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R&D PROJECT RISK MANAGEMENT IN PG IEC LV-MOTORS AND GENERATORS

ABB Motors and Generators, Global R&D

School of Technology
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Project Management

ABSTRACT

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This thesis explores the views of the global project implementation at the product development department. The large case company operates globally in various industry segments. Project plan documents are made by one or more persons. The plans give the purpose of the project and estimated goals and timeline. This the-sis aims to find out the project management risks on global projects. The list of issues that can go wrong in projects is long, for example an inexperienced project manager can make poor estimations of the project. In addition, resources can be selected wrongly, and the persons expertise might not fit the purpose. If the project preliminary study is made poorly the project requirements might be not recognized. Without management support, the project is almost impossible to be executed well. This thesis investigates the risk perceptions of global R&D organization in different locations globally from management viewpoint. The study also determines whether there are differences concerning the opinions of risk importance between the management and the project manager. Lessons can be learned from every project, even if the project is a failure. Many companies do not document lessons learned because employees are reluctant to sign their names to documents that indicate they made mistakes. Thus, employees end up repeating the mistakes that others have made. Lessons learned from every project is mandatory if the company wants to learn from the past and really want to improve their project competence. The results of this thesis are that pro-jects that move too quickly to the implementation phase are challenging or even impossible to keep on schedule and the budget is often exceeded. The current project management model needs to be updated to meet global R&D require-ments. As a result of the thesis work it was found that the risks of project implementation are too rapid a start of project implementation. The implementation begins with incomplete basic and basic information. In addition, the resources allocated to a project are often too small or at least do not allow for a shortage of any person. Placing people globally in a project team also poses its own challenges in project implementation, but the company culture is evolving in the right direction day by day.

Keywords Project management, risk, global project

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ABBREVIATIONS

FMEA	Failure Mode and Effects Analysis
FMECA	Failure Mode Effects and Criticality Analysis
PFMEA	Process Failure Mode Effects Analysis
RRF	Risk Reference Framework
ABB	Asea Brown Boveri
CEO	Chief Executive Officer
DC	Direct Current
AC	Alternating Current
ASEA	Allmänna Svenska Elektriska Aktiebolag
BBC	Brown, Boveri & Company
OMXS	Open Mobile Exchange Stockholm(Office Max)
NYSE	New York Stock Exchange
SWX	Swiss Exchange Business
EBITA	Earnings Before Interest Taxes Amortization
EPS	Earnings Per Share
EVM	Earned Value Management

CHF	Confederation Helvetica Franc, Swiss Franc Currency
IEC	International Electrotechnical Commission
kW	kiloWatt
MEPS	Minimum Energy Performance Standards
ISO	International Organisation for Standardization
OHSAS	Occupational Health and Safety Assessment Series
cUL	UL Standards for Canada (Underwriters Laboratories)
CSA	Canadian Standards Association
Ex	Explosive atmosphere
QAR	Quality Assurance Report
QAN	Quality Assurance Notification
ATEX	ATmosphere EXplosible
IECEx	International Electrotechnical Commission Explosive atmospheres
EAC	East African Community
INMETRO	National Institute of Metrology Standardization and Industrial Quality
CNEx	Introduction of Nanyang Explosion Protected Electrical Apparatus Research Institute
US	United States
EurAsEC	The Eurasian Economic Community
ABS	American Bureau of Shipping

BV	Bureau Veritas
CCS	China Classification Society
DNV GL	Det Norske Veritas Germanischer Lloyd
KR	Korean Register of Shipping
LR	Lloyd's Register of Shipping
KN	Nippon Kaiji Kyoka
PV	Planned Value
R&D	Research & Development
RINA	The Royal Institution on Naval Architects
RS(RMRS)	The Russian Maritime Register of Shipping

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1 INTRODUCTION

1.1 Motivation for The Project Risk Management Research

The risk realization in the project is the most hated thing that can happen in the project. This study explores the project success by using the client's perspective in a global project environment. Quite often, the risk is not seen or there is not enough time to search all possible risks. Often the project audience or interested group think that project execution is nothing more than fulfilling the project given tasks and requirements. Sometimes when the project starts, everyone has an interest to go ahead and perform, not thinking of the project risks. There are plenty of possibilities to fail in project execution. In this "go ahead and perform" mode nobody can fore-see the risks before starting the execution of the project, but everybody notices if there is some error on the project timeline, cost or pro-ject deliverables. For example, if a project manager makes too optimistic a schedule for the project, there is no place for errors and risks are difficult to be minimized.

A delay of one task in the project can delay the whole project from a day to weeks, months or even years. This can be seen, for example, in the extended delivery time of a Finnish nuclear power plant. In this kind of a huge project several things can go wrong. One reasons in this particular project is communication or perhaps more specifically, the recording of the communication in project related discussions.

Memos and recording communication in one way or another are very important, especially for long-term projects. If the project manager makes too pessimistic a schedule, the end day of the project is so far away that nobody does not want to start the pro-ject execution. Project results may be outdated already before the handing over of the project. Long-term project cost impact can be huge depending on how many persons work on the project. Project managers should understand that the project timetable, scope and cost need to be frequently updated. If there are changes on the project scope, it almost always extends the schedule or increases the need for workforce. Project timetable changes are needed if project deliverables are to be achieved in the project. These forecasted or unexpected change needs are called project risks.

The project risks management must find the external parties involved. In global business, almost all projects involve external parties. At least different cultures must be considered, so there is no possibility to grow an undefeatable obstacle in the project implementation, including also internal project execution risks in global company. Generally, project risks are linked to the expectation of the pro-ject objectives whether the time, cost and performance objectives. Many risks can be expected and controlled. An integral part of the project must be the risk management through-out the entire life cycle of the project. Some common risks in projects include:

- Poorly or not known defined require-ments.
- There are not enough qualified resources.
- Management does not support the project.
- Project poor estimating on cost, time and scope.
- Present case or otherwise inexperienced project manager.

The identification of the risk is an art and it takes time to learn that. The project manager must to examine, permeate, and analyze all available data.

- The project manager’s tools include decision support systems, project steering committee.
- Expected value measures from the available data.
- Trend analysis / projections what have affect to project.
- Independent reviews and audits from different angles.

If the same or similar project has not be executed earlier, the risk analysis must make without supporting materials. If there is a template to check new project risks, the risks managing is not as difficult as it may seems.

In assessing the risks of a project, it makes sense to use the valuable information learned in previous projects, even if the in-formation is not tailored to that project.

1.2 Aim and Method of The Dissertation

The aim of this thesis is to find which kind of risks in a multinational company should be considered in R&D projects.

The aim is;

1. To find out what kind of management risk in projects the project management literature proposes

2. To find out what the most important risks in an R&D project are according to some practitioners in a multinational company. This is found out by an open

ended question

3. To develop a proposal how the risk management in R&D should be

improved in the multinational company

The method is qualitative. The open-ended question will be sent by emails only to a limited number of R&D project managers in different countries. The answers are analyzed. The R&D risk management improvement proposal is developed by using the empirical material and the literature.

1.3 Limitations of The Research

The research pursues to find answer to the open-ended question “what are the most important risk in R&D projects from the management point of view”. Thus, this research is qualitative. This kind of approach does not give a depth analysis of the topic, but it gives a viewpoint how to start to reduce the risks of R&D global project. The proposed R&D risk management method is based on the author's own ideas and the literature study. In the future, the ideas created in this research will be tested in the company meetings. In addition, it might be so that the real problems of R&D project management are not found with this kind of open-ended question, but it certainly gives an insight what the main risks are according to the managers in the selected units. The limitation of the use of the open question can be that the deeper analysis of the subject is not possible. The question lacks introductory nature and the respondent answers from his/her perspective. Regardless of the number of questions sent response rate is usually less than 50. This open-end question was sent to only 21 project managers and each project managers answered the question based on their experiences. This work total response rate was quite low only 38 percent. Low response rate increases the error margin of the open-end question.

I would also like to thank my colleagues for their support when completing my work. As well as the supervisor of my work Pasi Viitanen from thesis client side and supervisor Marja Naaranoja from University of Applied Sciences.

2 COMPANY PRESENTATION

The current ABB business unit Motion is based on the one man's dream from machine factory. ABB's roots in Finland – Strömberg machine factory. It can be seen from Figure 1 that the work environment has changed over the years. It can also see from the picture that large electric motors and components have already been manufactured at that time. (ABB history 2008)

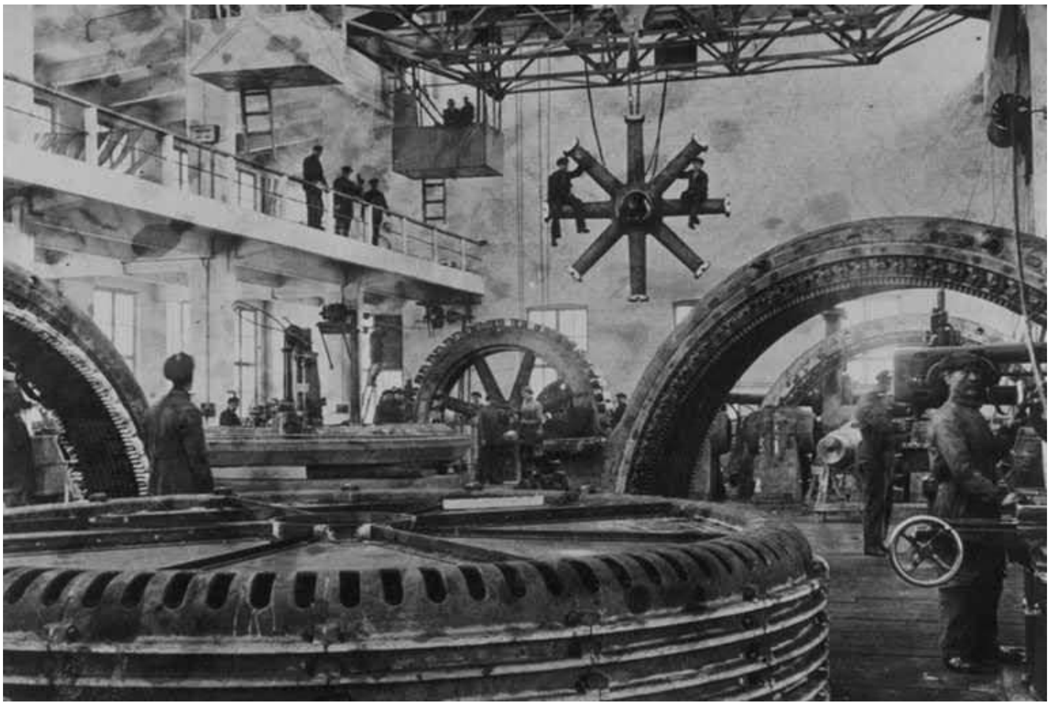

Figure 1. Gottfrid Strömberg's factory in early 20th century

2.1 History In Brief

In this section the history of the company is shortly presented in order to point out the role of R&D in the business field of the case company. The founder of the company, Gottfrid Strömberg, was the first person in the Finland to conduct academic research and teaching in electro-technology while acquiring the highest university level knowledge in Germany. 1889 Gottfrid Strömberg set up his electrical workshop in Helsinki. The core business was DC machines, lighting systems for residential and business premises and installation work. (ABB history 2008)

Figure 2. Gottfrid Strömberg. (ABB history 2008)

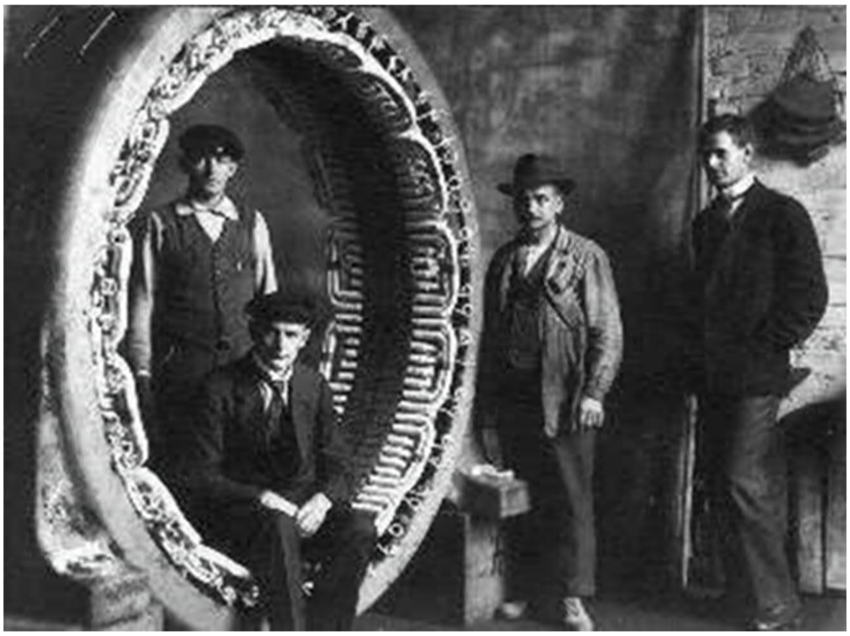

Figure 3. Stator of AC motor for Myllykoski groundwood plant, 1912. (ABB history 2008)

