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Industrial Quality Management

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Comprehensive Risk Management

– Development work in shipbuilding industry

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Comprehensive Risk Management

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This thesis was made as a development work for company’s risk management processes. The company’s existing risk management system didn’t serve the company’s benefits in the best possible way, even though it met the regular standard requirements. The company's risk management sought to develop an effective tool for the goals and needs of the company in question. The development was targeted at improving effectiveness by making risk management more comprehensive.

In this qualitative development work was utilizing flexible study method and case study as a strategy, and it followed a spiral model. Data acquisition methods used to achieve the goals were to examine the company's existing information and data to gain an understanding of the current state. Qualitative analysis and classification were used as the data analysis method. The company’s experts’ views were considered while analyzing the current state. Researching literature such as books, articles, standards, social media and already made theses. The case study also included one risk assessment semi-structured interview, which was targeted partially to test and support hypothesis.

The results achieved were tailoring risk management tools, classifications and analyzed items supporting the identification of risks. Other supporting aspects were standardizing the system.

Keywords:

Risk, Risk management, Shipbuilding

Opinnäytetyö (YAMK) | Tiivistelmä

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Sonja Pullinen

Kokonaisvaltainen riskienhallinta

- Kehitystyö laivanrakennusteollisuudessa

Opinnäytetyö tehtiin kehittämistyönä yrityksen riskienhallinnan prosesseihin. Yhtiön olemassa oleva riskienhallintajärjestelmä ei palvellut yhtiön etuja parhaalla mahdollisella tavalla, vaikka se täytti tavanomaiset standardivaatimukset. Yhtiön riskienhallinnasta tahdottiin kehittää tehokkaampi työkalu kyseisen yrityksen tavoitteisiin ja tarpeisiin. Kehittämistyön tavoitteena oli tehostaa riskienhallintaa kokonaisvaltaisemmin.

Tässä laadullisessa kehittämistyössä hyödynnettiin joustavaa tutkimusmenetelmää ja strategiana tapaustutkimusta ja sen eteneminen noudatti spiraalimallia. Aineistonhankintamenetelmät tarkastelivat yhtiön olemassa olevaa tietoa ja dataa nykytilanteen ymmärtämiseksi. Aineiston analyysimenetelmänä käytettiin laadullista-analyysiä sekä luokittelua. Yhtiön asiantuntijoiden näkemykset otettiin huomioon nykytilannetta analysoitaessa. Kirjallisuustutkimuksessa hyödynnettiin kirjoja, artikkeleita, standardeja, sosiaalista mediaa ja jo tehtyjä opinnäytteitä. Tapaustutkimukseen sisältyi yksi puolistrukturoitu haastattelu, joka oli kohdistettu osittain hypoteesin testaamiseen ja tukemiseen.

Tuloksena havaittiin, että riskienhallintajärjestelmästä saatiin kattavampi räätälöidyillä työkaluilla, luokittelun avulla ja analysoitavilla kohteilla. Muita riskienhallintaa tukevia näkökohtia olivat järjestelmän standardointi.

Asiasanat:

Riski, Riskienhallinta, Laivanrakennusteollisuus

Content

Appendix

Figures

Tables

List of abbreviations

AI	Artificial Intelligence
ARAMP	Allied Risk Assessment Management Publication
COSO	Committee of Sponsoring Organizations of the Treadway Commission
ERM	Enterprise Risk Management
FMECA	Failure Mode Effects and Critical Analysis
GDPR	General Data Protection Regulation
HR	Human Resources
ISO	International Organization for Standardization
MSA	Measurement System Analysis
NATO	North Atlantic Treaty Organization
NSA	NATO Standardization Agency
PRAM	Project Risk Analysis and Management
RMC	Rauma Marine Constructions
RPN	Risk Priority Number
RVN	Risk Value Number

1 Introduction

1.1 Background

Risk science was begun in the sixteenth century Renaissance (Dionne, 2013). Before that time, there were not many thinkers who had the courage to think or predict the future (NSA, 2012). The invention of the risk concept was significant development regarding modern civilization, as Berstain (1996) stated to:

> The revolutionary idea that defines the boundary between modern times and the past is the mastery of risk: the notion that the future is more than a whim of the gods and that men and women are not passive before nature. Until human beings discovered a way across that boundary, the future was a mirror of the past or the murky domain of oracles and soothsayers who held monopoly over knowledge of anticipated events. (Bernstein, 1996, as cited in NSA 2012, p. 3)

Risk management in the marine and ship industry has long roots. Somewhere at 2000 B.C.E Chinese merchants divided cargos to be transported multiple vessels to mitigate the risk of shipwrecks, which consequence would be losing the transported goods (Mando, 2023). In the year 1688 at Lloyd's coffee house, practical risk application about the development of marine insurance was invented. The insurance policy was made between merchant seaman and businessman for safe transport of goods. Lloyd's coffee shop became Lloyds of London later. Risk management was started to study after World War II (NSA, 2012). Nowadays risk management is increasing its popularity and necessity in companies and individuals because of the realization of global risks, such as Covid-19 pandemic, extreme weather phenomena, disturbances in energy supply and realized cyber threats, as a data breach at the psychotherapy center (Ala-Nissilä et al., 2021). Damage and financial risk are usually the most traditional risk management aspect, but in recent years the diversity of risks has

grown, and it has guided companies to widen the risk perspective (Kupi et al., 2009).

It is beneficial for the company to integrate risk management into all management processes; thus, the risk management process becomes more efficient and comprehensive through control. Comprehensive risk management process increases the knowledge in the company how they could reach their strategic goals via minimizing imminent risks and utilizing upcoming opportunities. Efficient and comprehensive risk management is also convincing a sales pitch (Ilmonen et al., 2016).

This thesis will be made as a study case for shipbuilding company called Rauma Marine Constructions. Rauma Marine Constructions is a shipyard which operates at Seaside Industry Park in Rauma (Rauma Marine Constructions, 2024b). The company's product range includes car and passenger ferries, icebreakers, government, and research vessels, and offers comprehensive life-cycle services including maintenance and repair operations (Rauma Marine Constructions, 2024a). The company's operation is based on project management and control, and cooperation with top professionals and network companies (Rauma Marine Constructions, 2024c).

Risk management plays a central role in the shipbuilding industry, where it is typical to carry out a complex delivery project in a competitive market, where margins are small and cyclical fluctuations are large (Hermonen, 2010). In this thesis is going to be investigated how risk management can be enhanced and made more comprehensive in the shipbuilding and big business environment.

1.2 Assumptions

As an assumption in the initiating phase of this thesis was that the risk management process is possible to make more comprehensive with spreading the risk knowledge, to make it available to whole company, making clear definitions, process and instructions, and by committing whole company to participate in by integrating the risk management system to the company's

management system. Another assumption in the initiating phase was that by studying different standards and methods widely and comparing those to the company's risk management needs and requirements and by questioning the company's existing tools and methods, there will be found improvement targets.

There was also assumed that investigating and testing new innovations such as software solutions would be beneficial. It was assumed that with some kind of innovative software system, it would be easier to handle and manage comprehensive risk management system in a big company environment. In the big company environment, a comprehensive risk management system, while functioning, would include hundreds of identified risks, many different lists of risks, multiple different analyzing perspectives and numerous needs to utilize the risk management tool. And after all, it's necessary to have risk data into a form that it's able to be analyzed at the level of the whole company or in its selected sections. Based on these assumptions, was begun to study the theory to create a credible hypothesis.

1.3 Goals for development work and research problem

Despite the risk management process meeting standard requirements, the effectiveness and efficiency of risk management was not at the desired level. The risk management process has been separated from the practical level of the management system. These problems led to the research question of how to develop a more comprehensive and effective risk management, to which solutions are sought in the development tasks. The goal for this development work thesis is to improve and develop the company's existing risk management process to be more comprehensive and efficient via integrating it into the company's management system and daily activities for the entire organization.

1.4 Research and development methods

Since it is a thesis on a development task, the spiral model of action research was chosen as the framework, because of its flexibility and item can be redeveloped at continuous cycles, circle after circle. In this model, the development tasks are described as spiral cycles, where there is an opportunity to advance the overall development one spiral at a time. In the spirals planning -phase, there is justified the item which needs development actions. The actions selected for development are organized and implemented in the action phase after planning phase. After actions are done and tested in use, its observations turn. In observation -phase, it's needed to study observations from the actions (Salonen, 2013). In this study observation type used was participant by being involved watching, listening and with asking clarifying questions (Gillham, 2000). The last phase is Reflection. In the reflection phase the critical assessment, interaction and reflection are important perspectives in development actions effectiveness (Salonen, 2013). The spiral model is described in figure 1, which is translated from the work "Tutkimuksellinen kehittämistoiminta: näkökulmia kehittämisprosessiin, osallistamiseen ja tiedontuotantoon" Toikko et al. 2009."

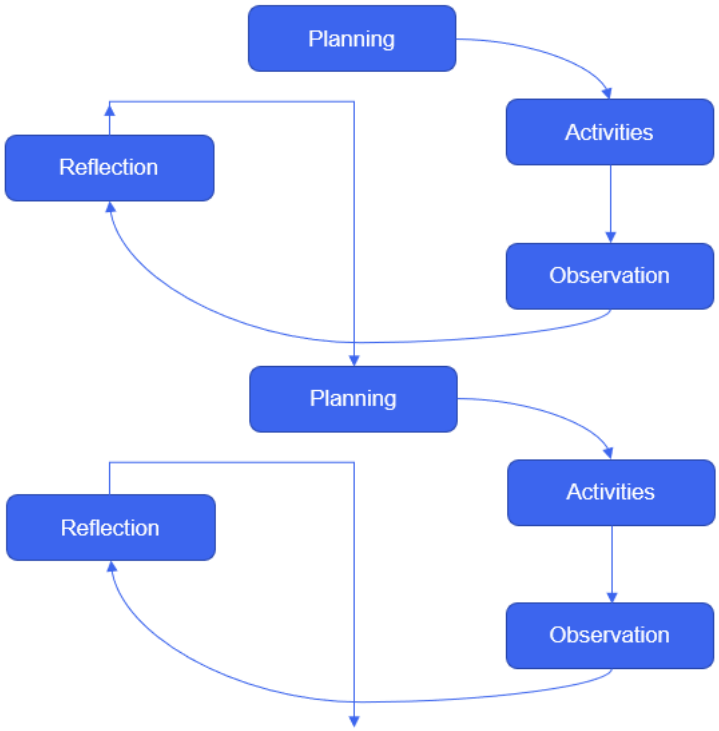

Figure 1. Thesis framework, spiral model (Lewin, 1948, as cited in Toikko et al. 2009).

