don’t do it*”. However, a project manager suggested, “*I hope PMO arranged the session because if I as a PM organize it, I cannot really anticipant it*”. Another project manager actually benefits from PMO organizing the risk management session. But he noticed, “*Opportunities are less defined, but if we define, we treat it similarly*”, which can be seen from the difference score for threat and opportunity regarding “Risk Assessment” and similar score for “Risk Treatment and Mitigation”, “Monitor and Review”. Statement mentioned “risk appetite” in “Risk Assessment” was rated lower.

Most of the statements in “Risk Treatment and Mitigation”, “Monitor and Review” were graded low. The project management office explained that the current risk log used by the organization is not formally

done as the treatment strategy only contains mitigate and accept, no transfer for instance. Similarly, risks are updated but not specifically as written in the statement "active, managed or occurred". Furthermore, time and cost of treatments are not considered in the project context. The process analyst mentioned, "*The procedure for cost and schedule is very messy, we don't updated because there is no procedure*".

4.2.7.3. Improvement Areas

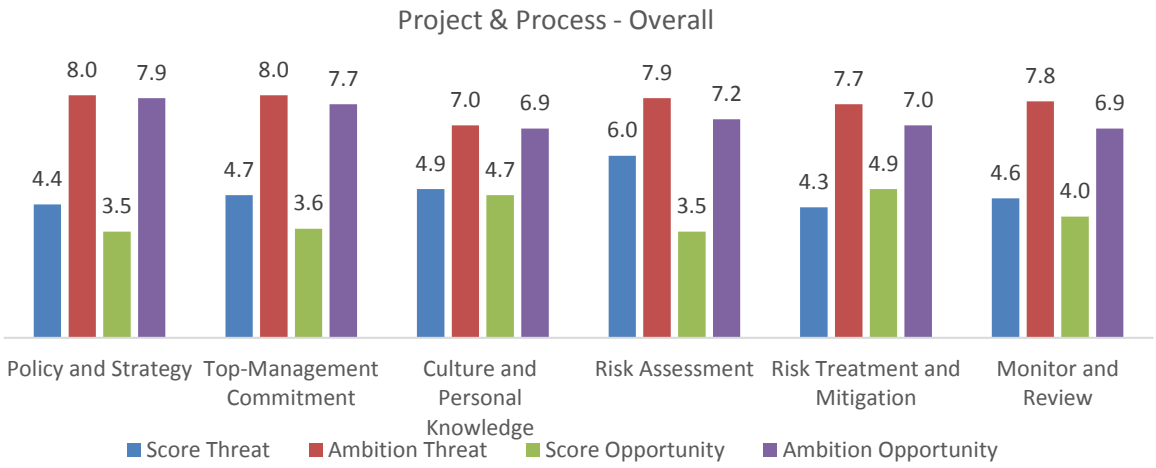


Figure 34 Score with Ambition on Average – Project & Process (Threat & Opportunity)

Comparing other aspects, "Policy and Strategy", "Top-Management Commitment" have lower score for current situation and higher score for ambition which can be seen as the focal points for improvement. The project management officer pointed out the problem of not following a procedure, "*I think in general risk management (or other procedure) is difficult to follow in the organization. Everyone is enthusiastic about solving problems, creating a process, but they don't stick to the process. On one hand, the organization is difficult to stick to a process, on the other hand, if it is too flexible then everyone just do their own staff. Then people start to ask about the process*". He suggested more support from the management for process also he highlighted, "*Risk management and other processes in the company are made in a bottom-up approach. Then it can't reach top management well and top management don't check if processes are followed*". So the way of making process and the following actions from the top should be improved.

The gap between current situation and ambition is lower in "Culture and Personal Knowledge". E.g. three of them thought people don't get enough risk management training, but the importance and ambition of the statement related is lower as told by a project manager, "*You need to use the team what they are trained for. They don't need much of this knowledge for their job*". However, they all agreed that there is barely no experienced team/person responsible for risk management, high importance and ambition were given. As a result, an independent team/person taking charge of risk management is recommended.

For “Risk Assessment”, the identification of threat is within a satisfactory level, but opportunities are not well defined which is an area for enhancement. The treatment, control and review of risk also require changes. The project management officer who organized the risk sessions noticed, “*For the RM session, it is difficult to follow up. Some project managers don’t transfer e.g. the result of risk log in their day to day business. Then the team will experience risk management is not an integrated part of a project. Besides, people don’t take project meetings seriously, it is due to the culture of the company*”. Making people concentrate on project is necessary and the previously mentioned project driven organization is a solution. A project manager said, “*Sometimes in project, we write done the measures in a detailed way but then it wasn’t used. So the next time when people define again the risk, they won’t put too much effort. I think people see less the benefit of RM, they see good planning or cost report as core activities, and they never experience the benefit of risk management*”. Both of them mentioned people in the organization don’t have such way of thinking and it takes time for people to be more active in project and understand what can be gained from a formal risk management process. Moreover, both of the project managers expected sessions that several project managers or managers sitting together and speaking out their experience over risk management. So more communications among (project) managers will also contribute to it.

4.2.7.4. Summary of the Outcome (Project Department and Process)

Table 10 demonstrates the average result over two project managers, one project management officer and one process analyst. Threat was scored higher than opportunity however, they all had a higher ambition of improving the management of threat.

project & Process	Organization Area			Application Area		
Aspects	Policy and Strategy	Top-Management Commitment	Culture and Personal Knowledge	Risk Assessment	Risk Treatment and Mitigation	Monitor and Review
Threat	4.4	4.7	4.9	6.0	4.3	4.6
Ambition	8.0	8.0	7.0	7.9	7.7	7.8
Opportunity	3.5	3.6	4.7	3.5	4.9	4.0
Ambition	7.9	7.7	6.9	7.2	7.0	6.9
Result	Current situation: Threat > Opportunity Ambition: High ambition in threat					
Statements in GRMM	Low in: Organization commits resource for risk management; Risk appetite; Risk management is integrated with project management	Low in: Management use risk management for decision making /communicate goals and strategies of risk management; Defined roles performing risk management	Low in: Risk attitude	Low in: External stakeholder involvement	Low in: Defining different strategies for treatment (reduce, avoid, transfer, accept)	Low in: Updating of risks
Comments interviewees	We are at a low maturity level of risk management; Risk management is not often connected with managing cost and time	Risk management has just been implemented since 2016	People have different attitudes and they don't communicate	Only few projects, when client asks, they are involved	Even the risk log in the previous step is not mature	Generally risk session is not for all projects still
Reason behind	No clear strategy and objective	People don't and not used to work accordingly to procedure	Lack of communication	No formal procedure	For control measures of risk, e.g. "transfer" is not included, procedure is not formally done	No formal procedure

Table 10 Summary of outcome – project department and Process

4.2.8. Interview within Directors

Six department heads from sales, engineering, supply chain, production, commissioning & testing, after sales participated in the interview. The director in sales didn't fill the model. Besides, the results from the director of production scored much higher in all six aspects due to highlighting safety risks which is mentioned in chapter 6.2 Limitations so his outcome will also not be used for the discussion below. In addition, the director of supply chain didn't fill the opportunity, the director from commissioning & testing (C&T) filled everything but later he told that he cannot fully understand opportunity so only the opportunity results from director of technique and director of after sales are taken into account.

4.2.8.1. Results of GRMM

Threat:

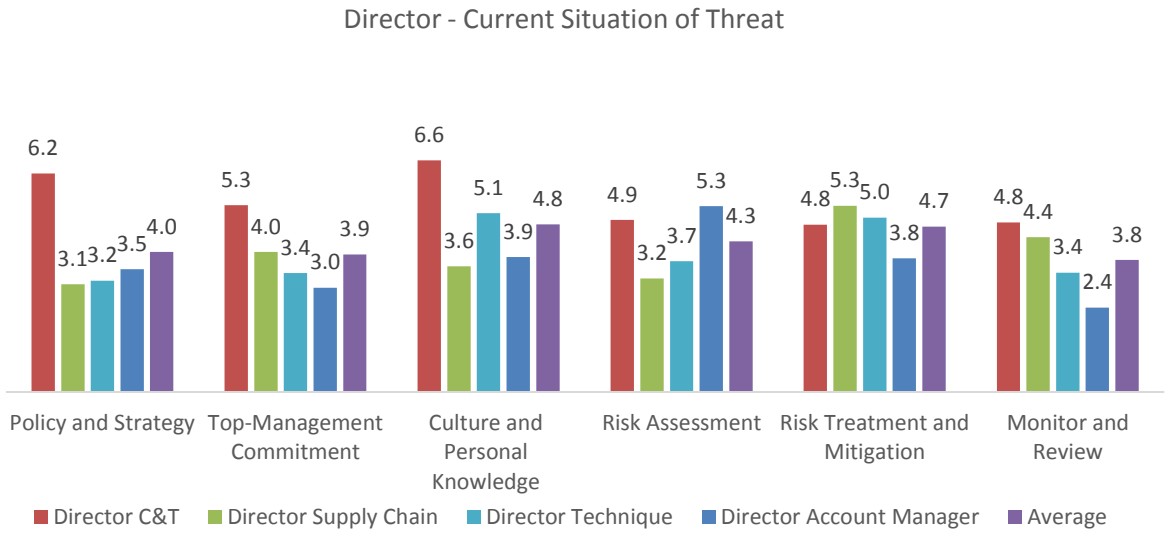


Figure 35 GRMM Result Value – Director (Threat)

The director C&T scores higher in the organization area (first three aspects) but the difference is only bigger in "Policy and Strategy" so all in all, the average score is reliable. There is no difference between the organization area and the application area (last three aspects). What is more, the average result for all the aspects are below 5 which means directors realize the current situation of risk (threat) management is not mature.

Opportunity:

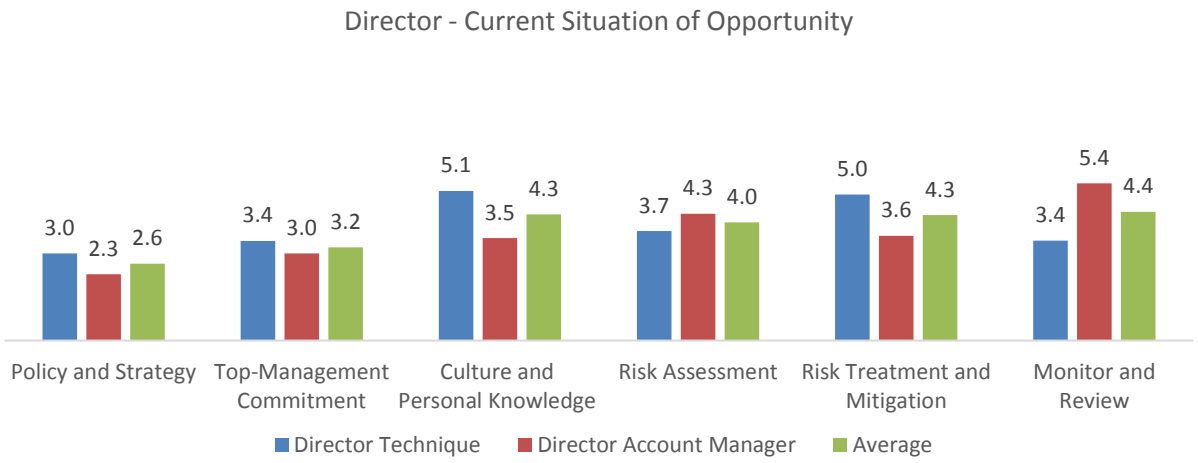


Figure 36 GRMM Result Value - Director (Opportunity)

The two directors provided similar scores for all aspects regarding opportunity. Application area got higher outcome than organization area. Still, all aspects score lower than "5", opportunity management is also not mature. "Policy and Strategy", "Top-Management Commitment" have the minimum scores, little resources are dedicated to manage opportunities, top-management doesn't use that for making decisions.

4.2.8.2. Discussion of the Results

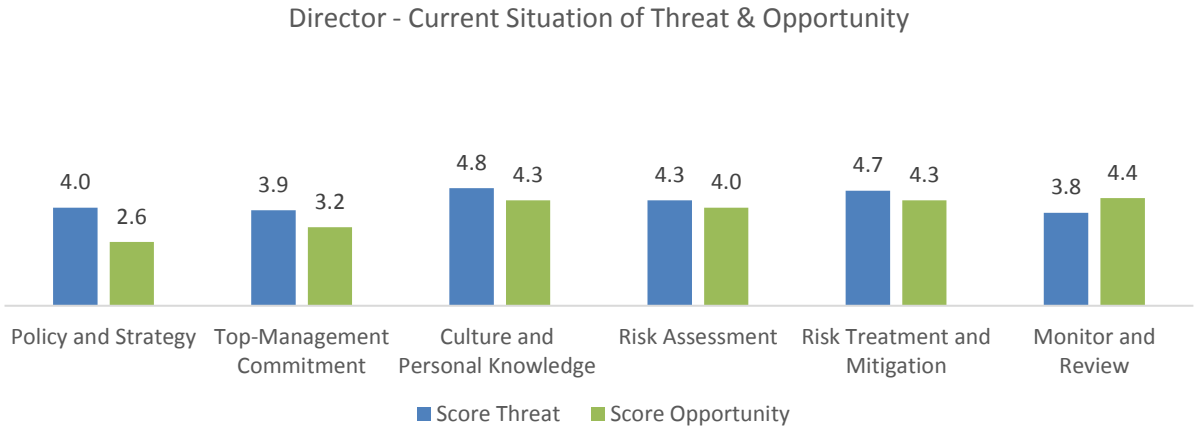


Figure 37 Score on Average – Director (Threat & Opportunity)

From the figure, negative side of risk management performs better in the organization area and for the application, threat and opportunity are being managed equally. All the aspects were rated under "5" so that risk management need to be improved.

For the "Policy and Strategy" all the directors put "1" and "4" for statements about "objective". One director mentioned, "*We have only identified objectives on sub-components but not as a strategy for our company*". The other responded, "*I am not aware of them, this is not a topic I have to follow up from my side, I don't have priority to ask for that*". So the risk management objective is not on the agenda. "Risk

appetite" is not internally communicated as said by the technical director, "*For risk appetite I don't think at the moment we have it well transferred from top to bottom. On the upper level, the people know the risk or opportunity but we do not translate down*". All of them pointed out the lacking of database. The director in C&T interpreted, "*I don't think there is a database to collect all the information about risk management. I recognized that there is no fixed database that we register all risk management results*". Another mentioned that there are scattered database but not in line and not uniformed.

