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Risk management improvement in the sales phase of a global construction business to increase the profit of projects and business

Action research

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ABSTRACT :

This thesis studies the risk management improvement in the sales phase of an energy construction business and if risk management executed already at this phase can increase the financial business result through decreasing the negative margin deviation of the projects. The study is made from the constructor business perspective. The basis of the research method is an action study. The research question is how and what type of risk management should the global, case construction business implement in the project sales phase to have a meaningful, positive impact on the project cost overruns?

The business result of the case company was heavily impacted at the end of 2019 by projects which were delivered with negative margin deviation. One of the root causes for the result was studied to be an inadequate risk identification and management at the sales phase.

The theoretical part of the study analyses the concepts of project risk management in general, risk management specifically in the sales phase of projects and further the risk management in the construction business. In addition, it reviews the risk management tools as well as the concept of contingency reservations. Also, the concept of action research is defined and its relevance for this study is analyzed. The framework for the case action research is also defined.

The practical part of the action research follows the planning and implementation of risk management process in the case company. The effect of the implemented risk management process is reviewed against the results on the project margin deviations. Results demonstrate that the described implementation of risk management in the sales phase of the case company was successful. The margin deviation summary report demonstrates the A class projects with implemented risk management practices in sales phase causing 66% less negative margin deviation in average than projects without risk management. This means that the case company could increase its profit by 66% having the risk management implemented for all the future A class projects.

KEYWORDS: projektien riskienhallinta myyntivaiheessa; Rakentajaliiketoiminta; toimintatutkimus; tuottojen kasvattaminen, projektin marginaali, riskivaraus

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Tässä opinnäytetyössä selvitetään energiarakennushankkeiden myyntivaiheen riskienhallinnan parantamista ja sitä, miten tässä vaiheessa toteutettu riskienhallinta kasvattaa liiketoiminnan tulosta. Tutkimus on tehty rakentajaliiketoiminnan näkökulmasta. Tutkimusmenetelmän perustana on toimintatutkimus. Tutkimuskysymys on, miten ja millaista riskienhallintaa globaalin energiarakentamisen tapausyrityksen tulisi toteuttaa projektimyyntivaiheessa, jotta sillä olisi mielekäs ja positiivinen vaikutus projektin kustannusten ylityksiin.

Case-yhtiön liiketoimintatulokseen vaikuttivat voimakkaasti vuoden 2019 liiketoimintatulokseen projektit, jotka toimitettiin negatiivisella katepoikkeamalla. Yksi tunnistetuista juurisyistä oli riittämätön riskien tunnistaminen ja hallinta myyntivaiheessa.

Tutkimuksen teoreettisessa osassa analysoidaan projektiriskien hallinnan käsitteitä yleensä, riskienhallintaa erityisesti projektien myyntivaiheessa ja edelleen riskienhallintaa rakennusalalla. Lisäksi riskienhallinnan työkaluja tarkastellaan, kuten myös riskivarauksen hallintaa projektin budjetissa. Myös toimintatutkimuksen käsiteja sen viitekehys tälle tutkimukselle määritellään.

Toimintatutkimuksen käytännön osuudessa seurataan riskienhallintakäytäntöjen suunnittelua, parantamista ja toteuttamista case-yrityksen myyntivaiheessa ja toteuttamisen vaikutusta projektien tulosmarginaalin parantamisessa. Tulokset osoittavat, että tutkimusosiossa kuvattu riskienhallinnan implementointi tapausyrityksen myyntivaiheessa oli onnistunutta. Ne A-luokan projektit, joille oli toteutettu riskinhallinta myyntivaiheessa, tuottivat 66% pienemmän negatiivisen marginaalin kuin projektit, joille riskienhallintaa ei oltu tehty. Mikäli jatkossa kaikille A luokan projektille edelleen suoritettaisiin riskienhallinta myyntivaiheessa, voisi liiketoimintayksikön katetuotto parantua 66%.

KEYWORDS: projektien riskienhallinta myyntivaiheessa; Rakentajaliiketoiminta; toimintatutkimus; tuottojen kasvattaminen, projektin marginaali, riskivaraus

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Abbreviations

AI	Artificial Intelligence
ANN	Artificial Neural Network
ANSI	American National Standards Institution
APM	Association for Project Management
AR	Action Research
BBN	Bayesian Belief Network
CASPAR	Compliance and Supervision Platform for Assessing Risk
CCR	Cost Contingency Reserve
CEO	Chief Executive Officer

CRM	Customer Relationship Management - tool
E2E	End to End
EEQ	Engineered Equipment Delivery
EPC	Engineering, Procurement and, Construction
FBBN	Fuzzy-Bayesian belief network
FHM	Fuzzy hybrid method
FST	Fuzzy Set Theory
GA	Genetic Algorithm
HSS	Health, Safety and Security
IEC	International Electrotechnical Commission
IEEE	Institution of Electrical and Electronics Engineers
IPMA	International Project Management Organization
IPP	independent Power Producers
ISO	International Organization for Standardization
KPI	Key Performance Indicator
P&L	Profit and Loss
PLC	Project Life Cycle
PM	Project Manager
PMI	project Management Institution
PMP	Project Management Professional Certification
PRAM	Project Risk and Management
PUMA	Project Uncertainty Management
R&D	Research & Development
RAMP	Risk Analysis and Management for Projects
RPA	Robotic Process Automation
RM	Risk Management
SEM	Structure Equation Modeling
SHAMPU	Shape, Harness, and Manage Project Uncertainty
SRM	Senior Risk Manager

1 Introduction

This thesis studies the improvement and implementation of project risk management in the sales phase and its effect on a construction project margin deviation and the financial result of a business from the perspective of a constructor. The study follows a global energy power generation construction business case through development, improvement, and implementation of risk management practices for the sales phase. The research is conducted using an action research method. The study also reviews the theory and literature of the topic and provides input towards both to practical implementation and academic research.

1.1 Motivation for the Study

Project cost overruns are common in all types of construction projects. The overruns are higher the more demanding and complex the project is (Merrow, 2011). Cost overrun in a construction project is a global phenomenon and not linked to any specific country as the studies show (Aljohani et al., 2017; Merrow, 2011) even though the cost overrun reasons may vary per country (Aljohani et al., 2017, p. 5). The statistics show the same phenomenon in power infrastructure projects as Brookes and Socatelli (2015, p. 3) studied. Power and utility megaprojects run 35% over budget in average (WFO, 2016). The big projects catch attention in the media and provoke discussion in general of construction project failures. The phenomenon of negative margin deviation occurs also in medium size construction projects. The Korean research studying 29 medium sized project found the average cost overrun to be 32,5% (Han et al., 2009, p. 1) which is close to the average megaproject overrun.

In this study the case company is an energy construction business based in Finland but operating globally. The focus will be in medium size, new build power construction projects which are more than 50 M€ but less than 500 M€ budget projects. The case company had its financial performance impacted in 2019 by cost overruns in projects which were caused by inaccurate assumptions in cost estimates, insufficient risk identification and supplier related challenge as stated by the CEO of the company in the annual report (Annual report, 2019). The effect of the project budget overruns for the energy business 2019 was more than 200 M€. It was an interest of the company to understand how to improve the success of the projects. An improvement initiative for the risk management on the sales phase of the projects in energy business was started.

This research follows the improvements made and the implementation of energy construction contractor business sales phase risk management practises in the context of decreasing cost overruns and improving project margin deviations and thus ultimately aiming to impact positively the business financial results of the case company. The focus will be on energy business construction complex projects which are classified as A class projects within the company. A class projects, in case company, are mainly EPC (Engineering, Procurement, and Construction) contracts that are delivered on a guaranteed date, price and performance. Also, other types of contracts exist within the case companies (B and C class projects) such as EEQ projects (equipment delivery only) but the margin deviation within these projects were identified being less significant than in A class projects which caused the focus to be on complex projects.

Theoretical motivation for the study is to search existing literature for the topic and to research the suitability of the theory in practice for the case. The case study results are reviewed in the light of academic studies to understand the suitability or gaps in theory and the further improvement possibilities within the case company.

1.2 Research Gap

This thesis combines elements of creating project risk management process in the sales phase for a contractor in construction business, risk management aiming to positively affect the project margin deviation and thus business result, and a combination of implementing these in practice. Although separate elements of the content of this thesis are multiple to be found in the literature the specific combination used in this study was not found in the academic literature. A closely related study is presented by Ibrahim et al. (2014) on their study on setting cost contingency reserve (CCR) for constructors although focus is on CCR in the context of a one project. The existing studies can identify possible high-level factors leading to a project cost overrun. It is known the bigger the project is, the more the following three aspects are either underestimated, downplayed, or down right ignored: high stakes, uncertainties and conflicting values. The risk management to address these aspects in practice is, however, typically missing. In this thesis the focus is to prepare for all the issues listed above even prior the commitment for the sales is done. The literature of project risk management done in the sales phase, is in many cases focused on losing/winning an opportunity, contractual risks in a legal framework or financing risks but not aiming to identify future project execution phase risks in a constructor perspective and its effects on margin deviation. Also, in the research the focus typically is on a sales team rather than a combination of sales, project and support teams working together, although the value of such co-operation is captured.

In the construction business the application of risk management practices have been considered low (Uher & Toakley, 1999, p. 161). The main reasons for the unsuccessful implementation identified by Uher and Toakley are the negative culture and attitudes within construction business, limited training possibilities, and not understanding the concept of risk management nor its usefulness in practice.

The cost overruns of projects start appearing during the project execution phase, cumulating towards the end. A lot of academic literature is made on project execution phase risk management. Even one of the well sited project risk management literatures e.g., Chapman proposes the risk management to be initiated towards the end of the plan stage as “By this stage of a project a fair amount of information about the project is available” (2003, p. 257). Unfortunately, the possibilities of affecting the root causes, the decisions made in sales, are too late at this stage, and the firefighting takes place making it harder to keep the original budget. Overpromises or issues left open, unattended, or overlooked in the sales phase affect the possibilities of success in the project execution (Merrow, 2011). The sales team and the execution team can have a gap in between and working separately. If the contract details and content, promises, schedule and the sales price in the sales phase are not adequately examined, the unclarified issues are prone to overflow as risks to the project execution (Merrow, 2011).

1.3 Research questions and objectives

The purpose of this study is to follow, report and analyse the actions and results in the energy business sales phase risk management improvement initiative and to compare them against the academic studies. The resulted improvement needs are studied both from the practical and from the theoretical perspective.

The research question is **how and what type of risk management should the global, case construction business implement, in the project sales phase, to have a meaningful, positive impact on the project cost overruns?** The sub-questions to study are:

1. What is related current theory and academic literature explaining the phenomenon of construction business cost overruns in relation to risk management in the sales phase?
2. How should the case company estimate the risks of sales opportunities and make an educated decisions on the sales price to improve financial performance?

1.4 Scoping and Limitations

Risk management can be understood from several angles. Business risks, project risks and operational risks. In this thesis the scope is limited to project risk management specifically in the sales phase opportunities to be sold when contract is not yet signed. The thesis is not covering the risk management during the project execution phase after the contract has been signed and the sales phase ends. The lens is on contractor, not on client. More so, the study is limited to a business in one company concentrating on new build energy construction projects, the service type of projects is out of scope. Detailed legal issues of contracts are not considered more than on a general level if/when related to the study. Additionally, the risk of loss of a sale is not in focus rather presumption is that the risks identified during the sales phase guide the constructor whether to take a risk on a sales opportunity or not. Operating risks related to fixed costs required is neither in the focus, this is covered in enterprise risk management studies. Also, the organizational change practices in a case of an improvement initiatives are not considered in theory.

1.5 Thesis Structure

In the first chapter the motivation for the study is being enclosed, the research gap and problem with the research questions and the sub-questions introduced, the limitations of the study presented, and the thesis structure displayed.

In the second chapter the existing academic literature is reviewed. The academic literature is limited to basic risk management, risk management in the sales phase, risk management in construction business and contingency planning as well as to related risk management tools. In addition, the contingency reservation is studied. Third chapter explains the used research design and methodology which is action-based research. Fourth chapter concentrates on the case study. In the chapter the plans, actions, decisions, and outcomes during the action research are presented. These are demonstrated via improvement spirals made during the risk management improvement initiative. The improvement steps in a spiral are planning, acting, observing, and reflecting. Fifth chapter discusses the findings both from the practical and theoretical view. The chapter proposes further actions for the case company and management as well as towards the theoretical studies based on the findings. Additionally, the limitations of the thesis are presented.

2 Literature Review

The goal of the literature review is to find the relevant studies which connect the interest areas of project risk management, risk management specifically in the sales phase of the project affecting the project execution and implications to a construction projects' margin deviation. Within each of these lenses, via which the risk management is studied, it is relevant to understand their key concepts as well as methods of implementation to the action research. The literature review consists of main areas that overarch the goal of the study as illustrated in figure 1. These areas to provide a coverage of relevant literature and establish a baseline for the subject studied.