This development work was made to RMC with applying the research sample of qualitative research. In data collection and analysis flexible design was used (Robson, 2010). The selected suitable research strategies for study were case study, empirical research and survey research. A case study, because the study only concerns the real-life context from the operations of one shipbuilding company, whose operating model differs from many other shipbuilding companies (Wohlin, 2021). Empirical research was selected as a research strategy because in this development research it is necessary to base the initial data of the research on observations, experiences and their measurement and analysis and it enables to interpret and develop although something is not theorized previously (Ercan et al., 2022). With utilizing survey research, such as questionnaires, development tasks during the study were verified (Conjointly, 2024; JYU, 2024).

In this thesis interviews and semi-structured interviews will be utilized for information research. In the semi-structured interview, the questions format is typically determined, but it allows the participant to express thoughts in their own words. The semi-structured interviews are used to verify the usability of defined perspectives. The advantage of this data collection method is interaction with the interviewee and flexibility in collecting data (Hirsjärvi et al., 1997).

The sources used in the work are searched for in a versatile manner according to the literature review, such as articles, books, standards, thesis, benchmarks and social media for example LinkedIn. All the literature that is referred to are made criticality review to find out if the source is reliable enough. There is considered the time when it's written, is it published from known source and is the written text academically credible. Literatures that are relevant to the research problem are selected for the research (Hirsjärvi et al., 1997).

The background research will utilize the company's existing data and information to obtain sufficient and valid information. Background research will probably include discussions with experts and specialists, so that user-based experience can be utilized and considered in the development research.

Since this development task focuses on the operational environment, goals and backgrounds of only one company's real life, the data analysis method in the study will be qualitative analysis (Hirsjärvi et al., 1997). The qualitative analysis method used classification and thematization (JYU, 2024). Figure 2 describes the structure of the research method of the thesis, which was explained above.

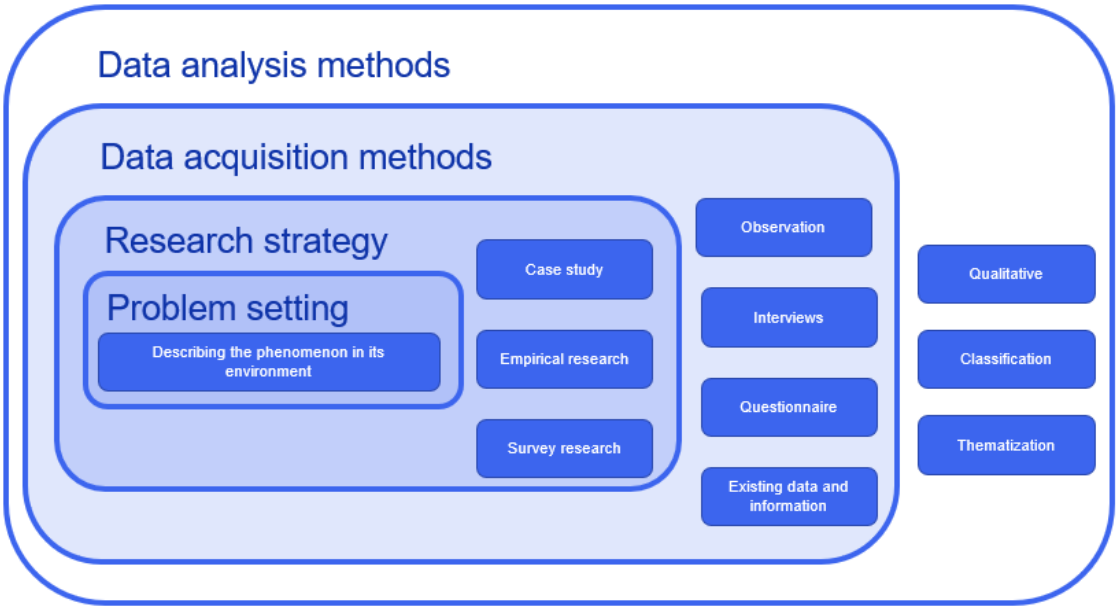

Figure 2. Thesis research method structure.

After the research methods have been chosen and defined, a plan is made for the progress of the thesis. The plan starts with a problem which is set to be solved in the development work. After solving the problem, a hypothesis is made based on the assumptions and theories studied. In the empirical section, the hypothesis is worked on and tested. The empirically obtained results and conclusions are reported and analyzed. Further research topics not part of the thesis, but related to the topic, are described at the end. The progress plan of this thesis is generically described in figure 3.

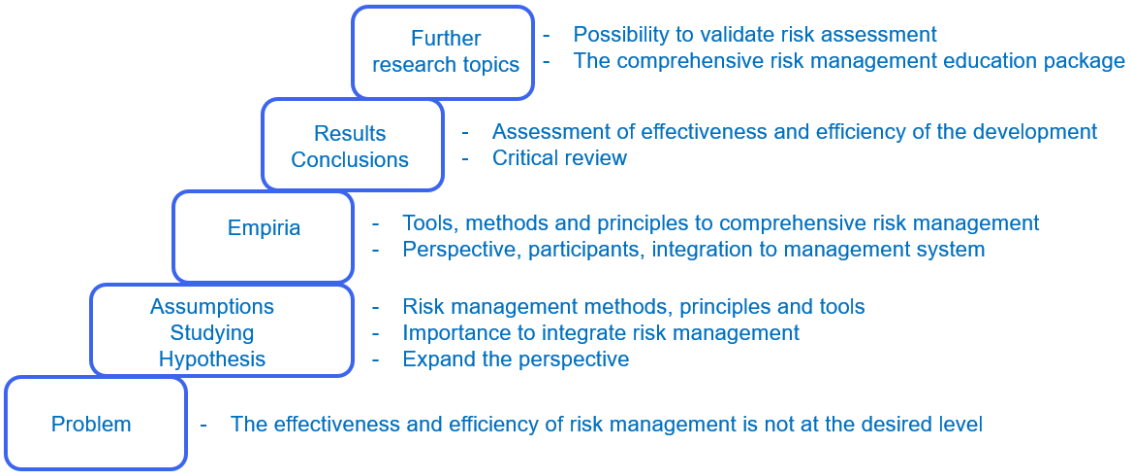

Figure 3. Thesis progress plan.

2 Risk management

2.1 Risk knowledge and awareness

The word risk is probably a loanword from the Swedish word risk. The traditional meanings of risk are threat of loss and danger of loss (Juvonen et al., 2014; Riski, 2024). According to standard ISO 31010:2019 risk includes different kinds of uncertainties and risk can affect negatively or positively (SFS, 2019). Suominen (2003) says that in everyday language, the word risk predicts an unpleasant event and signifies danger factors. Juvonen et al. (2024) states that risk means danger or threat in general language. It seems that a repeating theme in the definitions of the word risk is some future events whose realization is uncertain and whose consequences are uncertain. According to Gigerenzer (2015), risk knowledge and awareness is the basic knowledge of living in today's modern technological society. Risk knowledge and awareness nowadays is compared to being as important and necessary skill as writing and reading skills were before. Society needs risk knowledge and awareness to avoid and mitigate risks caused by rapidly developing technology. Increasing risk knowledge and awareness is itself a mitigation action for all risks (Gigerenzer, 2015).

Gigerenzer (2015) argues in his writing that the problem of the lack of risk knowledge and awareness isn’t an individual's fault but a phenomenon that has spread to society. The risk knowledge and awareness aren’t included in the basic school subjects, thereby it isn’t taught automatically to people. Risk knowledge and awarenesses is mathematical uncertainty and statistical thinking. Uncertainty management is a big part of risk management (Gigerenzer, 2015).

Aware means attentive, resourceful, and wise. Risk awareness means the courage to face an uncertain future. Uncertainty is something that is humane to avoid and unwanted, however certain things are rare, the delusion of certainty is more apparent. The pursuit of certainty is the biggest obstacle to becoming risk aware (Gigerenzer, 2015).

Without risk knowledge and awareness people might make decisions driven by unrealistic fears or hopes. It is human error to focus to avoid one specific risk, activities outside the area of focus may become more riskier without noticing. Probability of this human error increases when handled risk is so called dread risk, in that case the avoidable risk effect includes the death or risk of death of many people at the same time. Another human error is forgetfulness, every new crisis causes concern until it's forgotten and starts to worry about the next one (Gigerenzer, 2015). Gigerenzer (2015) emphasizes in his book that with good risk knowledge and awareness decisions are based on facts and sense.

Comprehensive risk management Juvonen et al. (2014) states that the trending aspect in risk management is to comprehensively manage issues and to detect the relations between them in the company's big picture level The perspective in comprehensive risk management is to achieve the company's strategic targets by mitigating the threats and utilizing possibilities. Comprehensive risk management can be achieved by identifying the inspected phenomena's all related dependencies (Juvonen et al. 2014). Experts agreed that risk management can't be separated process from company's management system, but it is beneficial to integrate risk management into every management process in the company to receive as reliable information as possible. Unfortunately, the connection between the company's management system and risk management is frequently weak. Comprehensive risk management also produces up-to-date information on the state of the company, and sometimes new synergies are discovered by utilizing it (Ilmonen et al., 2016; Juvonen et al., 2014; Kupi et al., 2009).

The risk management's purpose isn't to manage all the risks at the same level but identify with analysis and assessment which of the risks or possibilities are beneficial to focus on targeting to get the best possible outcome with the least amount of effort (Juvonen et al., 2014). Juvonen et al. (2014) describes that the company's risk field is wide and complex; to facilitate it you need to have a systematic way to handle and manage risks. In the systematic way to handle risks includes risk identification, analysis, prioritization, control means, mitigation and monitoring (Juvonen et al., 2014).

The challenge of big organizations is to handle and control the co-operation between different departments in internal risk management, according to (Ilmonen et al., 2016). Due to the challenges, it is important to structure risk management and its processes and reporting as transparent as possible. This also increases transparency to the problems at the organization's interfaces and their development needs (Ilmonen et al., 2016).

Ilmonen et al. (2016) and Juvonen et al., (2014) agreed and justified that the functional comprehensive risk management is the company's competitive advantage and image benefit, which in the long term creates a positive reputation in the market. You get a well-managed image of the company when risk management is effectively integrated into the company's processes

(Ilmonen et al., 2016; Juvonen et al., 2014; Kupi et al., 2009). Figure 4 describes the main elements of comprehensive risk management.