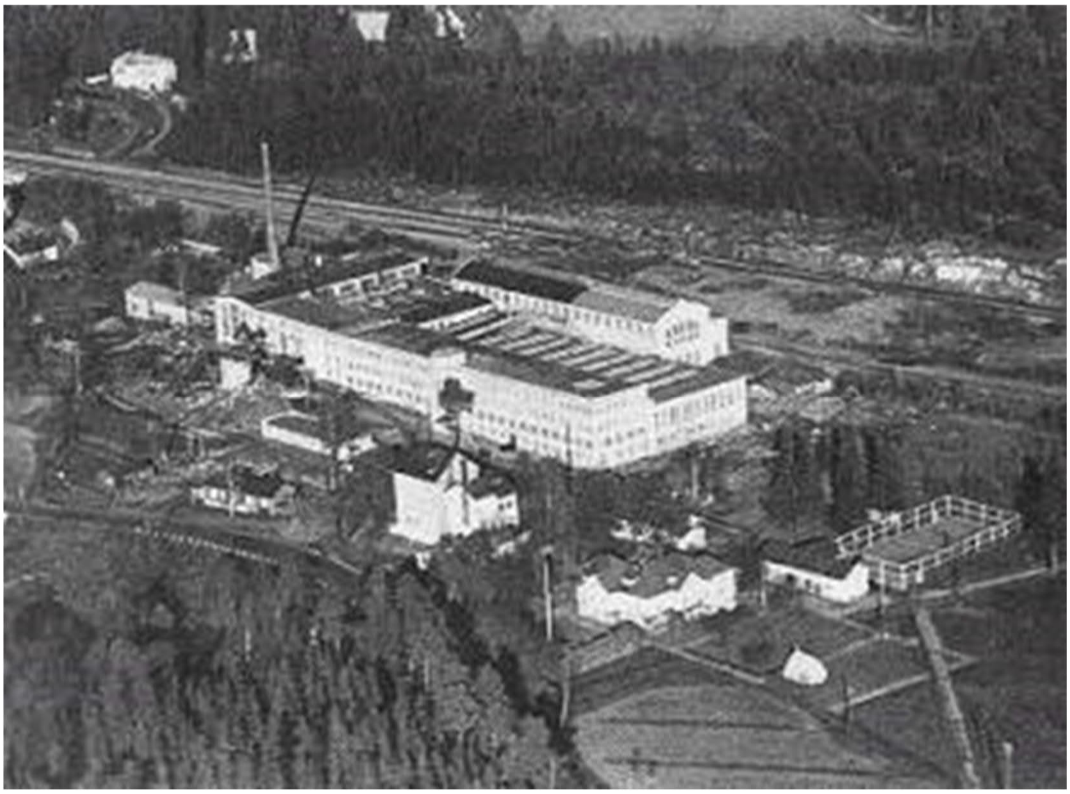

Figure 4. Aerial photo of Pitäjänmäki, 1935. (ABB history 2008)

During the war, in the 1940s the production continued with a focus on smaller machines. War materials, such as ammunition, mortar triggers and searchlights were also manufactured. The factory in Vaasa was started in 1944 with low voltage equipment as a significant product group. After the war, the electrification continued in Finland. Strömberg became one of the ten biggest Finnish industrial companies. Cage induction motors became the main product of the company. Strömberg took part in war reparations by delivering transformers, motors and generators. (ABB history 2008)

Figure 5. Factory was camouflaged during the winter war in 1940. (ABB history 2008)

Figure 6. Motor stator winding line from 1943. (ABB history 2008)

In the 1950s, many hydropower stations were built with large generators tailored by Strömberg. The product development of high voltage equipment and systems started in research laboratories in Vaasa and Helsinki factories. In the 1960s, power electronics were included in product development. In the 1970s, active product development based on AC technology. Frequency converters for speed control of cage induction motors became the flagship of export trade. (ABB history 2008)

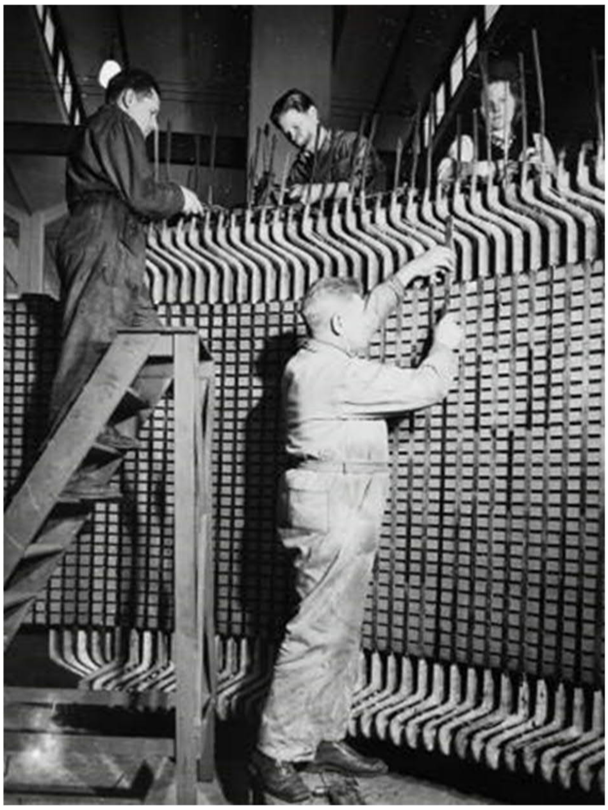

Figure 7. Winding a generator for Merikoski hydropower station. (ABB history 2008)

In the 1980s, Strömberg developed a microprocessor-based relay system for protection and control of electrical networks and also fully digital industrial drives. In 1986, a Swedish company ASEA bought Strömberg. After the merger of ASEA and Swiss company BBC Brown Boveri Ltd in 1988, Strömberg's out-standing history continued as part of the ABB. ABB is a Swedish-Swiss industrial group headquartered in Zurich, Switzerland. ABB's operations are focused on automation and electric power engineering. ABB is a public limited company listed on the Stockholm Stock Exchange (OMXS: ABB), New York (NYSE: ABB) and Switzerland (SWX: ABB). The current CEO of the group is Björn Rosengren, effective March 1, 2020. (ABB history 2008 and Financial report 2019)

2.2 ABB Group In 2019

ABB facts during 2019 are as follows (Press release 2020):

- Orders $28.6 billion, steady; comparable +1%
- Revenues $28.0 billion, +1%; comparable +1%
- Operational EBITA margin1 11.1%, impacted by a combined 130 basis points due to stranded costs and non-core activities
- Income from operations $1,938 million, -13%
- Net income $1,439 million, -34%
- Basic EPS $0.67, -34%2; Operational EPS1 $1.24, -7%
- Cash flow from operating activities $2,325 million, -20%, incl. cash out-flows for simplification program and Power Grids carve-out
- CHF 0.80 per share dividend proposed (Financial report 2019)

2.3 ABB Motors And Generators Plant In Vaasa

Production in Finland started in 1889 and in Vaasa 1944. There are around 600

highly educated professionals with world-class competencies. The yearly production is around 75,000 units, out of which 25,000 are different products. There are a full range of tailored IEC low voltage motors for different segments and applications. IEC refers that the motors comply with the International Electrotechnical Commission standards . “IEC is the world’s leading organization for the preparation and publication of International Standards for all electrical, electronic and related technologies” (International Electrotechnical Commission 2020)

All motors are engineered or configured according to the order to meet the customer specifications with full documentation and testing capabilities. The average batch size is 2 motors/order line, 17 frame sizes. IEC International Electrotechnical Commission gives standards where the motor size is defined from shaft height 71 mmm to 500mm and the electric motor power up to 2 000 kW.

Figure 8. Vaasa factory and office building. Picture from Vaasa Factory presentation 1997 (ABB internal network)

Today, there are a total of 224 different certificates for motors and thousands of MEPS registrations, for example: ISO9001, ISO14001, OHSAS 18001, cUL, CSA; Ex certificates and factory approvals (QAR/QAN), ATEX, IECEx, EAC, INMETRO, CNEx, CSA; MEPS registrations in US, Canada, Australia & New Zealand, Brazil, China, Saudi Arabia, South Korea, EurAsEC (Russia), marine type and factory approvals and Motor Test Laboratory approval by CSA based on ISO/IEC 17025. Almost every motor and generator, which is manufactured in Vaasa factory is made according to some standard.

2.4 ABB Oy, Motors and Generators

Energy and production efficiency has improved for over 125 years. The industry consumes 40% of all electricity produced, of which two-thirds is driven by electric motors. Electric motors use more than 28% of the world's electricity. ABB is a pioneer in the development of energy efficient engines. ABB's Motors and Generators business line in Finland invests heavily in research and development of high efficiency motors and generators. The Motors and Generators business line in Finland develops and manufactures engines and generators for all industries and applications worldwide. The mills are located in Helsinki and Vaasa. ABB is the world's leading electric motor manufacturer. The Vaasa plant has the global responsibility for the manufacture and development of the company's low-voltage motors for demand-ing applications. The Pitäjänmäki plant in Helsinki develops and manufactures high-voltage motors, diesel generators and permanent magnet motors, among other things. Globally, ABB's motor and generator business employs 13,000 people in 31 factories in nine countries. This kind of organization needs plenty of R&D, as. (ABB history 2008)

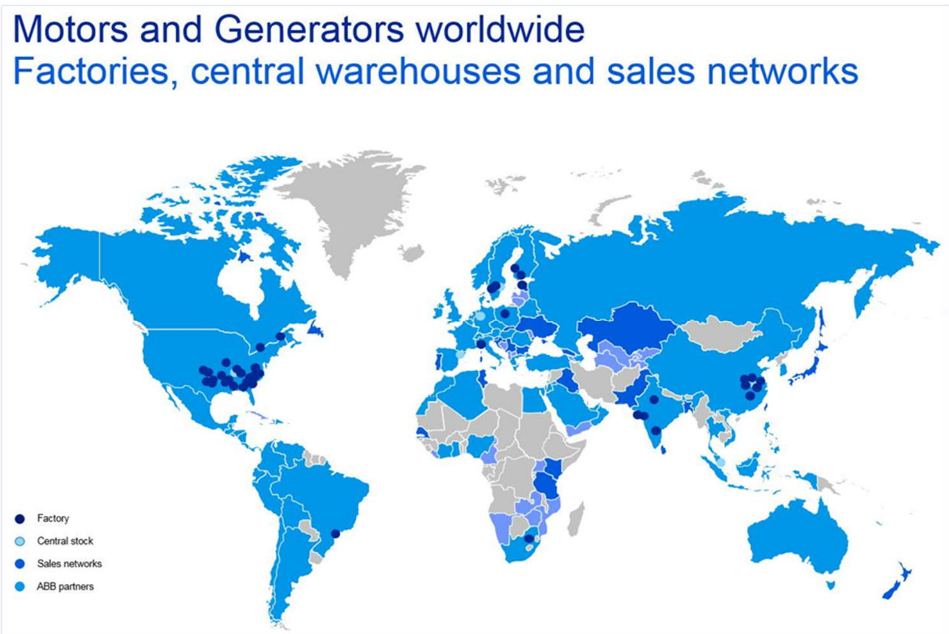

Figure 9. Motors and Generators globally. (ABB history 2008)

3 RISK MANAGEMENT THEORY BASE

3.1 Evaluation of Project Risks

Project risk management has a six- step process. The first is the identification of the risk. The second is quantifying the risk. The third is prioritizing the risk. The fourth is to make a strategy how to manage the risks. The fifth is to explain the management / project management team about the situation or topic that involves risks in getting the project deliverables. The sixth is to act in order to make changes to the anticipated future in order to prevent the risk realization. When we use this first step to identify the risk in a customer process, we need to clarify the effect on each change that we make to cur-rent process. For example, in the research and development department, the risk can be that there is not enough work force to execute the project in the given timetable. Furthermore, some special expertise may need to succeed in the project. Project risk occurs when a change is made to project process or the project is affected by some external normal process-modifying force. (BMBOK® 2013)

3.2 Steps of Risk Management

According to the Fairley risk management steps support project execution before, during and after the realization of the risk. With this, project managers get instruction how to handle risks in projects with a way that gives the possibility for success of pack up planning and avoid project stopper. This seven-step process shows how to uncover risk factors, count the probability and effect on a project execution and plan for and conduct risk management:

1. Identify risk factors.

2. Assess risk probabilities and effects.

3. Develop strategies to mitigate identified risks.

4. Monitor risk factors.

5. Invoke a contingency plan.

6. Manage the crisis.

7. Recover from the crisis.

(Fairley R. (994)

3.3 Scoring Tool For R&D Project

One scoring tool for research and development to evaluate R&D projects is the scoring algorithm developed by Henriksen and Traynor (1999) that includes trade-offs among the criteria and calculates the relative size of the project value given the fact that value is a function of both merit and cost.

3.4 Corporate Strategic Goals Links To R&D

Uncertainty is one of the biggest inherent difficulties in developing innovative products due to their new technologies and active markets. The occurrence of uncertainty easily leads to high R&D risks, leading to many project failures. Therefore, it is important to manage R&D risks throughout the implementation in order to improve the success rate of R&D projects. This paper proposes a new risk management approach that combines project risk management with corporate strategy and performance measurement system objectives. The scorecard is used to identify the key performance measurements of an R&D organization based on a solid vision and strategy. The implementation of quality functions is designed to adjust an organization’s functional benchmarks for project performance measurements, and a method is developed to identify, assess, plan, man-age, and respond to systematic risks. This risk management rule allows the R&D project to focus on achieving the company's goals and provides a more efficient way to identify, assess, analyze and monitor R&D risks during project implementation. The proposed method is presented in a drug development project. Studies have shown that the application of risk management techniques to R&D projects can improve their success, especially if completely new technologies and innovations at work. (Raz et al.,2002; Salomo et al., 2007; O’Connor et al., 2008)

Since R&D is people and knowledge intensive, Cooper (2003) suggests using knowledge management systems and collaboration tools that captured practitioner experience for reducing R&D risks. All the information that can be recorded somewhere are priceless for the company in the future.