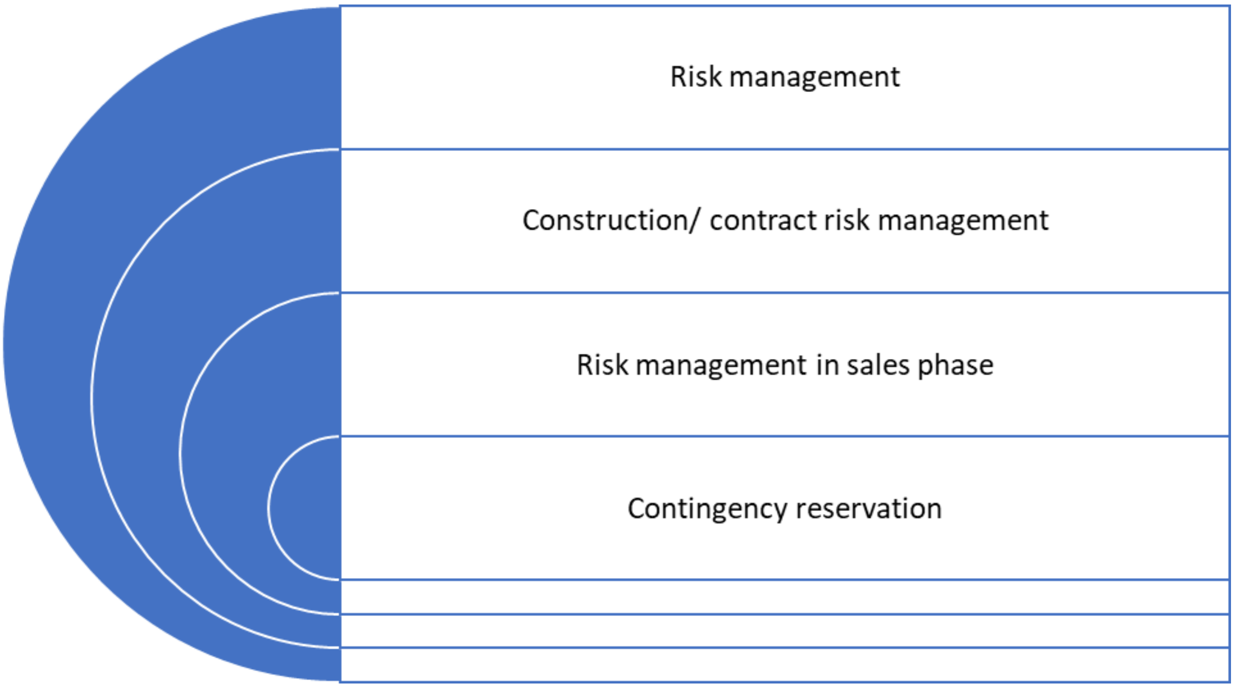

Figure 1. Theoretical approach of the thesis.

2.1 Definitions

Risk Management was established in scientific studies in the 1950s. The root principles are in effect today although new techniques have been developed (Aven, 2015, p. 1). It is firmly recognised as an integral part of project management and acknowledged in global management systems such as by International Standards Organization (ISO) (ISO:31000, 2018; IEC:31010, 2019; ISO Guide 73, 2009), Project Management Institution (PMI) in project management professional certification (PMP) (PMP-RMP, 2002) as well as widely recognized in other project management institutions such as International Project Management Organization (IPMA, 1998). Still, organizations or companies cannot be certified separately for risk management practices, but risk management is part of other certifications. The relevance and benefits of project risk management are seen to include avoiding disasters, improving the margin delta and decreasing the need for contingency (Chapman & Ward, 2003). In addition to these, there are spill over benefits from the formal risk process to increase project performance by influencing the project management practices (Chapman & Ward, 2013, p. 33) Benefits are to have project obstacles clarified and managed from the beginning and the actual decision to invest in the project made by comprehensive analysis (Smith et al., 2014, p. 2). In addition, the risk analysis data stored serves as a basis for upcoming project analysis and lessons learned (Smith et al., 2014, p. 2).

According to the PMI the definition of a project risk is a positive or negative occasion which can affect project objectives (PMBOK guide, 2023). In reference, the Association for Project Management (APM) body of knowledge defines risk analyses and risk management as a process which can optimise project result if risks are proactively analysed (APM Body Of knowledge). These views are accentuated by Chapman and Ward (2003, p. 6–15) who consider the essential part of definition to be based on certainty/uncertainty. Therefore, they consider that for risk management, a simple “lack of certainty” definition is sufficient. The terminology used within the area is still somewhat undetermined. Mostly used terms are plain risk management, risk and opportunity management, plain opportunity management or uncertainty management or combination of the previous. While all these aspects are taken into consideration in this thesis the wording “risk management” or shortly, RM, is used throughout the work for the practical reasons. However, the opportunities, threats, and certainty (or lack of) are included within the term. The opportunity definition has mixed terminology in the literature but in this thesis one of the definitions described by Hillson (2002, p. 1) is used: risk is an uncertainty having a possibility of being either negative risk or positive opportunity. An opportunity here is the upside of the risk if managed well which is also supported by the PMI and APM in their risk definitions. It is noteworthy, that risk field suffers from a lack of clarity and consensus regarding the various scientific pillars of its discipline (Aven et al., 2018). In their study, Emblemsvåg and Kjolstad (2005) present how three separate consulting companies gained very different conclusions in conducting a risk analysis on the same power plant.

Project risks are event-based risks where the event might or might not happen, also known as stochastic risks (Curto et al., 2022). Non-event risks can be identified and categorized as variability risks or ambiguity risks, also known as aleatoric and epistemic risks (Curto et al., 2022). Variability and ambiguity risks exists when there is uncertainty such as not having a full confidence on the result (Chapman & Ward, 2003, p. 26). In addition, emergent risks, also known as ontological risks, are so-called unknowable unknowns that can affect the project which has several implications for the project and project results (Curto et al., 2022). These are the risks that cannot be foreseen (Smith, 2014, p. 4). According to PMI guide (2023), project needs to be prepared for the risks in many ways. The guide instructs that a project needs to have contingency for both specifically identified risks and emergent risks. It continues to explain the need to have flexibility in the project such as existing change management practices and adjustable targets given by the stakeholders. The project team needs to be empowered and they need to understand the early warning signs (PMBOK guide, 2023, p.399).

It must be taken into consideration that an individual project does not operate in a vacuum but is a part of a big picture together with other projects in the business. This is specifically noteworthy on contracting organizations where ongoing, at the same time, is tendering of multiple of projects. Therefor it is important for the project strategies to be managed from the top rather than being emergent as all the projects utilize the same business pool of resources and knowledge (Mintzberg, 1978). Projects are taking place as part of an organisational context and there can be risks at any level off the organisation that can affect the projects (Smith et al., 2014, p. 174–175). This requires enterprise risk management practices and portfolio risk management to be in place to ensure the necessary escalations or delegations of the risk mitigation. However, in this thesis the enterprise risk management is not covered. On portfolio level, the organisation needs to make sure that the combination of projects does not expose too high of a risk level for the business (Smith et al., 2014, p. 82–83).

Sales phase in the construction business is not conceptualized consistently and mixed terminology is used. The “sales phase” is defined in literature with labels such as pre-execution phase, appraisal, pre-contract, tendering, preparation for the bid, conceptual, feasibility, formation, conceive or initiation phase or stage, dependent of the project type, its environment and organization involved. The list is long but not exhaustive. The phase name is dependant of the viewpoint also, whether viewed by a customer, a constructor, a contractor, or a developer angle, for example.

It is widely understood that the pre-execution phase of the project is impactful and meaningful for project execution phase ((Zou et al., 2007, p. 1; Uher & Toakley, 1999). In the context of risk management, the sales phase and project execution phase can be two different entities leading to a disconnected process. Uher and Toakley studied the risk management in the conceptual phase in the Australian construction industry (1999). They found out that despite the increasing popularity of risk management in the conceptual phase, the implementation was still relatively low. They explained the risk management conducted in the concept phase being the most crucial stage since decisions made in this phase have an important relation to project execution and affect the final cost of the project.

2.2 Risk Management Process

A formal risk management process is beneficial as it provides control for the business and direction for the people (Chapman, 1997). Several formalized processes have been introduced in literature. The PMbok-2000 (Project 2000) process provides standards in relevance to IEEE and ANSI standards and is process oriented. The APM (the Association of Project Managers) provides Project Risk and Management (PRAM) process (Chapman, 1997) containing less phases than in PMbok. Risk Analysis and Management for Projects (RAMP) process was devised for the construction business specifically. The institution of Civil Engineers and the Faculty and Institute of Actuaries created RAMP and it covers the entire project life span (Telford, T, 1998; Simon, 1998; Lewin, 2002) but is focused on safety aspects specifically. The Shape, Harness, and Manage Project Uncertainty (SHAMPU) process was introduced by Chapman and Ward (2003) as a generic process. The Project Uncertainty Management (PUMA) is a risk management process created specifically for the construction projects with focus on the project owner and the owner managing the consultants helping with the construction (Del Caño et al., 2002, p. 1). These are examples (list not exhaustive) of the formalized project risk management processes. In the end, all the models have a similar characteristics and goals within them. The similar process steps are to initiate the risk management, identify the risks, quantify them, develop risk responses, and control the risks. The basic elements in all processes are illustrated in figure 2.

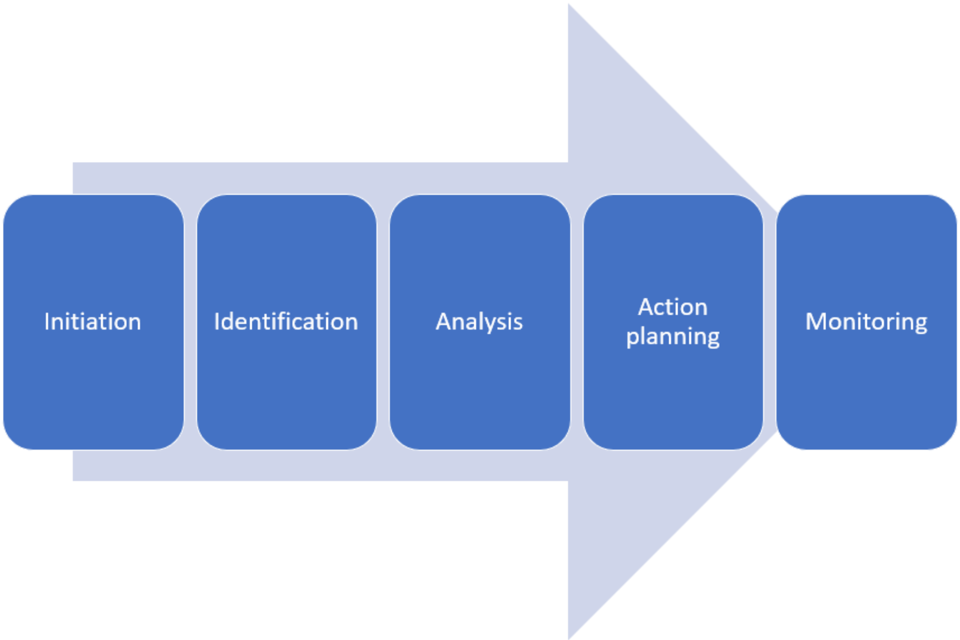

Figure 2. General project risk management process combing the ideas of theoretical risk processes.

The general risk management processes are recommended to be modified according to circumstances and specific needs (Raydugin, 2013). This is an issue in all the existing process models as all of them require modification dependent on business, context, country, particular project details etc. A one process to fit all does exist in high level but not in detailed level.

To build risk management practices, Keshk et al. (2018, p. 4-5) listed the needed elements for the organisation to define, specifically in the construction business. The elements are presented in the picture 3.

Figure 3. The elements to define the risk management process in detail. Adaptation from Keshk et al. (2008, p.4-5).

Keshk et al. (2008) elements in Figure 3 can be categorized in three parts: the organisation needs to decide on processes, tools, and resources needed for the implementation. Each element needs to be connected to create a seamless end-to-end socio-technical approach. Socio-technical approach is defined as being a technique to coordinate tasks between people (Sierra et al., 2018). The processes, tools and methods coordinate the risk management activities between people, make the activities visible and transparent for the organization and create an aligned understanding for the organization how the risk management is interpreted (Keshk et al., 2008). The socio-technical methods and tools are aiding to conceptualize, evaluate and manage the risks (Sierra et al., 2018).

In the construction contractor business environment, the target to implement the risk management process is to analyze various factors that can affect the project's viability. This process helps to identify the best strategy to minimize the risks and ensure that the project is completed on time, on budget and with targeted quality. Another important step on the development of a risk management is to identify the appropriate contractual arrangements and deciding on which of the project parties are to take the ownership of possible risks and thus the responsibility with the possible contingencies, actions and consequences (Francis & Adams, 2008).

The following three-stage risk identification and assessment approach was used in the study, adapted, and modified from the study of Francis and Adams (2008, p. 2). The approach is generated for construction contractor risk management but is arguably a general one.

1. Identifying the various risks that can affect a project's viability
2. Analysis of risks and uncertainties in a qualitative and quantitative manner
3. Response management with the aim to remove as much risk as possible

As a preparation for risk assessments, the projects with need to have a full risk identification and management process need to be defined. As Smith et al. (2014, p.219-220) describe there should be a predefined question list to categorize the projects requiring risk process. They are proposing a list of questions regarding the project attributes of client, technology, novel methods needed, scale and constraints of the project, experience of the participants, regulatory issues, and stakeholder complexity to identify the risk level of a project in general.

Sales phase of the projects in construction business is the phase with a lot of uncertainties. Chapman and Ward (2003) discuss how uncertainty is present throughout the whole lifecycle of any project but is specifically evident in the early phases prior the execution starts. They list 5 uncertainties which are characteristic in the early phases: variability with estimates, uncertainty of the basis of estimates, uncertainty on design and logistics, uncertainty on the goals and priorities as well as uncertainties on the stakeholder relationships. All these five areas are possible causes for risks (and opportunities). Chapman and Ward continue that the variability of estimates is due to unclarities in the specifications, certain activities being new and thus lacking experience, complexities the bigger the project is, shortages in activity analysis as well as the possibility of specific events or settings affecting the activities. Chapman and Ward add that all the other than the specific events or settings are easily passed over as they are unclarities rather than something “traditionally” understood as risks. Chapman and Ward write that proactive and reactive risk management should not be considered as separate processes but interlinked and connected to the project management process. The separation of these three processes should be as minimal as possible to limit expensive defects and errors. Sales opportunity shaping is a way of working where both the sales team and the project team including the technical team are working together to adjust the business opportunity into a feasible project to work on as defined by Merrow (2011). Although Merrow is reviewing the opportunity shaping from the investor perspective, the same principals apply for a wide variety of stakeholders to understand the project prior committing to it. He continues that the project opportunity needs to go through a suitable level of scrutiny of, for example risks, prior understanding the feasibility of the project.