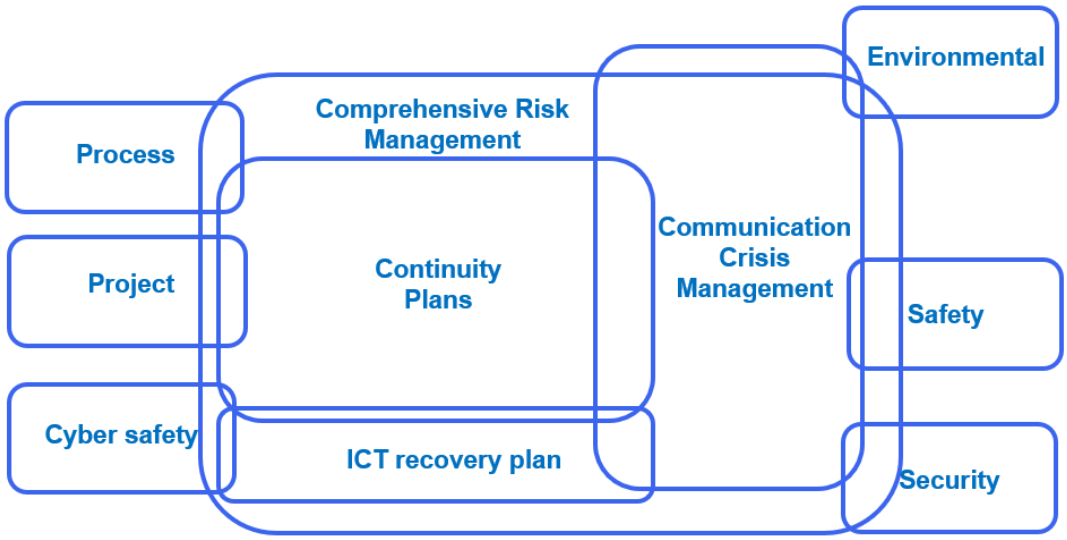

Figure 4. Comprehensive risk management. Figure is based on Ilmonen et al., (2016).

2.2 Risk management

Objectives

Juvonen et al. (2005) states that the primary goal of risk management is to avoid disasters and ensure business in all conditions. The second goal is to support the company to maximize its financial efficiency and support the implementation of the company's strategy. The standard publication ARAMP-1 defines the purpose of risk management in the same tone from the perspective of life cycle thinking (NSA, 2012).

Ilmonen et al. (2016) states that the goals of risk management have always been in constant change. Changes have been caused by the development of risk management theories and practices, as well as the increase in mandatory risk management requirements and their changes. Many companies apply

some risk management standards and require companions to comply with them as well (Ilmonen et al. 2016).

For risk management goals to be determined for the company, an overall picture of risk management and sufficient understanding must be achieved internally within the company (Ilmonen et al. 2016). It includes company level understanding of what risk management means to the company and which factors it is structured of. The objectives are also affected by the relationship between the different subject areas, such as safety and environment, whether they are dealt with separately or as part of a whole (Juvonen et al. 2014).

While setting risk management objectives is beneficial, take under consideration how to classify and divide different risks. Risks can be divided for such as internal and external risks (Juvonen et al. 2014; SFS, 2019). While analyzing risks it's beneficial to separate risks that can be influenced, and which are those that cannot be influenced in the company and take that into account in the risk management objectives (Ilmonen et al. 2016). The company's risk management history data is beneficial to utilize in defining company's risk managements objectives (Juvonen et al. 2014).

Resources

Ilmonen et al. (2016) describes that the main principle of risk management is that even though the company's board of directors and CEO are responsible for risk management, the risks have its owners, and they are managed at an operative level. Ilmonen et al. (2016) and Cochin (2014) agrees that the board of directors needs to ensure, by approval of risk management policy and processes, that the company has a functional risk management process to identify and control critical risks. The board of directors is responsible for defining the company's risk appetite. Ilmonen et al. (2016) specifies that that this functional risk management process needs to include risk management objectives, methods, responsible parties and define the rights and obligations to check the functionality of internal risk management.

Business management is responsible for its own risk management tasks and defines the balance between risks and incomes (Ilmonen et al. 2016). Business management handles risks more often and more thoroughly than the board of directors. The business management responsibility area includes planning future risk development actions, changes and the most critical risks assessments (Ilmonen et al. 2016; Cochin, 2014). The risk management in business management level is more linked to the operational action than the board of director's level (Ilmonen et al. 2016). Risk management's steering groups are usually included in the bigger company's organization (Ilmonen et al. 2016). The steering group in made for deeper risk investigation and analysis risk management lists and risks development curve more carefully (Ilmonen et al. 2016).

Standard ARAMP-1 and Cochin (2014) states that risk management processes should be regularly objectively audited or inspected, and inspections reported. Risks are mainly managed at the business management level, with the set rules and regulations. Risk management responsibility areas, communication between them and between them shall be clear in the company (Ilmonen et al. 2016).

When resourcing risk management, the level and scope of risk management work must be considered (Ilmonen et al. 2016). The larger the group is of risk assessment work that is done, the greater the risk that the review will not remain focused, but will stray from the topic, therefore it's beneficial to keep the number of participants limited (Ilmonen et al. 2016). The group which is performing risk assessment needs to have expertise and knowledge about the topic under assessment (Ilmonen et al. 2016).

In every assessment group work needs one facilitator who plans the assessment event (SFS, 2019; Cochin 2014). Utilizing facilitators is especially important when the company is in the beginning of the systematic risk management system (SFS, 2019; Cochin 2014). At a later stage, it could benefit from the fact that each department within their scope of the risk management process has its own facilitator. In addition to own work, the facilitator takes care

of the progress of risk management in his/her own department (SFS, 2019; Cochin 2014). Facilitator isn't responsible of risk management nor produce content to risk management, only create the qualifications and work as a chairman in risk management events (Cochin 2014). It seems that in other publications the title facilitator and other coordinator were used, but the tasks and responsibilities largely corresponded to each other (SFS, 2019; Cochin 2014).

The primary roles and responsibilities can be identified to risk managements organization (NSA, 2012). The size of structure and organization of risk management process can vary (Ilmonen et al., 2016). There can be included different sizes of groups, and there can be internal groups or external parties also (Ilmonen et al., 2016). Roles must also be suitable for the level where risk management is performed, and they need to be planned to fit the organization (Cochin 2014). For instance, Cochin Shipyard has defined risk management roles to list form in table 1.

Table 1. Risk management roles (Cochin, 2014).

Roles	Responsibilities
Board of Directors	• Approve risk management policy • Review and approve risk management process and provide inputs/ directions to the executive management • Set 'Risk Appetite' for the company
Risk Management Steering Committee ('RMSC')	• Lead the Risk Management initiative within the company • Set standards for risk documentation and monitoring • Recommend training programs for staff with specific risk management responsibilities • Review and approve the risk management report including selection of critical risks to be put before the Board of Directors
Risk Management Committee	• Implementing the risk management initiatives across the functions • Review implementation of risk management process including identification and assessment of the relevant risks at functional level • Approve and submit risk documents to CRO/ RMSC • Provide updates to RMSC on risk management at RMC level
Chief Risk Officer ('CRO')	• Implementing the risk management initiatives across the entire organization • Liaise with the Risk Coordinators to coordinate flow of information and escalation of key risk issues/concerns between the RMSC and Risk Coordinators • Ensure that meetings of the RMSC are held regularly • Prepare and maintain relevant documentation for the company and present it to the Board of Directors of the company.
Risk Coordinator	• Liaise with the Risk Owners to coordinate flow of information and escalation of key risk issues/concerns between the RMC and Risk Owners • Ensure that meetings of the RMC are held regularly • Prepare and maintain relevant documentation for the RMC and submit the same to CRO
Risk Owners (RO)	• Ensure preparation of a suitable risk mitigation plan keeping in mind the current controls mechanism in place, proposed mitigation measures and organizational priorities • Ensure that the risk profiles are filled and key risks are escalated to the respective RMC for their approval of proposed mitigation plan • Ensure that the approved plans are implemented within the target timeframe and reported regularly
Employees	• Assist in complying with risk management policy adopted by the company • Responsible for identifying and escalating risks to the next level • Exercise reasonable care to prevent loss, to maximize opportunity and to ensure that the operations, reputation and assets are not adversely affected

Techniques and methods

The risk management standard, ISO 31010:2019, states that many of the risk management techniques were originally developed for particular purpose to seek and manage unwanted outcomes in a specific industry field. For the same reason, different techniques are similar but aren't using the same terminology. That's how the independent development of risk management techniques can be observed (SFS, 2019).

The ISO 31010:2019 also describes that the selection and tailoring of the risk management tool and method should be done according to the intended use and the desired information. In the selection of the available resources, the significance of the tool for the company should be considered and the associated costs (Juvonen et al. 2014). Decided is the qualitative or the quantitative technique more suitable for the purpose. Is one tool enough or should it be selected multiple (NSA, 2012). In publications NSA (2012) and Juvonen et al. (2014) there was a similar interpretation.

One standardized tool, in standard ISO 31010:2019, for risk management is FMECA (SFS, 2019). The abbreviation FMECA comes from the words Failure Modes, Effects and Criticality analysis (SFS, 2019). The FMECA tool records information about, for example, the cause of the risk, the consequences and the detection (SFS, 2019). In FMECA -tool is also analyzed the criticality of the risk for example utilizing RPN or some matrixes (SFS, 2019). Criticality can be analyzed qualitatively or quantitatively (SFS, 2019; NSA, 2012). FMECA can be used in many types of processes for planning, manufacturing or improvement, and it can be applied at many different levels in entities or more specific objects (SFS, 2019). FMECA is implemented by an expert team about specific matters and analyzes are performed under the guidance of a qualified facilitator (SFS, 2019). Strengths of FMECA is its wide utilization and easy form (SFS, 2019). In limitations of FMECA can be attributed that it handles single risks not combinations, its challenging to control and it's not the easiest tool for complex multi-layered systems (SFS, 2019).

After the risk identification and assessment, the suitable risk management method is selected (Juvonen et al. 2014). As alternatives are for example, from mitigation, avoidance, sharing, transfer or holding it at your own risk (Juvonen et al. 2014).

Risk mitigation is often considered as the most significant means of control (Juvonen et al., 2014). Risk mitigation targets to minimize risk events probability or decrease its severity effects (SFS, 2019). Mitigation is unavoidable when the risk can't be avoided, eliminated, or transferred (Juvonen et al., 2014). Risk mitigation might be beneficial also to increase production efficiency or quality of service (Juvonen et al., 2014).

Juvonen et al. (2014) states that risk avoidance means that actions that might cause the risk aren't performed. This method is primarily used when risks severity is intolerable (Juvonen et al., 2014). Avoidance of risk can be handled with structural preventive actions, with personnel training and occupational safety actions (Juvonen et al., 2014). The ultimate exceptional form of risk avoidance is eliminating the risk, it requires that the root cause of the risk must be able to eliminate (Juvonen et al., 2014). Eliminating might be an expensive solution to avoid the risk, but it might be exposed to be profitable compared to severity of the risk (Juvonen et al., 2014).