3.5 Manage project risks during the R&D project

Keizer et al. (2005) describe the development and applicability of a risk reference framework RRF for diagnosing risks in technological breakthrough projects. In contrast to existing risk identification strategies, the RRF centers on an integral perspective on risk (i.e. business, technological and organizational) and the assessment of risks in ongoing projects. The resulting RRF consists of 12 main risk categories and 142 connected critical innovation issues and has been developed for a globally operating company in the fast-moving consumer goods industry. Our analyses show that to some extent, different project members identified the same risks and that saturation occurred in the number of new risk-issues brought to light. We conclude that the success of breakthrough innovation pro-jects improves through formal risk assessment.

Risk planning techniques include: (1) Risk avoidance, (2) Risk mitigation, (3) Risk transfer, and (4) Risk acceptance Risk reference framework means that you look at the risks from the project point of view or do you look at it from project owning company point of view, or from the client point of view.

Table 1. Risk reference framework: 12 risk categories with the number of connected critical innovation issues.

Risk categories	Number of identified risks per category	%
Commercial viability risk (CommViab)	17	12
Competitor risks (Compet)	9	6
Consumer acceptance and Marketing risks (ConsAcc)	16	11
Public acceptance risks (Extern)	8	6
Intellectual property risks (IntProp)	7	5
Manufacturing technology risks (ManTec)	12	8
Organization and Project management risks (OrgProj)	22	15
Product family and Brand positioning risks (Prodfam)	13	9
Product technology risks (ProdTec)	11	8
Screening and Appraisal risks (ScrAppr)	6	4
Supply chain and Sourcing risks (SuppCh)	11	8
Trade customer risks (TradCust)	10	7
Total number of critical innovation issues:	142	100

3.6 What Is Successful Project Implementation?

According to Pinto and Slevin, (1988) the success of a project is based on that the project itself succeeds. Another factor influencing success is that performance, schedule, and cost remain at the level assigned to them. These parts of the project have an impact on the success of the project in terms of the usability of the project result in terms of customer satisfaction and benefit.

In addition to defining the organization's projects, it is important to record exactly what a successful project is before attempting to discuss all the steps involved in a successful project. What are the goals of the project and if the goals are achieved 100%, is the project successful? However, the success of a project can be easily measured with four basic steps. A project is generally considered a success if it is implemented within the timeframe, within the budget, achieves basically all the goals originally was set for it and are accepted and used by the clients for whom the project is intended.

According to the project definition, it includes a defined schedule, the project must have a start and end, a defined budget, and a defined performance set. In addition, the outputs of a project usually have a receiving client or target group, internal or external. It would therefore be reasonable for all evaluations of the success of a project to cover all four points.

Companies face more difficulties in implementing strategies than in formulating them, which is entirely justified because everything always works well in theory. This article examines the implications between project portfolio management, business strategy, and business success, to bridge the gap between strategy design and reality. Previous studies have found some evidence of a positive relationship between concepts, but so far, there is no coherent and consistent rule covering the entire cycle from strategy to success. Therefore, current research on project management will be increased in the direction of strategic orientation. Based on the literature, a comprehensive conceptual model is developed that looks at strategic orientation, project structure, portfolio success, and business success. This model can be used in future studies on the impact of the planned strategy on project management and its success. From the project customer's point of view, successful projects offer the company future opportunities. (Teller and Kock 2013)

In software projects, risk management is also considered an important factor in the success of the project. In his article, Banerman (2008) reviews the state of risk and risk management in the literature and in practice. This analysis is also supported by a study of the risk practices of Australian state authorities, which supports the grievance of public sector research. This study finds that risks are narrowly addressed, and risk management is not valued in practice. Based on the results, some traditional notions of risk management and project management can be challenged. For example, it was found that software projects do not follow a similar structure, as is often assumed in the literature. This highlight different assumptions in the risk and project management challenges faced. The results show that ordinary project management is not necessary, but it is still not enough for a project to succeed. The conclusion from this is that risk management re-search falls into practical needs and in practice risk management leaves research guidelines. The implications and directions for future research and practice will be discussed. Project process succeeds, which means that focusing on continuous improvement on the project process eliminate major project-critical challenges.

4 IDENTIFYING RISK

Project risk in R&D department appears if there are no guidelines or working process to handle new and ongoing projects. The project needs a clearly defined scope. The project must have staff assigned to it, which has designated tasks. If there is changes in project tasks or project staff, there will affect the project timeline. The project timeline will always be extended. Quite often when the pro-ject is ongoing new tasks are discovered, and they cannot be added to the project without an impact on the project timeline or project personnel. Of course, if the project workload will be reduced, it has a negative effect on the project timeline. In addition, if a miracle were to happen and the project would be offered more manpower during the project it reduce the project timetable.

The normal learning process should be remembered if the new persons are not professional on project tasks. When this learning process is ongoing, it takes capacity from those already in the project. The project manager must keep a record of all decisions and changes related to the project. If the project was completed earlier than estimated, at least the multinational companies have new projects waiting to get started. Project teams have at least one hundred percent employment all the time. Project members' workload must be also clear to all project members and project managers. If the project resource is working also for another project, it must be clearly informed when or how much the project member is working in other projects to all needed project managers. Of course, the project management must know where and what kind of contribution they are making in given projects. If there are some tasks what is not related to any project, this grey work may destroy the project timetable or budget. When the project scope, cost and schedule are confirmed, any change anywhere in the three projects foundation values has an effect on project is deliverables.

4.1 Definition of Risk Management

Risk management is a company part, department or collected group of people who act or practice and deal with projects risks. Risk management includes risk planning, identifying risks, risks analysis, monitoring and controlling risks to determine how they have changed and developing risk response strategies. Risk management is one aspect of good project management. Risk management should be closely coupled with normal project processes, all project steps and involved parties. Project management and systems engineering can typically think a project risk management, even it is typically connected with project man-agement. The purpose of risk management is be proactive rather than work as reactive party. Risk management is meant to be a positive party rather than negative and the main idea is to increase the probability of project success. As an ex-ample, an item to the customer electric motor requires that a new technology be developed. The schedule indicates that one year is reasonable time for this development, but the steering committee thinks that half a year is much more likely. At that time, the project manager must react rapidly to the crisis, because valuable time has disappeared from the project timetable. The cost of course halved, but the technical performance of the deliverables could be also not compliant. When the schedule is shorter, the risk grows. The risk to have errors on the de-sign, implementation or testing would also increase. Risk management tries to reduce the errors on the project, the probability of an error and the magnitude of its impact. The project result is important; the project will not start if it does not achieve something that will repay the project's investment. Of course, it should produce something for the project client in the future. No country, company, community, individual wants to invest if there is no reasonable payback time for the investment. Risk investors are their own kind.

4.2 Certainty and Uncertainty

Decision-making falls into three categories: certainty, risk, and uncertainty. The easiest case to work with is certainty decision making. When decisions are made with the all needed knowledge and all information available, it will help to make the right decision. The project outcome can be predicted with confidence. There are no probabilities assigned to each natural effect, there is always a chance for a major error from for example, impacts of nature, a disaster such as a flood, volcanic eruption or a contagious disease. During the writing of this thesis, a contagious disease caused delays in projects. Something shocking happened and the new

influenza virus began to spread globally. Of course, the biggest problem with this event is the loss of lives, not project delays. The disease spread globally to almost all industrial countries and caused delays in the delivery of parts. When there are delays in production parts, it is quite easy to predict the order between production parts and project proto parts. When the decision is made under certainty, the results will be known with 100 percent accuracy. The result matrices show this mathematically. When constructing a payoff matrix, we must identify the element which we have no control. Then we select our own actions to be taken for each of the basic values. Together all our decisions are called strategies. The values in the return table are the results for each strategy. A matrix what is based on decision-making under certainty has two features: Regardless of which value exists, there will be one strategy that will produce larger paybacks and smaller risks than any other strategy.

4.3 Decision Making Uncertainty

The difference between an uncertainty and a risk is that the risk can be recognized, and contingency plans can be made for risks. An uncertainty is a challenging issue in the project implementation because a backup plan cannot be made for all uncertain things. If uncertainty decision making plays a big role in the early planning phase of the project it can even be a project disaster during the project execution. (BMBOK® 2013)

4.4 Decision Making Under Risk

When a decision is made with high risk and there is no supporting information from the recent history of similar projects, it is very important to consider that there is a contingency plan in case the original plan fails. Even if it is not so long time from the completion of a similar project c, the project risk must be evaluated carefully. If a long time has passed since the previous similar project has been carried out, there might be updates in laws or regulations. The currently used part may not comply with the future regulations or laws. Then in the project risk management another profitable option should be made, though it may be more expensive and slower to implement. If there is not a second plan to execute the project ordered deliverables, project risk is very high. When new technology is involved in the project deliverables, risk is at least high even if there is the second or even the third option to implement if the two first ones are not possible to implement the customer process. When the project complies with the new law or regulation there is a big risk in the project execution , that one small chance can causes large difficulties in the project execution . The project manager's most important task in the project estimation is reduce all founded risk in the project. When project risk be realized, it makes some changes in the project scope and almost always, a realized risk has an effect on the project timetable and of course project cost. One realized risk can end the whole project execution. If there is no possibility to achieve project given goals, it is no longer sensible to continue. It should always be remembered that all projects must have a start and an end point even if the project deliverables have not achieved. (BMBOK® 2013)

4.5 Communication, Collaboration and Project Management Across Borders

Communication, collaboration and global project executions are also one of the global project risks; how different teams use global project programs and frameworks to project implementation. This is one important task in international companies to support global program and project managers to succeed in their daily work in project executions with cross cultural and international projects. Virtual communication gives one more step to challenge the project members to present innovative solutions to project members over virtual communication.

The project team can be located in a room, different rooms or in multiple locations. When all stakeholders are located at the same location, face-to-face meetings can be easily organized and then the influence of body language and social interaction is helping the project meeting discussion and understanding the new ideas. We can call global project management when at least two project teams or team members are located in two different countries. When using the phone and video conferencing as the only way to keep the project team members informed, it is crucial to take care in the project risk assessment how the project members can keep the communication way and frequency to a high level. Diversity be-tween project members can be found even inside the same department in one company, but usually the complexity of project team members comes from multiple departments or even for multiple companies working for the same goal. Pro-ject managers need to get the people involved in the project and their own man-agement skills to understand different policies and procedures in different cultures. Complexity of commercial agreements is also a challenge. Motivation tends to increase for many people as new people work in a cross-cultural environment and information is exchanged across borders. Of course, this diversity also increases the risk of conflict and misunderstood situation, but the project manager must take this into account in his or her own duties. Different languages cause challenges in a multicultural project, but also by different placement in the same time zone. Not to forget the different time zones for example, due to a time difference, when some start their workday, others are clocking out and other colleagues may be asleep. (Borders 2009)

More on cultural diversity in Chapter 9 where the locations of the thesis client organization are compared with the different countries with the characteristic differences.

4.6 Evaluating R&D projects with Hedging behavior

R&D project risks cannot be eliminated totally even if a similar project has been implemented in the past, some new risk may materialize, but then there should be a risk mapping in place to eliminate the risk or at least risk awareness lowers the impact of potential risk on project implementation. It is important when project implementation is planned to use some currency to calculate the cost of the project and the repayment period from the project price tag. The NPV rule is easy tool to calculate the project deliverables payback time. In this example calculation Industrial Research Institute thesis Evaluating R&D Projects with Hedging Behaviour (2015) shows that the first step is to develop new technology; the next step after the first step is to commercialize the invented technology.

Decision makers can systematically reduce the unique risk of an R&D project by taking the company hedging behavior into account and split the risks. The research by Lieh-Ming Luo, Her-Jiun Sheu and Yu-Pin Hu (2008) shows the NPV calculation and how it is divided in the project. There are three levels of estimated probabilities, how the project succeeds in normal, over-optimistic and over-pessimistic situations and what that means on project cost side. In Chapters 5 and 5.1 is an example calculation on PV and NPV- method calculations how the return on investment changes over time and what is the effect from risk.

When lower project risk amount is to break down project deliverables into smaller parts allowing project costs even if the project is not successful to remain at a reasonable level. If there is not expertise in the company in short term, it is reasonable to get it outside of the company and the project timetable can be kept within an acceptable timeframe. When thinking project risk modeling, the first step is to invent new technology and the second step is commercialized the product. The price of the first step can be for example 500000 € and the second step cost can be three times more than in the design phase.

Example calculation shows simplified stochastic process of an R&D project both market and technological risks. The numbers in parentheses represent the revenues of each project, in millions of U.S. dollars. Investment success or failure can be calculated real option methods with the NPV rule which are accepted in the literature. In the sample calculation is simplified without company hedging behavior. Because the estimated probabilities will be controlled by the subjective expectations of the company, we consider three kinds of attitudes it could have toward the future prospect of the R&D project: normal, over-optimistic and over-pessimistic. In the median case, the probability that the market condition will become better (growing) is set at 0.6, so its probability of becoming worse (declining) is 0.4. In addition, the probabilities of the R&D’s success and failure are set at 0.8 and 0.2, respectively.