2.3 Tools

There are both qualitative and quantitative methods to approach risk management. Qualitative risks are based on subjective background, knowledge, perceptions, and opinions as defined by Chapman & Ward (2003). Chapman and Ward continue to define that quantitative methods aim to convert the risk exposure to numerical figures using only quantifiable data. Typically, quantitative risk analysis can only be done after qualitative risk analysis and as such both approaches are needed (Chapman & Ward, 2003, p. 54). The chosen method is also dependent on what phase of the project life cycle the risk management is done at (Chapman & Ward, 2003). The risk analysis is never entirely objective but subjective to some degree. The degree of subjectiveness is dependent on how much quantitative analysis can rely on objective data (Smith et al., 2014, p. 24).

The qualitative method of risk process is typically gathering a group or groups of project expert stakeholders together to identify, evaluate and quantify risks. This team approach leads to discussion amongst stakeholders and for a united view on risks and thus leveling the bias from one individual only. The group discussions should be led by an objective risk analyst to ensure all aspects are covered. The risk analyst brings in an outside view, equalizes opinions of strong individuals, facilitates methodical approach to risk management and levels the pressure to reach a solution. (Chapman & Ward, 2003, p. 24–26)

There are different types of risk assessments and analysis used in construction business. For the identification of the risks Chapman and Ward (2008) suggest problem solving in group where experts from several functions are present. Within the risk assessments, a various technique can be utilized to identify risks such as checklists/ prompt lists, risk records, brainstorming, interviews and What if- analysis. The analysis process after identification of the risks continues by quantification of the risks in terms of probability and severity which typically results into monetary uncertainty or other type of consequence estimation. The analysis methods to analyze the impact can be decision trees, fault tress, event trees, probability, sensitivity, scenario, simulation, or ranking options. Probability of a risk to occur and its severity can be assessed by using expert judgement, historical data, scaling (low-medium-high) and/or detailed analysis of individual risk consequences should the risk realize. (Adams & Francis, 2008)

Quantitative methods include methods such as probabilistic Monte Carlo analysis which attempts to illustrate the range and bandwidth of the cost and/or schedule risks within a project. A Monte Carlo simulation takes a variable with uncertainty and randomly values it by using multiple values to average the result. This process is repeated several times. The results are then averaged to arrive at an estimate. The model tool runs and produces a result. By using historical data, one can project a possible data trajectory. The results generated by simulation are then analyzed and distributed in a normal distribution, which is a bell curve. The middle curve is where the most likely result is, and there is an equal chance that the result will be higher or lower (pessimistic and optimistic). Although no simulation can predict the inevitable outcome, Monte Carlo analysis is a method that aims to provide a sound estimate of the likelihood that an outcome will deviate from the projection. (Dunn et al., 2011)

Counterarguments to use mathematical probability calculations exist. Smith et al. (2014, p. 29) use an example from London underground building project (NAO, 2004) that used cost projections and Monte Carlo simulations and analysed it being overly detailed and unnecessary due to problematics in the input data. Afzal et al. (2019) also highlight the limited number of studies found on reliability of the subjective input data in probabilistic calculations. Additionally, Dunn et al. (2011, p. 90) highlight the need to carefully study the correctness of the input data since wrong input can produce significant errors in output data.

By 1996 the risk analysis methods used in construction business were specifically listed to be “risk premium, risk adjusted discount rate, subjective probability, decision analysis, sensitivity analysis, Monte Carlo simulation, stochastic dominance, Caspar and intuition” (Akintoye & Macleod, 1997, p. 5). Afzal et al. (2021) explain that due to the complexity of the project's risk network and the lack of information about the various factors that can affect the project's cost overrun, many construction risk assessment models have adopted AI-based hybrid methods to solve the issues of subjective input by a fuzzy logic or Bayesian Belief Network (BBN) calculations. These are used specifically in the cost risk estimations. Afzal et al. state that fuzzy logic output is a spectrum rather than a binary yes or no answer (0 or 1). They continue that BBN is probabilistic graphical interpretation of interconnections between variables based on historical data. Multiple tools are tested or used to manage risks in construction projects. Every hybrid tool search to interpret the needed contingency level on different certainty levels and the interdependencies between risks. Such tools tried are Artificial Neural Network (ANN), BBNs, Genetic Algorithm (GA), Structure Equation Modeling (SEM), Fuzzy hybrid methods (FHMs), Fuzzy Set Theory (FST) and Fuzzy-Bayesian belief network (FBBN) (list not exhaustive). Although both the Bayesian and fuzzy structured networks have their own constraints when it comes to performing uncertainty measurement and risk modeling, they can still provide support when dealing with a large number of variables. A study by Francis and Adams made in United Kingdom (2018) concluded that predominantly the construction contract risk management relied on single expert assessments.

Study made by Akintoye and MacLeod (1996) concluded that the use of risk analysis techniques in construction projects is low and mostly based on the checklists used by the management. As the construction projects are unique in many ways based on different parameters, such as customer, location etc, the Akintoye and MacLeod refer to study made by Jamieson and Low (1990) that the use of a checklist leaves risks unidentified and cannot be considered as a proper method. Akintoye and MacLeod (1996, p.5-6) also studied the contractors' reasons for not using the risk analysis techniques. The reasons highlighted the unfamiliarity of the risk management amongst respondents and the combined doubtfulness towards the results and its confidence.

According to Chapman and Ward (2003, p. 52-54) documentation of the risk management is essential to follow a clear-thinking process and clear communication (specifically with the customer and separate organizational units), to train new project employees, recording the rationale of the decisions, creating lessons learnt and for clarity on the data needed. They continue that the main reason is for the project stakeholders to create together an integrated view on risks and by this enabling collective decision-making.

2.4 Contingency reservation

Sovacool et al. studied construction cost overruns for electricity infrastructure in 401 projects worldwide (2014). They found 66.3% cost overrun per project where most prone to negative cost deviation were nuclear reactor and hydroelectric dam projects whereas solar and wind projects presented the least risk (Sovacool et al., 2014). Aljohani (2017) reviewed the existing literature on the causes of the construction business cost overruns. One of the top 7 reasons for construction project cost overruns, found by Aljohani, is cost estimations. He describes the process of estimating costs involving arriving at an estimate of the resources that are required to complete a project. Aljohani continues that these estimations are usually performed rather fast. He states that the preparation of comprehensive cost estimate for a construction project involves gathering, organizing, and manipulating a vast amount of data and information. Aljohani argues that cost estimation for construction projects is a thoroughly complex work although many techniques for it have been created. According to him, the main reason for inaccurate estimations is optimism bias, where estimators have optimism and estimate the costs to be higher than actual cost but lower than actual risks. The other causes he highlights are inaccurate cost estimation, unreliable data during bid, lack of national databases for prices, lack of experience and human errors.

Construction projects are unique in many ways, such as having long execution schedules, complicated processes, arid environment, financial intensity, and dynamic organizational structures (Shubert, 1971). Typically, many construction projects are also unique due to location and its environment. Schubert (1971) studied construction project risks during the tender and the construction phases. He identified 26 risks and their probability and the cost. He ended up with the average summary risk cost of individual risks to be 2,72% with additional average cost of 1,04%. Brokbals et al (2019) presented the more recent analysis of the risk cost calculation landing to an estimation of risk cost range being 2.71%-8.67% of the construction costs with 90% probability where 2.71% is the minimum limit). These results affirm the older calculations made 50 years ago by Schubert (1971). Hence, Brokbals et al. are forewarning from too tight profit calculations in the tender stage (2019, p. 8).

Construction business is specifically prone to projects with heavy margin deviations and schedule delays. This is due to dynamic and complex nature of construction projects. For this reason, a systematic approach for cost contingency reservations needs to be addressed (Afzal et al., 2021). Typically, costs are set as expected values, as values realized on average (Chapman & Ward, 2003, p. 55). Chapman and Ward argue that if uncertainties are not quantified, and single value performance levels, such as average costs values are used, organization will have disastrous results and confidence to the set goals will be eroded creating a cycle of mistrust among project managers (2003, p.73). According to the studies, having risk management in place, is the key benefit for project managers in terms of stopping the cycle of changing targets, and to have the goals set appropriately from the beginning (Chapman & Ward, 2003).

According to analysis by Francis and Adams (2008, p. 1) contractors are more likely to use predetermined cost contingency reservations than having separate risk analysis sessions. Often, individuals' perspectives on risks are gathered. Francis and Adams (2008) are proposing the need to combine analytical, objective methods to subjective group input to improve risk management efficiency and effectiveness. They state that an appropriate level of risk contingency reservation needs to be established which could be done by a lump percentage of the opportunity budget or by output from the quantified risk assessments. A study by Curto et al. (2022) propose a method where all uncertainty/ risk types (stochastic, aleatoric, epistemic and ontological) are taken into consideration in the contingency reservation. They state that ontological risks' contingency is a straightforward percentage of the margin as the risks are unknown. For other risk types a risk register is created, and Monte Carlo simulation performed (Curto et al., 2022). As a result, the simulation is received with varied confidence levels (confidence levels 10%-90%) and the risk contingency decided based on the risk-taking strategy the organization is ready to take and has agreed upon (Curto et al., 2022). Via this sort of integrated risk method, they claim, a more precise contingency reservation can be determined.

2.5 Summary of the theory

As a summary, the theory implicates the need to have the risk management process agreed and implemented as illustrated in figure 4. Both general and detailed process needs to be defined and the tools and techniques agreed. As an outcome of the risk process the risk contingency reservation should be agreed on to minimize the project margin deviation and business losses. The action part of the study aims to follow the theoretical approach in practical implementation and review the results in practice in terms of how the implemented process has been able to improve the project margin deviations and thus the financial result of the business.

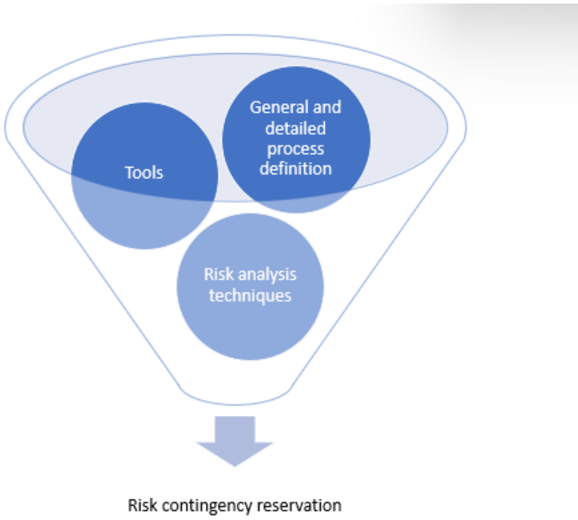

Figure 4. Summary of the theory of risk management as how to approach the risk management to reduce margin deviation.

As the study has both theoretical and practical implications, the used research approach in the study is action research, also known as participatory action research (PAR). In next chapter the selected research methodology is described and additionally explaining the context, process and expected practical and business outcomes to create a framework for the case.

3 Action research

Although fogginess in the origin of action research in the academic studies, there are multiple researchers referring the origin to Kurt Lewin in 1940s (Shani & Coghlan, 2021; Masters, 1995). Lewin described action research as "proceeding in a spiral of steps, each of which are composed of planning, action and the evaluation of the result of action" (Masters, 1995, p.1). Within his book Costello (2003) summarises the understanding of actions research from various writers and studies. Costello sums up the action research being a process that can be described as a spiral or cyclic process which enables both practical and theoretical growth at the same time. Practical output can be improvement or a change whereas theoretical gains are understanding the phenomenon and/or increasing the knowledge of the research topic in question (Costello, 2003). Action research is a research method in where knowledge building, and critical reflection take turns (Costello, 2003). Costello writes that the typical action research follows the steps of plan, act, observe and reflect in repeatable spins as many times as needed. A such, it is a continuous improvement process.

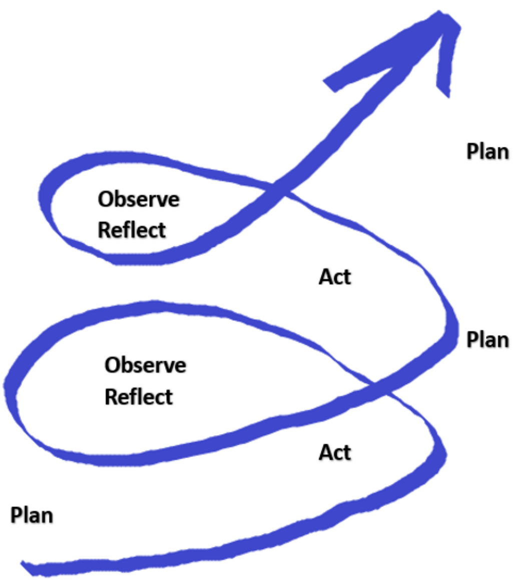

Figure 5. Action research spirals. Adapted from Costello (2003).