According to Juvonen et al. (2014) the number of independent risks is increased in risk sharing and risk sharing is central to method risk management. The aim is to prevent risks caused by unilateralism (Juvonen et al., 2014).

Juvonen et al. (2014) stated that in risk transferring, the risk can be transferred by agreement to the responsibility of the other party, such as insurance company or supplier. This method is mainly used to transfer financial risks (Juvonen et al., 2014).

Ilmonen et al. (2016) states that in some minor risks are assessed to be profitable to holding it at your own risk. Sometimes taking the risk as your own responsibility is unfortunately not a conscious choice (Juvonen et al., 2014).

Identification

Suominen (1999) and Chapman (1998) agreed that risk identification is one of the most important phases and foundation for the risk management process, because it has the biggest impact for the accuracy of risk management. The risk identification is one of the two substages in PRAM and the rest of the process is built upon those substages (Chapman, 1998). The risk identification techniques can be divided into three categories, conducted by a risk analyst, with a team interview conducted by a risk analyst and a work group brainstorming led by a risk analyst (Chapman, 1998). The capability to identify risks is prerequisite for functional and comprehensive risk management (Chapman, 1998; Suominen, 1999).

There are a variety of methods and techniques to risk identification (SFS, 2019). The technique used usually is determined by users' knowledge and experience (SFS, 2019). Despite what technique is selected to use, the approach should be efficient and systematic (SFS, 2019). Risks should be identified in advance to be able to perform preventive actions, but also recurring risks need to be identified to prevent repetition of realized risks (SFS, 2019).

The risk classification and categorizing creates the prerequisite for a comprehensive identification of risk (Cochin, 2014). With the right and comprehensive classification, risks that are not so obvious and generally aware of can be highlighted and brought to awareness. (Cochin, 2014)

2.3 Risk analysis

Keshk et al. (2018) stated that risks analysis can be done qualitatively or quantitatively. Qualitative and quantitative risk analysis and utilization are mentioned also in standards ISO 31010 and ARAMP-1 (NSA 2012; SFS, 2019).

Risk Qualitative Analysis

In the qualitative risk analysis is important to arrange the risks depending on how it affects objectives (Keshk et al., 2018). In qualitative risk assessment it is necessary to define how important the risk is and to be aware of in which order risks need to be handled (Keshk et al., 2018). Graphical tools are often used in qualitative risk assessment (Keshk et al., 2018). One of the qualitative risk assessment tools is Probability Impact Risk Rating Matrix -tool (Keshk et al., 2018). The assessment of risks probability is included in qualitative risk assessment (Keshk et al., 2018). Probability is usually estimated by specific characteristics to describe with verbally and numerically how probability the risk is to materialize (Keshk et al., 2018). The lower the number, the less probably the risk will occur (Keshk et al., 2018).

Keshk et al. (2018) stated that in qualitative risk assessment risk consequence is also assessed. The consequence is as well estimated with verbally and numerically (Keshk et al., 2018). The bigger the number, the more severe the consequences are if the risk occurs (Keshk et al., 2018).

Both indicators are filled in the risk matrix and by multiplying these numbers together we get the right handling order to risk (Keshk et al., 2018). Risk matrix is usually colored according to prioritization, it’s important to know the meaning of different colors (Keshk et al., 2018).

Quantitative risk analysis

Quantitative risk analysis describes the risk according to the probability of occurrence and constructs value, for example monetary value (Keshk et al., 2018). In quantitative risk analysis a significant role is interviewing (Keshk et al., 2018). Quantitative analysis starts with interviews between stakeholders and different specialists (Keshk et al., 2018). The results of interviewing are collected according to probability distribution type and that is adopted in quantified estimating of risk (Keshk et al., 2018). In quantitative risk analysis methods are used as decision tree and charts to show relation of probability and costs (Keshk et al., 2018).

2.4 Risk assessment

According to ISO 31000 standard, risk assessment includes risk identification, risk analysis and risk evaluation (SFS, 2018). And it should be conducted systematically, iteratively and collaboratively, drawing on the knowledge and views of stakeholders (SFS, 2018).

Risk evaluation can be verbally or numerically evaluated, eighter way risk evaluation is always subjective, and the result is affected by human factors (Ilmonen et al., 2016). Because of those factors, there is no worth pursuing to perfect risk evaluation value (Ilmonen et al., 2016).

3 Comprehensive Risk Management System

To develop company's risk management to be more comprehensive the perspective of risk management was expanded. The figure 5 describes the aspects of risk management which are taken into account while handling risks and the process flow continues.

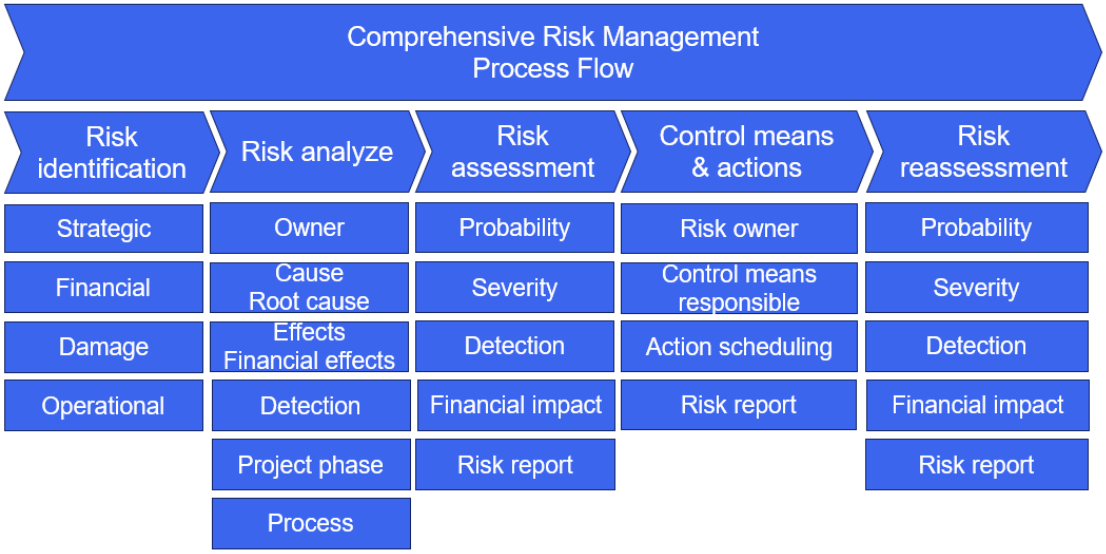

Figure 5. Comprehensive risk management process flow.

3.1 Risk identification

In this thesis, the goal was to develop the company's risk management more comprehensively. One way to achieve comprehensive risk management at the company level was to enable the entire organization to report the risks it identified. That's how the company has comprehensive risk identification, from multiple people and perspectives.

The tool of risk identification is mainly used brainstorming and observations during one's own work. To make risk identification easier, there are added company project phases, processes, and classifications to the risk assessment tool. It is easier to identify risks when you have given some point of view. In risk identification it is important also to consider events in history, is there a

possibility of some threat appearing again. Because of that there is structured a link between deviations and lessons learnt items and risks.

In risk identification, whether it is new or from historical data, it has been thought to be important to review and remember the risk at the right time. Because of that, the risks are viewed based on the events of the following months, for example focusing on the most significant risks of the coming seasons or project phases. Risk identification becomes comprehensive when everyone recognizes the risks specific to that moment in time.

3.2 Risk classification

It is necessary to define and describe each risk classification accurately to minimize the impact of the person who is identifying the risk.

There are selected 4 upper-level classification strategic risks, damage risks, operational risks and financial risks. Upper-level risk classifications are divided into 15 different risk classifications to this thesis to support the identification of different risks. By dividing the classifications to the upper level, it is targeting to keep it wide enough to management level, but all risks are identified to 15 different classifications and that supports the comprehensiveness of risk management. The dividing structure is described in figure 6.

Figure 6. Risk classification in comprehensive risk management.

3.2.1 Strategic risks

Figure 7. Risk classification, strategic aspect.

Continuity

The continuity risk classification is intended for the type of risks and incidents that are seen to have an impact on or jeopardize the whole company's operations and continuity. This classification is made to support the company's continuity management and plan.

These risks can be related, for example financial and cyber risks. Particularly in this category there are both identified risks and opportunities.

In the continuity risk classification is taken account the content of standard ISO 22301:2019.

Reputation

In the reputation risk classification is reported and assessed risks and opportunities which affect company's or project's reputation. These risks are assessed the extent of the publicity, whether the impact on the reputation is long or short-lasting and the impact on the reliability of the company's operations.

Strategy

The strategy risk classification is intended for the type of risks that are seen to have an impact on the success of the company's strategy. Particularly in this category there are identified both, risks and opportunities.

Legal Risk

The legal risk classification includes risks related to regulations or contracts, and its obligations or duties. Legal risk includes risks from soft to hard laws, laws, directives, regulations, government and private rules.

Legal risks can be negative or positive, in this category there is identified both risks and opportunities.

This classification also complies with the ISO 31022:2022.

3.2.2 Damage risks

Figure 8. Risk classification, damage aspect.

Cyber Risk

Cyber risk classification includes risks related to information and cybersecurity and privacy protection. Threats of this classification might be such as information breaches where information is lost or transmitted, or other wise inappropriately handled against the rules. In this classification is also taken into account vulnerabilities from cyber aspect.

This classification considers the requirements and content of the ISO 27001:2023, ISO 27002:2022 ja ISO 27005:2022 standards.

Environment

The environment risk classification is made for risks which are threatening the environment. The environmental point of view is very important, especially because operating field is in the immediate vicinity of the sea.

This classification also complies with ISO 14001:2018.

Safety

The safety risk classification is made for risks which are threatening occupational health or safety. To this category includes short- and long-term work accidents and damages.

This classification also complies with ISO 45001:2015.

Security

The security risk classification is made for risks which are threatening the company's, employee's or project's security.

Security risk classification includes risks related to information security and privacy protection. Security and cyber risks are strongly related to each other and it must be assessed on a case-by-case basis whether the risk should be classified only in one or both risk categories.

This classification considers partially the requirements and content of the ISO 27001:2023, ISO 27002:2022 ja ISO 27005:2022 standards.

3.2.3 Operational risks

Figure 9. Risk classification, operational aspect.

Compliance

The compliance risk classification is made for risks which are threatening the fulfilment of the requirements of the final product.

In the complex shipbuilding environment, there are multiple sources of requirements laws, customer's and flag authorities' requirements, and selected classification society's rules and regulations.