"Top-Management Commitment" also got very low score and the respondents all indicated top-management doesn't communicate goals and strategies of risk management within the organization. At the same time, they could not provide an explicit reason. One said, "*I haven't heard from them, strategy is something that we are trying to communicate now but not related to risk management*". The other simply replied, "*I don't know why but it is a fact*".

As to "Culture and Personal Knowledge", all the directors found that the personal lacks openness and trust in reporting risk. One explained, "*I think the project keep the big problems to themselves for too long. Try to solve by themselves instead of asking knowledge people. We should unlock the available knowledge within the company, it is more effective for the project*". When this comment was discussed with another interviewee, I got one possible reason is that the risk tolerance is not clear for the different roles so that people don't know what certain risks they need to report and what are their boundaries. Another director mentioned, "*There are no people to report, e.g. I was reporting risks but nobody did anything with that risk. They don't response or take seriously*". Reporting is not only bottom-up but also need feedback loops.

When defining risks, all managers sensed that the risk owner of each risk is not clear, which is apparently an improvement area as one respondent said, "*I don't know who is responsible. If you sign a risk owner, he/she will be more eager to mitigate it*". Most of them found key external stakeholders don't participant in risk identification. One mentioned, "*It is not standardized within our organizational procedure*". The other made it more precise, "*I think those things are discussed with e.g. suppliers but it's not seen formally as part of risk or project management*". A problem can be discovered here as external stakeholders are part of the project.

The statements regarding external stakeholders in "Risk Treatment and Mitigation", "Monitor and Review" were rated lower. One respondent pointed that risks are taken without really thinking over which may be suppliers' risk. Even more, he added, "*Sometimes we take the product (from suppliers) and think we can modify by ourselves. Actually we make the risk, we think we know better (than the suppliers)*".

4.2.8.3. Improvement Areas

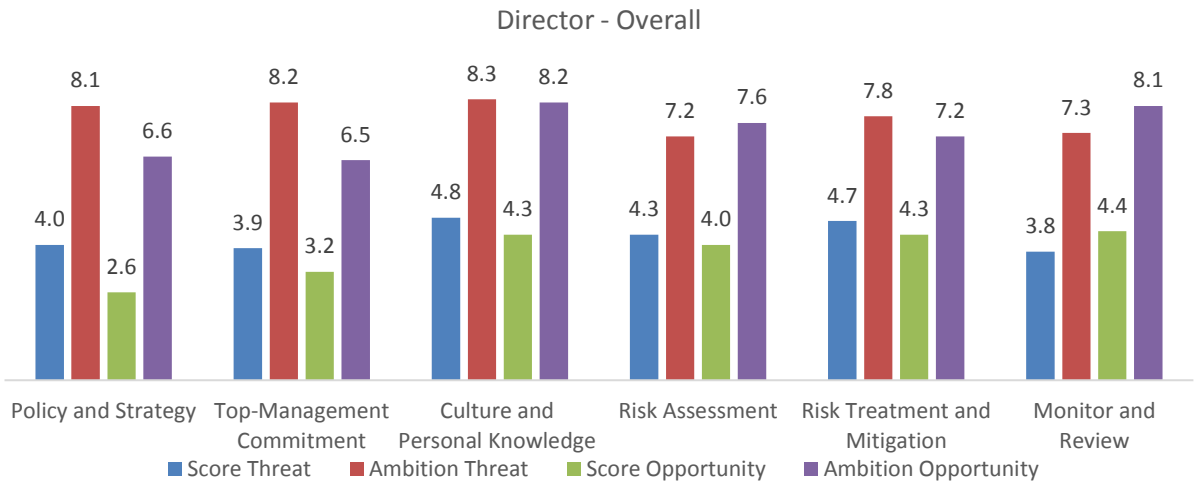


Figure 38 Score with Ambition on Average – Director (Threat & Opportunity)

In the organization area, ambitions are higher in threat, but for application area, director has similar ambition for both sides of risk. From the figure above, "Policy and Strategy", "Top-Management Commitment" can be recognized as priorities for growth. As discussed in the former part, it's not clear within the organization who is responsible for what risks (threats) and how to take decision on a certain risk, one manager said, "*Everyone is looking up*". Thus, clear borderlines for risk management in different levels within the organization must be set up. Managers are also in favour of an integrated database as stated by one of them, "*We have different tooling within departments. But what we should have is an IT department which can connect those systems, to draw report out of the systems for one complete risk management log from the individual systems*". Some managers believed risk management is higher on people's agenda and they have a lot in place, but the focus is structured information. The data can be shared so personal knowledge about risk will be developed. Three out of four managers put high importance and ambition for the personal training, one answered, "*I don't know why people don't receive enough training but I think it is a wrong decision*". So besides project managers and managers, certain roles require more risk management knowledge.

Regarding risk management procedure, one manager mentioned, "*After the procedure is in place, we have to use examples to show the people that it works, to make people aware that if you do little more work in the front, we can save lots of work in the end*". At this moment, it is mentioned that people feel it as additional work. Besides asking people to follow the instructions, the manger asserted, "*The important thing is to make people know why they have to do it. When people know why and see the result, it can motivate people*". Referring to the answer from a project manager, it is important that people really see the benefit of it. Moreover, as stated by one manager, "*I think some people are not aware of risk management, as they don't see the impact on other part of the organization*". So the benefit does not just stay in the department, but throughout the project/organization, which also fits the changing process into a project driven organization. Another respondent revealed, "*Everything we do is risk based and value*

driven. Just the understandings among departments are different. What we are doing is not wrong, but we don't have a common understanding on risk management". Such deviations in understanding will also be mitigated if the organization can successfully transferred. For the managing of risks, a manager specified that the organization can get a big gain by properly managing suppliers and sub-contractors.

4.2.8.4. Summary of the Outcome (Directors)

Table 11 is the overall outcome of all the directors interviewed. Threat was scored little higher than opportunity but they all stayed at a low level. Meanwhile, they put higher ambition in threat.

Directors	Organization Area			Application Area		
Aspects	Policy and Strategy	Top-Management Commitment	Culture and Personal Knowledge	Risk Assessment	Risk Treatment and Mitigation	Monitor and Review
Threat	4.0	3.9	4.8	4.3	4.7	3.8
Ambition	8.1	8.2	8.3	7.2	7.8	7.3
Opportunity	2.6	3.2	4.3	4.0	4.3	4.4
Ambition	6.6	6.5	8.2	7.6	7.2	8.1
Result	Current situation: Threat bit better than opportunity but both are below a basic level Ambition: Higher ambition in threat					
Statements in GRMM	Low in: Risk management objective; Risk appetite; Database; Risk management is integrated with project management	Low in: Management communicating goals and strategies of risk management	Low in: Openness and trust in reporting risk; Risk attitude; Personal training	Low in: External stakeholder involvement; Owner of the risk	Low in: Defining different strategies for treatment (reduce, avoid, transfer, accept); Sub-contractor/supplier risks	Low in many statements
Comments interviewees	Risk management is scattered among departments	We are trying to communicate strategies but they are not related to risk management	People keep it within the team; Or when report, no enough response from the top	It is not standardized	Besides pushing people follow the process, they should understand the importance of risk management	
Reason behind	No formal procedure; Information is not being shared	Need to change to project driven organization	Risk tolerance, responsibilities for different roles are not well defined	No formal procedure	People haven't experienced the benefit of risk management, lack of training	No formal procedure

Table 11 Summary of outcome – Directors

4.2.9. Interview within Top-Management and Big Move Office

The (previous) Chief Operating Officer (COO) and process analyst in the big move office were interviewed. The COO didn't fill the score for opportunity as he said, "*We focus on mitigating risk/threat, and we have lots of mitigation work to do, not finding opportunities. E.g. when you see an opportunity from a new supplier, that is managed by supply chain or purchase strategy on the organizational level. In project, we don't want to define something new. It's always an additional risk if you put new technology in a project with scheduled lead time and scheduled cost (fixed scope and delivery date). Except for Research and Development project, that is another type of project*". Besides, he scored higher in all aspects comparing with others as he also explained at the end of the interview, "*I think I am the most positive guy. Because within project management, we are already working with risk management for quite some time. When you look from other departments, first they don't see what we are doing, they are not aware about the information. Also, within some departments, they are at the beginning of this kind of activities (risk management)*".

The process analyst in the big move office filled in both threat and opportunity and explained he scored lower as he has been working in supply chain department before so he knows more from the operational standpoint. Considering their different experience within the company and later the outcome of this part will be seen as one layer for further comparison, accepting only one result is unilateral, an average score is suggested. Since the COO only filled the threat, the score for threat is going to be analysed in this section solely.

4.2.9.1. Results of GRMM

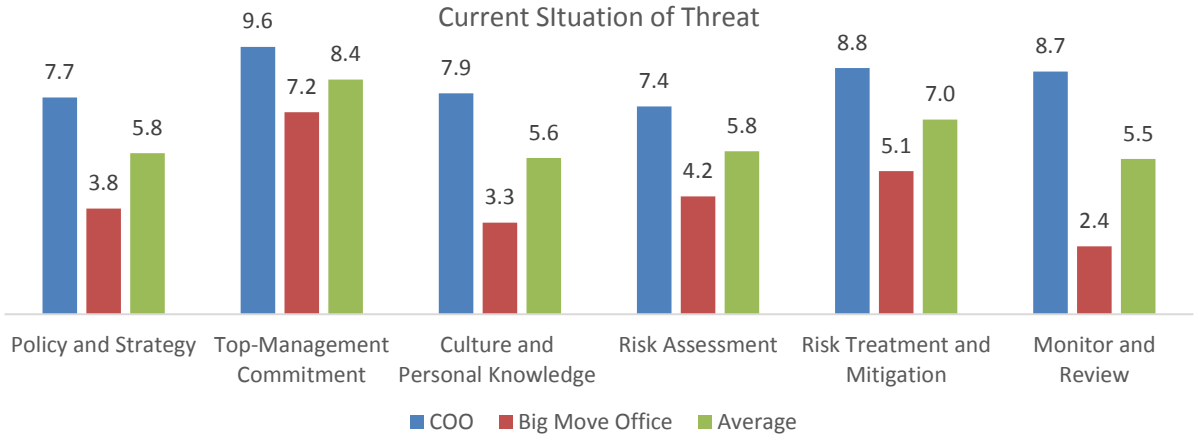


Figure 39 GRMM Result Value – COO & Big Move Office (Threat)

Differences exist in most aspects as mentioned already respondents have different experience in this organization and also from earlier interviews, even in top or management level, people don't have an agreement on risk management. In "Top-Management Commitment", both of them gave a high score so that top management support and use risk management. "Risk Treatment and Mitigation" received a "7"

which indicates assessed risks are being coped with professionally. The average score of all aspects are higher than 5, threats are normally under control.

4.2.9.2. Discussion of the Results

Despite that the COO put high numbers for most of the statements in "Policy and Strategy", he gave "4" to both the statement related to "procedure that report risk management to internal/external stakeholders" and "database". He stated, "*We have everything in excel and we are not sharing it. All people are doing their own project and they are not sharing the overall knowledge because it is not the priority. Also the system is not very easy to share (with excel sheets). If you have a perfect tool e.g. a database, it is far easier*". There is a big difference in the scoring of statements related to process and documentation, the process analyst explained, "*We don't have a proper process. Our quality management system is not good, we have a strong informal organization people tend to arrange things informally. We have some in project management but in many departments, there is no risk management process*". Hence, the functionality of the risk management procedure is questionable.

"Top-Management Commitment" got a very high score, which is higher than the other two aspects in the organization area for the two interviewees. Nevertheless, as the process analyst admitted, "*Top-Management supports it, but doesn't commit resources. And they have limited influence because many things don't go to top-management. For instance the COO is active and encourage risk management, but it doesn't get executed in the layer below*". This can be confirmed from the words of COO when answering why a lower score was given to the statement about defining roles to perform risk management, "*It is part of my job to make people aware about the impact if they don't perform risk management according to the guide. I have to give more attention, which is also due to priority issue*". Therefore the result here is arguable as support and commitment without enough action is not sufficient.

Both of them put lower numbers for "risk attitude" and "responsible person/team for risk management" in the "Culture and Personal Knowledge" aspect. According to the COO, "*Some people are more aware of the risks than others. And many people don't understand risk is not something that cost your time and money, instead it saves time and money. The training of awareness is not enough, it also depends on the type of people*". Thus, there is a gap of knowledge and some even lack the elementary, and the COO continued, "*I hope everyone can focus on risk*".

As for the identification of risk, they agreed that currently, key external stakeholders are not often participate in the identification, moreover, the internal involvement is not enough. Quantitative risk analysis is barely performed, the COO said, "*It is not the priority and not business as usual for everyone*". The process analyst had a more detailed explanation, "*The reason is that we don't have data, we can*

identify the risks and we think we can estimate the possibility, but not time and cost impact. And we are not required to do so, something is more urgent and important for many, but we should have it".

They didn't share the same opinion on statements in "Risk Treatment and Mitigation", the COO thought that most of the steps are taken care of including "secondary risks", "residual risks" while the process analyst believed they are not been dealt with. The situation is similar regarding "Monitor and Review", however they acknowledged that the risk management process is not evaluated and updated regularly.