Imagine a situation where the market risk is the neutral of technological risk and it follows that the probabilities of the four states in the first stage would be 0.48 (= 0.6 × 0.8), 0.12 (= 0.6 × 0.2), 0.32 (= 0.4 × 0.8), and 0.08 (= 0.4 × 0.2), respectively. Moreover, in the second stage, the probabilities of technology possession and technology reimbursement are supposed to be 0.7 and 0.3, respectively. The expectation of the eight states at the second stage would be 0.202 (= 0.6 × 0.8 × 0.6 × 0.7), 0.086 (= 0.6 × 0.8 × 0.6 × 0.3), 0.134 (= 0.6 × 0.8 × 0.4 × 0.7), 0.058 (= 0.6 × 0.8 × 0.4 × 0.3), 0.134 (= 0.4 × 0.8 × 0.6 × 0.7), 0.058 (= 0.4 × 0.8 × 0.6 × 0.3), 0.09 (= 0.4 × 0.8 × 0.4 × 0.7), and 0.038 (= 0.4 × 0.8 × 0.4 × 0.3), respectively. Therefore, all the evaluated expectations and cash flows for various states in the graph have been specified. For simplicity, assume that the risk-free interest rate is zero and the required return on a product development project is fixed at 10 percent. When we calculate the NPV of the project with the yield require-ments as the discount rate, we find it equals −$4.7 million (= (0.202 × 66.402 + 0.086 × 16.601 + 0.134 × 20 + 0.058 × 5 + 0.134 × 20 + 0.058 × 5 + 0.09 × 6.024 + 0.038 × 1.506)/1.12 − 18/1.1 − 6).

Next, consider the case with dismissal as the only option. If the market situation is not well or if the R&D has failed, the firm will not continue with this project. In this case, the expected net valuation of the project (the calculated value of the project minus all expenses) would be $0.85 million (= 0.6 × 0.8 × [(0.6 × 0.7 × 66.402 + 0.6 × 0.3 × 16.601 + 0.4 × 0.7 × 20 + 0.4 × 0.3 × 5)/1.12 − 18/1.1] − 6). Now, let us consider the case in which both the reject and the postponement options are compound together.

The firm will not need for commercialization before it is certain that market conditions are fine, and that the developed technology will control the market. Then the net worth of this project will rise to a moderate $ 1.76 million. (= [0.6 × 0.8 × 0.6 × 0.7 × (66.402 − 18 × 1.1)]/1.12 − 6). The following step is there is only yes and no to choose if the project proceeds or not.

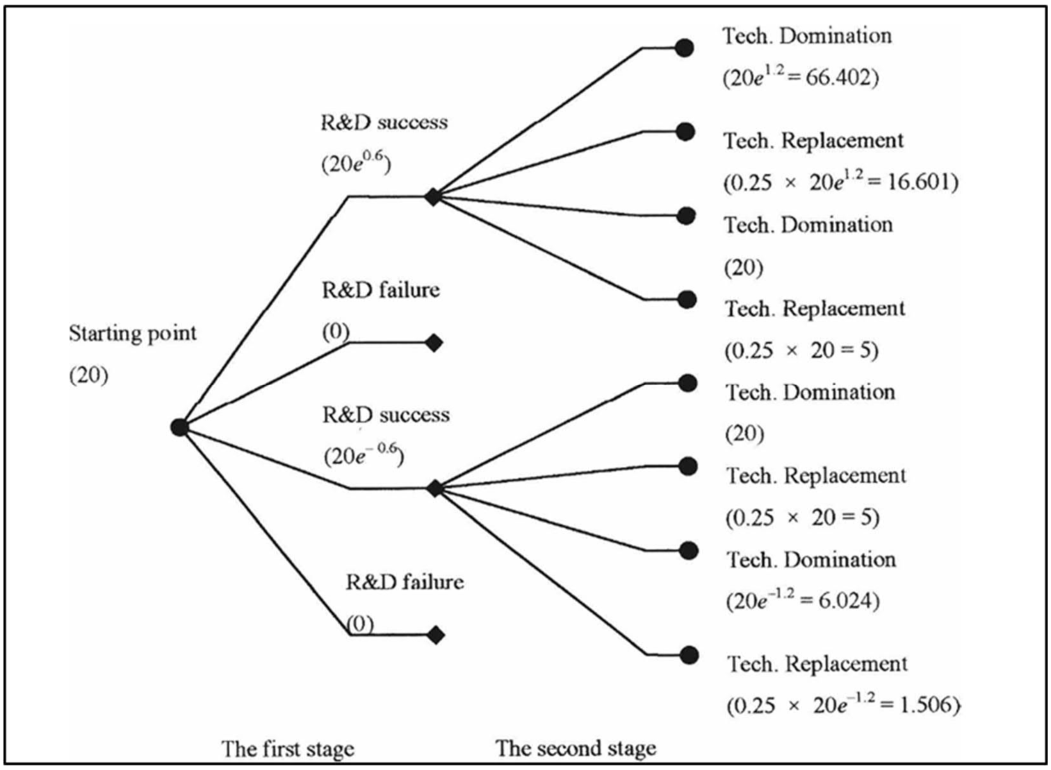

Figure 10. Is showing how success and failure affect the in different stage of project. (Luo et al. 2008

The simplified stochastic process of the R&D project presents both market and technology risks. The figures in parentheses represent the revenue of each state in millions of U.S. dollars. If project management distributes profits forward, it may increase opacity in project risk management. Therefore, it is very important that the project members see the risks of the project so that they do not fall or drown when project risks are implemented or identified. In Tables 2, 3, and 4, the numerical values indicate the differential attitude and the hedging effect. (Luo et al. 2008)

Table 2. Valuation Results of the R&D Project Using the Conventional Real Option Method (Luo et al. 2008)

	Firm's Attitude Toward R&D Project		
Option Type Contained in R&D Project	**Over-Optimistic**	**Normal**	**Over-pessimistic**
NPV (no option)	2.82	(4.70)	(15.75)
Abandonment option only	6.94	0.85	(5.62)
Both abandonment and defer options	7.82	1.76	(5.12)

Table 3. Valuation Results of the R&D Project Using the Proposed Method Incorporating Hedging Behavior for Various Attitudes Within the Firm (Luo et al. 2008)

	Firm's Attitude Toward R&D Project		
Option Type Contained in R&D Project	Over-Optimistic	Normal	Over-pessimistic
No option	(13.27)	(13.27)	(13.27)
Abandonment option only	(2.02)	(2.02)	(2.02)
Both abandonment and defer options	0.81	0.81	0.81

Table 4. Valuation Results of the R&D Project Using the Proposed Method Incorporating Hedging Behavior for Various Degrees of the Hedging Effect (Luo et al. 2008)

	Degree of Hedging Effect		
Option Type Contained in R&D Project	High	Middle	Low
No option	(9.55)	(13.27)	(20.96)
Abandonment option only	(0.06)	(2.02)	(5.96)
Both abandonment and defer options	2.83	0.81	(4.66)

5 DEVELOPING RISK RESPONSE STRATEGIES IN PROJECT ENVIRONMENT

5.1 Risks in Projects

Many researchers have studied risk response strategies in project. The table 5. describes how the researchers propose to analyze the risks in project. There are some very thorough assessment methods for response strategy (e.g. Marchwicka and Kutchta 2017) who have created very accurate strategy evaluation methods. However, the evaluation parameters are difficult to estimated and the analysis was really time consuming. These methods are difficult to be used though they are considered to allow more systematic and efficient risk management. (Marchwicka and Kutchta 2017)

Table 5. Literature on project risk response strategy selection (Yao and Fan 2014)

Authors	Focus of analysis	Approaches
Flanagan and Norman (1993)	The likelihood of occurrence and severity of the risks	The zonal-based approach
Elkjaer and Felding (1999)	The degree of influence and degree of predictability of the risks	
Datta and Mukherjee (2001)	The weighted probability of immediate project risk and that of external project risk	
Piney (2002)	The acceptability of impact and probability of risks	
Miller and Lessard (2001)	The extent to which risks are controllable and degree to which risks are specific to the project	
Chapman and Ward (1997)	The expected costs of risk response strategies and uncertainty factors	The trade-off approach

	of the expected costs	
Pipattanapiwong and Watanabe (2000)	The expected cost of risk after applying the risk response strategy and degree of risk to access the risk response strategy	
Kujawski (2002)	The probability of success for a given total project cost and the total project cost for a given probability of success	
Haimes (2005)	The cost of risk response strategy and percentage of work losses associated with the risk response strategy	
Klein (1993)	Uncertainties in project duration, cost and quality	
Chapman (1979)	Work activities, and risks and risk response activities associated with the work activities	The WBS-based approach
Klein et al. (1994)	A variation on Chapman based on the analysis of a prototype activity	
Seyedhoseini et al. (2009)	Selecting a set of response actions that minimizes the undesirable deviation from achieving the project scope.	
Ben-David and Raz (2001)	Project work contents, risk events, and risk reduction actions and their effects	The optimization-model approach

Ben-David et al. (2002)	Interactions among work packages in respect to risks and risk abatement efforts	
Fan et al. (2008)	The risk-handling strategy and relevant project characteristics	
Kayis et al. (2007)	The available mitigation budget and strategic objectives of the project	

High-risk and low-risk projects can be categorized by studying from earlier projects data and outputs and view if they can be used in a new project base. If similar project has done before and not much time has passed since the earlier infomation is excellent template to evaluate the new project and compare it to the realism that has come true in earlier project. When the project deliverables might be unexpected because project is on the edge of something new. For this reason, many R&D and Management Information System projects are high risk projects.

On research & development projects the high risk commences from the very beginning. First R&D research pursues to find a new idea in general or useful to current project needs. Control and regulations need to be followed when this idea is further developed to become a sellable new product or service. There are also technology development projects that try to find new approaches, materials and techniques and at the same time remember rationality e.g. cost viewpoint, efficiency and environmental impact. Without Project Management Information Systems, in other words (PMIS) project execution might make high risk on the projects. Project management information system include all the needed and supporting information for project approval, start phase, planning, timetable, ex-ecution, monitoring, controlling and project closure. For this reason, it is highly recommended that the same global project management rules and project implementation rules be applied throughout the global organization. For this reason, there should be no external project partners, and it is a good idea to limit external activities that affect internal changes before they are completed. If external labor is used in the project, they must also be taught the right way to act in the implementation of the project. But, the first step to success is that project management and pro-ject managers implement same project culture globally. When the projects parties follow the same rules it is easy to track and see the results during the project implementation. All projects are not similar and they cannot be executed in exactly same way. Projects can be executed to some extent in similar way even on global level both in technology project, product development project or product transfer project when the instructions are clear. (Project Management 11th Edition by Har-old R. Kerzner)

5.2 The Project Personnel and Management

If given project resources is from same company project managers have some ideas and expectations from each person if they are not just hired. Project manager can easily to place people according to their strengths and even their personalities. When starting a project, it must be presented to the Steering Group / Project Steering Group. The next step is to look at the overall impact of the pro-ject, whether it is a local or global project. Project management process is a third step. Fourth step is the project manager. When starting a big, small, local or global project there must be a transparent start meeting to the project with all involved organizations. In the kick of meeting project manager can tell about the goals of the project and what it requires from different organizations to realize it. Project must have a specific outcome and completed deliverables within certain specifications. Project have always two mandatory steps and they are start and end. Project should have also funding limits project must be paid back within a reasonable time. Reasonable time is basically a custom schedule created by each project sponsor. If the project final end is not known, the cost of the project can-not be known. Resources are the project's most important thing. Resources determine if the project schedule succeed or not. These resources include human and machine resources and it means funds, workforce and facilities. Are there enough persons in the project that need to reach the project schedule. Is there sufficient funding for the entire financial year and to cover the total cost of the evaluation project.

For example, if project recurs or facilities effort is only 10 percent, the outputs is time consuming. The benchmark can be taken as an eight-hour working day with a 100 percent input to the project. If the input to the project is only 10 percent, it takes two weeks to achieve the same result. Here can also easily find out what multitasking means in schedules. Of course, if the task is not 100 percent employ-able then there is justification for multi-tasking. When the project is multi-function-al must be concern the different ways to work inside the one location different departments and also if the project is global like these days is quite common. On multi-functional global projects way to success what really matters, is the differences that come from differences from different cultures and understanding that. There is also place to error on project timetable if project starts with totally incomplete information. Globally can also observe different attitude an employer loyalty regardless of different cultures. Nowadays employers are mowing easier and try-ing to find different experiences in their career. For this reason, a good employer will usually get the most capable workforce themselves. We also have to remember that the global week calendar is not the same for all of us. Holidays for different countries and religions. Different countries have also different way to communicate in the projects with different project stakeholder during project change management. When there is changes on the project the changes have different effect to the project culture in different cultures. In Pro-ject change stakeholder communication research is shown how change communication practices in two different case contexts differs from each other. Case study results underline the fact that an effective communication ensures stake-holder participation in the change management processes through teamwork and empowerment, whereas lacking communication routines lead to a rational and straightforward project culture where task performance and efficiency are preferred over stakeholder involvement. Theoretical results suggest that project communication planning re-quires more attention on the know-how of stakeholders than the current stake-holder evaluation models instruct.

(Project change stakeholder communication, Aurangzeab Butt; Marja Naaranoja, Jussi Savolainen, November 2016)

5.3 Project Success

Project success is widely discussed in the literature. As a result from studies, the reasons for project success and standards for measuring project success have been found (De Wit, 1988; Baccarini, 1999; Dvir et al., 2003; Zwikael, 2009). Success criteria need to be separated from success factors, as both appear often in literature. The measures of projects judged in terms of failure or success are criteria.