This risk classification takes account of general, and project specific risks related to shipbuilding.

Infrastructure

In the infrastructure risk classification is classified risks that is related to facilities, buildings, machines, equipment and/or energy network.

The energy network includes electricity, gas, compressed air and protective gas network.

In the infrastructure risk classification includes risk related to the adequacy of the premises and the capacity of the equipment and the suitability of the facilities to intended work or project such as crane capacity adequacy.

Integration

The integration risk classification is intended to risk that may occur when different parties' interfaces are combined into a whole or when different systems and/or structures are combined.

Material

In the material risk classification, it is reported risks that are related to material availability, correctness, working challenges and suitability.

The risks of counterfeit material are also recorded in this category.

This risk classification takes account partially AQAP-2110 standards content and requirements.

Resource

In the resource risk classification is reported risks and opportunities which is related to resources.

Risk resource classification includes employees, facilities, machines and equipment, and the risks related to their competence, ability, obedience, qualification and adequacy.

The risks for maintaining the knowledge and skills of the personnel in the company are also recorded in this category.

Schedule

In the shipbuilding environment the schedule risk is one of the most important ones. Shipbuilding projects' success are strongly depending on and oriented by schedule.

Many identified risks may have schedule classification assigned along with some other classification.

In the schedule classification there are reported risks that threaten the agreed schedule. These risks are assessed how the risk affects to the project schedule, to the hard points or possible interruption of operations.

3.2.4 Financial risks

Figure 10. Risk classification, financial aspect.

Finance

The finance risk classification is made for risks and opportunities which affect the company's or project's outcomes.

These risks are assessed by the effect of the cost impact and profit forecast.

The risks classified significant finance risks have separate financial assessment handling, where the risk to profit is assessed and calculated to money values.

3.3 Risk analysis

In this thesis and in this study case risks are analyzed qualitatively. With risk qualitative analysis is clarified the following basic information about the risk before numerical, qualitative evaluation (Keshk et al., 2018; Ilmonen et al., 2016).

After risk identification, it is important to analyze the risk. The risk analysis includes the risk causes/root cause, owner, effects, detection, processes, and project phase, as figure 11 describes.

In the risk analysis is analyzed the main reason, reasons, or the root cause of what caused the risk. It is mandatory to analyze the reasons what caused the risk, since in this way corrective actions and control means are aimed at correcting the right issue or problem.

The consequences of the risk are needed to analyze what the impact of the risk is to project or to the company. It is important to analyze whether the risk has an impact on more than one risk classification. The consequences differ from each other if viewed from the perspective of different classifications.

During the risk analysis it is necessary to consider the risks' impact on money value. This analysis is done either by a person who is qualified and capable of doing an analysis of the impact of the monetary value of the risk or with a financial specialist. A financial specialist can perform the analysis independently if all the necessary information is available to perform the analysis. If the risk appears to have significant impact on the money value, the money value is calculated to risk to profit with its defined calculation formula.

In risk analysis it is necessary to analyze the right owner to the risk. The owner can be from any department or function of the organization, the most knowledgeable and suitable is selected.

It is important also to analyze the detection of the risk, what is the visibility to the risk at the moment or is the risk totally invisible. Is there some continuous or random inspection points to that particular risk or is there no visibility or follow up to that risk at all.

In order of integrating the risk management system into the company's management system, the process where the risk occurs was added to the risk assessment tool to be one of the items that needs to be analyzed during the assessment process. In shipbuilding environment is beneficial to knowledge what project phase the risk, when realized, has an effect. With analyzing the project phase, important classification information is obtained to be aware of relevant risks in a timely manner. In figure 11 is described that in comprehensive risk management is analyzed risk owner, causes of the risk, effects including financial effects, detection of the risk, project phase and process where risk occurs.

Figure 11. Risk analysis in comprehensive risk management.

3.4 Risk assessment

Criteria definition

After risk identification and analysis, risk needs to be assessed/evaluated, to clarify the level of the risk.

To make the assessment as clear and coherent as possible, it is important to create the assessment criteria. The assessment criteria also minimize the personal effects of the person doing the assessment.

In this case there is three assessment dimensions, and the risk value number is calculated by multiplying the three values together, as in equation below.

$$RVN = Probability \times Severity \times Detection$$

In this study case is used qualitative assessment. In this qualitative, criticality assessment there is three dimensions, which are defined in the following paragraphs. (Keshk et al., 2018)

Numerical assessment and evaluation

To be able to handle and avoid those risks that need it more, it is necessary to evaluate each risk individually, so that the company's most significant risks stand out from the crowd.

Probability

The probability assessment is definitions and criteria are made to support of the evaluation the likelihood of risk to occur.

The probability assessment is evaluated how rare or certain the risk occurring is. In this study case probability value assessment and evaluation follows the table 2 example.

Table 2. Criteria for probability assessment.

Risk probability value	Frequency of risk	Probability of risk
1	0% - 10%	Very low / Very rare
2	11% - 20%	Low / Rare
3	21% - 50%	Moderate / Possible
4	51% - 90%	High / Probable
5	91% - 100%	Almost certain / Certain

Severity

The severity assessment is evaluated the risks consequences and how severe those consequences are.

In the assessment of severity there are significantly more different perspectives than other evaluable values. Such as occupational safety, operative action, finance, environment, and reputation. In this study case those perspectives conform to different risk classification items.

The value of severity is rarely mitigatable, and it is the most difficult to make control means. That's because if the risk occurs it effects almost always as severe as it was assessed. In this study case severity value assessment and evaluation follows the table 3 example.

Table 3. Criteria for severity assessment.

Risk severity value	Effect of the risk	Effect
1	Non-existent disturbance	Insignificant
2	Minor disturbance	Moderate
3	Disturbance	Severe
4	Large disturbance	Very severe
5	Intolerable disturbance	Critical

Detection

The detection assessment is made for identifying risks appearance and discoverability. The detection scale is assessed how predictable, visible, controllable and discoverability the risk is.

In shipbuilding environment and processes it's very often the case that it has a significant financial impact at the time the risk is detected. Detection is assessed without taking account of the severity or possibility of the risk. With detection ranking is also assessed and taken account of how likely is that risk is exposed with existing methods and procedures. (Carlson, 2019; General Motors, 2001). In this study case detection value assessment and evaluation follows the table 4 example.

Table 4. Criteria for detection assessment.

Risk detection value	Possibility to detect the risks appearance	How likely is that the risk is detected
1	The risk is prevented	Almost certain / Certain
2	The risk is detected at the same process step	High / Very High
3	The risk is detected after the project phase	Moderate
4	The risk is detected after the process step	Very low / Low
5	Not possible to detect / Not likely to detect at any time	Almost impossible / Very non-existent

Financial impact assessment

The financial impact of risk is assessing the risks' impact on money value. It is assessed and calculated by a person who is qualified and capable of performing the assessment and the calculation. Risks that have significant impact on the money value, the assessment is calculated with its defined calculation formula.

Risk value number

Before this development project multiplying two factors result was called RPN. RPN comes from the words Risk Priority Number which refers to prioritization in order. Based on the discussions and observations during the development work, the term RPN was found misleading, because the most important risk has the biggest number, it didn't refer to it to being first in priority list by its number. Since RPN referred to wrong thing, the new name for factors multiplying result was risk value number, RVN. The risk value number defines order to which

risks are more significant to react. It also gives guidance to the need for actions to mitigate the specific risk.

If the RVN is big enough it needs actions to mitigate the risk asap and in the worst-case scenario it might stop operations regarding the environment and/or process where the risk is possible to occur. If the RVN is minor and insignificant it might not require any action at all.

All the factors, probability, severity and detection, are assessed one to five, derived from this, the highest RVN is 125 and the lowest is 1. RVN values and related significance level are described in table 5.

Table 5. Criteria RVN importance.

RVN Value	Risk Significance
1-2	Insignificant
3-6	Minor
8-32	Moderate
36-75	Significant
80-125	Critical

3.5 Risk management resources

Because of this development of comprehensive risk management isn't planned to listed companies and the number of employees in the company is moderate, thereby there are no necessary for massive risk management organizations

with steering committees as Cochin (2014) for example. Nevertheless, if it is to be effective and produce results, a few new responsible people with clear responsibilities are needed for risk management in this case.

The biggest change compared to the situation at the start of thesis regarding resources, is that the whole personnel are now part of the company's risk management. New roles and responsibilities are planned to keep risk management's wheels turning all the time and everywhere in the company.

One of those new roles is risk coordinator. The risk coordinator is responsible for conducting risk assessments and risk reporting, regarding coordinators assigned risk area. The risk coordinator role isn't a full-time job, it is handled in addition to their own work. The risk coordinator's role is planned to be in every department. The risk coordinators are trained for the task, and they are supported in their task by the owner of the risk management process.

Risk management process owner is also a new role. Risk management's process owner is responsible for instructing and education of company's risk management process. The process owner is also responsible for the development of the company's risk management and for reporting risk management results to business management or the member thereof. The risk management process owner also updates the company's risk policy and delivers it to business management.

Risk owners were already existing roles, but their responsibilities needed to be clarified. Risk owners own the specific risk and are responsible for it, even though the control means and actions to mitigate the risk can have several different responsible persons.

It is the responsibility of the entire organization and each of its representatives to bring into the open the risks they identify and to participate in their handling, analyzing and mitigation if necessary. This study case's developed risk management system's roles and responsibilities is described in the RACI-matrix form in table 6.

In RACI-matrix:

R = Responsible, for completion of task

A = Accountable, in charge, decision maker, responsible to get task done

C = Consulted, asked opinion, advice or help to the task

I = Informed, needs to be informed

Table 6. Risk management roles and responsibilities RACI-matrix.

Roles & Tasks	Board of directors	Business management	Risk management process owner	Risk coordinator	Risk owner	Control means responsible	Whole organization
Risk management policy	A	C	R	I	I	I	I
Risk management plan	I	A	R	I	I	I	I
Risk management process	I	A / C	R	I	I	I	I
Risk management procedures	I	A / C	R	I	I	I	I
Risk assessment coordinating	I	A	C	R	I	I	I
Risk identification	R	R	R / C	R / C	R	R	R
Risk management reporting, company level	I	A	R	I	I	I	I
Risk management reporting, risk area level	I	I	A	R	I	I	I

3.6 Risk management tools

3.6.1 Development of existing methods

There has been an FMECA form as a used tool in existing risk management process. The FMECA form has been used in an excel format.

The FMECA form has a functional structure already, but to make it a more efficient tool to this specific environment it was beneficial to add the project phase and the process where the risk occurs. There were made new columns to the additions in the formats analysis area.