4.2.9.3. Improvement Areas

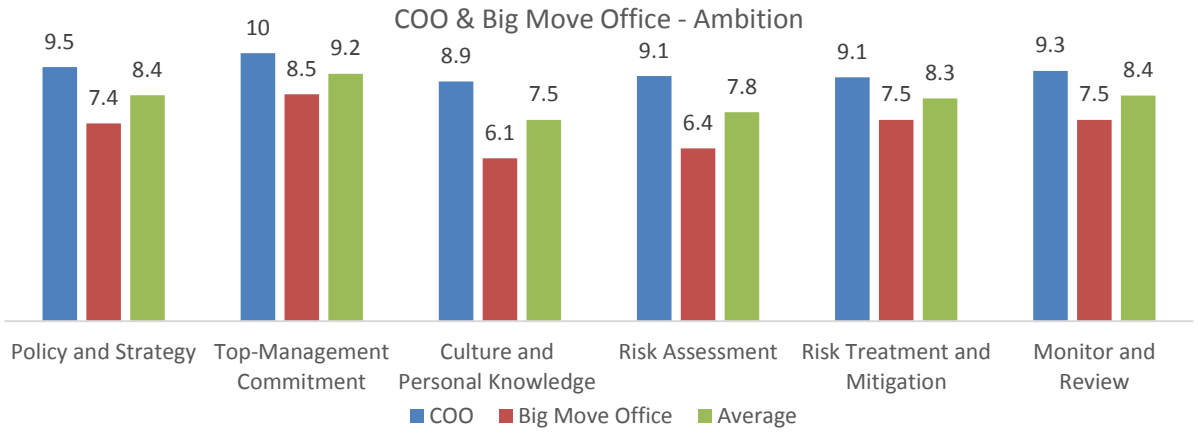


Figure 40 GRMM Result Ambition – COO & Big Move Office (Threat)

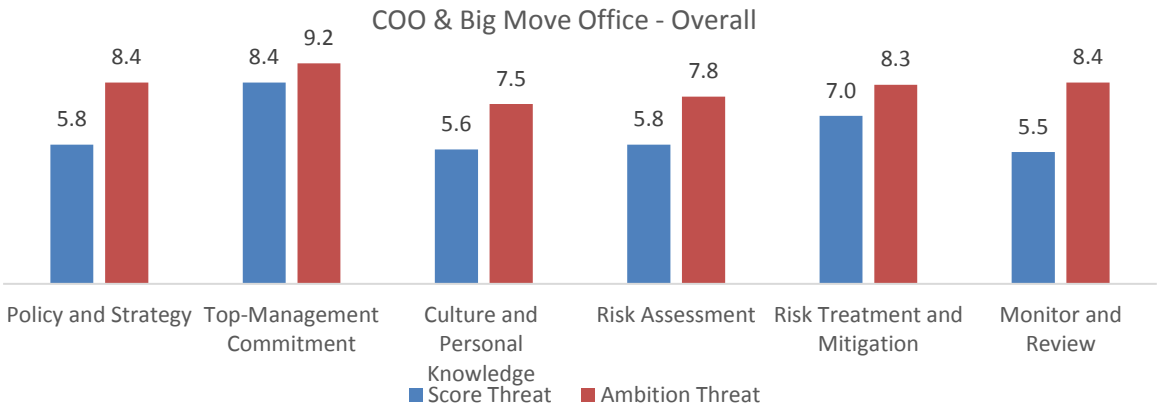


Figure 41 Score with Ambition – COO & Big Move Office (Threat)

The COO has higher ambition in all the aspects, it is apprehensible as he scored higher. "Top-Management Commitment" has the highest ambition, the score is high but as discussed formerly, the score is debatable so it can be spotted as the improvement area. Management should take actions to show the importance of risk management. For the other two aspects in organization area, a remark from the process analyst associated with is, "*The culture is very incidental reactive so we don't have the habit to foresee the things (risks) coming and do more incidence management. There exists a 'fire-fighting' culture*". It can be presumed that more effort have been put on incidents rather than risks. Moreover, it was told that (top)

managers spend many time working on incidents so their measures carrying out risk management will decline. And some people cannot distinguish between risk and incident. The first step, in line with what the COO advised, "*It is a step-by-step approach. Primarily, get the risk in people's mind, discuss about it from monthly base to weekly base for instance*". Thus, basic training is necessary also a formal procedure is required as the process analyst pointed, "*We need a good, solid process of risk management first, modify that later*".

Based on the figure, in the application area, "Risk Assessment", "Monitor and Review" have more room for enhancement. They both acknowledged that risks are defined, however the identification of each risk is restrained, e.g. external stakeholders are not involving, risks are not quantified etc., it can also be felt in the risk meetings of the organization, people are not actively participating, some steps are not obligatory for the project team. Most of these can be fixed through enforcement from the top.

4.2.9.4. Summary of the Outcome (Top-Management and Big Move Office)

Table 12 is the overall result from the COO and process analyst in the big move office. The given score reflected that risk is being managed but comparing with the higher ambition, there are still plenty of improvement areas.

COO & Big Move	Organization Area			Application Area		
Aspects	Policy and Strategy	Top-Management Commitment	Culture and Personal Knowledge	Risk Assessment	Risk Treatment and Mitigation	Monitor and Review
Threat	5.8	8.4	5.6	5.8	7.0	5.5
Ambition	8.4	9.2	7.5	7.8	8.3	8.4
Result	Current situation: Risk (threat) is being managed Ambition: High ambition in "Top-Management Commitment"					
Statements in GRMM	Low in: Database; Procedure of reporting risk	High in: Management encourages and supports risk management	Low in: Risk attitude; Risk management team	Low in: External stakeholder involvement	Low in: Secondary/residual risk treatment	Low in: Update of the process
Comments interviewees	We don't have a proper process, people don't have the priority to share information	Top-management encourages risk management, but it doesn’t get executed in the layer below	People have different awareness regarding risk management	Even for analysing, we don't have enough data and it is not priority	People focus more on incidents instead of risk	
Reason behind	Due to the culture, people tend to arrange things informally	Not enough push from the top	No enough training, some people don't have enough knowledge about risk	Not enough push from the top	"Fire-fighting” culture	No formal procedure

Table 12 Summary of outcome – COO and Big Move Office

4.3. Comparing the results

For comparison, the interviewees are divided into three groups:

1) Operation, including 2 technical project managers, 1 supply chain manager, 1 production manager, 1 C&T manager and 2 account managers.

2) Management, including director in technique, supply chain, C&T, after sales, plus 2 project managers, 1 project management officer and 1 process analyst.

3) Top-management (strategy), including the COO and 1 process analyst from the big move office.

4.3.1. Comparing among the roles

Before discussing among the three layers, the different roles in operational level will be compared. For the 2nd group, previous chapter has separated it into "management" and "project department & process" so these two sub-groups are going to be integrated. The 3rd group has already been analysed.

4.3.1.1. Comparing among the departments (within the 1st group)

Threat:

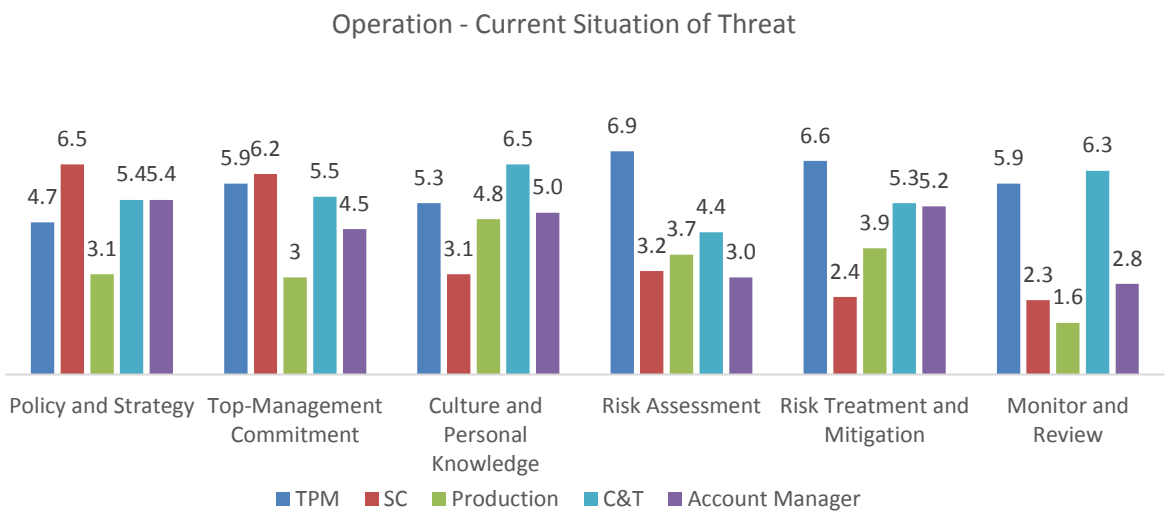


Figure 42 GRMM Result Value - Operation (Threat)

It can be noticed in the figure that technical project managers perform better in the application area of risk management, the score from production department is lower in most of the aspects. The differences is not distinct for other departments. Generally, organization area is better rated than application area.

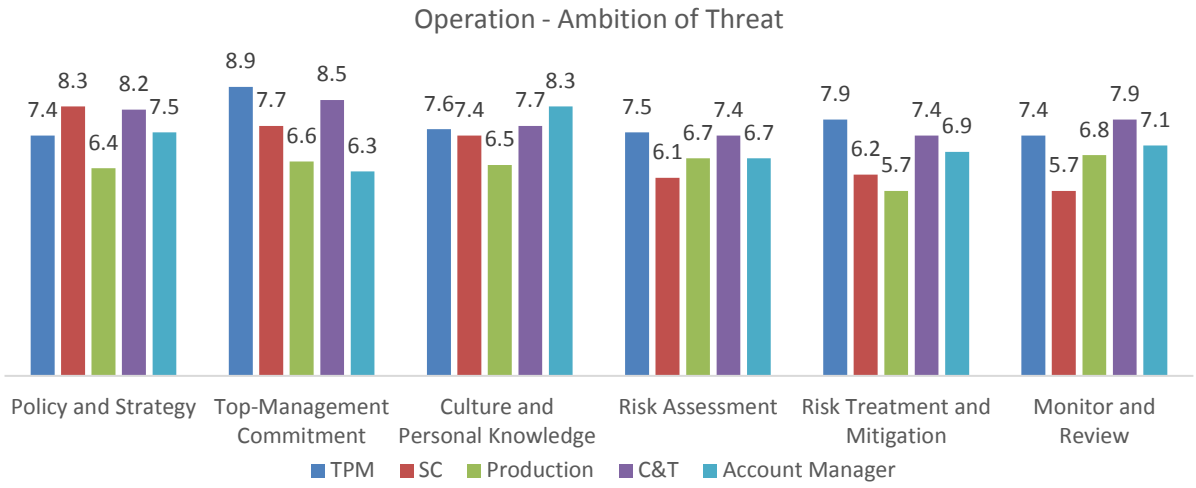


Figure 43 GRMM Result Ambition - Operation (Threat)

Differences regarding ambition of threat for respondents from the five departments are small, production manager has lower ambition in most of the aspects, supply chain manager doesn't have high ambition in the application area. Overall, interviewees have higher ambition for the organization area.

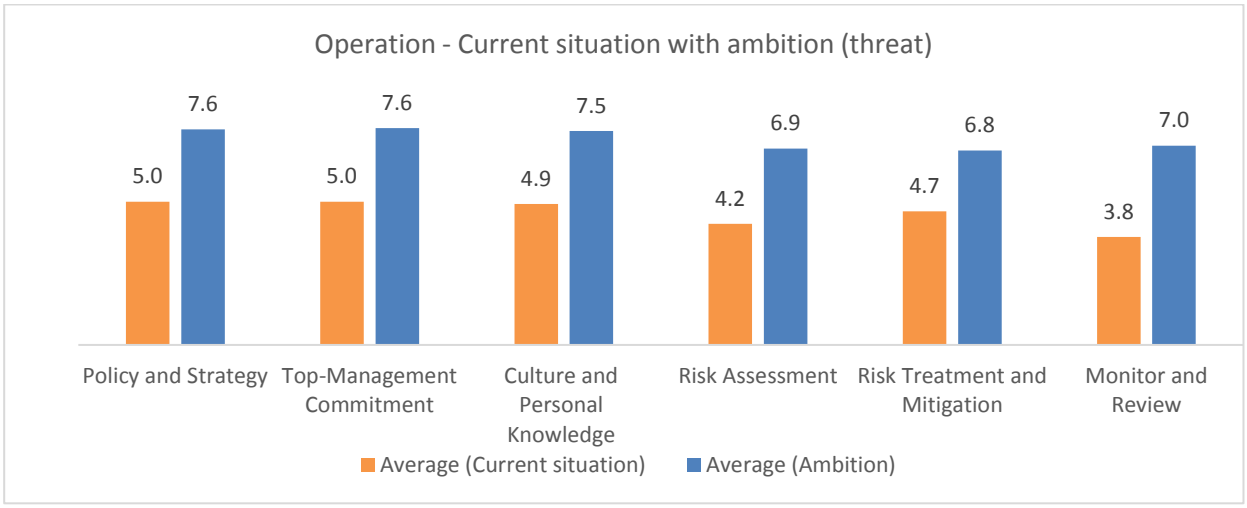


Figure 44 Score with Ambition – Operation (Threat)

For the risk (threat) management of people from the departments, organization area is rated higher both regarding current situation and ambition.

Opportunity:

Only technical project managers and supply chain manager gave scores for opportunity.

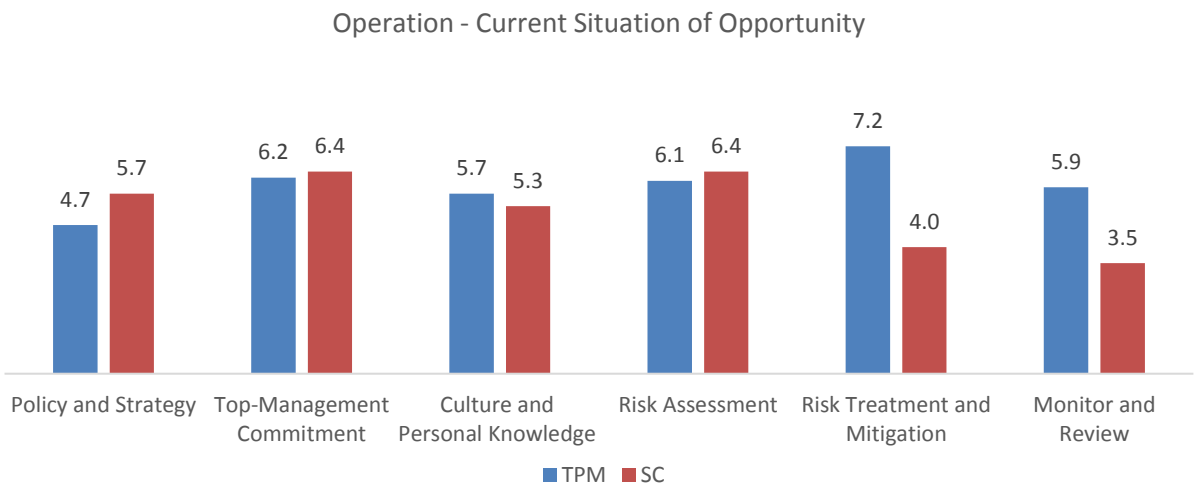


Figure 45 GRMM Result Value - Operation (Opportunity)

The figure demonstrates that engineering department treats and controls opportunities better than supply chain department, for other aspects, they have similar behaviours.