Many studies specify that cost, time, and quality are used as project success criteria. (Olsen, 1971; Pinto and Slevin, 1987; De Wit, 1988; Pinto and Slevin, Turner, 1999).

Historically the understanding of project success criteria has evolved from triple constraint concept, known as the iron triangle (time, cost and quality) to something that encompasses many additional success criteria such as quality, stakeholder satisfaction, and knowledge management (Atkinson, 1999). Projects are said to be successful if the iron triangle criteria are met delivered on time, within budget and meeting the predetermined quality measures (Atkinson, 1999). Various models have been developed to measure project success influenced by different underlying assumptions and studies. (Dvir et al., 2003; Pinto and Pres-cott, 1988; Zwikael, 2009). The outcome of project success is affected by what is measured and to what extent (Koops et al., 2016). The study attempts to measure the success of a project using the iron triangle from the perspective of project management processes. However, these processes are laborious and laborious, which takes a considerable amount of time and effort from the project manager. Different re-searches have shown that the project success depends on project management processes (Dvir et al., 2003; Zwikael, 2009; Zwikael and Sadeh, 2007). These re-searches tried to point out the important processes that affect the project success. A successful project requires a review of important design functions as a whole that includes human, managerial, technical, and organizational factors. Figure 1. is presenting a template from research (E. Tesfaye, T. Lemma,

E. Berhan, B. Beshah, 2016) for the effects of different factors on each other. This model is excellent quide line to evaluate to any project's performance. (E. Tesfaye, T. Lemma, E. Berhan, B. Beshah, 2016)

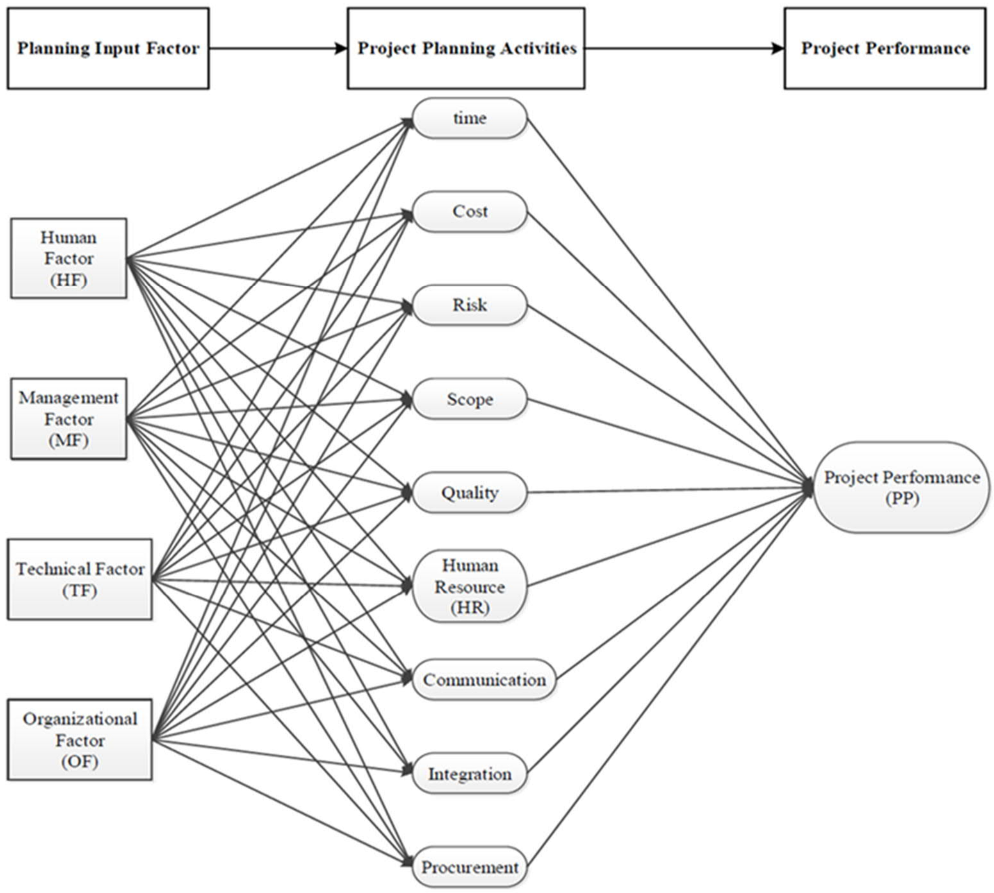

Figure 11. Project research model. International Journal for Quality Research (E. Tesfaye, T. Lemma, E. Berhan, B. Beshah, 2016)

A successful project is determined by three basic details: time, cost and scope. It is not possible to create supporting project schedules and if the project does not have a basic timeline and therefore the cost of the project cannot be determined. At the beginning of the project need to know what the scope of the project is. The scale of the project will affect the funding, timing and resources. After these three main tasks, there will be the following three values that must be considered for the performance of the project. The first is safety, which is now number one. There are currently no major companies that are concerned about safety. For ex-ample, on the thesis client own www-pages can found with the word safety more than

3880 articles from safety. There are many ways to inform from safety, there might be some phrase to inform personnel this highly important information for instance, don’t look the other way on safety - if you see a hazard, fix it or See it, solve, report it. The quality of project management process has a direct link to the project deliverables. Aesthetic is also value nowadays. From this reason even so-called heavy industry what this thesis is studying, give thought to what the end product looks like. On the figure 9. is shown the Project Management Triangle called also the Triple Constraint, Iron Triangle and Project Triangle is a model of the constraints of project management. (BMBOK® Guide 11th Edition page 43)

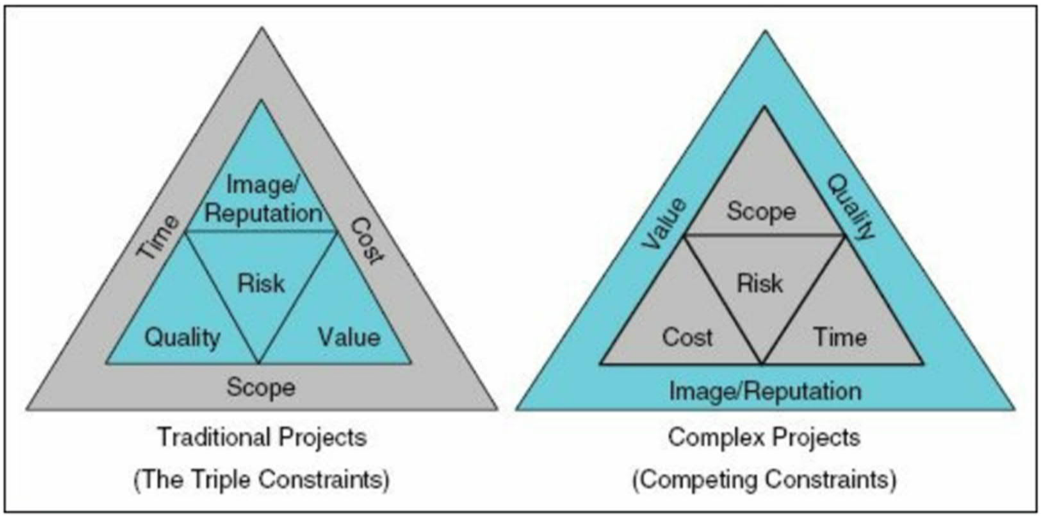

Figure 12. Project Management Triangle (PMBOK® Guide, 11th Edition)

Project success will be measured always when executing the project and when the project ends. Project Management valuate the project deliverables and com-pare with the given tasks beginning of the project. Project risk management gives tools to lover the project risk. When planning the implementation of the project it is important to notice risk assessment, risk prevention and risk mitigation. Project management tool to evaluating the project success is to calculate earned value management (EVM) Earned value management gives project managers tool to make corrections to pro-ject if there are some major changes in the project execute. Project is always a temporary company with the current workforce can be changing during the project execution. Project management support to create unique product, service or result when making complex and multidisciplinary contexts. There is also research where are used planned value (PV) for project and the method improves forecasting accuracy by an average for earned value 23,7% and actual cost 17,4. This method gives project managers predictive in-formation from project and it is more reliable concerning earned value and actual cost. With this information project managers can make actions if needed in pro-ject execu-tion. Project risk is an uncertain event and it has a positive or negative effect on one or more project objectives such as scope, schedule, cost or quality. There is many quide lines and studies from project management and they are excellent tool to perform projects, but the project management frame to carried out the project must be suitable on each project implementation. In project execution must also take concern project work packages and their effect to other work packages in-cluding chronology and other projects what may have effect to this project or con-trariwise. On the figure 2. is present with Gantt chart project execution and what project work packages can do at the same time and what needs to be ready before the next step of the project. (Cinzia Muriana and Giovanni Vizzini, Received 6 September 2016)

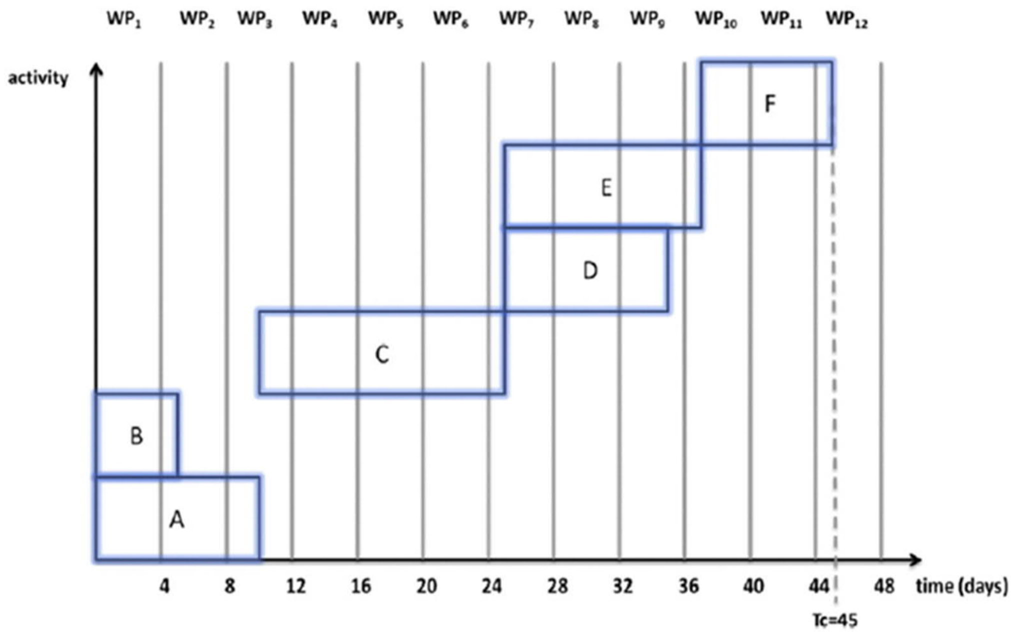

Figure 13. Gantt chart of the project. (Cinzia Muriana and Giovanni Vizzini, (6 September 2016)

6 DIFFERENT RISK ANALYSIS TECHNIQUES

6.1 FMEA Failure Mode and Effects Analysis

Often presented with "failure modes" in plural) is the process of reviewing as many components, assemblies, and subsystems as possible to identify potential failure modes in a system and their root causes and effects. For each component, the failure modes and their outcoming effects on the rest of the system are recorded in a specific FMEA worksheet. There are diverse variations of such worksheets. An FMEA can be a qualitative investigation but may be put on a quantitative basis when mathematical failure rate models are united with a statistical failure mode ratio database. It was one of the first highly structured, systematic techniques for fail-ure analysis. It was developed by credibility engineers in the late 1950s to study problems that might arise from dysfunction of military sys-tems. An FMEA is of-ten the first step of a system reliability study.

A few different types of FMEA analyses exist, such as: functional, design and process. Sometimes FMEA is extended to FMECA (failure mode, effects, and criticality analysis) to indicate that criticality analysis is executing too.

FMEA is an inductive reasoning (forward logic) single point of failure analysis and is a core task in credibility engineering, safety engineering and quality engineering.

Successful FMEA operations help identify potential fault states based on previous experience with similar products and processes as well as the physics of general fault logic. It is widely used in the development and manufacturing industries at various stages of the product life cycle. Impact analysis means examining the consequences of these failures at different levels of the system.

As a result, functional analyzes are needed to determine the correct fault condition at different system levels, both for the functional FMEA and the Piece-Part (hardware) FMEA. FMEA is used for risk reduction as well as mitigation. It helps on the basis of reducing the severity of the impact of the failure, or on the basis of reducing the probability of failure, or both. FMEA is basically a complete inductive (forward logic) analysis, but the fault probability can only be considered or reduced by understanding the fault mechanism. Thus, the FMEA may include information on the causes of failures (deductive analysis) to reduce the likelihood of occurrence by eliminating the identified root causes. (D. H. Stamatis, 2003)

6.2 FMECA Failure Mode Effects and Criticality Analysis

FMEA is a bottom-up, inductive analytical method which may be performed at either the functional or piece-part level. FMECA extends FMEA by including a criticality analysis, which is used to chart the probability of failure modes against the severity of their consequences. The result highlights failure modes with relatively high probability and severity of consequences, allowing remedial effort to be directed where it will produce the greatest value. FMECA tends to be preferred over FMEA in space and North Atlantic Treaty Organization (NATO) military applications, while various forms of FMEA predominate in other industries. (Borgovini, Robert; Pemberton, Stephen; Rossi, Michael Apr 1993)

6.3 Design Failure Mode and Effects Analysis

DFMEA is a detailed method for identifying possible faults and causes. Although it was originally developed artificially to look for where rocketry have a high risk of failure. Today, it is used in many industries to avoid failures. DFMEA is used to identify fault conditions during each design and redesign phase of projects. This is DFMEA's five-step process:

The following are explanations of the individual systems and system components of the project, as well as fault conditions and their severity.