The other bigger development target was fulfilling the format and specifications for performing that. There was added small, one sentence, instructions to straight below of the column names to the form. It was found out that the form is easier to fill when you have specific questions which you are responding to. In this context, the definition of risk owners was developed so that the risk owner is determined according to which department or function the risk appears. The departments and functions were also updated to meet the nowadays organization chart.

The biggest development regarding the risk assessment was to start to analyze and assess the detection of the risk. This needed also specifications and guidance on how to assess that as uniformly as possible. Because there was added one factor more, the RVN's calculation changed also. Before development actions, two numbers were multiplied together, now there are three factors. In the process the RPN was changed to RVN.

3.6.2 Support from software tool

Even though the form was developed and made many clarifications, it didn't erase the problem that sometimes the specific risks or needed actions or the ownership were forgotten. If the management of such a large entity, all the risks of the entire company and their actions, monitoring and control, is only dependent on human memory and actions, the possibility of mistakes and inefficiency strongly exists. That is when the information technology's support is needed.

In this study case, one software was also tested with some tailoring to support the company's comprehensive risk managements implementation. The tailoring of the software was based on already improved FMECA form.

With the software solution, was able to select multiply project phases and processes to one risk, the risk classification choice was left to one, because of controlling the assessment process.

The agility of risk management reporting and the different graphs for monitoring and developing the situation were one of the biggest developments compared to the old tool. The software has the option of choosing a reporting perspective, whether there is a need to look at the entire company's risk management situation or a specific project or sub-area. There is also the possibility to monitor risk specific development with the help of charts and risk development arrows.

There were also reports and charts for monitoring for realized risks. From realized risks is the possibility to take input to company’s lessons learnt process.

3.7 Risk control and mitigation

Development actions for risk control and mitigation were partially handled by clearing the roles and responsibilities. The clearance of reporting the person responsible helped to follow control means and actions. The risk owner term was also defined as clearer and helped to identify risk owners according to function and organization. Added the schedules and responsibilities to each control mean and risk owners to each risk.

The most effective development action to control and mitigate risks is support from software solution, which will take care of reminding responsible actions schedule. The software solution also enables efficient reporting possibilities related to control means and mitigation actions, and to whole company’s risk control.

4 Comprehensive perspective of risk management

Developing risk management to be comprehensive was necessary to study the perspectives needed in this specific company operational business environment. There was observed that in shipbuilding environment it is important to what project phase or process the risk is linked to. Also risk classification was beneficial aspect for utilizing risk management as a tool. For example same compliance classification risk can occur different project phases such as detail design and steel production, and it can be related to for example configuration management process.

By adding the different perspectives into the tool wasn't only to make utilization of the tool better, but also improved risk identification. When risks are identified from a wide perspective, there is less likely that some risk area is forgotten to identify. Utilizing risk sorting from the tool, from the different perspectives from the gathered risk data, it enables to look and remember to focus on the right risks at the right time.

The different perspectives functionality was tested with risk assessment interviews, in the semi-structured interview. Participants in the interviews were selected from different areas of expertise, different levels of organization, with different times of experience from ships or shipbuilding industry. An interview was requested by 22 people, of which 3 interviewees invited themselves to the interview. In total 21 people were interviewed during spring 2024.

Interviews were conducted in groups and individually, face-to-face or through teams. In the Teams interviews, no more than one interviewee participated via Teams.

The average experience from ship or shipbuilding field was almost 19 years. Experiences varied between 2 months and 46 years. Two of the answers had experience in less than one year. The years of study related to ships or shipbuilding were also counted as years of experience.

Different expertise fields were represented in production, design, support function and sales. The respondents had the following job titles specialist, manager, director, engineer, supervisor and inspector.

In the interview forms were partially prescribed such as selectable different predefined risk classifications and project phases. Interview allowed open discussions also. The task given in the interview was to identify generic risks related to shipbuilding. The questionnaire form is in appendix 1.

Based on the answers of 21 people, the sample was judged to be sufficient and the answers comprehensive, and partially the same between different interviews. There was no need to continue the interviews.

As a result of the interviews, 585 generic risks were identified, the significance of which was estimated to be 3,43 on average, in the scale of 1-5, where 5 meant the most significant. The interview results were handled with categorizing answers with utilizing excel -program.

It was noticeable from the interviews that the risks of the fourth project phase were identified the most quantitatively. In figure 12 the distribution of identified risks is shown by project phase. From the risk classifications it was clearly observed that classifications 14 and 15 were the most identified, and those were related to most of the risks in this operational environment. In figure 13 the distribution of identified risks by risk classification is shown. According to assessed significancy, participants rated their identified risks as significant rather than insignificant. In figure 14 the distribution of identified risks is shown by significance level.

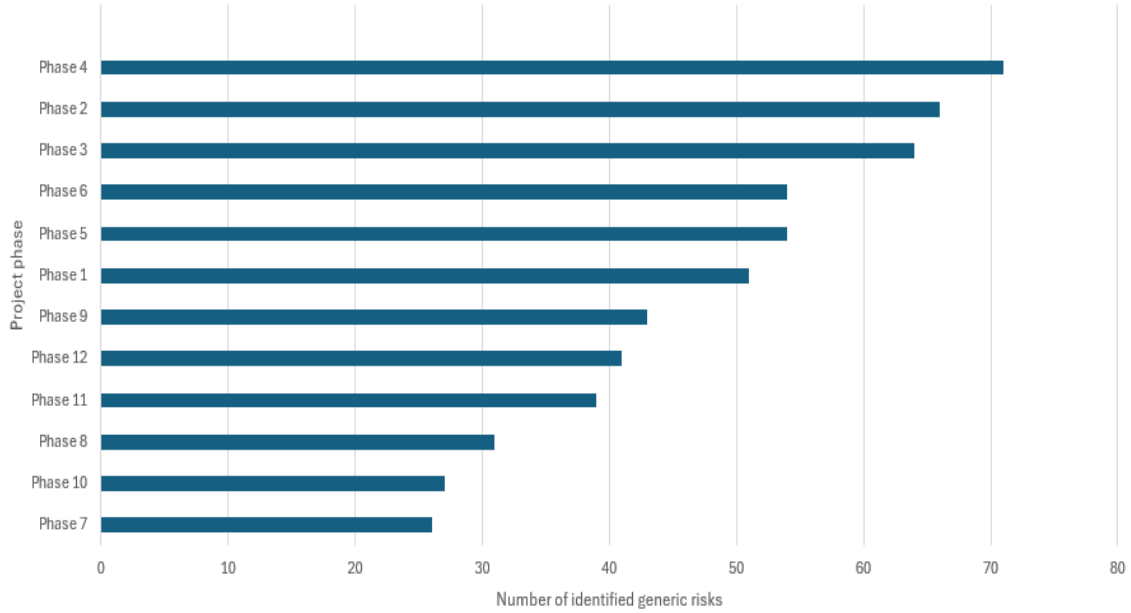

Figure 12. Number of identified generic risks by project phase.

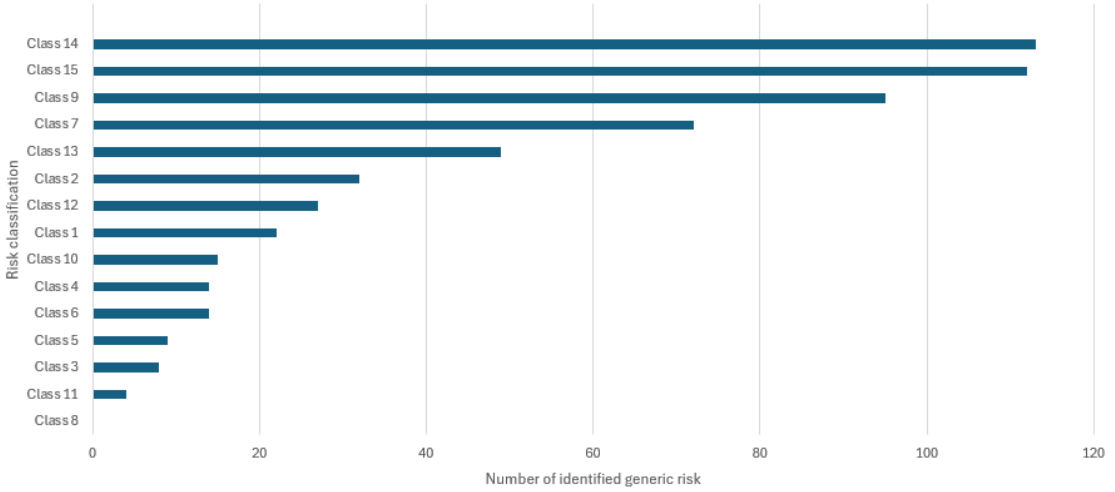

Figure 13. Number of identified generic risks by risk classification.

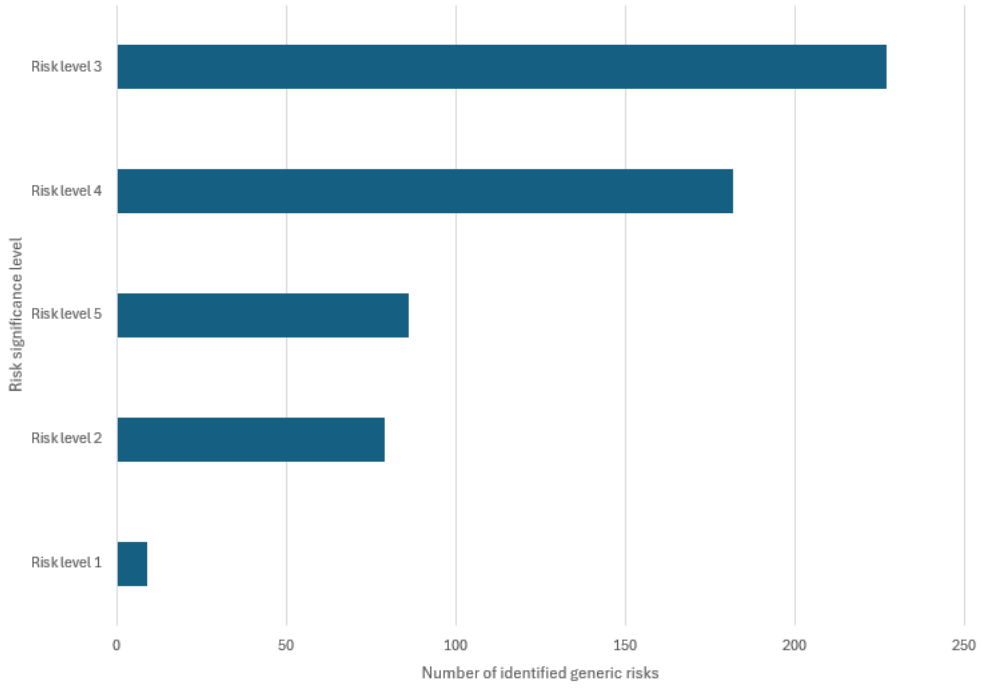

Figure 14. Number of identified generic risks by risk significance level.