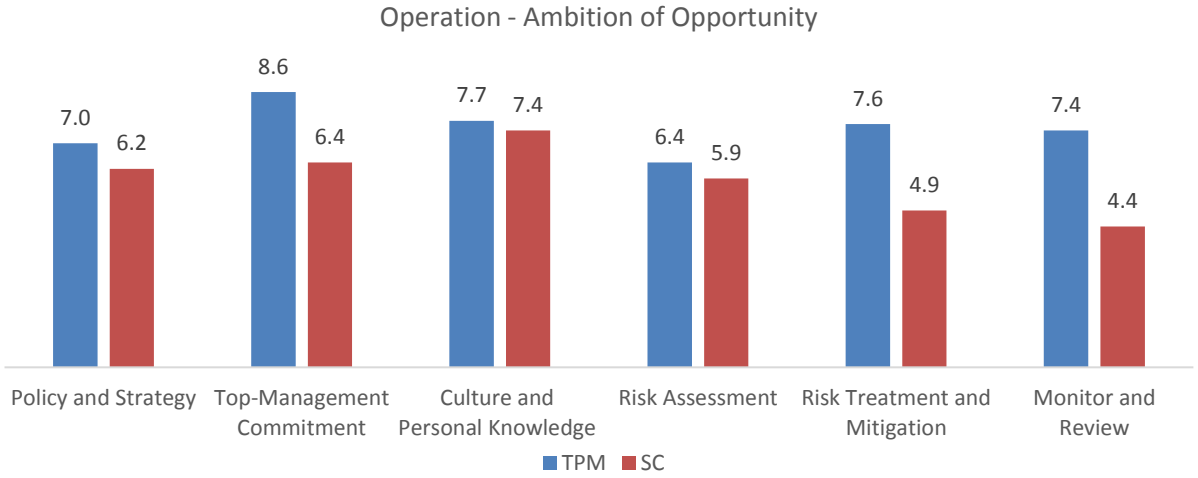
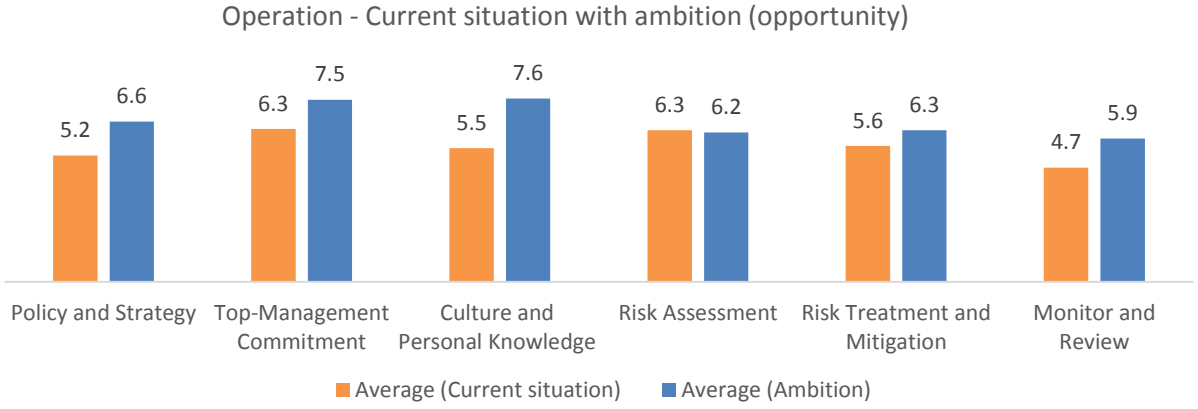


Figure 46 GRMM Result Ambition - Operation (Opportunity)

From the data above, it is clear that technical project managers had a higher ambition for managing opportunities, especially in the application area.



For managing opportunity, high ambition appears in the organization area. In application area, the current situation is very close to the ambition.

Overall:

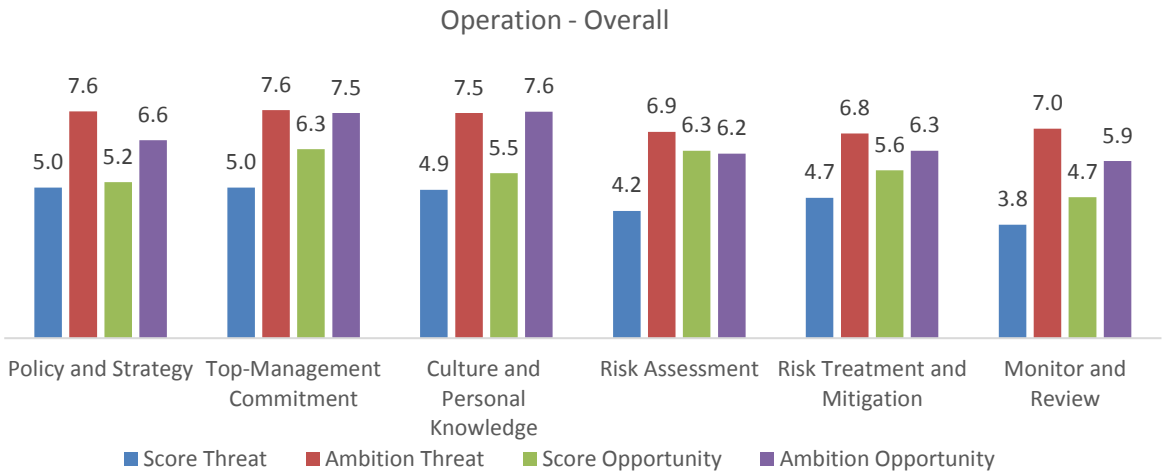


Figure 47 Score with Ambition on Average - Operation (Threat & Opportunity)

An overall score of operation is in the figure, which shows for operation, current situation of opportunity is better than threat, however, operation group put more ambition over threat. Besides, result shows they have more ambition in organization area. For application area, they do not want to improve the current situation of opportunity as it is satisfactory.

4.3.1.2. Summary of the Outcome (Operation Group)

Table 13 presents the average result for all the interviewees in the operation group. For the current situation, opportunity was better managed but they showed higher ambition in threat

Operation	Organization Area			Application Area		
Aspects	Policy and Strategy	Top-Management Commitment	Culture and Personal Knowledge	Risk Assessment	Risk Treatment and Mitigation	Monitor and Review
Threat	5.0	5.0	4.9	4.2	4.7	3.8
Ambition	7.6	7.6	7.5	6.9	6.8	7.0
Opportunity	5.2	6.3	5.5	6.3	5.6	4.7
Ambition	6.6	7.5	7.6	6.2	6.3	5.9
Result	Current situation: Opportunity > Threat Ambition: Threat > Opportunity					
Common low scored statements in GRMM	Database; Risk appetite	Management communicating goals and strategies of risk management	Personal training	External stakeholder involvement; Owner of the risk	Defining different strategies for treatment (reduce, avoid, transfer, accept)	Low in most of statements
Common comments interviewees	No structured procedure; Scattered in departments	Management works differently	More focus on departments; Departments have different risk management maturity level	Project teams are not actively involved, think it takes too much time	Bad at managing external parties (sub-contractors, suppliers)	Less involvement
Reason behind	No formal procedure, need to change to project driven organization	Not enough push from the top	Lack of communication	No formal procedure	No formal procedure	No formal procedure

Table 13 Summary of outcome – Operation group

4.3.1.3. Comparing among the management (within the 2nd group)

Threat:

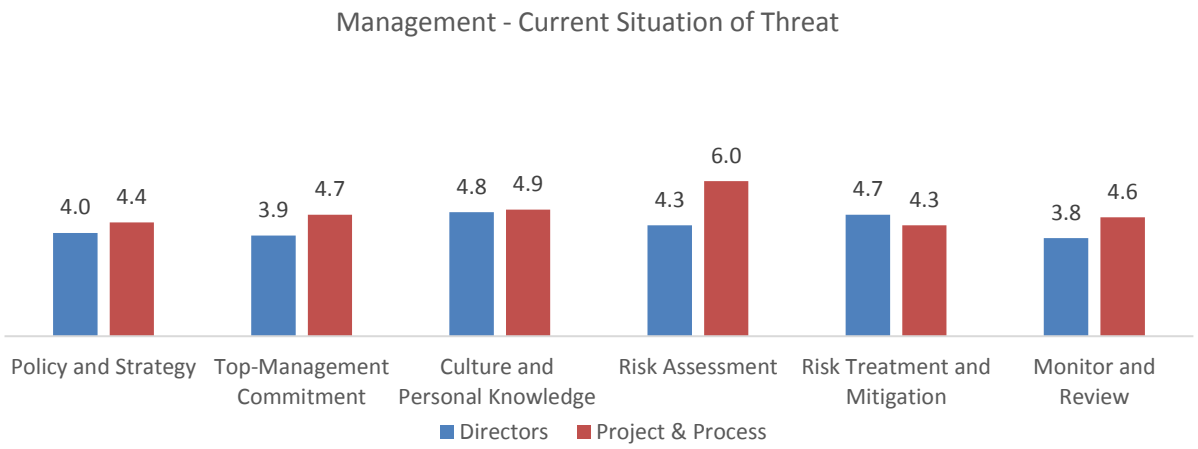


Figure 48 GRMM Result Value - Management (Threat)

Project & process interviewees scored higher than the directors but the difference is small.

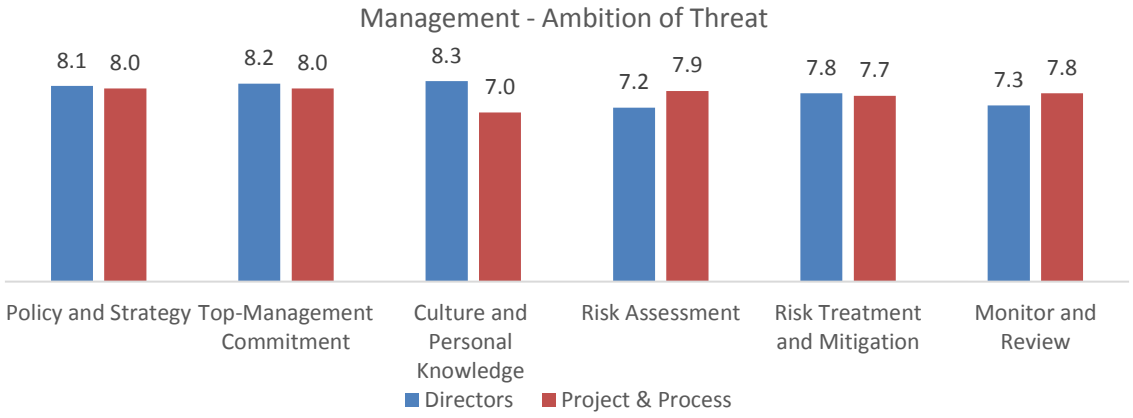


Figure 49 GRMM Result Ambition - Management (Threat)

Similar scores were given in most of the aspects according to the figure above.

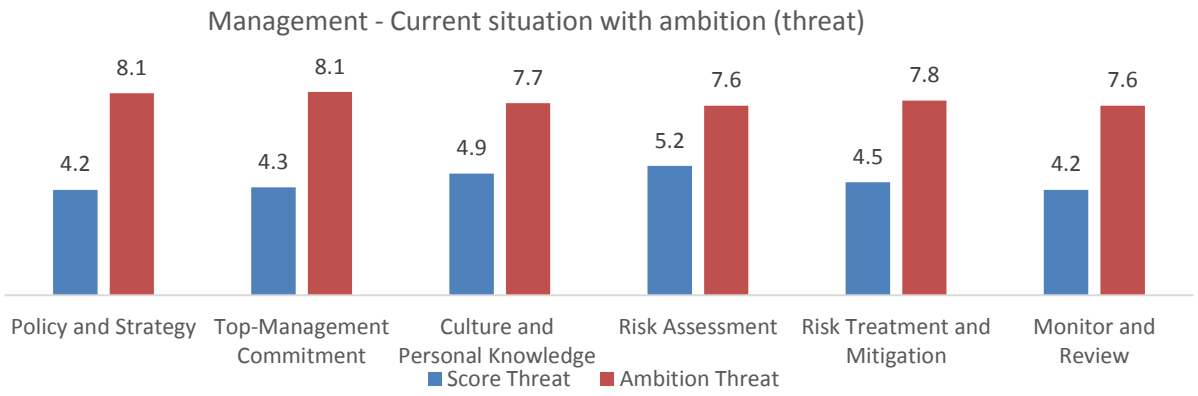


Figure 50 Score with Ambition – Management (Threat)

For management, there is no big difference between organization area and application area regarding current situation and ambition, the gap is bit larger in “Policy and Strategy”, “Top-Management Commitment”, which can be recognized as growth direction.

Opportunity:

Interviewees from project and process all filled the opportunity whilst the director in supply chain and C&T didn’t.

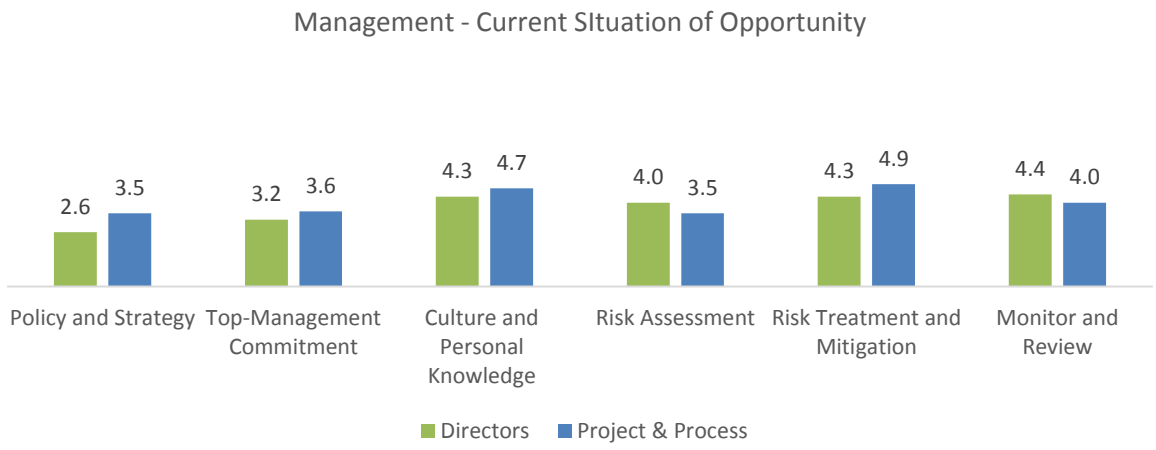


Figure 51 GRMM Result Value - Management (Opportunity)

All the scores are under “5”, therefore for management, opportunity is currently not being managed. “Policy and Strategy”, “Top-Management Commitment” is even lower which signified they are not in favour of opportunities.