Nowadays, action research is specifically described as an approach which integrates and connects the practical problem solving and scientific theory or knowledge building. The application in business management is various as described by Shani & Coghlan (2021, p. 2). They describe the action research solving real life organizational issues combined with present day organizational know-how and scientific knowledge. Just as Lewin was describing the action research evolving in spiral steps, the Shani & Coghlan (2021) second the action research nature being an improvement process. They state that action research takes place in an identified, specific context, in a business world for instance solving problems in certain organizations, businesses, business functions or specific processes. The action research involves collaboration and participation of defined stakeholders and typically has a facilitator/ researcher in lead (Shani & Coghlan, 2021). Specifically suitable and simplified definition of action research for this study is the one used by Meyer (2000) as he defines it as a process in a specific situation, involving people with a target to improve the present situation contributing both to theory and practice. Although, Meyer is focused on action research in medical and health field, the same definition applies to other action research. Typically, the action researcher is an individual attempting to understand the subject matter more while at the same time creating improvement in practice.

Thus, the action research in this paper aims on the knowledge building and continuous improvements within the case company based on the critical reflection done in each cycle. These cycles were not predefined prior the study but were emergent during the process and identified while evaluating the results.

Mode of interiority in action research is used in this thesis. Mode of interiority in action research is described by Coghlan & Verlag (2010) as an integration of practice, theory, and interiority from the first-person perspective. This view is described in the figure 6. The figure illustrates the practical knowing being rooted in experience and being the descriptive mode of the research. The theory is rooted in the understanding of the phenomena via research studies and is explaining it in theory. Interiority is rooted in judgement and is a basis for the critical thinking. All of these integrate in the interior action research.

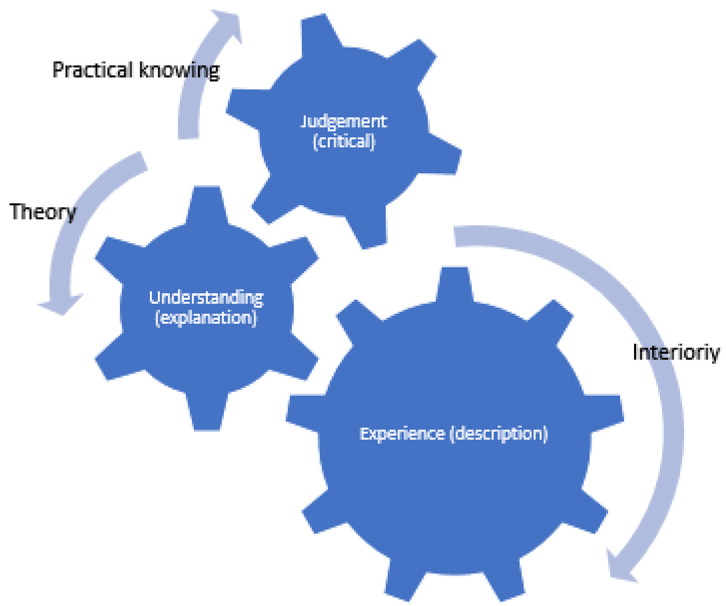

Figure 6. Realms of meaning in interiority framework adapted from Coghlan & Verlag (2010, p.11).

This triangle of realms of meaning in cognitive process could be explained by thinking the left human leg being the theory and the right leg being the practice. Each make a step, but a person cannot walk unless the head signals the legs to move in sync, one by one. Thus, the head can be considered as the essential interiority which makes the system complete. In this study the case works as the practical part, being one leg. The practical knowing comes from the literature while the writer is bringing in the combining "head". This first person practice means that the writer's own experience, thinking, assumption as well as values are considered in the work (Coghlan & Verlag, 2010).

3.1 Framework

The framework of the study is defined in below sub-chapters. It is based on the action research framework from Shani & Pasmore (2016). They have defined four factors:

context, quality of relationships, quality of action research process itself and outcomes that need to be present in the action research for it to be of good quality. In the following chapters the context and relationships in general are defined but the actual outcome and analyses of the quality of the study are interpreted in chapters 4 and 5.

3.2 Context

The case study was made for a global business-to-business company providing marine and energy technologies and solutions. The specific focus was the energy business of the company and specifically its risk management practices in the sales phase from a viewpoint of a contractor. The energy business mission, at the beginning of the study 2019, was described by the company as leading the transition towards a 100% renewable energy future (Annual Report 2019). Annual report (2019) presents energy business offering as power plants, energy management and energy storage systems together with the services on the above. At the time energy business had 72 GW of installed power plant capacity worldwide in 180 countries. The main customer segments were utilities, independent power producers (IPPs) and industrial customers. Utilities are suppliers of electricity, heat, and gas, whereas IPP’s are financial investors in power generation. Industrial customers are typically private companies which need energy on their production such as cement factories, mining or data centres (Annual report, 2019). The delivery scope of energy business can be engineered equipment deliveries (EEQ), engineering, procurement and construction (EPC) packages or services and upgrades to the existing plants.

The energy business net sales for 2019 was 1861 M€. The operating result for 2019 for energy business was 152 M€ which was 45 M€ less than on previous year. Energy business considers one of its top strengths to be competitive EPC capability (Annual Report, 2019) yet 152 M€ were lost due to cost overruns in project deliveries in all company. From 152 M€ of losses, 101 M€ were recognized in energy business. The initiative for improvement was set originally by the CEO and the management team of the company due to the identified gaps in control, processes, and management. One specific gap was identified to be risk management practices in the sales. The facilitator and the leader for the improvement initiative was nominated 11/2019 and is the writer of this study. The position was new without previous predecessors and the organizational positioning was within the Project Management function as the main effects of the risk management in the sales phase (or the lack of it) would be evident and materialized in the success of the project execution and thus is project margin. The Senior Risk Manager acted as the facilitator for the whole energy organization. The research study took place during a three-year period between 12/2019-12/2022.

3.3 Stakeholders of the action study

During the period, many stakeholders were involved in the activities, so the collaborative nature of the action study was present. The pre-information for the study included the involvement and input of an external consulting company (Autumn 2019-01/2020), the benchmarking conducted Spring 2019 and the financial reports 2019. The plan for the improvement initiative was made by the Senior Risk Manager but the involved personnel in the development and implementation were various from sales personnel, project team members, legal function, system developers, robotic process automation (RPA) specialist, management, supplier function, engineering, technology development, R&D personnel etc. Basically, all energy business personnel involved in the sales or project delivery were involved to a degree. The people involved, were all internal energy business employees except the participation from external consulting company in the beginning. The main responsibility to identify the needed improvement, implementation and follow-up of the risk management was on the Senior Risk Manager reporting to the Vice President of the Project Management function.

The Senior Risk Manager was in Vaasa, Finland but the participants were globally scattered dependent of the location of the sales opportunities identified. The meetings and discussion started mainly as face-to-face meetings accompanied by virtual participants but proceeded to virtual meetings due to the global Covid-19 pandemic and its consequence for personnel to move to home office work environment since March 2020. The facilitator of the improvement initiative and research study (Senior Risk Manager) had been working for the company already 9 years prior the start of the study and the organization and its practices in general were familiar. The facilitator had been working previously as the head of energy quality organisation including also experience from operational development, project management, health safety and security (HSS), portfolio management and technology development so, a wide part of the different organizational functions and employees were well connected to the network of the facilitator previously.

One of the challenges in organizational dynamics was the organizational separation of sales and project execution. In the development the aim was to bring these two organisations to work together for the same goal of improving the business outcome. Previously, the projects to execute were brought to project organization without much involvement of the project team in the sales phase. Now, the aim was to make sales and project execution teams to work together already in the sales phase.

3.4 Action research process

The research method used during the case study was the Risk Manager to participate in the development of improved risk management practices closely and to lead the work. The research included various methods from observations, notes and meeting minutes, presentations, decisions, interviews and free discussions to participation and facilitation of sales risk meetings. Furthermore, information from trainings and their feedback as well as the data retrieval and data systems updates were used. Also, financial records were followed for the improvement of the actualized margin deviations. This all happened on a very personal level as suggested to be done in action research mode of interiority. The research data included both company confidential data, such as financial records for the margin of the projects and personal observations during the risk management improvement process.

3.5 Outcomes

The expectations were for the energy organisation to implement and sustain a formal risk management process for the sales phase. It was known that the final goal of improving the project margin deviation would not be visible instantly as the ongoing projects in execution had not had the risk management done in the sales phase. The projects typically lasted from 12 months upwards, and the sales opportunity negotiations took typically long time up to years. The plan was to implement risk management procedures in steps, starting from the EPC and so-called A-class projects which were the main cause for losses in the financial business result. Also, noteworthy was the financial project reports indicating the greatest losses being in the business area, nuclear energy business, which was already decided to be discontinued. However, the expectation was that nuclear business losses would continue for the upcoming years and would be weighing the margin deviation reports as the ongoing project was still unfinished. The detailed outcome results are presented in the chapters 4 and 5.

4 Findings

This chapter demonstrates the actions and findings made throughout the followed action study. The structure follows the plan, act, observe and reflect spirals following up to two cycles of spirals. The first spiral identified the need to have risk management implemented in the sales phase and took the first steps to understand what actually needed to be improved. The second spiral was to create and implement the risk management way of working internally to the business. The third spiral is the reflection of the risk management implementation results to the project margin deviations and business result as well as recommendations by the spirals one and two to continue the improvement as is presented in chapter 5.

4.1 Identification of risk management improvement need

During year 2019 it was understood within energy business that number of projects were making losses. Several projects' financial outcome did not meet the planned budget. There were many projects that created significant negative financial impact and the total yearly energy business result had high losses (> €100 million) in 2019. These cost overruns were identified to occur mostly in the complex EPC projects. The causes for the cost overruns were identified In the CEO review 2019 by CEO as being inaccurate assumptions in cost estimates, insufficient risk identification end supplier related challenges. The company decided to take actions to improve better up-front identification of risks and opportunities in sales phase (Annual Report, 2019).

2019 a benchmarking session with another Finnish origin, global company was arranged on their experience and implementation of risks management. Their presentation was clear and confirming the benefits and a need to have an end-to-end risk management in place to protect the project execution from margin deviations. They were presenting their current overview and practices on the risk management on which they identified the need for an early and comprehensive risk management in their company. They were using a calculation for the financial risk exposure for the projects as well as the proactive actions for the risks. They also emphasized the regular updates and actions follow-up in risk exposure calculation. Also, as contingency estimation, they combined the execution risk value, opportunity values and cost uncertainty values, however, it was noted that technical risks should be calculated separately and compared to warranty reserves.

The improvement activities for the risk management were initiated with an involvement of an external consulting company. They joined in 2019 and made the initial analysis off the situation by gathering financial data and by having interviews within the organisation. In the analysis (not attached due to confidentiality reasons) they summarized 602 projects being ongoing in whole company of which 69 projects were having significant issues. In Energy business, specifically, 10% of projects were identified as problematic but majority being on track. Particularly, 9 projects were named as being truly troublesome with possibility of more than 10% margin slippage. Significant weight of the profit loss originated from one project only from the nuclear business area. The root causes analysed by external consulting company in Energy business were fold in three: strategy to grow top line without considering risks, unclear responsibilities, and process incompliances.

The consulting company identified initial actions to be taken by interviewing the energy organization members. The main issues identified by the members were: sales phase not setting execution up for success, lack of project management and technical capabilities and inconsistent process capabilities. Sales phase as one root cause was explained to be due to complex A class projects sold as fast track projects without risks understood. Also, local standards and codes were not identified prior cost analyses and there were scope and work items missing from the cost calculations in the sales phase. Additionally, engineering costs were underestimated as the unique requirements were not analysed or considered in the budget.

The actions to tackle one of the root causes were identified as a need to have mandatory risk reviews in sales phase, having risk mitigation plans, and involvement of the project management team at the sales phase for the A-class projects to be sold.

To correct the issues, a centralized global project management function, specifically for the A class projects, was to be created and schedule management and logistic tools to be analysed. There were also additional actions to drive a change to mindset and culture, hire a risk manager and to have high focus on requirement management in the sales phase. The early diagnoses demonstrated possibilities to further enhance project performance by actions towards project governance and portfolio management, scheduling, costing, risk management and recovery. It was also proposed to enhance project risk classifications and requirements to pass review gates, especially in bid approval. Additionally, the need to provide portfolio level, real-time visibility to progress and risks, and to adapt the progress reporting to force discussions on most important risks and actions to mitigate for projects in execution was identified. To upgrade the scheduling on ongoing projects, it was proposed to maintain management level schedules, continuous risks assessments and proactive critical path analysis. For costing and risk management, consulting proposed continuous tracking of cost development and risk updating as necessary for projects in execution.

The immediate actions taken were the risk and opportunity workshops for the A class projects in execution having possible risks in margin deviation. 13 projects had a deep-dive assessment with the full project team participating and 12 shallow dives with just an interview with the project manager. Majority of the assessments were done for the engine-based energy projects. With this method, the management team was to get a full view off the risk exposure of ongoing projects to the business.

Prior the project risk assessment workshops took place the related material was collected including project block diagram of final systems to be delivered, project schedule, breakdown of costs and risk register.

Once these files were shared the consulting team reached out for a 30-minute introductory call with the team joining the workshop. The team consisted off project manager, project controller, project planner, engineering manager, accounts/ procurement manager and proposal manager. If it was a case of sales phase opportunity project, the sales personnel were invited as well. The consulting company used a Monte Carlo analysis within the workshops. The Monte Carlo was used both for the schedule and for monetary risk evaluation. Monte Carlo simulation for costs was mainly made via the provided project budget and current financial statements in comparison to the risks identified via the activity flow simulation. The activity flow simulation was conducted within the workshops by a contribution from the project team. The activity simulation was done backwards from the final task of a project towards the beginning of a project. The project team was asked the main activities of the project and how long these activities would take typically, in best case scenario and in the worst-case scenario. This method created the data for the Monte Carlo calculation and would provide 3 possible scenarios within a probability distribution.

1. Optimistic as P90 probability in Monte Carlo
2. Expected as P50 (expected value) in Monte Carlo
3. Worst as P10 probability in Monte Carlo

The participants were not asked to prepare themselves for estimations before the meeting but during the workshops the members were asked to estimate based on their experience, best guess, and knowledge.