Fault conditions are defined in 5 different categories, complete fault, partial fault, inconsistent fault, impaired fault, unintentional fault.

The severity of faults is usually classified by numerical values between 1 and 10, with 1 being insignificant:

2-4: A minor annoyance. Things like a loud screech of a microphone when turning on, or an occasional visual “flutter” on a screen that doesn’t significantly impair function.

5-6: Degradation or complete loss of a minor or secondary function of a device, like the clock in a car or the sound card in your computer.

7-8: Degradation or complete loss of a primary function of a device, like the ignition of your car or a motherboard failure in your computer.

9-10: Catastrophic and dangerous implications, often violate regulations. Your car’s brakes failing and airbag failing to deploy, or your computer overheating to the point it catches fire.

The next step can determine the reasons for the failure; this varies by type. For example, a boat's engine failure can be due to poor maintenance or the wrong materials that cause it to break down quickly or fail. Next, determine the number of probability errors for 1-10 probable errors based on your design data and rede-fine the severity of the damage:

1: Fault, current processes prevent realization.

2: The design is similar enough to the existing model that failures are highly unlikely.

3-4: Individual defects that are so rare that they are difficult to replicate.

5-6: Random failures have occurred in testing or in the field with the current or sufficiently similar structure.

7-9: New model without knowledge and previous experience.

10: A new design without prior art knowledge is done in a purely theoretical or experimental implementation.

When determining risks based on severity, you can perform tests based on what you have learned in the past with previous implementations. It is also possible to determine risks on the basis of observations. If a risk is detected and corrected, it usually means that the risk is level 1. A value of 10, on the other hand, would mean that it is impossible to assess.

- This would lead to very serious high-risk errors that occur and are difficult to manage during project implementation.
- The next step is to define the necessary steps:
- Eliminates very serious fault conditions
- Reduces incidence
- Decrease in results

The process is repeated until the desired level is reached or it can be stated that this is impossible. Once these steps have been completed the result is less unexpected design errors and it is possible to determine how failure points can be avoided.

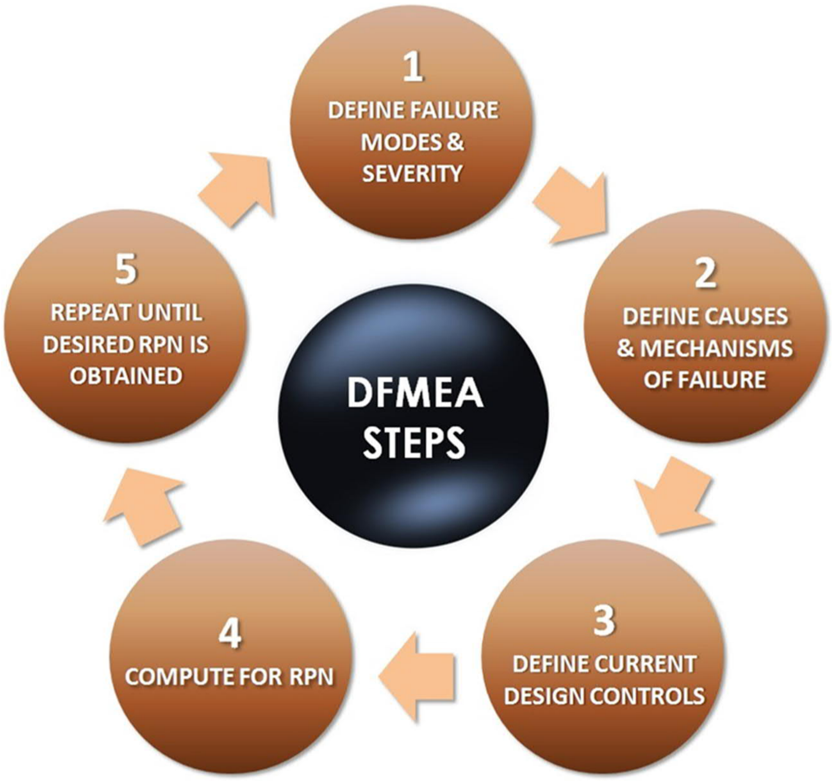

Figure 14. From DFMEA steps.

6.4 Process Failure Mode Effects Analysis (PFMEA) Explained

In general, the operational processes of service or manufacturing organizations are never perfect. There may be anomalies in the process and day-to-day operations that prevent the organization from achieving its goals. When you identify risks, the key to success is operations management and sensible risk preparedness. In a conventional systematic way, the Six Sigma methodology provides a tool called Process Failure Mode Effects Analysis (PFMEA) to achieve this goal.

PFMEA is a step-by-step method for analyzing a process to identify and evaluate its critical failure states. The tool is best utilized in the design phase of a project and should be updated as the current system is optimized. Once all critical sys-tem failure conditions and their associated consequences have been identified and weighted, the organization may arrange for itself to facilitate the appropriate removal of these opportunities or the reduction of frequency based on the highest priority. Proper documentation of potential system failures and associated risks facilitates the implementation of continuous improvement activities, such as design activities. Once the system is built-in, guarantees of improved durability can be made easier.

Effective PFMEA assessment requires a multidisciplinary team with both fresh and experienced eyes to ensure that different perspectives are taken into account. For example, in the manufacturing process, you would want to deal with staff at different levels (operators and supervisors), process designers, the process control team, and the reliability team of electrical and mechanical engineers to ensure that all basics are addressed in identifying critical system vulnerabilities.

The process that has identified the extent of system, appropriate vulnerability indicators should be placed on the chart. Visual representations of a process can be simple process flowcharts or more sophisticated views. The splitting of the process into process units continues until the appropriate detail is defined. Critical questions are asked until the operation of each stage and its risks are clearly identified. A suitable format for documenting fault conditions is highlighted below in table 6.

The table above seeks to identify critical fault conditions for each process function. The example above focuses on the different functions of the process. The first column of the PFMEA model contains the function. When moving from left to right, fault conditions are identified. Only one is highlighted in this example. An easily detectable fault in the function used is a clogged drain. The consequence or severity (S) associated with this condition is identified on a scale of 1 to 10, with ten being the highest severity.

Table 6. Example from PFMEA template.

S	Potential Causes of Failure	O	Current Process Controls	D	RPN	CRIT	Action Results					
							Ac-tions Take	S	O	D	RPN	CRIT
8	Scale build up in discharge line	5	Suction line pressure point	5	200	40						

Function	Potential Failure Mode	Potential Effects of Failure
Dispense proses fluid	Blocked Discharge	Pump Dead-head

This is followed by a root cause analysis of the problem. Categorize the event and create a level based on the identified root causes. The baseline rating is determined on a scale of 1 to 10, with 10 being the highest order of inhibitory events.

The third step is to identify and classify existing system drivers. The detection of exceptions (D) used on a scale of 1 to 10 indicates the existence of control. When the meaning of the identification rating values is reversed, i.e. a value of 10, it would indicate that no controls are in place.

Once all the values in the formula are in place, the two additional variables are calculated according to the following formula: Risk Priority Number RPN = S x O x D

Risk Priority Number RPN = S x O x D, where S = severity (1)

O = occurrence

D = detection

Criticality = S x O, where S = severity (2)

O = occurrence

Once the events and their probability have been presented, the risks can be identified on the basis of the probability and criticality of the risk priority. The higher number in the table and the calculation gives information that more accurate the attention should be to that risk. A plan must be made for the implementation activities that eliminates the risk or reduces its impact. An organization that is able to be prepared for challenges is always a pioneer. PFMEA is a good tool for to the arsenal of operations optimization.

6.5 Project Quality Assurance Plan

From the early 1950s to the late 1960s, quality control shifted from quality assurance to avoiding problems rather than detecting problems. Made quality assurance principles such as: cost of defective programs, reliability planning, quality cost, complete quality control. Today, the focus is on strategic quality management. This is in use today

This quality tool includes the following definitions:

Quality is determined by the customer.

Quality is related to profitability both on the market and on the cost side.

Quality has become a competitive advantage.

Quality is now an integral part of companies' strategic planning process.

Quality requires the commitment of the entire organization.

The project manager has the ultimate responsibility for project quality management. Quality management has a big impact on cost and schedule management.

However, direct quality measurement may be the responsibility of the quality assurance department or the assistant project manager.

The support for the management of a labor-intensive project is typically 12 to 15 percent of the total labor costs of the project. About 3-5 percent is due to quality management. Therefore, up to 20-30 percent of all workforce in a project office could easily be relied on for quality management.

They include:

- Quality policy
- Quality objectives
- Quality assurance
- Quality control
- Quality audit
- Quality program plan

Ideally, these six concepts should be embedded in the corporate culture. Quality assurance is the formal operation and management processes that seek to ensure that products and services meet the required level of quality. Quality assurance also includes efforts outside these processes that provide information to improve internal processes. The quality assurance function seeks to ensure that the scope, cost, and time functions of the project are fully integrated. A good quality assurance system identifies objectives and standards, is multifunctional and proactive, a plan for collecting and using data over a period of continuous improvement, a plan for establishing and maintaining performance measures, including quality controls. (PMBOK® Guide, 11th Edition)

7 MONITORING AND CONTROLLING RISKS

When analyzing project risk, it is on some cases impossible to find out all risks what can happen in R&D projects. Sometimes the project investment is not giving payback. If the project is producing deliverables that can only meet the new requirements changes or of course trying to exceed them and also on same time get answer future requirements. Certainly, all project must have some payback time, but it is probably longer than normal product development project. In such cases, it is not always possible to develop the product, so it improves its cost-effectiveness. New needed solution can be more expensive than current solution. On the section 5.1 is an example examination where is calculated with NPV-formula the amount and timing of an investment payback in two imaginary projects. (BMBOK® Guide 11th Edition page 1081)

Everyone knows that a euro today is worth more than a euro a year from now. The reason for this is because of the time is value of money. To illustrate the time value of money, let us look at the following equation:

FV = PV(1+k)n, where FV = Future Value (3)

PV = Present Value

k = Investment interest rate

n = Number of years

Using this formula, we can see that an investment of 1,000 € today (PV) invested at 10% (k) for one year (n) will give us a future value of 1,100 €. If the investment is for two years, then the future value would be worth 1,210 €. Now, let us look at the formula from a different perspective. If an investment yields 1,000 € a year from now and cost of money is 10% To solve the problem, we must discount future values to the present for comparison purposes. This is referred to as discounted cash flows. The previous equation can be written as:

PV=FV/((1+k) ^n), where FV = Future Value (4)

PV = Present Value

k = Investment interest rate

n = Number of years

When using given data, we get result:

PV = (1000 €)/(1+0,1)^1 = 909 €

Therefore, 1,000 € a year from now is worth only 909 € today. If the interest rate, k, is known to be 10%, then you should not invest more than 909 € to get the 1,000 € return a year from now. Discounting cash flows to the present for comparison purposes is a viable way to assess the value of an investment. As an example, you have a choice between two investments. Investment A will generate 100,000 € two years from now and investment B will generate 110,000 € three years from now. If the cost of capital is same 15%, the investment A will be better. Reasults we can get using the formula for discounted cash flow to example A and B.

PVA = (100000 €)/(1+0,15)^2 =75614,4 €

PVB = (110000 €)/(1+0,15)^3 = 72326,8 €

Result from PVA = 75614 €

Result from PVB = 72327 €

The difference between options A and B is therefore 3287 €.

This implies that a return of 100,000 € in two years is worth more to the firm than a 110,000 € return three years from now. If the investment value should be same the investment B amount should be 115,000 € For these reasons, it is good practice to consider changes in the value of money in normal situations when planning a project what have long term implementation. If there is a major economic transformation, it is a risk, but it is challenging to forecast it. When the invest-ment is short term the change in the value of money is not that important for the project valuation. The change in the value of money which has also impact on invest-ments and re-payment times is calculated using the PV formula.

7.1 Analyzing the Risk

When review two similar projects, both projects require the same initial invest-ment. Projects have identical net present values and they require the same yearly cash inflows to break even. If the first investment had a probable return 95% on the second investment 70%, a risk analysis would indicate that the first invest-ment is better. If cash flow is very well known, the risk analysis of an initial capi-tal investment will be accurately calculated. Revenue is based on sales forecasts, raw material costs and taxes. Labor cost and the general economic situation also affect income.

A common approach is to estimate NPV (Net Present Value) based upon an opti-mistic (best case) approach, most likely (expected) approach, and pessimistic (worst case) approach. This is shown using Table 3. Both Projects A and B re-quire the same initial investment of 10,000 € with a cost of capital of 10%, and with expected five-year annual cash inflows of 5,000 €/year. The range for Pro-ject A's NPV is substantial-ly less than that of Project B, thus implying that Pro-ject A is less risky. A risk lover might select Project B because of the potential reward of 27,908 € whereas a risk avoider would select Project A, which offers perhaps no chance for loss.