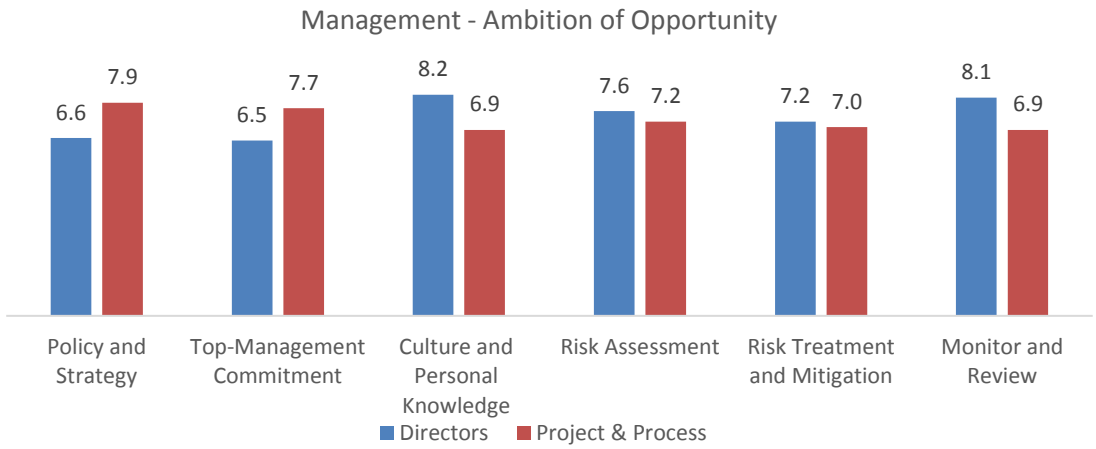


Figure 52 GRMM Result Ambition - Management (Opportunity)

Directors have higher ambition in the application area and they hope opportunities can be identified and treated. On the contrary, project managers and process analyst expect more support from top as they put higher ambition on “Policy and Strategy”, “Top-Management Commitment”.

Overall:

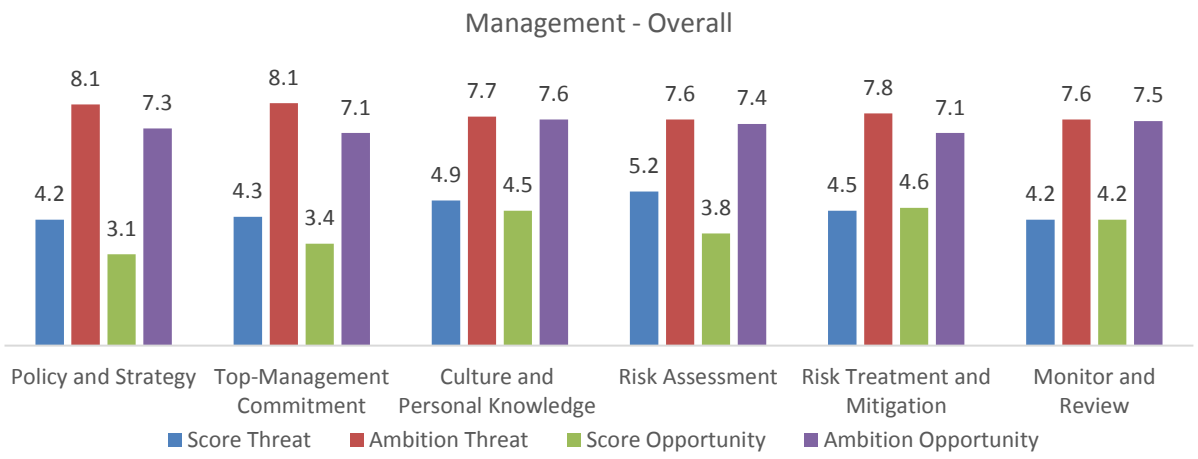


Figure 53 Score with Ambition on Average – Management (Threat & Opportunity)

Above is the overall score of management, current situation of threat is better than opportunity, notably in organization area. Management and top-management put more importance to threat as indicated by higher current scores as well as ambition in "Policy and Strategy", "Top-Management Commitment". Threat are identified more often than opportunities reflected from higher current score of threat in "Risk Assessment".

4.3.1.4. Comparing among the management (within the 2nd group)

Table 14 gives an overall of the results from all the respondents from the management group. They believed threat was better managed than opportunity even though both of them were in a low maturity level and they had higher ambition also in threat.

Management	Organization Area			Application Area		
Aspects	Policy and Strategy	Top-Management Commitment	Culture and Personal Knowledge	Risk Assessment	Risk Treatment and Mitigation	Monitor and Review
Threat	4.2	4.3	4.9	5.2	4.5	4.2
Ambition	8.1	8.1	7.7	7.6	7.8	7.6
Opportunity	3.1	3.4	4.5	3.8	4.6	4.2
Ambition	7.3	7.1	7.6	7.4	7.1	7.5
Result	Current situation: Threat > Opportunity Ambition: Threat > Opportunity					
Common low scored statements in GRMM	Database; Risk management is integrated with project management	Management communicating goals and strategies of risk management	Risk attitude	External stakeholder involvement	Defining different strategies for treatment (reduce, avoid, transfer, accept)	Low in many statements
Common comments interviewees	Risk management is not mature in the organization		People don't communicate enough within team and between layers	It is not being regularly used in projects	Same as before	Same as before
Reason behind	No clear strategy	Lack of communication and push from the top	Responsibilities are not clearly defined	No formal procedure	Same as before	Same as before

Table 14 Summary of outcome – Management group

4.3.2. Comparing among the groups

For the threat, all three groups are compared and for the opportunity, as in the Top-Management Group only the process analyst filled this part, operation group and management group will be studied.

4.3.2.1. Managing threat

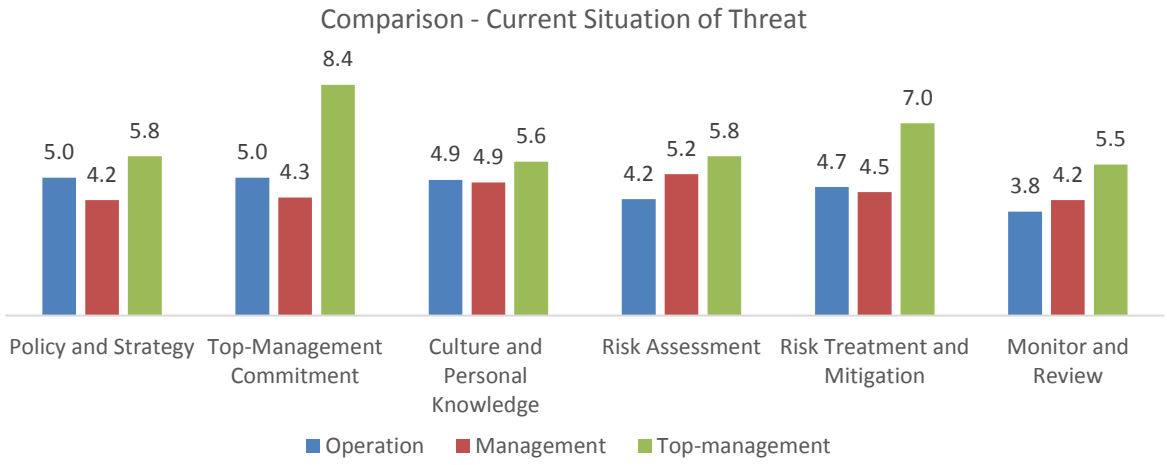


Figure 54 GRMM Result Value - Comparison (Threat)

It is very obvious that top-management put a higher score in every aspect. The distinction between operation and management is not noticeable, operation scored higher in organization area.

For the "Policy and Strategy", all the groups placed low score over "database" and statements related to "risk management procedure" are also lower. Top-Management put the highest score in this aspect as risk (threat) management has only been implemented in the company since 2016, so the top-management receives more information on the policy and strategy level. But, they are not satisfied with the current procedure since for all the groups, risk management is something not high in their priorities and it is not being followed in a constant manner. Also, there is not a uniformed database and only scattered databases exist in departments. Then information is not easy to be transferred and it will affect the internal communication. Operation and some respondents in management gave low numbers on statements about "risk appetite". One reason is that for some interviewees, "risk appetite" is something new for them. Another reason is that there is a difference in the statement regarding "risk management objectives" where top-management thinks it is defined and documented but the objectives are not reaching management and most of the people in operation. Moreover, top-management believes "*risk management is integrated in the project management approach*" which is disagreed by many. The primary reason can be right now, people concentrate more on their own department rather than projects, but for top-management, they can see over several projects.

There is a considerable difference in “Top-Management Commitment”. Top-management itself supposes risk management is supported and encouraged, it is used in the decision making. Nevertheless, top-management admits organization doesn’t commit enough resources to risk management from a statement in the previous aspect. Therefore, it directly influences the score from management. Operation even put a higher score which can be explained that management gives more real support on risk management comparing with top-management. Since management group has a direct influence on operation group. As mentioned by COO, he knew that more attention is needed to make it executed. Through observation, top-management is using risk management for the decision making as related documentation was displayed during the interview. However, some management people and many in the operation group put low score in this statement (“management uses risk management reports to make decisions”). It may be partly due to the immature reporting procedure and such reports are not shared among the project team.

The groups give a medium score for “Culture and Personal Knowledge”. Most of the interviewees kept low scores for statements linking with “personnel training” and “team/person responsible for risk management”. Throughout the interviews, it is noticed that the level of the understanding of risk management is different, not only among groups or departments, even within the same department. From one interviewee, management also some managers e.g. technical project managers receive training on risk management and people are invited to join the risk session, but the interviewee said that the procedure is fake so these are not on the agenda. For the independent risk management team, currently there is only a risk manager in the engineering department responsible for only the technical risks. Perhaps that is the reason why engineering department has the highest score in the application of risk management among departments. But there are many other types of risks and the benefit of having an independent team/department is mentioned by many. For people in operation, filling in different kinds of risk assessment is timing consuming, for project managers, they want to participate in the risk meeting instead of organizing it.

In “Risk Assessment”, all the groups acknowledged that key external stakeholders are not participating in risk identification, only few clients, the ones with structured process are active and asked for that. It is basically because that the organization itself is not mature in risk management and more often than not, some key internal stakeholders are not involved. It goes similar for the statement on the outcome of risk assessment, project teams are not always updated let alone external stakeholders. Many interviewees scored lower for “quantitative risk analysis”, at the same time, the importance of the statement is not high. As explained by some respondents, currently they have to focus on previous steps e.g. better identification and quantitative analysis is something afterwards.

Top-management rated much higher on "Risk Treatment and Mitigation", actually in department as engineering, they have similar score on this aspect. The reason that top-management has a higher score can be referred to from an interviewee that technical risks normally got more attention in the organization. So regarding dealing with identified risks, there are huge gaps among the departments. That brings the low score of management especially project managers as they can see the performance in all the departments. It is worth noticing that sub-contractor and supplier risks are not sufficiently managed as reported by interviewees in all the groups and in projects, many risk fired because of these external parties. As a consequence, top-management should concentrate more on risks from outside and not only try to mitigate risks but also transfer part of that.

All the groups have the lowest score on "Monitor and Review" which is reasonable as this is the last step of risk management process. Without a good risk identification and treatment, risk cannot be monitored and reviewed. The statement "The entire risk management process is regularly evaluated and updated" were rated low by almost all respondents as discussed in "Policy and Strategy", the scores related to "process" are low. As interviewee from project department pointed, "*Process such as risk management is difficult to follow in the company, everyone is enthusiastic about solving problems, creating a process instead of sticking to it*." On one hand, processes are being made, on the other, people don't follow it or just question about it. What is more, project managers talked about the benefit of risk management and people have never felt it so that with proper review of risk management procedure, people can be more aware of what we gain by doing it.

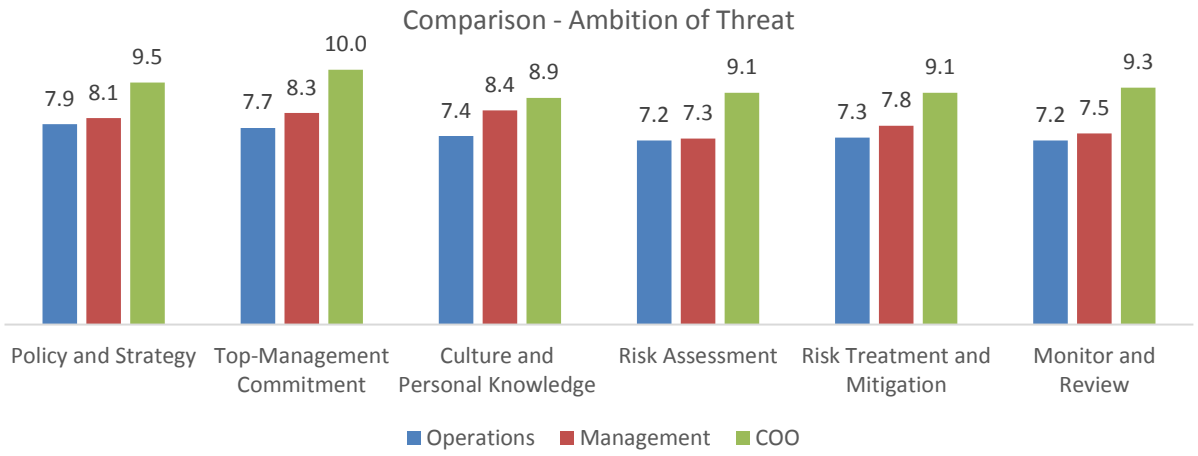


Figure 55 GRMM Result Ambition - Comparison (Threat)

It is undoubtedly that top-management is the most ambitious group. Management and operation gave lower ambition as mentioned by a people in the management group stated, "*I want to put a '10' on many statements for the ambition, but I put a '7' instead, as I know it is impossible to be '10' and I will be more realistic*."

For all the groups, “Policy and Strategy”, “Top-Management Commitment” hold the most ambition which indicates the root cause of lacking maturity in risk management. Top-management gave the highest in “Top-Management Commitment” as for themselves, they understand the importance of risk management. As stated by the COO, he hopes everyone can understand and use it. However, more resources must be committed from top, to make people trained, to set up solid procedure, database and other tools. Application area has lower ambition and it is assumed that the by upgrading the first two areas, better application can be accomplished afterwards.