As an outcome the consulting team provided and output report from the workshops including summary of

1. project risk status
2. Monte Carlo simulation results for schedule risk analysis
3. Monte Carlo simulation results for cost risk analysis
4. updated risk registers for mitigation planning

In figure 5 is an example of the outcome of the Monte Carlo simulation which provides the information of project risk and opportunity exposure as provided by the consulting company.

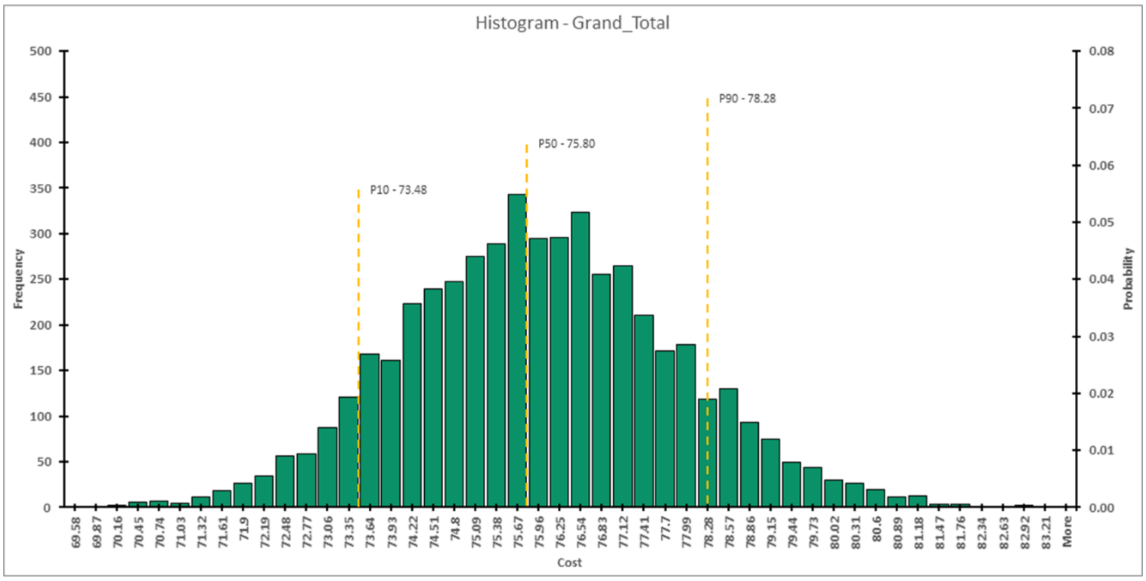

Figure 7. An example of the financial Monte Carlo analysis result

In addition, an internal process to review the upcoming sales opportunities was started. This involved a facilitator from the quality function to gather a team from sales and project execution personnel to join in on an extensive (day or more) assessment where risks were identified by the full team present, and data being stored in excels. The identified lists became very detailed. The information included: Category of the risk, Risk/Opportunity name, max impact [€], probability [%], probable impact [€], mitigation actions, owner of the risk, status info, target resolution date, link to attachments and notes. Typically, one session was not enough but multiple sessions were needed to gain all the above information and because this type of identification was new in the sales phase.

The effectiveness of the consultancy lead first improvement spiral could not yet be verified in terms of the results to the margin deviation. Yet, it gave kick-off for the next spiral and several notified improvement needs, a base to start improving from. It was obvious that the consultants were able to bring in methods and ways of working and a base information of the causes via discussions with the employees. Yet, the methods were still not inherently aimed for the specific business or were not tailored for a specific organization.

Both internal risk sessions and the consultancy sessions gave the organization an idea what the risk management could be and how it should be tailored. It familiarized the employees with the concept of risk management in the sales phase. Leaders message on why new way of risk management was needed was especially beneficial. Specifically, as the reasons could be backed up with financial numbers. This type of reasoning was clear and could be continued in the next improvement phase. Yet, management message did not include taking management responsibility for the problematic result although it was "well-known" that many risky project decisions were taken purely by a management decision. The projects that had highest margin deviations and causing most of the damage to the financial result were decisions made by the management. These were for example to go for a new type of business or countries without reasonable payback calculations. Instead, organization had had personnel lay-offs where the price was paid by the project managers who had not been able to deliver the unreasonable targets. This caused mistrust in the organisation.

It was also obvious, that a tool would need to be established for the sales risk management. The excel-based data storing was ineffective and caused a lot of manual work when different versions started to float around and needed to be united. At times, it was also unknown who had the latest version. The excels were not transparent to the organization but served only the project in question.

Another observation was the Monte Carlo analysis made by the consulting company to be inadequate. The method was to come to the assessment unprepared, presume or just randomly guess the range between P10, P50 and P90 probability values. This was not based on any verified past or available data if not seasoned experts with similar projects in the past were present. Yet, at this point, the results of the calculations could not be verified by realized data, as said, so the assumption was that the organisation continues the same way.

Thus far, sales and execution had worked mainly separately and now the borders between the two functions needed to be connected. There was initial resistance, but also positive feedback started to flow. The resistance is a classic example of the first feelings when attempting to change the organisational culture. In the next spiral, the benefits of the collaboration in the sales phase risk management needed to be further emphasized.

By the November 2019 a senior risk manager (later SRM) was selected and nominated (the writer of this thesis) for energy business as proposed earlier in the report by the consultants and feedback from the organisation. The SRM was the leader and facilitator for the energy business risk management activities. SRM had previous knowledge with risk management both within and outside the company. The SRM benefited of having a background in company and knowing its processes. Also, the benefit was that in her past position of directing the quality department globally in the energy business made her participate in the early steps of spiral – in the initial internal risk assessments and participating in the consultancy lead assessments. The challenge was to create a new type of risk management process not existing in the company before. A transformation was needed as well as the implementation as a practise. The consulting company left two months after the SRM started in the position, Early 2020.

At this moment, the starting point for the risk management improvement spiral 2, the margin deviation data (December 2019) was as in figure 5. It implies heavy margin losses, mainly in project category A, in EPC projects in Europe. What is visible is that there were also projects with positive margin deviation, but the negative margin deviation outweighed the positive. The figure also illustrates the type of reporting made for the margin deviations at the time.

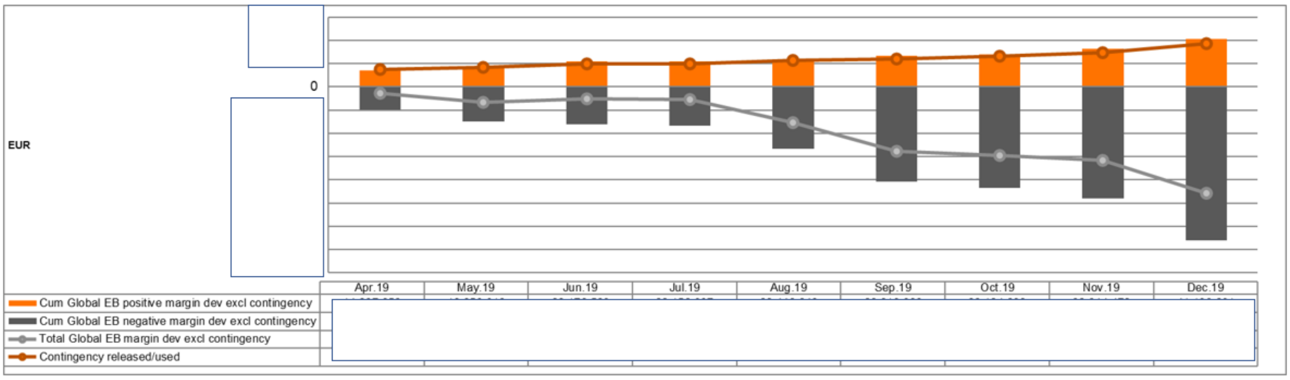

Figure 8. Margin deviation report December 2019 in energy business.

4.2 Improvement of the risk management practices in the case company

By the end of January 2020, the external consulting company left. It was time for the business internally to initiate sustainable, own way of working for risk management for the opportunities in the sales phase. The main responsibility was taken by the SRM.

Energy risk improvement plan was published by the SRM for the organisation in February 2020 as in figure 6. There were two main topics to cover. First, to create a risk management process for the sales phase of the business and second, to actually execute the risk assessments in the sales phase in practice.

Before the risk improvement initiative, the risks in the sales phase were discussed briefly being mainly evident via the sales project kick-off milestone meeting minutes. The kick-offs were not organized in the sales methodically and thus such minutes were not always found, or kick-off was not held at all. In meeting minutes, the risks were mainly verbalised as list of “challenges”. The challenges were listed but no further evidence was found on how the challenges where solved, if at all, by who and how the challenges were accounted in the sales budgets. In discussions with the SRM using the word “challenge” rather than “risk” was explained by several employees to be because of the internal culture not willing to talk about risks. Talking about risks was considered to be negative thinking and suffocating the sales. Also, the sales personnel, verbally, made it clear that adding new processes was only adding extra, “unnecessary” workload which was considered sufficient as it was. The psychological safety of the organisation did not support employees to bring up issues and risks openly. One of the reasons was considered, by the employees, to be in the organizational structure in where the four big, global sales area organizations had the profit responsibility. Also, bonus targets favoured the sales results over project results. The sales personnel bonus targets where different to the ones the project execution teams had. In addition to the personal discussion SRM had with the employees, the psychological safety was raised up and discussed also on energy business townhall/ information meetings where the whole energy personnel were invited. On top of that, the issue was also noted in the results of the annual employee satisfaction survey. The company had experienced lay-offs, and it was an opinion by the employees that some of them were because employee had been vocal on the issues within the business. It was also considered that the employees laid-off were treated unfairly as the blame for the margin deviation was targeted to the specific project members although the initial decision to go for a risky business opportunity was done by the management team of the company rather than by the employees receiving the impossible tasks and projects to run. The responsibility of the management should be evident but when searching for the material of who made the decision and when to go-ahead with the highest margin deviation business deals, the information was not found or stored in documents without access to. There was also no evident approval process by the business management team for the project portfolio risk decision taking. The four sales areas made the decisions to take sales opportunities separately without any approval process by the business management team or without an overarching business portfolio management.

An overall risk management improvement charter was created by the SRM as illustrated in figure 6. It has it foundation on the findings made in the risk management improvement spiral 1. The plan included description of the risk improvement initiative, major milestones, key benefits, scope and decomposition, team set-up, key interdependencies, and metrics. The name of the initiative was officially: Institutionalize

E2E (end to end) risk management. The objective was to formalize the process so that risks are properly assessed and mitigated early on in sales phase and managed during project delivery. This was to improve the reliability of the projects margins to ensure business continuity. Key benefits were seen to be delivering projects with limited margin deviation from initial sales estimation, developing organizational capability to assess and manage risks in the sales phase and to build organizational culture of actively considering and managing risks within energy business. In scope was to identify and implement the needed roles, processes, and tools across the interfaces (sales, project management and support services). Out of scope were the pure service agreements and strategical risks (e.g., competitor analyses). The risk management initiative had two key interdependencies to two other initiatives ongoing. The first one was towards “sales capability building” which clarified for sales roles and responsibilities and the needed changes in the sales capability building. This would affect risk management initiative mainly on risk management roles and responsibility nominations and with any new process definitions. The second was to improve the requirement management procedures that had not been implemented in the organization fully before, just like risk management. If the requirements would not be fully managed during the sales phase it would mean that neither could all the risks be fully identified in the sales. This would, obviously, affect the risk management greatly. The timeline to improve both requirement management and risk management was initially the same. The target was to ensure that all the A-class opportunity projects in the sales phase would have both requirement management and risk management done during 2020 and that both ways of working would have been settled during the same period. Team set-up for risk management initiative was organized so that the sponsor for the initiative was the vice president of project management organisation, and the leader was the SRM. In the core team, following up and advising the progress were the project management financial director, legal director, project management director and the director for sales improvement initiative. The actual working group was led by the SRM including a member responsible on improving the risk reporting, a member responsible of the requirement management, and an expert for Monte Carlo analyses calculations. Most of the participants were from project management function, not sales function. The idea and thinking behind the team composition was that the actual outcome of how well the risk management is done in the sales phase, affects the project execution organisation the most.

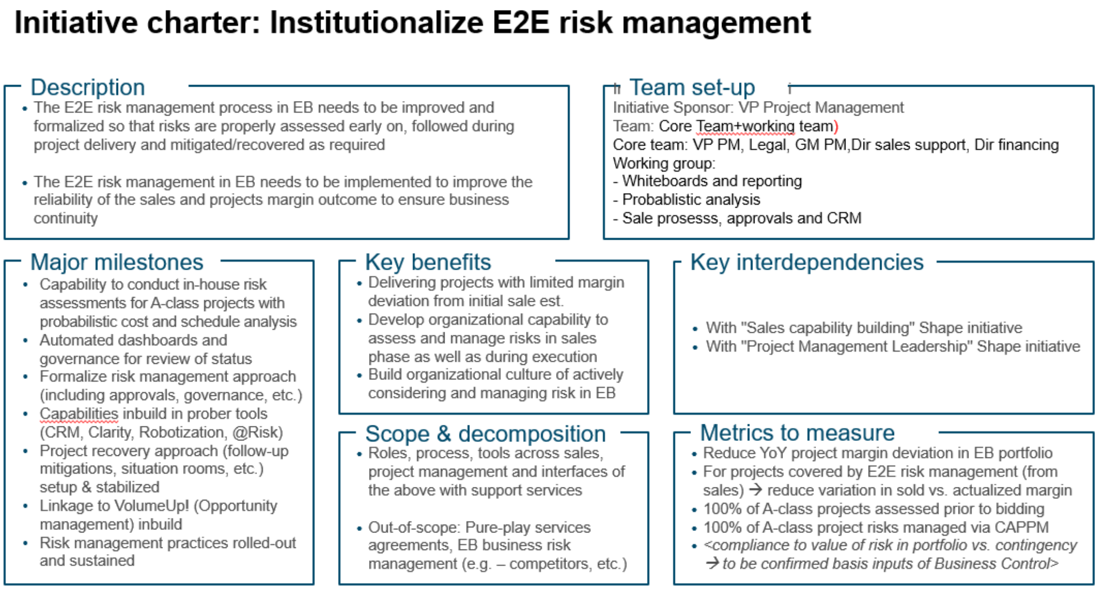

Figure 9. Initiative charter for risk improvement.