Table 7. Initial investment table shows difference between project A and B

Initial investment	Project A 10,000 €	Project B 10,000 €
	Annual cash inflows	
Optimistic	8,000 €	10,000 €
Most likely	5,000	5,000
Pessimistic	3,000	1,000
Range	5,000 €	9,000 €

	Net present values	
Optimistic	20,326 €	27,908 €
Most likely	8,954	8,954
Pessimistic	1,342	< 6,209 >
Range	18,984 €	34,117 €

$$\text{NPV} = -\text{Initial investment} + \frac{Inflows}{1+reguired\ return} + \frac{Inflows}{1+reguired\ return^2} + \frac{Inflows}{1+reguired\ return^3} + \frac{Inflows}{1+reguired\ return^4} + \frac{Inflows}{1+reguired\ return^5}$$

(BMBOK® Guide 5th Edition page 1082)

7.2 Risk Definition

Project risk assessment is a measure of the like hood of a risk in a project and the consequent failure to achieve the project objective. Can the specified structural demands have achieved. Can the all project deliverables produce within budget. Are the project deliverables ready on promised time. If there is possibility that one of the project risks may happen it is very important for the project time plan to have a few contingency plans. They can of course change the cost structure of a project, but the project can be completed within a specified time frame. Risk probability can measure with questions which determine the likelihood of a risk. However, other risk-related effects and potential losses must also be considered when defining the risk. In Figure 16. scatter is shown the rule how risk is grow-ing two-dimensionally between the X and Y axes. Near the origin the probability and effect from challenge are small. When think some big happened and the im-pact is large from X axis far away from origin the probability may be low from Y axis it is not big issue to project implementation. Example destructive earthquake in Finland truly large impact but quite low probability. Then Y axis, high probability for example could and slippery winter in Finland, probability high but the risk impact to project execution is low. For this reason, all project risks should be considered as broadly as possible, and in a multi-level organization, each de-partment have its own customized risk mapping list. Once each part of the organization has done its own risk analysis, it is important work to ensure that all known risks are considered. It is also important to link the risks of different parts of the organization and their risks impact on the whole project. The likelihood of risks and the evaluation of consequences are not reliably measurable attributes. Although decisions are based on statistics and existing attributes, risk has two main components. Probability of occurrence and its impact. There are many tools and ways to assess risks. However, all assess the impact of the risk on the realization of the project and the potential frequency of the risk. On Figure 16. is scatter from risk growth and Table 4. is shown the components of risk.

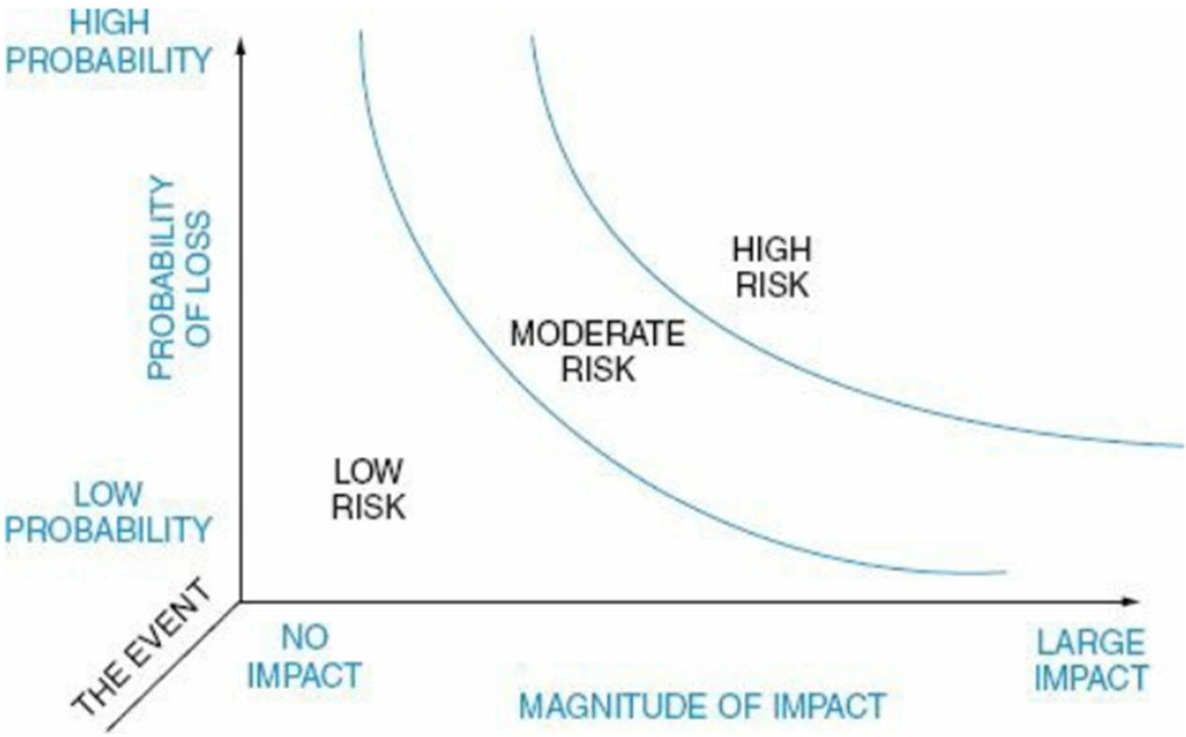

Figure 15. Rough graph from risk levels.

Table 8. Basic risk matrices.

C O N S E Q U E N C E S					
	Medium	High	**Very High**	**Very High**	**Very High**
	Medium	Medium	High	**Very High**	**Very High**
	Low	Medium	Medium	High	**Very High**
	Low	Low	Medium	Medium	High
	Low	Low	Low	Medium	Medium
	P R O B A B I L I T Y				

7.3 Risk Probability and Consequence

Risk = f (probability, consequence)

When risk probability or consequence increases, both must be considered in risk management. The risk is based on a lack of ability to assess the future. Positive are called risks. However, risks and opportunities are not black and white issues. In the project decision there is also area between black and white. This prospect theory has developed Nobel Economics Laureate Daniel Kahneman and Amos Tversky his colleague. This theory examines, that people tend to value the same level of gains and losses differently. Also note that potential opportunities may have risks associated with them. Potential opportunities may have risks associated with them. These not known consequences may appear as extra task or issues.

Like other risks what not taking a count when evaluating project risk. Result from evaluating project risk, all opportunities must be thoroughly check for potential risks. Another side of risk is its cause or more specifically, the root cause. Ideally situation is if root cause has found out before investigating a risk. Well known hazards can be handled by knowing them and taking action to avoid them. Example, empty swimming pool is a much bigger danger to a swimmer who don't know for that, than to one who empty the swimming pool and remember that still. This leads to the second representation of risk: Risk = f (hazard, safeguard)

Good project management is to identify risk and make decision to minimize the impact of project realized risk. If suitable options to lower the risk likelihood are known then risk can be moved to an acceptable level. Project management is very complicated to manage with likelihood of the risk, the risks and the effects of the risks. All three items are partially related through the consequence (C) dimension but different in either the probability (P) dimension or time frame. A summary of risk, issue, problem, and opportunity with regards to probability, consequence, and time frame is given in **Table 8.**

Table 9. Concise definitions of risk, issue and problem.

Item	Probability	Consequence	Time Frame
Risk	0 < P < 1	C > 0	Future
Issue	P = 1	C > 0	Future
Problem	P = 1	C > 0	Now
Opportunity	Unclear (0 < P < 1?)	Unclear (C > 0 or C < 0?)	Unclear (now, Future?)

Issues and problems have equal probability to occur. Risk may not occur (P < 1) but an issue will occur in the future while problem occurs in the present.

Things and problems are just as likely to occur. There may not be a risk (P <1), but an issue occurs in the future while the problem is present.

The probability dimension for an opportunity is unclear because there is no equivalent differentiation as in the probability dimension for risk, issue, and problem. Moreover, it is not possible to define the consequence dimension in a unique manner since an opportunity may represent, according to three simple definitions, a positive outcome, a less negative outcome, and an outcome that is better than expected.

Period united with a possibility is not clear because it may be on the future or now. The above writing shows definitions from risk, issue, and problem. Precise specification cannot be determined for possibilities that is universal applicability. That's why risk and opportunity are not the black and white issues or problems. (BMBOK® Guide 11th Edition page 1281)

7.4 Measuring Risk Coefficient of Variation

The standardized measure of risk is risk per unit of return. Calculated as the standard deviation divided by the expected return. This is useful way to verify where investments differ in risk and expected returns.

$$Cofficient\ of\ variation = VC = \frac{Risk}{Return} = \frac{\sigma}{\hat{k}}$$

7.5 Tolerance for Risk

There is no single rule or answer on how to manage risk on the project. On complicated projects one solution does not work the other one. The decision on how to deal with the project risk is based on the project manager's risk tolerance, as well as the contractual requirements and stakeholder preferences to handle the project risks. Three commonly used classifications of tolerance for risk is shown on Figure 17. On the figure is three different value of risk, the risk averter or avoider, the neutral risk taker, and the risk taker or seeker. On the figures Y-axis presents benefit. The X-axis in this case shows money. The same X-axis can also represent technical performance or schedule. These curves can show the project manager's or other key decision-makers' risk tolerance.

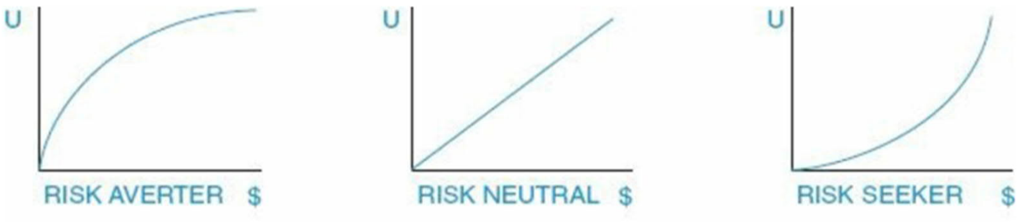

Figure 16. Risk preference and the utility function.

A project manager who takes risks into consideration and protects risks will get benefit slowly. In other words, as more money is at stake, the project manager's risk-taking appetite is reduced. With a risk-neutral project manager, the benefits are constant. The benefits of a project manager who is looking for risks are growing faster when there is more money at stake. The risk taker favors a more uncertain outcome and may be prepared to pay a fine for the risk considered, while the risk taker prefers a more secure outcome and demands a reward to accept the risk. Although the risk tolerance of the project manager and other key decision makers can vary over time. And the project management with the project manager must respond to change. strong risk management culture has been suggested to significantly influence the efficacy of the risk management process strong risk management culture has been suggested to significantly influence the efficacy of the risk management process. (Karlsen, 2011); (Mongiardino and Plath 2010); (Sanchez et al., 2009) and (J. Teller, A. Kock 2013)

8 R&D PROJECT RISKS IN CASE ORGANISATION

8.1 The Process of Qualitative Study

An open-ended question was sent to global project managers in China, Finland, India, Italy, Poland and Sweden. The question was: Which kind of risks are important from the management point of view in R&D projects? The focus on thinking the R&D project implementation.

The anonymity of answers was promised to respondents.

The total response rate was quite low, only 38, percent. Normally this kind research questions response rate is between forty to fifty percent.

8.2 Reliability of The Qualitative Research

The question was open-ended. This resulted int all respondents reporting the biggest challenges in project executions. A more detailed introductory survey would provide a more comprehensive view of the existing challenges with different response options. The number of respondents (9) could be higher and the results would be more reliable.

In addition, the more structured question would have given more opinions of different things now the obvious challenges of the risk management practices were pointed out without thinking other issues.

8.3 Analysis of The Answers to The Open-ended Question

The answers were similar no matter where the answers came from. The following describes the quality of answers. The importance of the risks is not evaluated so the first mentioned may not be the most important, but it is the one that was most often pointed out based on the answers.

There is a strong desire in the organization to start R&D projects rapidly; therefore, the risk assessment remains halfway. Often this leads to schedule failures and the project cost increase.

Projects start without reason; there is no clear scope. Project planning in every area is deficient, there are no resources, technology and project schedule is too ambitious. Project execution is poor, no marketing, change on the scope and the project is not following the project rules. The introduction of a new product to stakeholders is missing or is unsuccessful. Decisions during project implementation which will change project deliverables.

The organization does not have proper tools to minimize project risks. The current tool is not suitable for the global project implementation or the product. The R&D projects also involve six different locations globally. This poses challenges through culture and naturally, different time zones add to the challenges to daily work. The gate-model is used to execute projects.

It would be beneficial at least to update the project implementation practice and it would be good to search a project implementation tool that is better suited to the modern project culture.

9 CONCLUSION

The main result of this thesis is that in the case organisation, the risks are inadequately managed. The project should not be started before the project is properly analyzed from different angles. According to the literature, the R&D projects are challenging all over the world and the risk analysis needs attention. However, all respondents had a unifying factor, which was resources or schedule, depending on what was the perspective. In addition, project managers still have work to do to unified global project management practices, but we hope that the situation will improve as global travel change back again near to the time before the virus.

After all, communication could be better in projects, at the office and everywhere.

The anonymity of the respondents was promised; as a result, only the jointly agreed issues are discussed here. However, nothing was left out since there were always respondents who shared the opinions to some degree.

The research method was qualitative, so it is not possible to generalize the results. The results refer to the current situation and the way project management is delivered in that global company. A larger sample would certainly provide a dis-tinct overall picture of that company’s global project management and its risks. However, the result is not inconsistent with similar studies in the company in the past. So even a qualitative research method can give the right kind of result, but any more deep and individualizing result are missing.