4.3.2.2. Managing opportunity

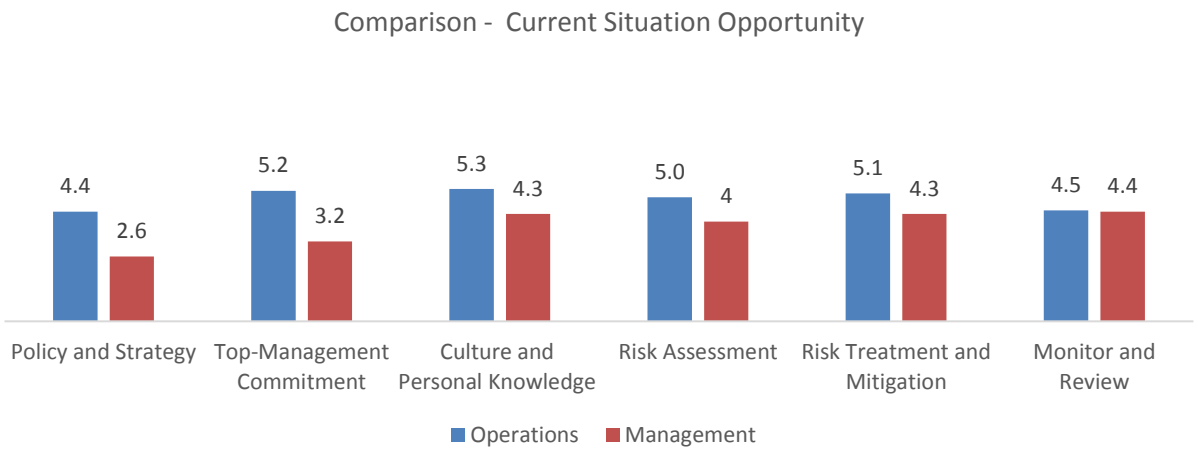


Figure 56 GRMM Result Value - Comparison (Opportunity)

Operation group obtains higher scores in all aspects. The participants in the operation groups are mainly engineers and according to an interviewee in the management group, engineers can see many opportunities and try to sell more. Besides, “development log” was mentioned by a respondent where possibilities of improvement (can be considered as opportunities) can be placed. It was also stated that people can foresee opportunities better, and as an innovative company, it is believed that people, especially in the operational level are more passionate about opportunity than threat. Some respondents mentioned that many people don’t understand by spending time and money on threat, they can benefit from that later. Ironically, another interviewee stated for opportunity, people know that with some extra work, they will have better quality and save time or cost.

Nonetheless, there is no formal procedure for managing opportunities. For instance, the risk matrix has only the negative side, for the risk log, normally people don’t know they can also put opportunities in that. During the risk session, participants discuss more about threat and some opportunities such as a new technology being applied in the project is considered as more of a threat. So in a project, the formal identification session concentrates on threat. Due to many informal way of identifying and treating opportunities, operation group puts a higher rate. The differences in “Risk Treatment and Mitigation”,

"Monitor and Review" are smaller as explained already, for management, if an opportunity is defined, it will be treated similarly as a threat.

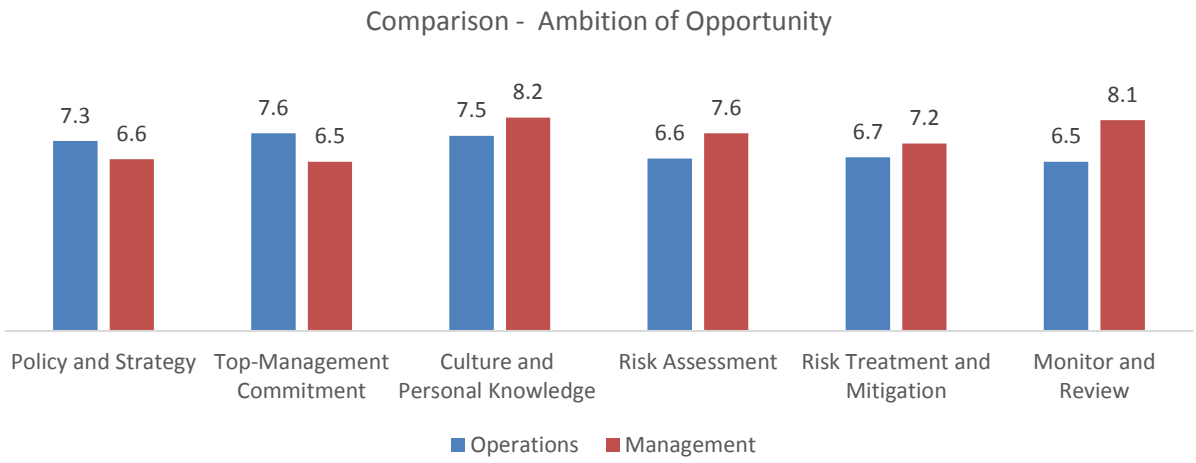


Figure 57 GRMM Result Ambition - Comparison (opportunity)

For ambition, oppositely, management seems to be more ambitious, chiefly in the application area. Based on a project manager, he admitted that opportunity is always been forgotten as the positive side of risk. Hence, they are aiming at thinking of opportunities throughout risk management procedure. But considering the current maturity level of managing threat is deficient, in general they have higher ambition in threat.

4.4. Overall risk management maturity level in Huisman Equipment

The GRMM was used to test the risk management maturity level in Huisman Equipment and the outcome of 17 interviewees were taken into account. Details of the results from each department as well as comparison among three groups (operation, management and top-management) has been discussed and the figure below presents the average score of all the 17 people.

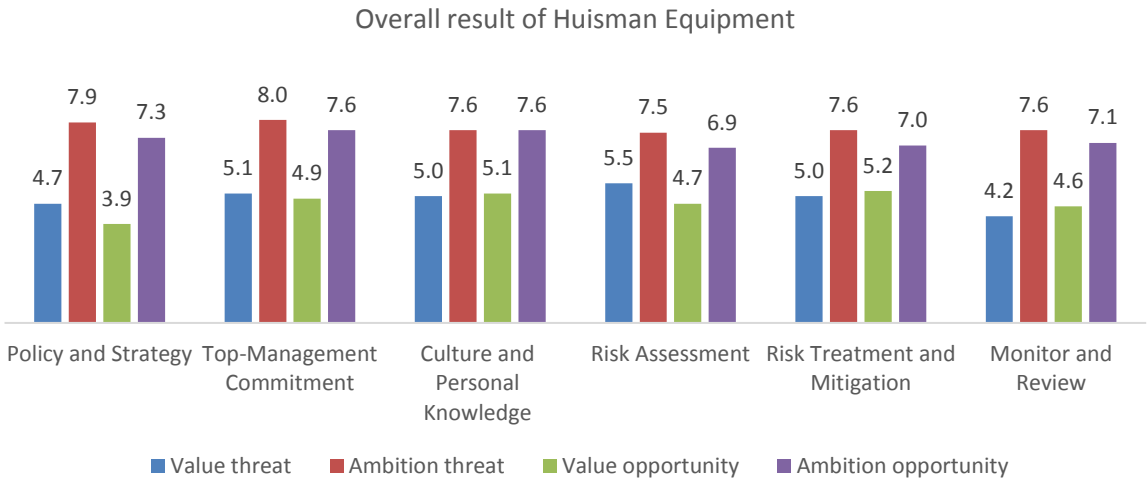


Figure 58 Average result of all selected interviewees - Huisman Equipment

Regarding the current situation (value) of risk management, it is immature in all aspects, while engineering department has a relatively higher maturity level among departments. There is no big difference in managing threat and opportunity. As an innovative company, it was assumed that Huisman Equipment performs better in the opportunity management. For the operation group, it turned out that respondents gave higher scores in opportunity, but for the management and top-management group, threat is better scored. The reason can be as mentioned by some interviewees in the management group that people in the operation group such as engineers, are intelligent who want challenge but for managers, they want to make sure the work is done with less threats. So that on an organizational level considering all the groups, there is no distinction between the current situation in managing threat and opportunity.

When talking about high ambition score and relatively low score for current situation, it indicates plenty of space for enhancement. Management and top-management group are more positive and have higher ambition than the operation group. Even though the difference is not obvious, it can be seen that threat got higher score for ambition in almost every aspects, which also applied to the majority of respondents who agreed to start with managing the negative side of risks.

4.5. Expert Session

After the analysis, an expert session was held for validating results and receiving inputs from the experts.

4.5.1. Preparation for the Session

4.5.1.1. Selection of the Experts

Seven experts were chosen to participant the session. Four of them had already joined the individual interview and three other experts who had not been to the previous interview recommended by the Expert A (from the table below) were invited. Certainly, short meeting regarding background information of the GRMM and this research with these 3 experts were taken before the session.

Expert ID	Role	If filled the GRMM
A	Process Analyst in Big Move Office	Yes
B	Group Leader Service Offering, HEU Sales	Yes
C	Global Discipline Manager C&T	Yes
D	Manager Operations	Yes
E	Senior Quality Assurance Coordinator	No
F	Project Manager	No
G	Process Analyst from Supply Chain Department	No

Table 15 Participants of the Expert Session

The activities for the expert session is available in Appendix B.

4.5.1.2. Input for the Session

Due to the time limitation of the expert session (90 minutes), only part of the findings from the interviews were used as input which finalised into three adjusted statements from the GRMM.

Primarily, 6 statements that most of the interviewees gave low score were determined:

1) The organization/project has a database for collecting information about risk management;
2) (Top) Management communicates goals and strategies of risk management within the organization/project;
3) The organization/project is aware of its risk attitude;
4) Key external stakeholders' involvement (risk identification, risk assessment outcome etc.);
5) The identified sub-contractor/supplier risks are communicated to relevant parties;
6) Per risk (a) control measure based on different strategies (reduce, avoid, transfer and accept etc.) is defined.

Besides, 3 statements that people had different opinions on (some interviewees put very high score while others scored very low) were found:

7) The organization has a documented process for risk management;
8) Risk management objectives are in line with organization strategy;
9) Risk management is integrated in project management approach of the organization.

After discussion with one of the participants, it is suggested to remove statements that:

a. experts cannot have a big influence on, for example strategies and something on a very top level including statement 8), 9);
b. experts are likely to put the responsibility (such as develop some new methods) on others which related to statement 1), 7);
c. not very specific, like statement 3).

In statement 2), if "top" is removed, then it became something that participants (mostly on the management level) could have impacts on. Statement 4) and 5) are about managing suppliers and subcontractors which can be combined. Lastly, statement 6) is very precise so that the basic input (adjusted statements) are:

1) Management communicates goals and strategies of risk management;
2) Define control measures to treat risks (reduce, avoid, transfer, accept etc.);
3) Properly manage risks from sub-contractors and suppliers.

4.5.1.3. Chosen Method – Value Proposition Canvas

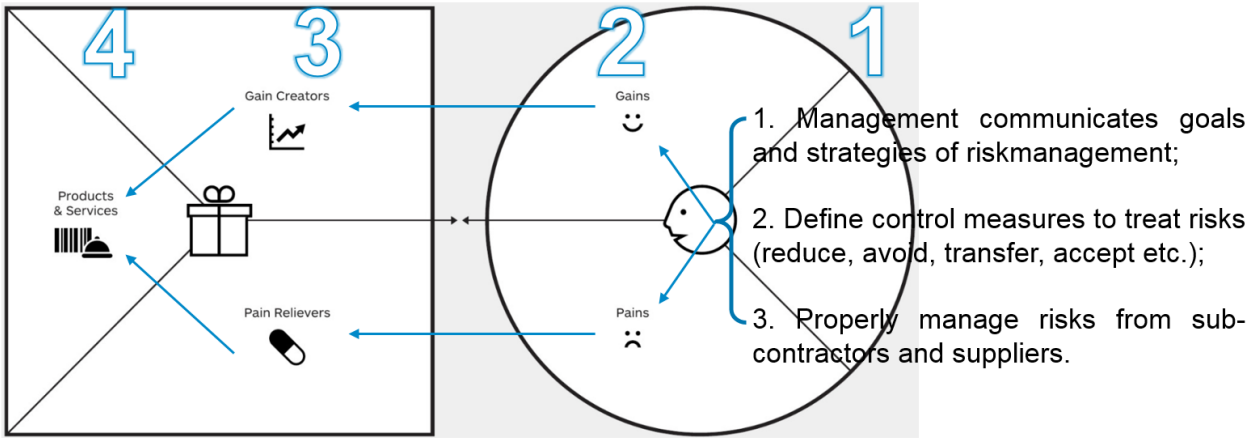


Figure 59 Steps in Value Proposition Canvas (Osterwalder, Pigneur et al. 2014)

As mentioned in chapter 2.3.5, Value Proposition Canvas is the chosen method for the expert session. From the figure above, this approach consists of 4 steps. The starting point is 3 statements chosen and adjusted from the GRMM based on all the individual interviews. Possible gains and pains linked with statement 1, 2 and 3 are presented after discussion with one of the experts and comments during the individual interviews:

Pains:

Statement 1. Management communicates goals and strategies of risk management.

1-1 People behave differently;

1-2 Risk management is considered as burden;

1-3 Risk-related information is not sharing among teams and departments;

1-4 Lack of responsibility and involvement;

Statement 2. Define control measures to treat risks (reduce, avoid, transfer, accept etc.).

2-1 Focusing on incidents instead of risks;

Statement 3. Properly manage risks from sub-contractors and suppliers.

3-1 Take extra/unnecessary risks;

3-2 Out of control in projects.

Gains:

Statement 1. Management communicates goals and strategies of risk management.

1-1 Process related can be followed;

1-2 People can report risks better;

Statement 2. Define control measures to treat risks (reduce, avoid, transfer, accept etc.).

2-1 Risk can be controlled proactively and solved in advance;

2-2 Benefits for lessons learned;

Statement 3. Properly manage risks from sub-contractors and suppliers.

3-1 Use the knowledge from external parties.

The experts will validate those pains and gains, then each of them come up with as many solutions as possible for all the pains and gains as “pain relievers”, “gain creators”, which is step 3. For the last step, the experts are going to be separated into groups of 2 people and come up with conclusions within groups, then every group present their solution, finally brainstorm to make agreements.

4.5.2. Outcome from the Session

4.5.2.1. Solutions from individual experts

After some introduction of the research, also 3 chosen statements with pains and gains, the experts agreed on all the input. Then they came up with plenty of solutions individually for each pain and gain as listed in Appendix C.

It can be noticed from all the solutions that many of them are intertwined and they can be classified into solutions related to “process and procedure”, “tooling”, “awareness of risk management”, “risk coordinator/department” and “external parties”:

1) “Process” is the focus – “Set up a uniform, clear, followed up process, start from sales through execution till service, used regularly with lessons learned and based on (top) management governance”;
2) “Tooling” is important to the process – “Establish accessible reporting tool with the support of a central database”;
3) “Awareness” is lacking – “Demonstrate the benefits of managing risks, compliment actions such as addressing risks”;
4) An independent “risk coordinator” or “risk department” is suggested – “Appoint a risk coordinator, he or she can assign risk to its owners, make sure it will be solved, managed or accepted by someone”;
5) Managing “external parties” – “Make supplier/sub-contractor evaluation mandatory, enhance involvement of key external parties as well as relation management”.