The major milestones and goals identified for the risk improvement were:

1. Capability to conduct in-house risk assessments for A-class projects with probabilistic cost and schedule analysis with Monte Carlo
2. Automated dashboards for easy management review
3. Formalized risk management approach and process (including approvals, governance etc)
4. Tools for risk management
5. Linkage to opportunity management viability calculations
6. Roll-out of risk management practices
7. Sustainability in risk management

The final way to measure the impact of the made improvements were to be identified via metrics of

1. Reduced year-to-year project margin deviation in business portfolio
2. Project covered by E2E risk management (leading to reduced variation in sold vs. actualized margin)
3. 100% of A-class projects assessed prior bidding in sales
4. 100% of A-class project execution risks managed via Clarity tool (PM management tool)

5. Compliance to value of risks in portfolio vs. reserved contingencies

To achieve the targets set, the SRM created an action plan with three areas to improve in the organisation to succeed, including solutions for identified improvement areas. The assumption at this point was to continue with the base methods introduced by the consultants but with the internal tools and employees. The effectiveness off the practises introduced by the consulting company were not verified yet at this point. The action plan was based on the needed areas for risk process as defined by Keshk at al. (2008 p.4-5) as in figure 3 with an additional element of a cultural change. The improvement areas were summarized in three:

1. Way of working: methodology, roles and responsibilities, scheduling and timing, risk categories, risk identification, information gathering techniques, scoring, budgeting, and assumption analysis
2. Tools: formats and templates, tracing, documentation review, diagrams, and checklist
3. Cultural change: ways of implementing the process to the organization sustainably

Figure 10. Risk management improvement action plan.

The SRM considered that these three areas need to be synchronized to make the risk management implementation possible in a sustainable way for the organisation. Ways of working topic included creating and agreeing a risk management process for the sales with the needed documents. In addition, relevant guidelines for the use of process and the tools needed to be developed to enable the implementation and trainings. The probabilistic analyses method needed to be created to enable schedule and cost risk analysis. The roles and responsibilities needed to be agreed for the new process and the management approvals needed for the new sales opportunity risk taking had to be set and agreed with the management.

The tools topic included creating sustainable tools and databases for risk management with the needed transparency for the risks throughout the organization. Selecting a tool for managing risks in the sales phase was proposed to be the existing tool, Customer Relationship Management (CRM), which the sales personnel were already using as the platform for other data needed to be recorded in the sales phase. It was considered by the SRM that adding a new tool on top of the existing ones at the same time as introducing a new process could delay the implementation of the new process, or even block it, as there is generally resistance to new tools. The Clarity tool was the project execution management tool and included the risk management function, so it was only logical to continue with that. To enable the end-to-end risk management, process flowing smoothly from the beginning to the end i.e., from sales to the end of project execution, an automated process between the sales and execution phase tools was to be created to enable automized transfer of the risk data between the tools without a need of manual work. The automated process was called creating “a robot” between the two tools, more officially a Robotic Process Automation (RPA) for data transfer. Additionally, a tool selection for the Monte Carlo analysis for the costs and the schedule needed to be chosen. This was to happen by searching available commercial tools outside the company as no correlating tools were used internally thus far. Finally, a data dashboard for the risk management needed to be created for easy access to follow the implementation and the status of risk management for decision making.

The cultural change topic notified and stressed, that no change would happen, let alone in a sustainable way, if cultural change would not take place. This was an addition to the implementation model by Keshk at al. (2008 p.4-5). The plan was to integrate the way of working with the tools and the organisational implementation via the trainings, personnel being involved in the risk management themselves (learning by doing), sharing information in so called Deep Dive sessions for the organisation to follow the materialization of the topic and informing organization within the internal information channels. Yet, one of the most important pieces of cultural change would be the management commitment, attitude, and support for the cause. If the supportive messaging of the importance of implementing the risk management procedures from the management would end, the implementation could not fully succeed.

In a more detailed plan, the needed steps that should be taken were scheduled. First quarter of 2020 was to be focused on process creation and, getting the whiteboards and dashboard and information availability of the risk management available. Additionally, the project A class criteria needed to be reviewed and governing body approval thresholds agreed for management risk approval meetings. The tools for the risk management needed to be decided and build. Also, a guideline for using Monte Carlo analysis needed to be created. The rest of the year 2020 was planned to be used for optimizing the process and the needed tools as well as training the personnel to enable cultural change to happen in the organization.

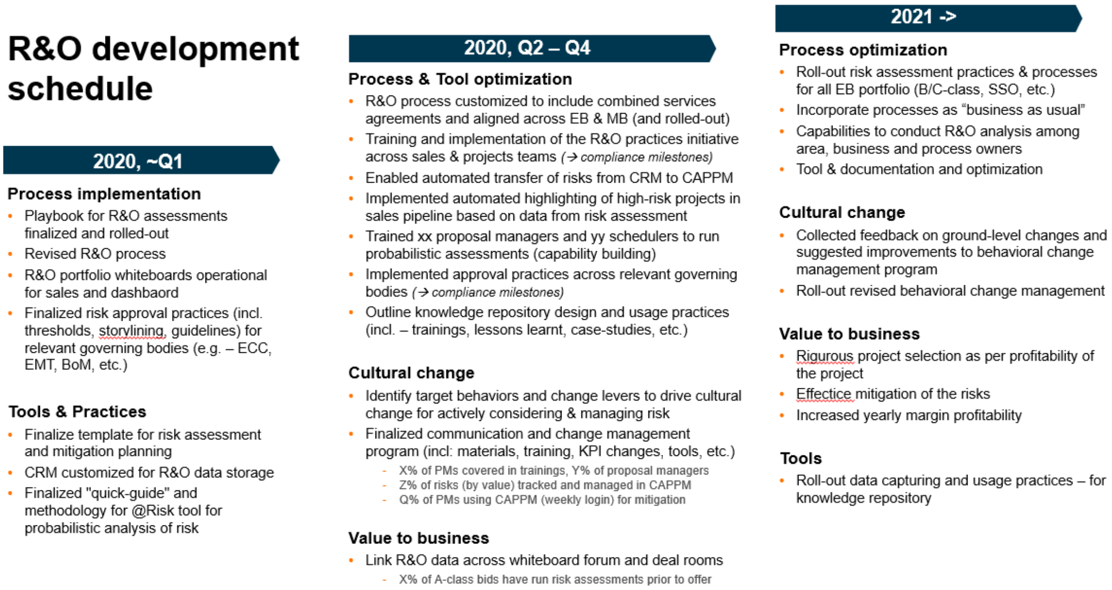

Figure 11. Scheduled risk process improvement implementation plan.

In addition to the needed improvement steps planned, the SRM personal targets for the year included having facilitated all the A-class criteria sales opportunities risk assessments prior an offer for the customer would be made. This would support the implementation of new way of working by having a constant discussion, observation, feedback, hands-on training, and knowledge building together with the participants from the sales, project execution team and the other supporting function personnel participating in the actual risk process. The support would be global, covering all geographical areas globally.

4.3 Implementation of risk management in the case company

The implementation of the risk management practices started parallel to making the plans for risk management improvement. The SRM started to organize, facilitate, and guide risk assessment meetings with the sales opportunities with high risk in A class projects. The high-risk projects needed to be categorized first. This was done according to recommendation by Smith et al. (2014, p. 219-220). Previously made definition for project categorization was reviewed together with the project management personnel and updated with the latest information of occurred risks. The definition for A-category project was approved to be if any of the terms in list would be fulfilled.

- Technical. New product or solution introduction (piloting of a new product or technology that has not been used before).
- Contractual. Projects which include Customer`s project specifications deviating from Energy normal way of working and standard solutions.
- Location. EPC or Consortium in listed countries (a separate list of countries).
- Location. EPC in country where EPC is delivered for the first time. Also, an EEQ project can be A-class if seen necessary.
- Customer segment. EPC for certain Customer segments.

A risk management process was created and is introduced in figure 12. The process is following the general risk process demonstrated in theory section in figure 3. The process defines the risk management to start already in screening phase of the sales opportunities where a categorisation for the projects is made according to the renewed criteria. The process defines the steps to be taken in each sales phase from discovering the sales, to offer tailoring and finally to the finalization of the sales when project moves to project execution in the hand-over milestone. The figure also defines what are the expected outcomes of each step as well as tools to be used, participants to join and the accountability of each step to take place.

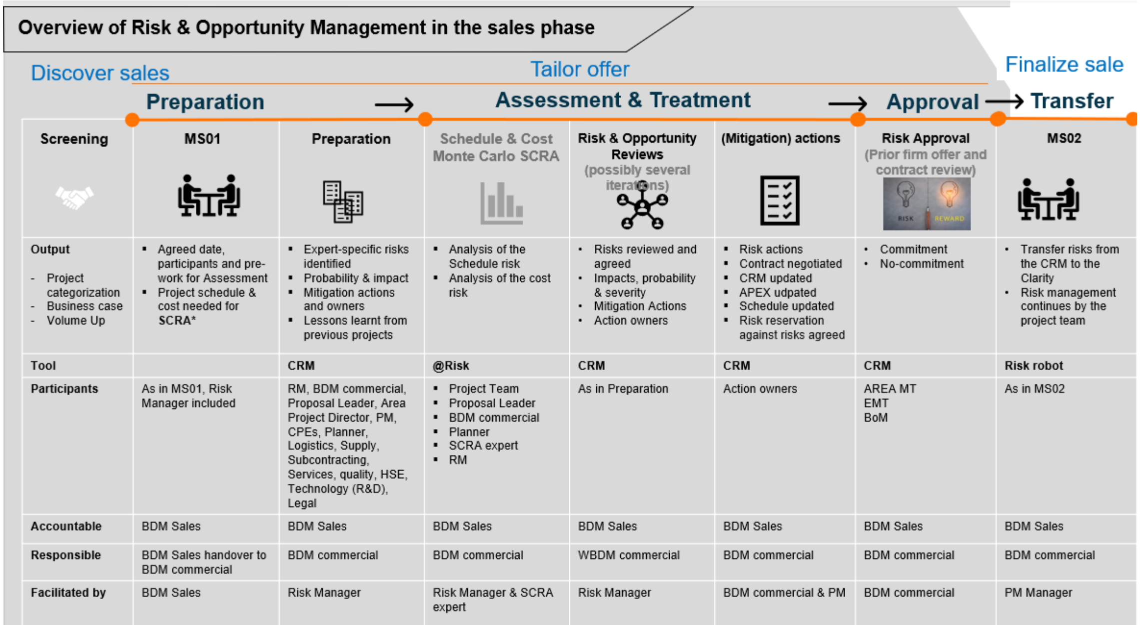

Figure 12. The realized energy business risk process in sales phase.

The process demonstrates the chosen tools be used for risk management in the sales was CRM tool which was the main tool already used by the sales personnel. Other tools, both commercial tools were considered also but the main reasoning on choosing CRM was that it was already familiar for the sales personnel. It was also financially viable option and contained the capacity to build a risk management needs within, specifically for the energy business needs. Together with the sales tool support team a new feature of risk management was developed to the CRM including all the categories previously used in the excel. The big change in here was that now all the latest info was available to anyone with the access for the tool, real time, without version issues and with capability for reporting functionality for metric dashboards unlike previously when using excel for the purpose.

It was additionally decided that risk management continues in the Clarity tool when project execution is ongoing. The reasoning was the same as when taking the CRM into use in sales phase. In addition, Clarity had already been used by the project managers for risk management, so ability was already built in. For the Monte Carlo analysis an outside tool provider was chosen. Only a few employees had the access to the tool as it was still in pilot. A project planner was working as the tool expert as well as inputting the data into the tool. He also familiarized himself with the specifics of Monte Carlo and shared the information to others needed in the organisation.

The tools' decisions meant that there would need to be "a robot" when transitioning the risks from one tool to the other when project execution enabling end-to-end risk process. A robotic process automation was built in by the operational development. A trigger for the automated process was made after hand-over meeting between sales and execution was made. The risk categories and functionalities were aligned by the SRM and operational support from the experts of both tools to serve the end-to-end risk process and to enable automated risk transfer process between the tools.

To have the management responsibility and visibility to the decision making an approval process was agreed. The proposal was made by the SRM and the legal support and approved by the management team as well as the CEO of the company. The approval process required all the A class projects to go through formal risk review at least in the area management team levels (Asia, Europe, Africa, Americas) and additionally in energy management team dependent on contract value, estimated risk value, risk value compared to margin or if other specific reason was seen by the area management. The contract value and risk value had defined threshold values according to which the escalation would be made. Similarly, agreed with the CEO of the company, projects should be escalated to board of managers dependent on contract value and estimated risk value or other specific reason. One specific reason for escalation could be the inability to estimate the risks within reasonable limits.