The purpose of the interview was to verify correctness and functionality of defined classifications and project phases, comprehensively by project, organization and statutory point of view as is described in figure 15.

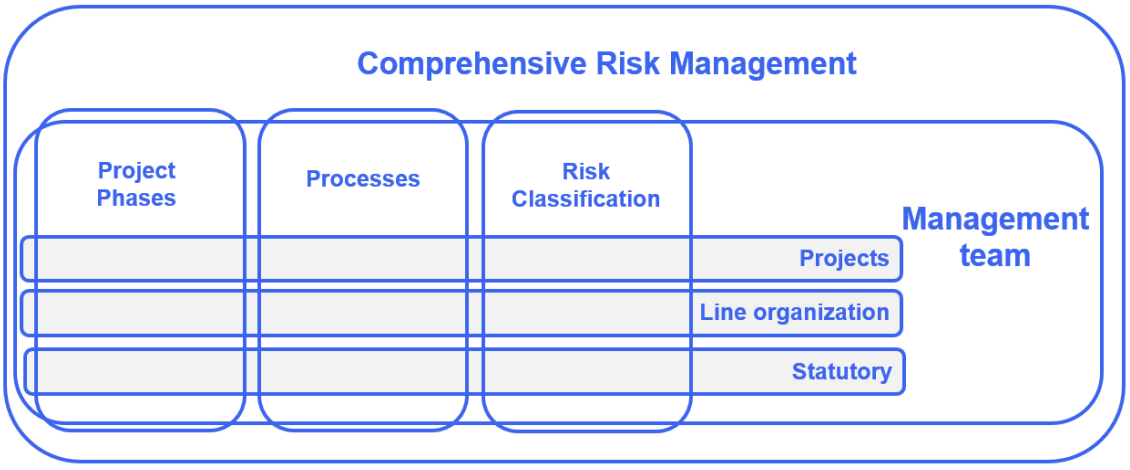

Figure 15. Comprehensive perspective of risk management.

The information collected in the interview will be used to compile generic risk lists for shipbuilding from the point of view of continuous improvement, which was excluded from this study case.

With these perspectives it is assumed to cover the risk assessment needs outside the normal risk management processes, such as occasional or special development or construction projects.

5 Implementation of Risk Management in Management system

To develop the risk management as comprehensive as possible is beneficial to commit the whole organization to process. On the other hand, if all the members of the organization are needed to shipbuilding, all of them and all the risks they identify are needed to comprehensive risk management process. That's how the risk management perspective is wide and comprehensive enough. During this thesis was noticeable that asking for opinions was important and valuable to many.

In the figure 16 is shown how the risks are reported and spread in the whole organization.

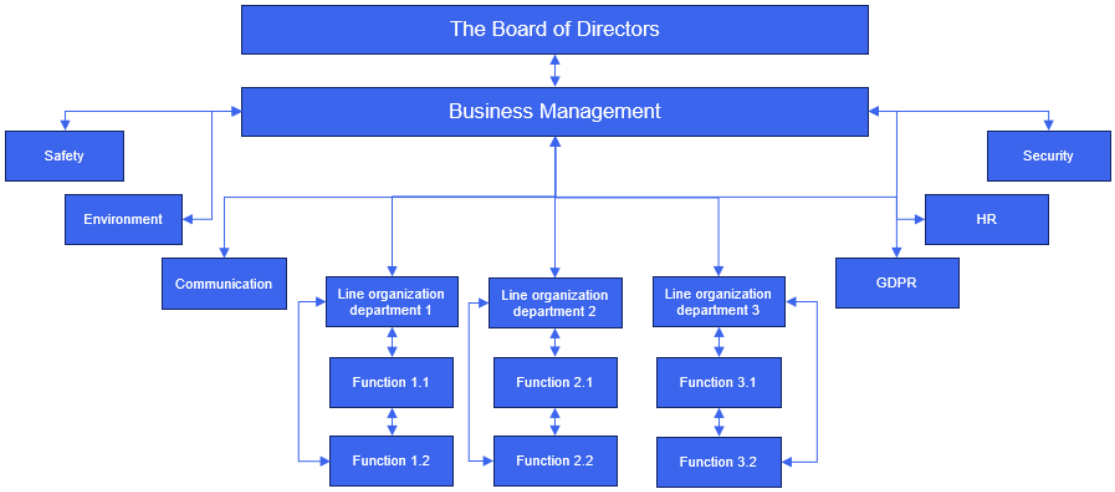

Figure 16. Risk management in company organization.

In the figure 16 and 17 is defined how the risk communication is handled from the top to the bottom and vice versa.

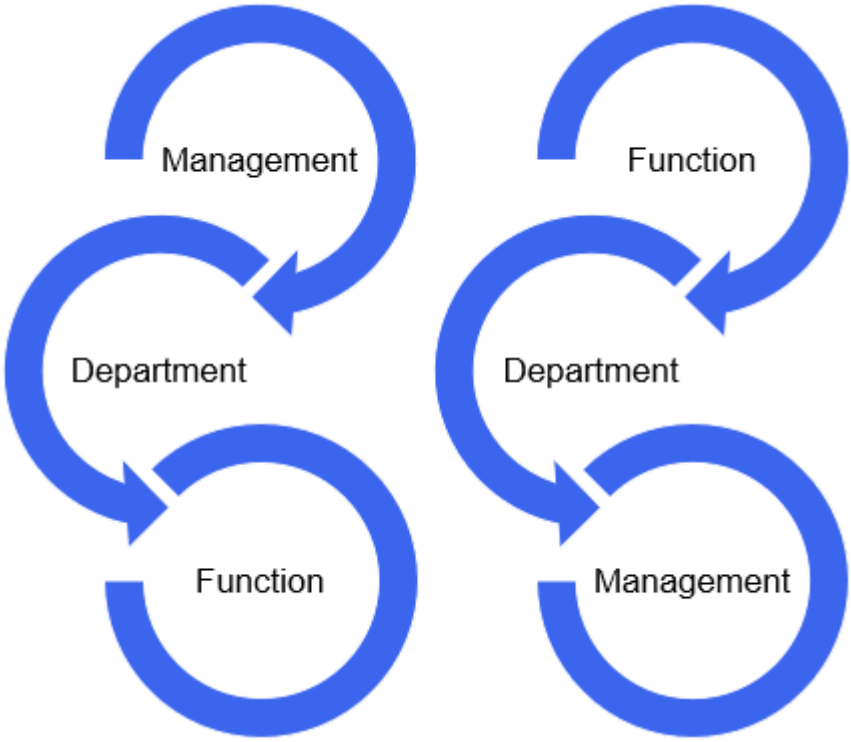

Figure 17. Risk management communication in company organization.

Based on discussions and observations during the development work it turned out that in a company of this size, it is important to integrate risk management into the existing management system in daily basis to support the handling of risks. A separate risk management system would be too heavy and time-consuming to deal with and it would be harder to commit it to. With this development work is targeted to make risk management agile and effective. As a result of these findings was planned that risk management and risk identification are integrated into existing meeting note forms and into departments' seasonal plans.

For these reforms to improve the efficiency and comprehensiveness of risk management, it is important to educate personnel about risk awareness and the company's risk management process. Educations about these manners are started with different kinds of lectures and performances, such as personnel info's short situation review about company's risk management development,

and bigger performance in supervisor forum where was invited whole company's supervisors.

Even though risk management is integrated into the management system it is important to integrate it into the existing operating system and its processes (Juvonen et al. 2014). The benefits of integration were also wanted in this development work that the risks are memorized and managed in a timely manner and clarify how it is linked existing support functions and processes. It's described in figure 18 how risk management was planned to integrate and linked to the company's management systems other processes and receives input from them. In the same figure 18 the outputs and benefits are shown as the results of a comprehensive risk management system.

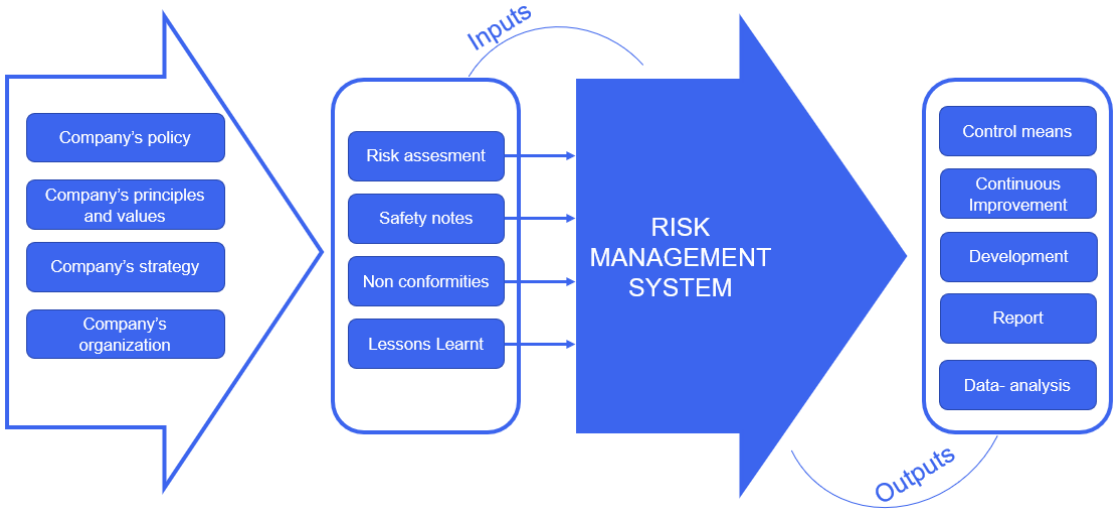

Figure 18. Risk management integration to management system.

6 Conclusion

As a conclusion can be stated that there is multiple developmental methods and action how to improve company's risk management to be more comprehensive. It is important to familiarize yourself with the company's operational environment, industry field and personnel.

In this study case the problem was that even when the company's risk management met the regular standard requirements, it didn't provide the company with the desired results. The development work that proceeded according to the plans was made at a generic level. Figure 19 describes the development works proceeding on a bigger scale and main points considering. Planning phase was designed to question form that what issue is planned to be solved or developed.