4.5.2.2. Group suggestions and conclusion

Three groups were set up to come up with ideas from all the listed solutions or particular pains/gains they would like to pay more attention to.

Group 1 (Expert D - Manager Operations & Expert E - Senior Quality Assurance Coordinator) presented that they believe lack of responsibility and involvement is the root cause of the problem. Hence, they pointed out the necessity to have a central person stand on top of risk management (a risk coordinator). In addition, make contribution of everyone in the project team measurable with clear governance and goals throughout the project.

Group 2 (Expert B - Group Leader Service Offering, HEU Sales & Expert G - Process Analyst from Supply Chain Department) looked over all the solutions, tried to make them work together and proposed a process:

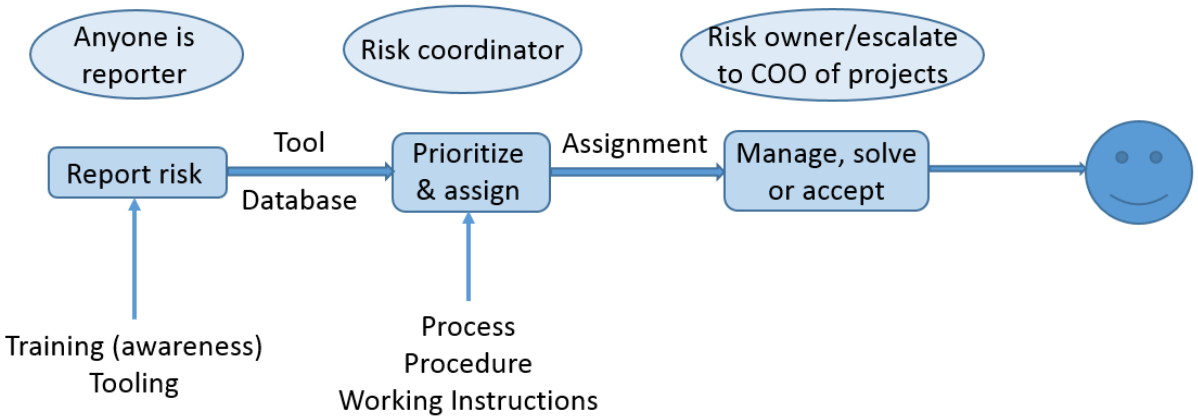


Figure 60 Risk process designed by group 2 in the expert session

Firstly, everyone can report a risk. But in order to achieve that, easy and accessible tools are essential. Also people within the organization need to be trained and be aware to do this. All the risk reported will be put in a database where identified risks should be assigned and prioritized. There is an independent risk coordinator who always informs the project about these risks. Besides, his or her judgement have to be based on process, procedure and working instructions in Huisman Equipment. The risk coordinator then assign the risk to responsible risk owner who will be accountable, make sure it will be fixed, managed or accepted by someone, with the possibility to escalate the risks to the COO of projects.

Group 3 (Expert C - Global Discipline Manager C&T, Expert F - Project Manager) focused on managing supplier. It was mentioned to make supplier evaluation outcome mandatory for supply chain decisions based on purchase order (evaluation can be risk based, delivery performance, financial etc.). The role of supply chain coordinator was highlighted, to receive inputs from reporting tools, aware of what is happening with the suppliers in projects and keep communicating with quality control. Apart from that, intensify suppliers' relation, and key suppliers' involvement.

The recommendation from group 1 that having a responsible risk coordinator is seen as the first step, while the action of reinforcing supplier/subcontractor management mentioned by the third group can

start. The suggestion from group 2 needs a much longer term as it requires advanced tools, database, mature procedures and working instructions.

5. Discussion

In this chapter, the result of GRMM from another research in Heijmans is used as comparison to make implication on manufacturing and construction industry. The experience with the model is further discussed. At last, it will talk about a debate between improving risk management and investigating knowledge occurred during the expert session.

5.1. Results of the GRMM

The overall result of Huisman Equipment is compared with the outcome of Heijmans, a construction company in which 9 interviews had been conducted with the same model in another research. Based on that, indication of risk management in the manufacturing industry and construction industry is explored.

5.1.1. Comparing with Heijmans

The model was originally designed to be used in the construction industry and similar research had been conducted in Heijmans, a construction company. Nevertheless, in that research, only negative part of risk (threat) was studied. So the average result regarding current situation of risk (threat) management of Huisman Equipment and Heijmans are compared in this part.

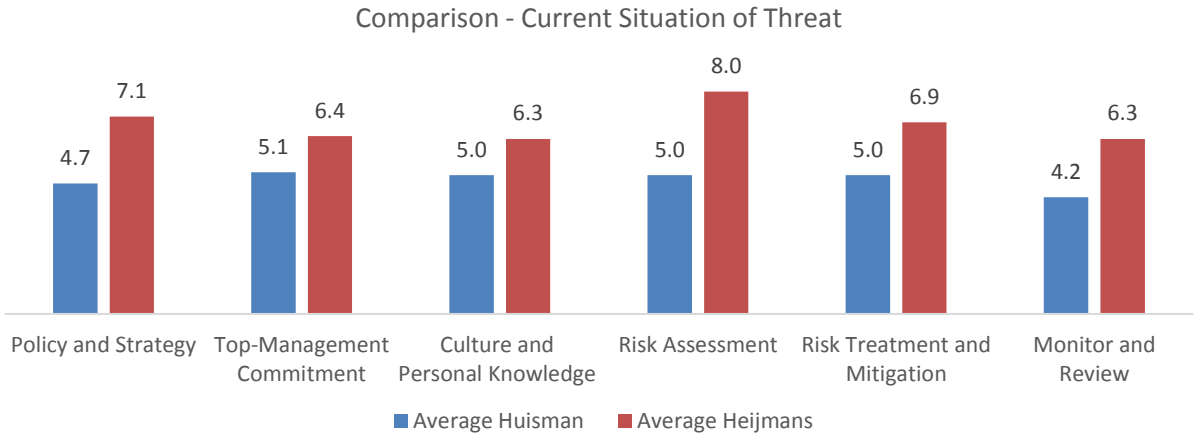


Figure 61 GRMM Result Value – Huisman and Heijmans

It can be observed from the *Figure 61* that Heijmans has a higher maturity level of risk management than Huisman Equipment in all the six aspects. The main reason is as mentioned, in Huisman Equipment, risk management has only been implemented in the company since 2016. The difference in the organization area (first three aspects) is smaller. In Heijmans, there is solid risk management process made from top and they have a mature level of risk management.

Although Heijmans has a mature risk management, Dyonne (2017) discovered several problems during the interviews for instance risk management is considered as burden, lack of overall risk awareness etc. and after comparing all the problems mentioned from the research in Heijmans with findings based on the interviews in Huisman Equipment, it is realised that the two companies shared similar problems:

1) Goals and strategies of risk management from (top) management is not clear. An explanation can be (top) management commits them but people have not recognized or be informed properly.
2) Maturity level of risk management differs among roles or even within the project team/same department.
3) Lack of risk awareness, there are people not (actively) involved and the experience of risk management need to be improved.
4) Independent risk department or coordinator is needed, even there are risk managers in Heijmans, people still complained there should be certain people proactive in making sure everyone is aware of risk and leading risk management.
5) Transformation from sales/tender phase to project execution, risk information gets lost or it is not uniformed.
6) Different maturity level between management and operation group. In Huisman Equipment, operation group lack of awareness and guidance while in Heijmans, the performance quality of risk management is not satisfied.
7) Lack of responsibility, in Huisman Equipment, there is no people responsible to follow up risk management process and in Heijmans, less ownership has negative influence on the risk management quality.

5.1.2. Indication for the two industries

This part plays as an implication for contributing risk management research based on the results from two industries: manufacture (Huisman Equipment) and construction (Heijmans) using the same model. Both of the companies design and construct complex, custom made project for clients, but one of the most significant difference between them is the organization form: Huisman Equipment is function oriented while Heijmans is more project based.

From a case study result (Hobday 2000), a project based organization is better in managing large, complex projects and can facilitate various knowledge to deal with project risks. As mentioned that the problem of managing supplier/subcontractor risk is critical in Huisman Equipment, according to Hobday (2000), it highlights in project based companies, project managers and senior engineers are able to visit key external parties more regularly so risk related to those parties can be better negotiated. Combined this literature with the results in 5.1.1, it can be implicated that construction companies, most are led by ongoing projects have a more mature level in risk management.

One of the disadvantages of a project based organization is that as the company focuses too much on each project, so cross project learning is weak (Hobday 2000), which can be implicated from the low score of Heijmans in the “Monitor and Review” aspect. Theoretically, function oriented form promotes

communication and knowledge sharing among departments. Unfortunately, in Huisman Equipment, many interviewees mentioned the scattered information in departments and lack of communication.

After all, only one manufacturing company and one construction company are studied with the GRMM and risk management has been introduced in Huisman Equipment for a relative short period. The results of the model well reflected the current state of risk management in the organizations and with a larger sample from different industries, more interesting conclusions can be attained.

5.2. Reflection on applying the GRMM

As said, the GRMM was previously developed for construction companies and it is firstly used in an ETO environment in this research. Hence, before applying the model, three pilot interviews were done. Participants had no difficulties regarding the statements and only made little adjustment on some wordings. However, due to the innovative characteristic of the Huisman Equipment, there is a significant change of the model to test separately regarding threat, negative side of risk and opportunity, positive side of risk.

In the 20 interviews that applying the GRMM, only 2 out of the 20 participants didn't fill in the model. The reason from one is that as an experienced production manager, he used his experience instead of structured risk management. For the other, a manager in sales department, mentioned that the statements are too detailed and some are out of his working scope and field of responsibility. Besides, interviewees from commissioning and testing, account managers in after sales also pointed out they have difficulties filling some statements. The question rises here is whether the model itself is applicable for all the roles or as long as people have enough risk management knowledge, they can fill the model. Certainly, for some roles, it is not necessary to know a lot about this topic as mentioned by one respondent in top management and a project manager who said the first thing is to get the job done, concentrate on their own tasks. Meanwhile, a process analyst suggested that anyone in the company can fill the model just sometimes, extra explanation is required to relate the statement to specific situations in the company. However, the aim of the model is that the person can fill it individually. Therefore, ideal candidate to fill the model is project manager, risk manager or people who can see over the departments and with sufficient risk management awareness.

Asking interviewees to fill both threat and opportunity side of risk made the process more difficult, costed more time and sometimes led to confusions. As some of the statements for example related to "risk appetite", "residual risks" are difficult to understand when thinking risk as opportunity. In total, 7 out of the 17 chosen interviewees had not fill in the score for opportunity. But for all the people from project

department, process analysts filled both threat and opportunity. It reflects if the interviewee possesses the knowledge and have an overall view on projects, the model is very applicable.

More than that, some interviewees questioned about the accuracy of scores as people have different criteria which means a “10” for one person can be a “7” for the other, or some people are very positive while some others are too strict. One of the respondents scored higher on average mentioned he compared the situation with 2 years ago when there was no risk management at all. It is imaginable that if someone compare the situation with another mature organization, lower results will be received. Also for the ambition score, a project manager said that he hope to put a “10” but he doesn’t believe the company can get a “10” then he scored lower in order to be more realistic. Such subjectivity can be very influential if there were less interviewees, but since 17 results were used in this research, the outcome of the interviews are reliable.

5.3. Improving risk management versus investing in knowledge

This section discusses in Huisman Equipment people should improve risk management or invest in knowledge, as at the end of the expert session, an expert believed that investing in knowledge will give better results than improving risk management and it will end up better identifying and mitigating risks. He related that to some circumstance that the project team failed to spot a certain risk, if a person with enough knowledge was there, such risk would not happen. Another disagreed with him that a few knowledgeable people cannot substitute that everyone is taking responsibility.

It is noticeable that experienced people in the company were more in favour of this statement as they have more knowledge. Following the risk management process is a more structured way of working, and Newell, Robertson et al. (2009) presented some downsides of it, as experienced people or knowledge intensive work requires certain flexibility, freedom from fixed process. However they added that exploit the knowledge and use them in other project teams need the support of procedure and documentation. From another source, Granli (2009) discussed that for projects which main challenge is complexity, a standardized, well-structured approach is encouraged with good risk management. Whilst if a project faces many uncertainties, a flexible and diverse way is preferable. From another research done in Huisman Equipment, the projects are getting more complex but at the same time, the amount of repetition in components is increasing which also mentioned by some respondents in this research (Teerlink 2013). Then, the success of the project cannot go without investing risk management. Nonetheless, if the organization initiates projects from another field, for such projects, knowledge will run first.

There are two ways regarding investing on knowledge, one is training more experts and the other is to have a very strong knowledge base. For the first one, the biggest problem is the knowledge will go once

the experts leave the company. The advantage for the experts is that they can see a problem over several projects and invest on knowledge base can accomplish that. So the second approach is suggested which can also support risk management.

For this case, it is suggested to invest on risk management, as it is observed that engineering is one of the competences of the company. Albeit the overall risk maturity level is low, within the engineering department, technical risks can be treated better among all the departments. Comparing with its level of knowledge, risk management leaves much areas for improvement so that the organization can benefit more at this stage.

6. Conclusions and Recommendations

The conclusion aims to answer the main research question, "*How does an Engineering to Order company perform risk management and what are the areas of improvements"* based on three sub research questions. Next, recommendations for the Huisman Equipment, the GRMM and future research are given.

6.1. Conclusions

The first sub research question, "*What are the risk management steps for ETO companies based on the literature*" is discussed in Chapter 3 and leads to a six-step process: risk management plan, risk identification, risk analysis, risk response plan, monitor and control, lessons learned. For the second sub research question, "*How does an ETO company perform risk management in practice*", by applying the GRMM, Chapter 4 includes all the results, cross case analysis with an overall outcome. Chapter 5 focusing on the expert session pertains to the third sub research question, "*What are the identified improvement areas regarding risk management in the ETO environment*", concludes five areas: 1) process, 2) tooling, 3) risk awareness, 4) independent risk coordinator/department, 5) managing external parties.