In the period between 2019-2020 more than 80 A class sales opportunity projects went through the risk assessment and analyses in the sales phase. Only two projects were handled without the facilitation due to having only one facilitator in the organisation and ongoing vacations. The assessments were initially held mainly face to face with typically sales personnel participating via virtual meeting but were transferred to full virtual meetings due to the global Covid pandemic that hit Spring 2020. However, the effectiveness stayed since the employees were anyways stationed globally. This also saved in travelling costs and in facility costs. It also enabled all the participants to hear each other equally which was not the case when part of the team had participated face to face in conference rooms and part of the team with virtual tools. Turning risk assessments into virtual meetings also made a difference to the meeting style making the assessment sessions shorter in time, asking the participants to prepare more beforehand and making the meeting frequency higher. This was a change for the better since the participants were more prepared in the meetings and the time between the iterative meetings matured the thinking of the participants further.

The exposure to the topic by the managers at the end of 2019 result announcement made it clear for everyone that the risk assessments needed to take place. However, the timing during the sales, when the first meeting should take place was initially difficult to find. If risk assessment was initiated too close to the bid, the quality would suffer. Specifically having enough time to plan mitigation actions, let alone implement them. On the other hand, if risk assessment was initiated too early, without yet understanding the viability of the sales, the requirements, content and delivery options, the risk assessment would need to be redone multiple times thus wasting resources. However, every single risk assessment session increased the learning curve of the organisation. The dilemma of having the right timing for the risk assessment was solved through the project directors dedicated for the sales areas who followed up the upcoming opportunities in sales to prepare for the right resourcing of project execution team. Project directors notified the SRM to get in touch with the sales team when the sales opportunity started to switch into real possible sales but still having time for bid. The purpose was for the sales personnel to understand the right timing in the long run once they got an understanding of the risk process steps needed. Once the participants and the right timing for the assessment were agreed, the SRM would send out invitations for the risk assessment for the participants. Typical meeting invitation included the reason for the meeting, tasks needed from the participants beforehand (identification of the risks), link to the specific location in the tool where risks were listed and the agenda.

Initially the risk assessment meetings were fully led by the SRM as the process was new. It started by introduction of new sales risk process and reasoning for conducting it. The initiation also enabled the participants to ask any question of the process before the actual assessment started, if needed. This was followed by the presentation by the sales on the details of the sales opportunity if the project execution team had not yet been participating in the details of the case before. If the risk assessment was a follow-up assessment, the changes in the content and schedule of the opportunity were reviewed. Typically, in the first risk assessment, the risks and first mitigation actions were identified by the team members and data was implemented into the CRM tool. Full information, such as the monetary impact value or probabilities of the risks, were not yet fulfilled. In the next meeting(s), particularly if many risks were identified in the first meeting, the risk information was then fulfilled to include the full information required by the tool to the degree possible.

The required info for the tool per risk or opportunity were the risk name, category, impact description, type (risk/opportunity), status (open/ closed), mitigation plan, max impact in euros and probability %. The tool automatically calculated the probable impact value (max impact value x probability% = probable impact value). All the separate risks could be seen also as a list in the tool and the sum of all risks' probable impact value summarized the total risk value of the sales opportunity. The maximum impact value signified the worst-case scenario if the risk would realize. The probability was less academic since there are no rules and exact foreseeing for the future. However, the guideline given was that 100% means the risk would happen for sure and should not be a risk rather than costed in budget, 0% is a risk closed. Anything in between 0-100% are risks possible to happen. 1-20% is rare to happen, 20-40% possible to happen, 40-60% likely to happen and >80% very likely to happen. Every mitigation action executed will decrease the probability but if all the possible mitigations have been done and there are still some leftover risk, the risk probable impact value should be costed in project budget as risk reservation and to be included into the total contingency reservation.

The cost reservation for the sales opportunities was calculated as illustrated in figure 13. On top of the opportunity base cost, the risk reservation, the business contingency reservation, and margin were planned which all together totalled project sales price. Business contingency reservation is planned for unknown risk whereas the risk reservation is based on actual project specific risks foreseen at sales risk assessments. This is following the hybrid contingency reservation model presented by Curto et al. (2022) where they propose a method where all uncertainty/ risk types are taken into consideration.

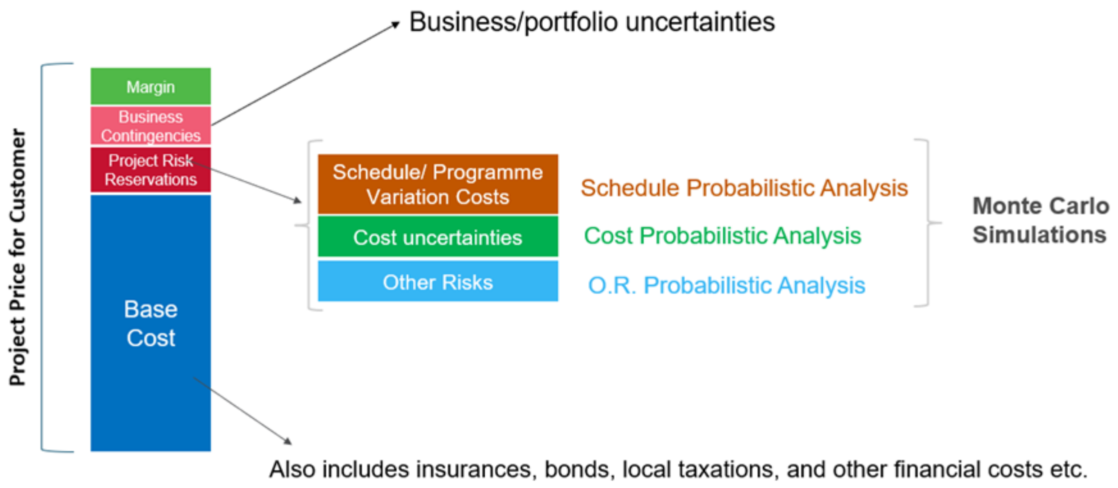

Figure 13. Contingency reservation model chosen for energy business.

After the risks were clarified in the tool, the Monte Carlo analysis could start. Base cost positioning in the bell curve should be a strategic management decision. The costs beyond confidence level P90 are considered as black swans but what should be the risk appetite i.e., where to position the target pricing of the projects should be based on a business strategy. On top of the base cost would be the business contingency reservation (unknown risks) and risk reservation (identified risks).

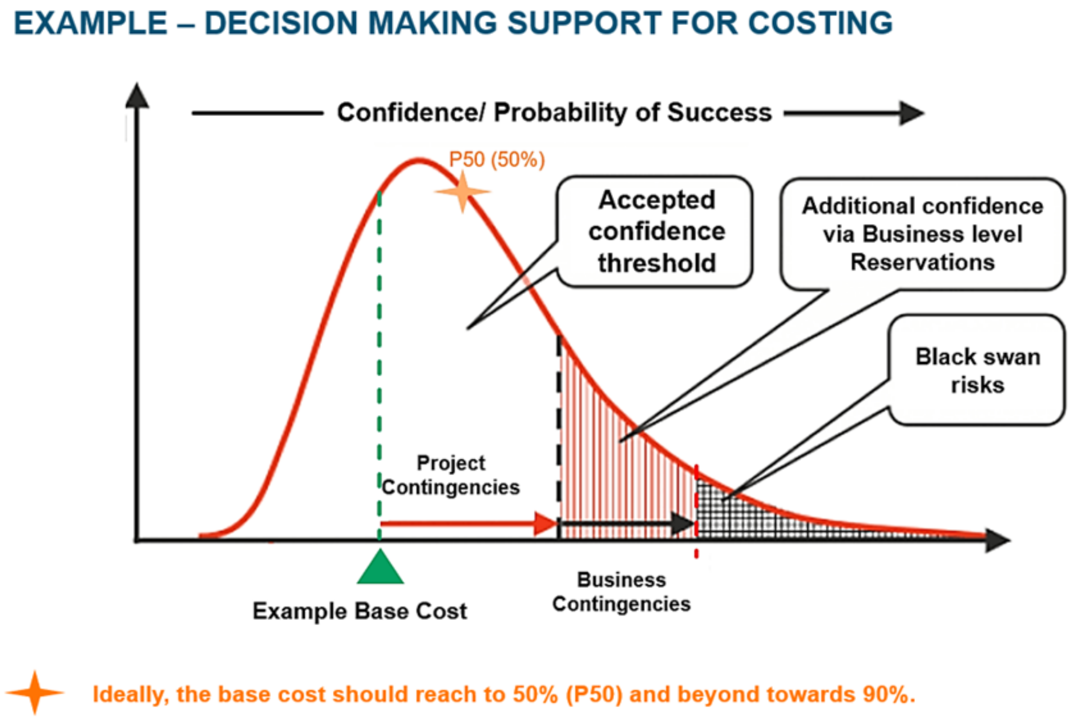

Figure 14. Contingency reservation support material.

After 6 months of using Monte Carlo analysis, in the Spring 2020, it was obvious that the Monte Carlo analysis was not delivering the results expected. The first projects, where consulting-based Monte Carlo analyses were made, started to materialize and were nowhere in the ballpark of the reality, even if it was just 6 months prior the actual results when the analysis was done. The actual margin deviations were higher than what Monte Carlo had been estimating. There are multiple explanations why this happened. People were new to the process and bias played a role in conservative estimations. Also, numbers given to the calculation were not based on numerical facts, not even always on experience but on a gut feeling on the spot. In addition, the lack of organizational safety was not mature to give "too negative" estimations. The same realization was made also in internal Monte Carlo meetings. Project team members struggled to estimate the P10 or P90 values as there was no data to lean on. P50 value was given by the internal cost calculating tools for normal project pricing. It was realized that if there is bad data going in, nothing of value cannot come out of the Monte Carlo analysis. The Monte Carlo analysis was put on hold. It was considered the risk assessment estimations of the total risk exposure on known risks was more informative than the estimation made by the Monte Carlo analyses.

An investigation started on how the data for a reliable Monte Carlo analysis could be obtained. On option of using the information from the previous projects realized costs versus the budgeted costs was discussed. The previous projects could give data-based range of P10 and P90 values for the Monte Carlo analyses. A ready-made data was not available for the analysis of the previous projects' cost comparison between realized costs versus the sold costs due to sales and project execution using different types of cost line items with different details. There was no continuous follow-up system. Some functions, such as site management and supply management, had created a reporting system suitable for them. They were following the past-project data and making needed changes accordingly to the base cost estimations should the cost estimations be decreased or increased. After meetings were held, led by the SRM, the numbers became available for all the organisational functions to use. However, the numbers needed to be analysed as there were many variables affecting the project costs. Even one project with big black swan risk realized, but never to occur again, could skew the data. The analysis work was given to function and is ongoing. For this reason, the Monte Carlo analysis is still on hold.

Once all the needed risks were identified and evaluated in the risk assessment meetings and agreed together with the whole team (specifically both by the project manager and the sales representative), the final risk exposure was presented to the appropriate management level for bid approval. The risks needed to be prioritized for the sake of the time keeping. Usually the top 10 risks (in terms of expected risk exposure) were discussed in more detail. In the first approval meetings a lot of time was used to the questions by the approval managers on the opportunity details. It was evident that pre-knowledge of the content of the opportunities was not on a mature level by the representatives of the managers. Also, management was really oriented as to from where the evaluation for the risk exposure came from which was a valid concern specifically in the beginning when the process was new. In addition, in the beginning of the process implementation, the maturity to estimate the risks' monetary values was not yet there. One of the reasons for difficulties in risk cost estimation was also that all the contract requirements were not fully analysed by the offering phase. This was due to the lack of maturity and implementation of requirement management in the organisation and sometimes also due to customer not able to give full details. If the requirements cannot be fully analysed in terms of financial and schedule impact, also the risk will not be able to be fully analysed. This in general was seen typical for the risk process – it was dependent on other processes such as mentioned requirement process but also costing process. If those processes were inadequate, the risk analysis would also be unfinished.

The main question in the approval meetings for the management to decide should be to understand the balance between the contingency reservations reserved, and the risk exposure analysed. If the management would be willing to reserve less contingencies than what was estimated by the team, the management would take the premeditated risk for business reasons e.g., tough competition in an opportunity that is strategically important to win. If the analysed risk reservation would be approved to be kept, and the project execution team could manage the risks well during operation, the unused risk reservation would be a surplus on top of the project margin. On the other hand, if the risk reservation would need to be used, the planned project margin would still be kept.

Throughout the risk management process improvement stream, the communication was vital for the organisation to adapt for the latest changes. The first risk "Deep Dive" information session was held as early as 13th December 2019 by the SRM. The information session started the knowledge building of the subject matter in the organisation. All the energy business organization members globally were invited to a 45-minute meeting online. The key points in the session were to introduce the new risk process and on what stages the needed steps should be taken. Also, the newly improved version of the A-class project categorisation list was introduced. Once the tools were ready to be used or if any changes were made for them, a tool training session were held. The SRM also actively participated in any internal meetings where info from the risk process was needed. The second risk deep dive session was arranged a year after the first one. In the session(s) case example(s) of an ongoing A-class project risk management examples were presented and explained how it had aided on the cost calculation and prevention of risks. It was emphasized that the project team members would get involved in the projects earlier than before, in offer tailoring, for not only to participate the risk analyses sessions but to engage early on for the best project preparation possible. The effects for the projects would be better performance and less unexpected surprises during the project execution phase. For the sales, risk process gave an opportunity for more accurate costing, understanding the details still needing further clarification and negotiation with the customer and a better insight to what was sold on which terms. For the whole organisation this provided unity and more predictive margin deviation and hence improved financial outcome for the business. Previously the project execution team had not had an active role in sales phase. The main route for knowledge building was still considered, by the SRM, to be the hands-on participation in the risk assessment meetings. Through these meetings, the participants received a first-hand understanding of the risk management, the tools, the actual process, and the benefits of implementing the risk management for the participants. On discussions by the SRM with the employees it was revealed that since an employee had once participated in the session, the questions and prejudice towards the process were reduced and the benefits were better understood.