REFERENCES

/1/ ABB history. 2008. ABB Oy, Motors and Generators, Vaasa. ABB intranet. Accessed 28.6.2020 https://go.insideplus.abb.com/fi/liiketoimintalinjat/motors-andgenerators/tyokalut-ja-palvelut/organisaatiokaaviot-ja-esitysmateriaalit

/2/ Financial report. 2019. Referred 5.10.2020 https://new.abb.com/news/detail/55793/full-year-and-q4-2019-results

/3/ International Electrotechnical Commission. Referred 5.10.2020 https://www.iec.ch/about/globalreach

/4/ ABB internal network. https://go.insideplus.abb.com/fi/liiketoimintalinjat/motors-and-generators/tyokalut-ja-palvelut/organisaatiokaaviot-ja-esitysmateriaalit.

/5/ ABB history. 2008. https://go.insideplus.abb.com/fi/liiketoimintalinjat/motors-and-generators/historia (ABB internal network)

/6/ Kerzner. Harold R. 2013. Project Management A Systems Approach to Planning. Scheduling and Controlling. 11th Edition.

/7/ Fairley R. 1994. Risk Management for Software Projects. IEEE Software.

/8/ Henriksen. A. D. & Traynor. A. J. 1999. A practical R&D project-selection scoring tool. IEEE Transactions on Engineering Management

/9/ Tzvi. Raz. Aaron Shenbar. Dov. Dvir. 2002. Risk management, project success and technological uncertainty Accessed 24.11.2020 https://doi.org/10.1111/1467-9310.00243

/10/ Cooper. June 2003. Journal of Engineering and Technology Management Volume 20, Issues 1–2, Pages 117-140

/11/ Jimme A. Keizer Jan-Peter, Vos Johannes, I.M. Halman,2005. Accessed 24.11.2020 https://doi.org/10.1111/j.1467-9310.2005.00391.x

/12/ Salomo, Sören. Joachim Weise, Hans Georg Gemünden. 2007. Accessed 24.11.2020 https://doi.org/10.1111/j.1540-5885.2007.00252.x

/13/Teller. Juliane Teller. Alexander Kock.2013. International Journal of Project Management 31 817–829.

/14/ Banerman. P. L. Banerman. 2008. Risk and risk management in software projects Journal of Systems and Software Volume 81, Issue 12. December 2008. Pages 2118-2133.

/15/ Borders J. Binder. 2008 Strategic Direction ISSN: 0258-0543

/16/ Lieh-Ming Luo. Her-Jiun Sheu. Yu-Pin Hu. 2008.

/17/ E. Marchwicka and D. Kutchta Modified Optimization Model For Selecting Project Risk Response Strategies. July 2017

/18/ Y. Zhang. Z.-P. Fan / International Journal of Project Management 32 (2014) pages 412–422.

/19/ Harold R Kerzner. PH.D. 2013. 11th Edition. Project Management A Systems Approach to Planning Scheduling and Controlling.

/20/ Naaranoja M. Butt A. & Savolainen J. November 2016. Project change stakeholder communication. International Journal of Project Management. Vol. 34. 2016 p. 1579–1595.

/21/ Tesfaye. E. Lemma. T. Berhan. E. & Beshah B. 2017. Key project planning processes affecting project success. International Journal for Quality Re-search 11(1) 2016 p. 159–172

/22/ Muriana. Cinzia. and Giovanni Vizzini. "Project risk management: A deterministic quantitative technique for assessment and mitigation." International Journal of Project Management 35.3 (2017): 320-340.

/23/ Stamatis. D. H. The ASQ pocket guide to failure mode and effect analysis (FMEA).
https://www.academia.edu/37714421/Failure_Mode_and_Effect_Analysis_Second_Edition_Revised_and_Expanded

/24/ Failure Mode. Effects and Criticality Analysis (FMECA) Borgovini. Robert. Pemberton. Stephen. Rossi. Michael Apr. 1993

/25/ Karlsen. 2011 International Journal of Managing Projects in Business. 5 April 2011

/26/ Mongiardino and Plath. 2010. Journal of Risk Management in Financial Institutions. Volume 3 / Number 2 / Spring. 2010. p. 116-123(8)

/27/ J. Teller. A. Kock 2013 International Journal of Project Management Volume 31. Issue 6. August 2013. Pages 817-829

/29/ Financial report 2019, https://new.abb.com/news/detail/55793/full-year-and-q4-2019-results Accessed 24.11.2020

/30/ https://www.whatissixsigma.net/dfmea/ Accessed 24.11.2020

/31/ https://www.whatissixsigma.net/pfmea/ Accessed 24.11.2020

/32/ Corporate social responsibility attribute rankings: Amy O’Connor. Mark Meister Public Relations Review. Volume 34. Issue 1. March 2008. Pages 49-50

ANNEX 1. List of tasks before project execution starts:

Are there any other BU factories that need to be taken into consideration?

Are there enough resources for making the project proposal?

Has the order-delivery process for this product been decided?

Have the project and product requirements derived from the order-delivery process been specified?

Is the product a standard product?

Have the needed capital investments been specified?

Has the market price level been studied?

Have the sales volumes been estimated?

Have the development, manufacturing and sales costs been estimated?

Have the project costs so far been calculated?

Have needed production investments been estimated?

Has the expected payback period been estimated?

Has the concept for the service network (own/third party resources) and service documentation been defined?

Has the project proposal been completed

Has it been decided which products will be transferred?

Have the update needs (if any) on the products been specified?

If products need to be updated, have the required resources been specified?

Have the resource owners been appointed?

Is the project scope detailed enough to be used for reliable project planning?

Is it clear which options and service products are included?

Have the main reviewers been nominated for each design and process area?

Has the production ramp-up based on the learning been estimated?

Have the indicators to measure the project progress and success been specified?

Have the project tools and equipment for design, testing and documentation been defined?

Are all resources needed in the project planning available and committed?

Do all resources in the project have the required competence?

Is there an investment plan available?

Have the preliminary payback period calculations per factory been made? Note: The production investments must be ready for use before Gate 3.

Is the feasibility study made at Gate 0 still valid?

Are there any unverified technologies and solutions planned to be used?

Have the dimensions of the product been specified?

Is the draft project plan ready?

Have the communications plan been prepared?

Has the plan for the product data been updated and reviewed? TRS/(MRS)

Are the material standards available for sending and receiving units? (differences in requirement e.g. in China and Finland)

Are PDDPs available? PEOPLES’ DAIRY DEVELOPMENT PROJECT

Have the item data been translated into languages needed in the project?

Have the production test concept for the subassemblies and final products been specified?

Has it been specified how to ensure that the quality targets during the design will be met?

Have the old problems in the product been fixed?

Have the production test specifications been prepared for both internal and supplier production?

Are there specifications for the test equipment and testing software available?

Has the production test concept for the subassemblies been defined?

Has the production test concept for the final products been defined?

Are there special requirements from customers related to material traceability? (For example, Ex-products)

Does the quality variation of the manufacturing methods create risks?

Is DFMEA used in the project?

Is PFMEA used in the project?

Are all resources needed in the project planning available and committed?

Do all the resources needed in the project have the required competence?

Has the communication plan been prepared in the own profit center for ABB?

Has the communication plan been prepared in the own profit center for the customer?

Are there sub-project plans for manufacturing machinery, tools, training, instructions and product data?

Have the responsible persons for each main area in both ends been selected?

Have the machines with long delivery time been identified?

Has the amount of trainees been identified?

Has the amount of trainers been identified?

Has the time needed for training in the sending PU been estimated?

Are interpreters needed?

How will the training affect to the production in the sending PU?

Is there an existing training plan?

How will the training be coordinated?

What are the current training methods?

How many different work phases need to be trained?

Has the required experience of the trainers been specified?

Has the required experience of the trainees been specified?

Has the training and competence needs in the whole production process

What are the training and competence needs in the whole production process?

What is the current language used in the work instructions?

What is the language in the receiving PU?

Should the work instructions be translated into other languages?

Has the project schedule been updated until G6?

Has the project budget been introduced in the project plan?

Review the cost targets set at beginning. Will the product be competitive when released?

Is the mirror organization in use?

Are expatriates needed?

Has the order-delivery process been analyzed?

Have possible challenges related to the order-delivery process been identified?

Support CNEMS in production tools related issues. Have the exact support model and responsible parties/persons in the project plan been defined?

Support suppliers in production tools related issues. Have the exact support model and responsible parties/persons been defined in the project plan?

Have the workers been given training in manufacturing AMG generators to ensure qualified manufacturing of the product?

Have the workers been given training in manufacturing AMG generators to ensure qualified manufacturing of the components?

Have the steering group's meeting invitations been sent to all gate meetings?

Has the communications plan been prepared?

Have the project plan and concept been finalized?

ANNEX 2. Original answers to question.

Which kind of risks are important from management point of view in R&D projects? Please, focus on thinking the R&D project implementation.

I do think that unpredicted risks or tasks shall be well identified and managed, which requires all related stakeholders constantly to brainstorm and recorded by project manager timely to ensure all predicted risks can be identified and review from time to time accordingly;

It is figured that efficient communication is required especially for global products or projects with different production site involved, such as FIMOT and CNMOT, since more people from different countries involved for a project, harder to keep communication management going smoothly. Therefore, in our daily work, it is suggested for international colleagues to communication frequently and learn from each other about different production operation logic or technical systems used for different production units.

If possible, project risks training or projects with successful or fail risks' management case sharing shall be held for people interested or project managers, which might help people to have a better knowledge of risk management and put it into practice for future use.

Here is a list of risks I see.

Project initiation:

There is no market for the planned new product

There is no customers for the new product

There is no business potential

Feasibility study not done

Management engagement is lacking

Project planning:

There is not enough resources in the project, or resources moved to other projects, or resources has other things to do

Project scope and specifications are not defined clearly

Project plan not done properly / All high-level tasks not pointed

There is too much technology risks

The product will not be technically feasible

Project schedule too ambitious

Project execution:

Marketing for the new product is done poorly

Stakeholders are not informed about the project and there is lack of communication

Project scope will change for some reason

Project is not followed properly (Weekly meetings with team, KPI's, SteCo meetings, Gate model not followed

Project control:

Component sourcing from new suppliers

Product manufacturability and functionality check not done properly. (Prototypes, 0-serie, PFMEA, DFMEA,…)

Products are not available in all systems

Product training not done properly for all functions

Project closure:

Project not closed formally; tasks continue to pop up to the project

Lessons learned not done

Product profitability not followed up after project

Technical risks: When doing R&D work the risks of project failure exist especially in technology development projects. When doing new product develop-ment projects the risks are more about causing delays to the schedule. Risks may be in electrical values (noticed in prototype tests) or in mechanical strength (no-ticed in FEM) or design mistakes (noticed in prototypes or 0-series or IP/IK or other tests).

Cooperation and communication: Bad communication between functions may cause a lack of knowledge or data. Drawings or calculations can be the wrong or old revision. Some tasks can be forgotten. The whole chain is a risk, for example, R&D,SCM,Supplier,SCM,R&D

Schedule: In many projects, the management seems to squeeze the schedule too short and unrealistic. In most of the cases, there is no end-user waiting the product so this can be done with only internal risks. Too tight schedule cause risks in everywhere.

Important risk from management point of view.

Project OTD risks, meaning everything (resources, technology, commitment,….) that can jeopardize on time delivery of project.

Business risk, meaning that project will not meet required DC cost (or TCO or ….). Reason for not meeting can be various. Business risk can also be that we have developed product that will not meet market requirement, but I cannot remember this kind of challenge in the past.

Technological risk, meaning that project will not meet product or project requirements. This can normally be solved, but may need some more time, re-sources and money, which is not planned.

Decision making in various steps of the R&D project.

Inaccurate forecasts of project costs & demand can be major impacts .

inappropriate allocation of resources and unrealistic estimates.

External risks include changes in market trends

Systemic approach to performing risk management in the R&D process

Timely development of new components

Quality level of new components as per global requirement

Confirmed project scope

Lack of empowerment of the PM and the team: who is in lead must be allowed to take decisions and quickly act consequently, and of course also to be accountable for them. It cannot be that whatever he/she wants to do has to be approved by someone else: delays and demotivation are the obvious results, otherwise.

Incorrect team setup: there must be those who are really needed

Uncertainty in project target: what to do must be clear, also to all the team members

Unclear or low project budget: money allocation must be sufficient, it must not be a problem for those who work in the project, to have and spend money

No responsiveness of the organization outside the team: if a decision is taken that involves someone outside the team, eg SCM, those “externals” must react promptly and quickly, otherwise again delays and frustration will occur (it has to do with empowerment)

Too much pressure from outside of the team: this may lead to panic and “shortcuts” to satisfy those pressures, that are detrimental for the project

Production readiness / schedule.

If bigger changes then it takes time and costs a lot.

Correct product structures and measures based on 0-series results

Successful pricing of a new product

Stock size, not too many components / too few

Installer training

Generic risks:

Cost effectiveness: the solution addressed by an R&D project, whatever it is, must be a sellable product, at the very end. Cost is one of the most important parameters for our Customers

Usefulness: the solution must be something of interest for our Customers, usable and sellable (this may not be applicable to pure R&D project, where "freedom" to explore everything is the most important thing; not a valid concept for indus-trial R&D).

Wrong "boundary conditions": if what is developed cannot be used if there isn't something that is necessary for it to work, it won't work at all (e.g Motor only runs with a X, if not X = Motor useless).

Time to market: it must be done when the market is needing it, not too early (I have some examples where we came too early, opening the way to our competitors, and we did not take any advantage of being so early) nor too late.

Technical risk: it is the least important in my opinion. If there is no risk, by definition it is not an R&D project