In general, the ETO company Huisman Equipment has a low maturity level of risk management. Risks are mostly not managed in advance, risk awareness varies among groups, departments or even in the same role. Among the departments, engineering department has the best risk management performance as technical risks get more attention from management. Most of the interviewees scored very low on several statements and three of them were selected and adjusted into:

1) Management communicates goals and strategies of risk management;
2) Define control measures to treat risks (reduce, avoid, transfer, accept etc.);
3) Properly manage risks from sub-contractors and suppliers.

Via the expert session, experts gave solutions to all the pains and gains related to each statement above and all the solutions can be put in these five directions:

1) "Process" is the focus – "Set up a uniform, clear, followed up process, start from sales through execution till service, used regularly with lessons learned and based on (top) management governance";
2) "Tooling" is important to the process – "Establish accessible reporting tool with the support of a central database";
3) "Awareness" is lacking – "Demonstrate the benefits of managing risks, compliment actions such as addressing risks";
4) An independent "risk coordinator" or "risk department" is suggested – "Appoint a risk coordinator, he or she can assign risk to its owners, make sure it will be solved, managed or accepted by someone";

5) Managing “external parties” – “Make supplier/sub-contractor evaluation mandatory, enhance involvement of key external parties as well as relation management”.

The experts were divided into three groups and make their own advice over the statements and solutions which can be concluded into a three phases:

1) Appoint a responsible risk coordinator or have an independent risk department. At the same time, strengthen the supply chain coordinator to better manage suppliers and subcontractors;
2) Make advanced tooling, database, encourage everyone to report potential risks will increase the overall risk awareness;
3) Establish a solid risk management process based on the first two steps.

Advice given by individuals and groups of experts answered the third sub research question. The overall answer to the main research question is listed:

From the literature, a six-step risk management process is suggested for the ETO environment (risk management plan, risk identification, risk analysis, risk response plan, monitor and control, lessons learned). In practice, the ETO company that used as the case is not mature in risk management but the engineering department is more mature comparing with other departments. Besides, even though they cannot manage threats properly, flexible approach is used to manage opportunities. The main areas for improvements are process, tooling, risk awareness, independent risk coordinator/department and managing the external parties.

6.2. Limitations

The main limitation of this research is that only one ETO company Huisman Equipment is studied. There are other ETO companies that come from another industry which will lead to different risk management performance.

Secondly, albeit 20 interviews were conducted, it was realised later that not all the roles are ideal to fill the GRMM so that the number of project manager and process analyst is not enough. During the interview period, the organization form is function oriented, on one hand, it is easier to know the risk management performance in each department; on the other hand, for some roles in operation group, they cannot see through the project easily. The results of some respondents who are not actively involved in risk, as they mentioned were from a side view. Meanwhile, some of the comments from the interviewees were not validated, for example, one top manager presented many risk related documents during the interview, but to what extend are those been fulfilled in projects needed to be verified.

Finally, the comparison of threat and opportunity is not accurate as 10 out of the 17 people filled both threat and opportunity part, 7 respondents only gave scores for threat.

6.3. Recommendations

6.3.1. Recommendations for Huisman Equipment

More specific recommendations are given based on the five directions concluded from the expert session:

1) For "process", instead of a bottom-up approach, process should be made top-down. Besides, detailed instructions need to be provided and top management have to push more. It was told during the interviews that the organization is good at making processes, but process needs to be tested in a PDCA (plan, do, check, act) cycle and it often ends after plan. To keep running the cycle, testing and improving the process continuously, it cannot go without attention from the top, to check if everything is being followed.
2) For "tooling", it was mentioned that there are different tools and database in each department and project managers or coordinators spent much time searching or asking for information. For risk management, a risk log from sales, to execution till after sales is recommended for the effective communication between departments.
3) For "risk awareness", people in Huisman Equipment have different levels of risk awareness. Apart from the knowledge, risk management is considered as burden not part of the work. A top-down strategy is needed to make sure for instance risk log, risk sessions are obligatory for projects and people are responsible for certain input.
4) For "risk coordinator" or "risk department", it was complained that filling in different types of risk assessment costs huge amount of time, each team member should have the access to escalate certain risks. Right now, there is only one risk manager in the engineering department for technical risks but more types of risks need to be managed. Instead of depending on someone takes the initiation besides his or her job, at least firstly, a person should be appointed or the project management office can take the responsibility.
5) For "external parties", the company currently suffers more from supplier and subcontractor risks, it was mentioned that the company is used to take those unnecessary risks. Changing the mindset, learn to share and transfer risk to another party is essential. Moreover, making supplier/sub-contractor evaluation mandatory.

On top of that, three other recommendations with respect to priority of improvement are listed:

1) Focus on threat – From the result of the GRMM, the company is far from a mature risk management both in threat and opportunity. It is recommended to start from improving the management of threat which is also reflected from the higher ambition score of managing threat. According to Olsson (2007), comparing managing the negative side of risk, it is more difficult to

provide a structured approach to manage opportunities. In another word, a flexible way to manage opportunity is recommended which is already been done in the company so the priority is threat.

2) Start internally – Even though managing external parties is an issue and key external stakeholders are not involved in process such as risk identification, it is observed that internal people are not active in these meetings. Only when the risk management is more mature within the organization, can external parties be better treated.
3) Start from risk identification – The firefighting culture is noticed so that people tend to fix the problem instead of taking actions in advance. Everyone is responsible for reporting a potential risk, an interviewee also said that taking risk identification seriously is the first step. Then comes the analysis, control and review of risk.

People have the tendency not to change especially if there is no one taking the responsibility. Not only risk management, but as long as the company wants to implement a new process, a person responsible, a top-down approach, detailed instructions and people have to know the motivation behind as for risk management, why it is important, what benefits can we get.

6.3.2. Recommendations for the GRMM

Two recommendations are given primarily based on the observation during the interviews:

1) Using "1, 2, 3, 4" instead of "1, 4, 7, 10" for scoring the current situation, importance and ambition of each statement in the GRMM. As introduced previously, the interviewees are asked to give 1, 4, 7 or 10 on each statement. In the interview, some people questioned about the reason behind, also one advantage to use "1, 2, 3, 4" is simply to speed up the process, an algorithm can be added in the model to magnify the final result.
2) Use the words "threat/opportunity" in the statements instead of "risk" if considering both the positive and negative side of the risk. Even though people understand that risk does not only mean threat, from Ward and Chapman (2003), the wording "risk" encourages people to think of the negative consequences. In this research, "threat" and "opportunity" are measured separately and it turned out to take too much time to fill in, then using "threat/opportunity" is an efficient solution.

6.3.3. Recommendations for future research

From the view of the research scope, there are two recommendations:

1) During the interview, it was not highlighted that the "risk" is the process risk, so that during an interview with the director of production, he put more importance to safety risks which resulted in a much higher outcome than other interviewees. It is certain that in production, safety is the

first priority. So if similar research will be done, safety related risk should be considered independently.

2) Due to lack of experience of organizing an expert session, the time was not well controlled during the session so there was not enough time left for the final brainstorm. It is suggested to put more time on brainstorm and arrange a meeting including broad members to discuss how to implement the conclusion of the research on a strategic level.

From a broader perspective, two more recommendations are followed:

1) Apply the model in other ETO companies, can be same type of organization or across several industries, to make comparisons and see the similarities and differences.
2) Since the result from Huisman Equipment (low risk maturity level) and Heijmans (high risk maturity level) showed common problems regarding risk management which mentioned in chapter 5.1.1, it is interesting to see if those probelms exist in most of the organizations. Then future research can be carried on to figure out the reason behind and how to solve them.

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Appendix

Appendix A: Protocol of pilot interview

Pilot interview

Introduction	Welcome
	First of all, I really appreciate for your time joining this interview. I do believe it will be great help for this thesis and I hope the result can contribute to the company in return.
	Self-introduction
	My name is Zhipeng Guo and I am pursuing my master degree in Construction Management & Engineering at TU Delft. Currently I am doing my graduation thesis here in Huisman Equipment about risk management in an Engineer-to-order (ETO) environment.
	Introduction of the research
	I would like to explore the risk management steps in an ETO environment. Furthermore, the Generic Risk Maturity Model (GRMM) developed by Hoseini will help to evaluate the risk management practice in Huisman. For this pilot interview, I would like to know the general risk management process as well as the applicability of the GRMM in Huisman Equipment.
	Interview procedure
	I will first ask about your experience in the company, then the general information about current risk management practice of Huisman Equipment. Most importantly, the appropriateness and adjustment of the GRMM.
	Introduction the GRMM
	The GRMM is initially made for the construction industry which helps to measure the level of maturity of your organization/project regarding risk management. Two primary areas are given as “organization” and “application and process” both contains several aspects with statements (questions). By answering those questions, users will get average score in each aspect and an overall score.
	Publicity
	This interview is going to be recorded so that I can come with a transcript afterwards, which will be sent to you. After your final comments, it will be used for further analysis and attached in the non-public version of the report.
Background interviewee	Roles and experience
	What is your role in the company?
	For how long have you been working on projects in the company?
	For how long have you been working with the company process?
Risk management	Risk management process and practice
	What is the current risk management process in Huisman Equipment?
	If some risk management tools are applied in Huisman?
	To what extends are these tools implemented in projects?
	The GRMM **(critical part)**
	We are going to follow the statements in the GRMM. I would like to know which of the statements are applicable in Huisman Equipment.

	(When judging the applicability, it doesn't matter whether the statement is current implemented in the company or not as long as it can be used in the context)
	If a statement is not applicable, I would like to know why and how should it be formulated. (The statements can also be adjusted even if it is applicable as long as you think some change regarding the wording)
	If a statement is applicable but you use e.g. different wording or you think it is not very clear, we can also adjust it.
Warp-up	Final questions
	Do you have one or few projects in your mind that can reflect the risk management process in Huisman Equipment?
	Who are responsible for the projects and can you recommend other people in the company for the following interviews?
	If you have any additional questions or remarks? (It is also possible that I ask more questions based on the interview)
	Thank you
	Again, thanks for your presence. It is nice to hear from your experience and understandings of these topics. As mentioned, I am going to send you the transcript of this interview as soon as possible. If the (adjusted) GRMM is pertinent in Huisman Equipment and you are available, a second round of the interview will take place regarding filling the GRMM to see the risk management maturity of the company.

Table 16 Protocol for pilot interview

Appendix B: Activities for the expert session

Expert Session - Value Proposition Canvas

Activities before the expert session:

1. Print 2 of this document, pens, sticky notes, tapes, markers, papers ready
2. Supervisor and I arrive earlier, open the files on the big screen (laptop with charger), and other settings

Activities during the expert session:

ID	Activity	Minutes
1	Welcome, short introduction – background, purpose of the research, and goal of this expert session	5
2	Results and findings from the interviews; Showing the statements and chosen statements as input	5
3	Explaining the method "Value Proposition Canvas" and the following steps; Show the pains and gains according to the chosen statements	5
4	Start recording	
5	Brainstorming on pains and gains (adjust, add or delete)	10-15
6	Individuals write down the pain relievers and gain creators on sticky notes (solutions for each pain and gain, distributing sticky notes and pens)	10-15
7	Group work (2-3 person/group, make conclusions within groups)	10-15
8	Brainstorming, make agreements on the solutions	15-20
9	Asking open questions (if still some time)	(10-15)
10	Collecting the papers/information and closing the session (summary of the focal points)	5
11	After, taking photos of all the information, minutes of the session	after

Table 17 Activities for the expert session

List of open questions:

1. What is the root cause of the problem (be more specific, e.g. related to a statement) you think?
2. Is it possible to keep our Huisman culture (entrepreneurship, innovative) and work formally at the same time?
3. What is the obstacle not doing risk management? And name one thing you want to improve on risk management?
4. Feedback of the model.

Appendix C: Solutions given by individual experts

Expert Session - Individual solutions for pains and gains

Pain	Solution (pain reliever)
1-1 People behave differently	Set up and implement clear procedures & instructions;
	Make clear approach on RM, make everyone aware by having session such as lunch & learn;
	Design uniform way of working;
	Launch one risk log, one approach, with regular meetings (among project team)
1-2 Risk management is considered as burden	Have independent (risk) department;
	Display and demonstrate the positive effect of eliminated risks;
	Effect of timely actions on risks need to be communicated;
	Point out benefit to every level/department of organization throughout processes;
	Give out candy or other positive things when people address risks;
	Award innovative risk management.
1-3 Risk-related information is not sharing among teams and departments	Arrange one central risk department;
	Build uniform risk (threat & opportunity) log throughout process (from sales to project till after sales) used by all stakeholders;
	Create central database for risks;
	Communication among department heads.
1-4 Lack of responsibility and involvement	Clear (top) management governance structure & follow-up;
	Appoint a risk coordinator;
	Risk log need to travel along with the project starting at sales, ending at Huisman Global Service;
	Sharing of information (from kick-off meeting);
	One source/database including all related information.
2-1 Focusing on incidents instead of risks	Formulate uniform risk policy (speak same language);
	Demonstrate the benefits/gains of elimination risks. “Hardly anybody sees the effect of eliminated risks.”
	Shift awareness from passive to pro-active; prevent instead of solve;
	Make things visible at the beginning;
	Firefighters are NO heroes, highlight timely actions for mitigating risks;

3-1 Take extra/unnecessary risks	Multiple validations of decisions;
	Establish an uniform set of pre-defined risks (and possible mitigations) applied for all projects;
	Supplier management must contains risk evaluation (time, financial, quality assurance etc.).
3-2 Out of control in projects	Make risk management part of project;
	Make risk management mandate for project managers;
	Include key suppliers in risk mitigation/opportunity management to increase predictability;
	Ownership of supply chain coordinator (demand timely reporting from supply chain department, supply chain/quality control communication).

Table 18 Individual solutions for pains

Gain	Solution (gain creator)
1-1 Process related can be followed	Apply simple but effective process throughout the company;
	Design and enforce uniform way of working.
1-2 People can report risks better	Supply easy and quick reporting tool;
	Build central database;
	Assign responsibility within project teams.
2-1 Risk can be controlled proactively and solved in advance	Clear approach and awareness in RM;
	Compliment people when an opportunity is seized or a risk is mitigated;
	Brainstorm on risks in advance at start of work, include lessons learned;
	Establish independent risk department.
2-2 Benefits for lessons learned	Share uniform approach, efficient acting on risk identified;
	Use continuous improvements to directly improve process and procedure;
	Clear reports on actions taken.
3-1 Use the knowledge from external parties	Include sub-contractors experience in risk logs to have more predictability;
	Supplier/subcontractor involvement in project (risk consultant);
	Strengthen supplier relation management;
	Join external platform.

Table 19 Individual solutions for gains