Once the understanding of the prototypical risks in sales increased, the SRM created a list of typical risks which had either been materialized in the energy business projects before or were typical risks brought up in the ongoing assessments. It contained 30 categories of typical risks which should be checked for new opportunities to avoid repeating issues. The list was not exhaustive and was not supposed to be treated as a check in a box type of a list. The SRM had had meetings with other units in the organisation where such list was once used and misused due to not thinking the specific novelty risks in the unique project in question. However, the list was useful background to start the risk analysis from or to be used as a backup list for the discussions in risk assessment meetings. Also, fundamentally the list could be used as organisational process improvement list. Also, the list of typical risks could be used as a tool for the legal function to review the contract details against.

4.4 Results of implementing sales risk management practices

By the end of 2022 margin deviation in result showed the results presented in figure 15. The margin deviation was worse than in 2019. When analysing the result further it was realized that mostly this was due to the nuclear business losses being written off in the result. Nuclear projects were not sold anymore for several years but were still affecting the financial result. If nuclear business effect would be bypassed, the margin deviation summary in result would be almost the same as in the year 2019. When looking deeper into only the projects which had implemented the risk assessment prior the sales offer (10 A-class projects), the graph looks drastically different. The margin deviation is only causing 8,1 % of the margin deviations whereas the projects sold prior risk management in sales was implemented caused 91,9% of the margin deviations. The A class projects which had implemented the risk management in sales phase made 66% less margin deviation than the projects without the risk management. This is a clear change for the better and, if anything, should convince of the risk management implementation success and need for the sales phase risk management to continue and even further to be improved.

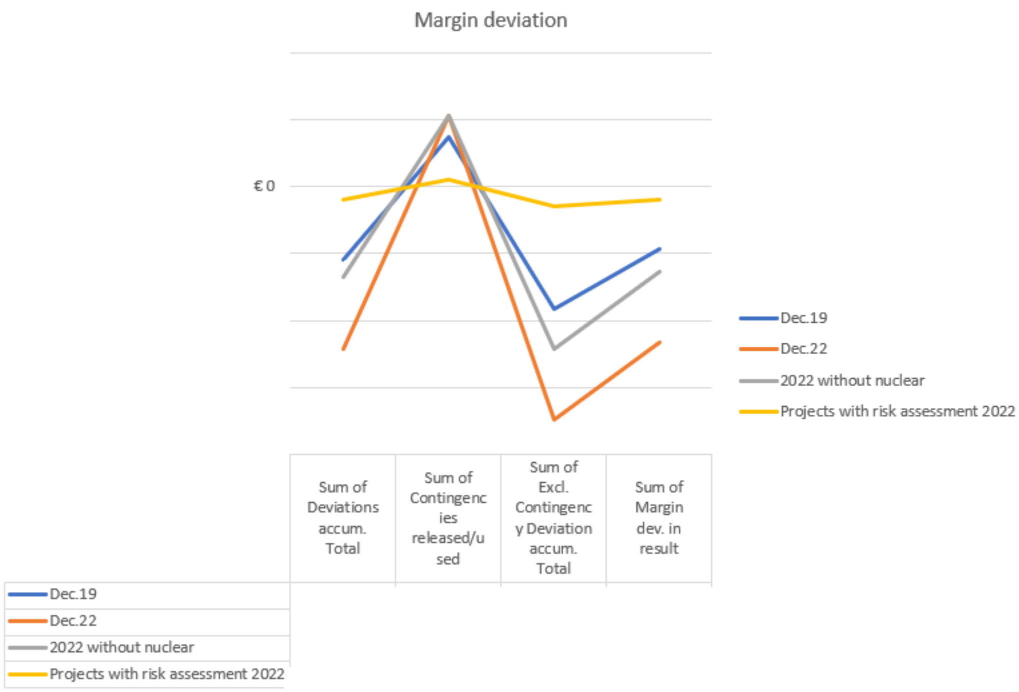

Figure 15. Margin deviation in result comparing 2019 to 2022.

4.5 Synthesis

In this chapter, the key findings are summarized. The initial research question with the sub-questions were how and what type of risk management should the global, case construction business implements in the project sales phase to have a meaningful, positive impact on the project cost overruns. The sub-questions to study were:

1. What is related current theory and academic literature explaining the phenomenon of construction business cost overruns in relation to risk management in the sales phase?
2. How should the case company estimate the risks of sales opportunities and make an educated decisions on the sales price to improve financial performance?

As a result, a risk management process was created for the business according to the theoretical guidelines. The risk management process is illustrated in figure 11 and it included the lens by which the theory was structured upon as in figure 4. The general as well as detailed process was defined, tools developed, and risk analysis techniques defined. As a result, the risk contingency reservation was agreed. Additionally, the roles and responsibilities were identified and agreed as in figure 11, involving now personnel from the sales and project execution teams together with the support functions enabling the end-to-end risk analysis and contingency planning. The tools were setup (as in figure 11) to support the risk management data repository and data information needs enabling transparent risk information sharing across organisation. Additionally, management approval processes to review and approve the risks of the sales opportunities was created including the review of the contingency reservations against the identified and unknown risks. The contingency reservation rules were introduced to include both unchangeable business contingency reservation for unknown risks based on project categorisation and risk reservation for identified risks. These two reservations together formed the full contingency reservation for the sales opportunities.

The best method to estimate the risk reservations or the identified risks was concluded to be group and knowledge based expert estimations on the specific project rather than Monte Carlo type of estimation. The Monte Carlo method gave wrong results as the input data was inherently not available to the needed detail.

The sales opportunities for which the new risk management process was implemented into showed dramatically less margin deviation than the previously agreed and sold projects without a formal risk management process. At the end of year 2022 the projects without formal risk management process generated 92% of the margin deviation losses while projects with formal risk management implemented already in the sales phase generated only 8% of the negative margin deviations. Of this 9 % negative margin deviation for projects with risk management, just one project generated 92,1% of the total 9% of margin deviation. The actual values are not presented in this thesis due to confidentiality reasons.

5 Discussion

During the years of 2020-2022 in the risk management improvement work the focus was to create the basis for internal risk management procedures and practices; to create the process, needed guidance documents, trainings, agreed roles and responsibilities with the risk process, facilitate the actual risk assessments for the projects in sales phase, piloting Monte Carlo simulations and overall do this for all A-class opportunities. As stated in the previous literature review, the general risk management process was applicable but the implementation business specific. Also, the tools needed to be business specific and build for business needs. To integrate the tools between sales and project management is a must when acquiring and end-to-end process.

The resources for implementation were thin, and the employees scattered to different time zones. Yet, the "piloting" year 2020 fulfilled all the targets as such. It was a year of great controversy in a sense that a lot of cultural barriers was needed to be exploded. This was mainly evident in the controversies between sales and project execution and in the attitudes towards the risk's meetings and risk thinking in the sales in the beginning. Organizational cultures have different barriers, and they need to be addressed at the same time as implementing a new way of working. The KPIs of the sales and project teams should be aligned so that neither is rewarded of a "bad" sales nor "bad" project management. If part of the sales KPIs would be connected to project margin realization and part of the project team KPIs and bonuses would be connected to the realized sales, the silo between the teams would further diminish creating healthier environment for the co-operation in the sales phase. However, once employees joined the risk assessments, the positive implications of it became evident.

To succeed in implementation, it was necessary to have both the formal process in place and to have the actual risk assessment ongoing at the same time. The management attitude is crucial in the success of the implementation as well as having clear evidence of why the risk management is needed. In this case, the financial result was a clear indication of the change needed and was supported by the management initially. The follow-up and support from the management could have been more long lived.

2020 was the year of new ways of working trial, and error, whereas 2021 and 2022 more of stabilization and finetuning of the process, tools, and guidelines as well as hands on training as all the sales nor project teams had not yet participated any trainings. Also new employees would join in the business and needed guiding. It was evident that via the risk meetings held the cost calculation were being able to be corrected, sales got new insight for discussions with the customer and project execution and support functions got new abilities to prepare themselves for the projects early on as well to bring in their know-how and experience from the previous projects to the sales.

The next steps in the company should be to make sure the implemented procedures and practices really make a root in the organisation. That the organisational culture is such that risks can be discussed openly without fear of lay-offs. The management should continue the communication of the importance of the risk management in the early phase and take responsibility of the difficult A-class project risk decisions when margin looks thin after risk assessment.

The probability simulation proved to be disappointing since neither the calculations made by the consultant company, nor the internal simulations were trustworthy due to the untrustworthiness of the input data. The Monte Carlo simulation could only provide as good output as was the input, as was noticed. The case business still needs to improve its history data of the costs versus budgets in the previous projects and the analysis of those costs. A possibility recognized during the improvement process was for project cost estimations at the sales phase to be estimated by three-point estimations (P10, P50 and P90) to aid risk assessment uncertainty calculations. At the same time, financial department was providing solid margin deviation reports monthly which enabled to follow-up of the progress, specifically once the projects with risk assessment started to be sold and proceeding.

Portfolio risk planning was missing that would cover all the areas and all the projects' risks. The reason is that the responsibility was shared to geographical area organizations. There were however organizational changes made late 2022 to cover the portfolio view and the results will be seen in the future.

It is evitable that one resource only is not enough in a global organisation to facilitate the topic (due to the time zones and number of projects), but additional resources would be needed. The facilitator need was considerable as the risk management culture was new and not fully rooted to the organization. This was recognized in the organization 2022 and an additional resource was hired.

It would be of utmost importance to concentrate on improving the areas where typical risks have previously occurred via prioritizing the improvement topics from the gathered "typical risks list". It would be of special importance to review the list within the legal team to understand which of the typical risks can/ could be protected through strengthened contract terms.

Requirement management practices in sales phase should be a must prior risk management assessment and before final budget values are given. The risks cannot be fully estimated if the requirements and their effects on project are not fully understood. Risk management is not a solution on its own but needs to be linked to project cost accuracy and requirements management. The requirement management practices still need to be improved in the case company to finetune risk management. The risk management practices should be spread int the organisation to consider also, B and C class projects and in addition the service projects. The practice should not be different in other units within the energy business such as battery business, but the practices should be coherent for the sake of efficiency and transparency.

Overall, the development and implementation of risk management in the business was a success which is shown in the margin deviation report December 2022 compared to the situation December 2019. The margin deviation figure shows clearly the difference between the margin deviation in the projects which had gone through the risk assessment process versus the ones without.

The answers to the research questions are that the theoretical, general framework given in the literature for the risk management process can also be applied in the sales phase and more specifically in the construction contract business if just adapted and adjusted to the organizational specifics and environment. However, the probabilistic tool(s) are controversial to be implemented. Although the mathematics behind the tools as such, as in Monte Carlo analysis is valid, the results are dependent on the input data. If there is not reliable data to back up the numerical estimations needed by the probabilistic tools, the output data cannot be trusted. The implemented risk process needs to involve the business personnel from sales to implementation and support functions and require common targets for the whole organization. In addition, the implementation needs to be hands-on for the organizational culture to change. The organizational change also requires formal process and tools for easy data access transparently for all the organization.

The contingency reservation should be based on hybrid method where unknown risks are covered with a fixed contingency reservation based on a percentage of the opportunity budget and the other types of known risks or uncertainties covered by a contingency with an outcome of the risk assessment.

5.1 Theoretical implications

As suggested by the theory, the risk process needs to be organisation/ business specific. Theory can guide but not implement the risk management. Yet, the general process and guidelines as such are valid. This study confirms the significant impact that risk management can have on financial result in construction business, specifically when done in sales phase already.

However, the use of probabilistic tools needs to be reconsidered when reliable data is not available. The belief in the mathematic equations as an answer to replace intelligent human input in risk management is not realistic if the historical or other objective data for tools does not exist.

Suggested for the further studies is to continue to understand business specific implementation of the risk management in practice as well as follow the success of implementing the risk management process already in the sales phase to the results of the realized margin deviations. There were no similar studies found with the focus on the effect of the implemented risk process. In addition to focusing on possibilities with statistical tools, a more thorough study would be beneficial of the input data required for the tools to provide reliable data.

5.2 Managerial implications

The improvement in the margin deviation summary in figure 15 clearly indicate the benefits of the risk management done in the sales phase. The risk management in the sales phase improves the margin deviation and thus the business result. The risk management should be started as early on as possible and involve all the stakeholders of the project including sales, project execution team and support functions. The KPIs of the business should be aligned with the whole organisation so that that everyone is working towards same goals. The contingency reservation should be hybrid reservation including a fixed percentage of the budget of the opportunity for the unknown risks and an additional a risk reservation based on the outcome of the risk assessment. The outcome of the probabilistic methods is based on the input data and should be reviewed for reliability.

A risk management process implementation can create significant and meaningful improvements for the construction company financial result and should as such be an indication for the management to implement it in practice.

5.3 Suggestions for future research

Future research on the topic could include the study of improvement of the risk management in the sales phase and its effect on margin deviation for bigger sampling of businesses or companies to verify the results shown in this paper. Also, the connection between risk management and requirement management and their effect to the financial results could be further investigated. In addition, the required reliability level of input data for probabilistic analysis could be deepened.

5.4 Limitations

The process presented in this thesis is not suitable to be implemented as such to any business or company but as stated in the literature, always needs practical fitting for the organisation in question. The action research was done in one company based in Finland, yet a global business in all the continents. Additionally, the implementation was within one business unit only. There is also a specific, unique culture within the case company studied. It is still evident that the same phenomenon is constantly affecting the construction business.

Participatory action research is a subjective experience with objective outcomes and cannot be repeated the same in another environment. A lot of material presented in this thesis can be verified from the databases, meeting minutes etc but also a lot of the material is based on observations, unofficial discussions, and decisions made by the SRM herself making the exact imitation of made implementations impossible.

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