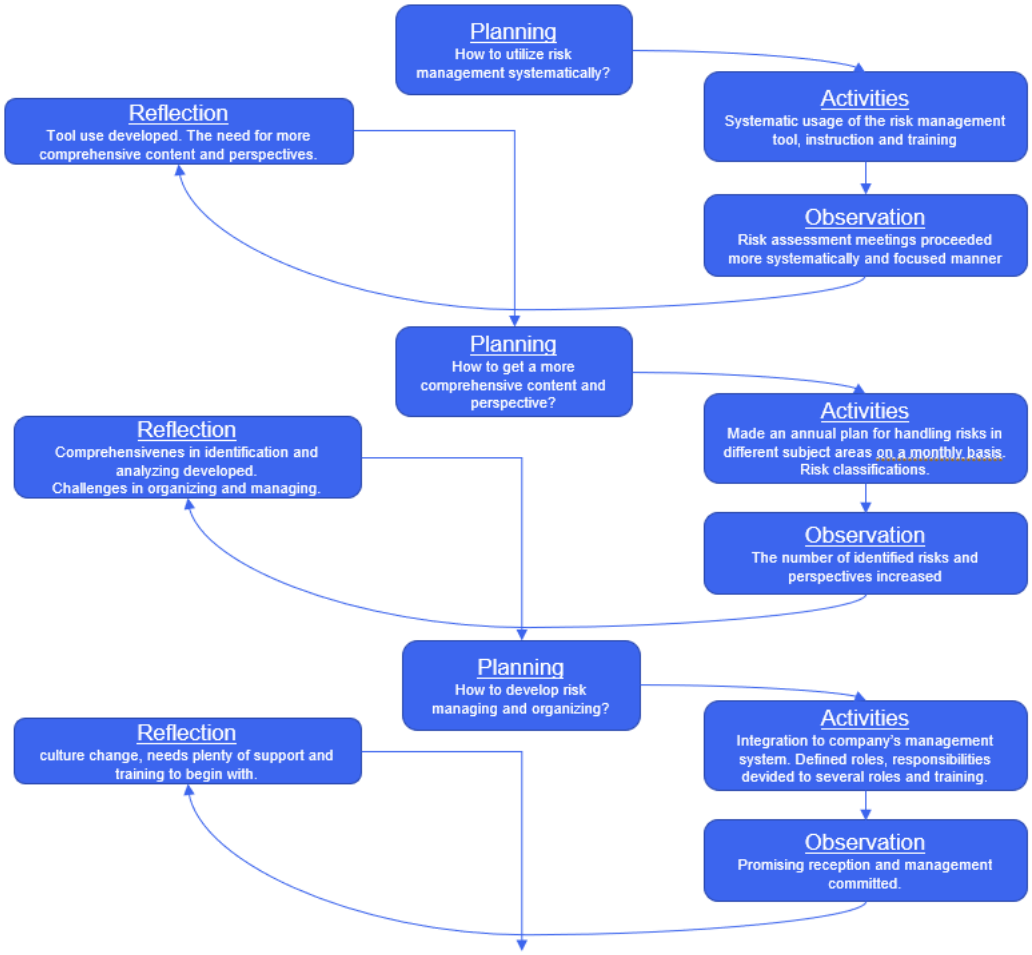

Figure 19. Development work framework as a spiral model.

The issues behind the problem were forgetting of identified risks, risks were viewed and assessed between small groups of personnel infrequently. These issues were most likely caused by the lack of risk knowledge and about the need for risk management resources. Those issues and cause and effect relationships weren't observed most likely because there were no prerequisites for adequate risk management data analysis and comprehensive risk reporting.

The first development actions were standardizing the methods and tools used in risk assessment, for example defining the risk owner more specifically. Then risk management scheduling and planning was made, frequency and needed participants. These steps developed the comprehensiveness of the company's risk management as follows: risks were assessed often enough and the tool

was used in a standardized way, making it easier to remember and handle risks. There were enough experts as participants and new risks were more widely identified, so the risk view became more comprehensive.

At the same time, when more new people were involved in the company's risk management, the amount of training, instruction and guidance for risk knowledge and risk assessment process increased.

After those actions were observed problems with managing the increased number of risks, their control means and the lack of time to manage it. To correct those raised issues was started to plan how to integrate risk management into the existing management system and processes. That development has started, but that kind of cultural change takes time to settle.

To promote this cultural change, it would be supporting to make training packages about comprehensive risk management. The package should include a description of comprehensive risk management process as a chart and procedure. These should also include a description of the risk management principles that are followed in the company. These should refer to and be in line with the company's risk policy. Opening and teaching risk knowledge and awareness would be a large part of the training package, so that the company's personnel would be as risk aware as possible, and it would contribute to the identification of risks and their conscious avoidance. People would also benefit from this outside the company. The training package should include guided practical exercises so that the exercises can teach the company's perspective on the verbal and numerical assessment of risks. It would be beneficial to compare with what kind of guidance and instructions to get the most effective and comprehensive training package that would suit as many people as possible.

To integrate risk management into the entire organization and the existing management system, the matter has been lectured and trained at various events, such as personnel information for all personnel, as well as in various supervisor and manager forums. With these performance requests and

arrangements, in addition to other support, the company's management shows that it is committed to the comprehensive development of risk management.

Even though there were multiple development actions performed, there were still issues with memorizing responsibilities towards the assigned risks and data analysis nor risk reporting. To improve those issues support from software solutions was investigated. After finding the suitable software it was tailored based on the company’s needs. The software was tested enough during this study case, but the long-term implementation and verification continues.

Finally, there are a few thoughts about comprehensive risk management. It is never ready, and it never ends, in this globe there is always a new angle, risk or possibility, for risk management, because it hasn’t been studied as science for very long and because this world is changing constantly. We can utilize AI or software solutions, but most likely those can’t replace communication within or between stakeholders.

7 Deficiencies and limitations

The most significant limitation of this study was that it was made for one specific company and its operational environment, business field, goals and backgrounds. The most deficient thing in the source materials was that not many of them have directly focused on the shipbuilding industry, which is in many ways different from many other industrial fields due to its complexity and long cycle time. Or the source materials aren't comparable with this company's business model.

Another significant deficiency of the source material was that there was not available material from the shipbuilding field what would have taken account the company's management or quality management system and included an efficient or comprehensive risk management process. Moreover, most of the source materials were approximately almost ten years old therefore some of the information might have been updated since those has been written.

8 Further development and research topics

8.1 Sustainability aspect in risk management

Sustainability is nowadays a trending subject to most business fields. It would be beneficial to study how to take more account of sustainability aspects in comprehensive risk management in shipbuilding operational environment. Utilizing risk classifications to highlight the sustainability aspects with its own classification or by integrating it with some other classification. Another possibility is making own risk assessment tools for sustainability risks and that way to connect that to the whole company's risk management system. Adding sustainability to the company's comprehensive risk management, it would be more comprehensive. This risk classification would take account ISO 26000:2020 standards content and requirements, where is noted issues such as human rights and its risk situations.

8.2 Study of risk policy

The risk policy is usually defined by the company's superiors. It would be interesting and timely to investigate whether the basic content of risk policy and its principles have remained part of the development and whether there is something to be developed and updated to the present day. However, the role of the risk policy is important as an indicator of the direction of the entire

company's risk management. Figure 20 describes main elements of risk policy and could work as a starting information or framework to the study.

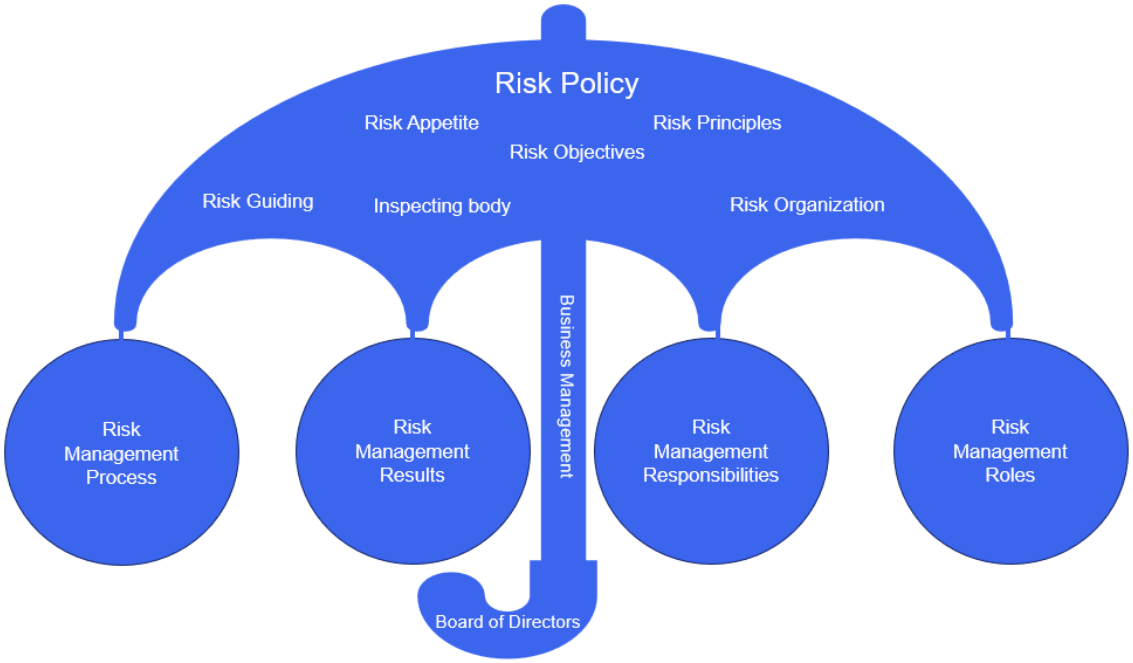

Figure 20. Risk policy.

8.3 Risk Assessment validation

The idea of validating the numerical assessment of risks performed by individuals, started from the methods of testing different assessment abilities. It would be exciting and interesting to study how to get personnel numerical assessment of the risks as identical as possible. References to this study could be found from on determinations and exercises of the necessity of work research, or methods of visual quality control.

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Questionnaire for shipbuilding industry specialist

Questionnaire for shipbuilding industry specialist:	
Your experties field:	a) Production b) Design c) Support function d) Intrestied party (relevant to shipbuilding) e) Multiple, which ones. Other, what?
Your job description:	a) Specialist b) Manager c) Director d) Coordinator e) Engineer f) Supervisor g) Worker h) Inspector i) Other, what?
Experience in years (Ship/Shipbuilding):	
Employer:	a) RMC b) Other, what (optional)

Project phases	Classification	Risk level
1	1	1
2	2	2
3	3	3
4	4	4
5	5	5
6	6	
7	7	
8	8	
9	9	
10	10	
11	11	
12	12	
13	13	
	14	
	15	