Risk management models in two Norwegian institutions

Petter Tømmerberg

Submitted for the degree of Doctor of Business Administration

Heriot-Watt University

Edinburgh Business School

10 2010

Abstract

The research field of this research programme was integrated risk management. The research methodology was inspired by action research. The candidate collaborated with two Norwegian institutions in their initiative to design, implement and use an integrated causal risk management model (ICRMM) to improve risk management decision making. The research question adopted for the analysis section of the research programme was:

- How can an integrated causal risk management model be designed, implemented and used to predict the likely effect of proposed actions on the risk profile?

The research was conducted in three research cycles. As part of the first research cycle, a qualitative ICRMM was designed and used by using causal maps to represent the risk profile. As part of the second research cycle, a semi-quantitative ICRMM was designed and used by running Monte Carlo simulations to represent the risk profile. The research results of these two research cycles indicated that both the qualitative and the semi-quantitative ICRMM can be used by organisations for predicting the likely effect of proposed actions on the risk profile.

The third research cycle looked at the early phases of an initiative to implement an integrated risk management framework, where the ICRMM was one of the core components in the framework. The candidate assisted in organising the project and looked at how the most important stakeholders influenced the design and implementation of the ICRMM.

The findings in the third research cycle indicated that using a project management methodology is effective in organising, authorising and managing an integrated risk management initiative in an organisation. By using project management methodologies, it is ensured that the various stakeholders in the organisation cooperate on the design and implementation of the framework, including the ICRMM. The use of project management methodologies thereby secures stakeholder ownership, which again increases the likelihood of future use of the ICRMM after the project is closed.

Acknowledgments

I would like to thank the personnel at the University of Life Sciences for funding parts of the work and also allowing me to use the university as a sample. Especially, I would like to thank the former managing director of the university Nils Dugstad that provided me with this opportunity.

I am also very grateful of the support of the personnel at Terramar, both for acting as a sample and for providing support and showing interest all the way. I look forward to the coming years where I can be a "normal" employee without having any exams or thesis writing competing for my attention.

I am indebted to my supervisor Professor Paul Hare for supportive and inspiring guidance. I would also like to thank Dr. William Wallace who safely guided me through the research proposal, and who also has offered and provided guidance along the way.

I would like to send special thanks to my friend, working partner and fellow student at the EBS DBA Robert Hartnett who has provided advice and motivation since my first exam on the MBA in December 2000. By the way, I am pretty sure you can use Hank's rocket technique to finish the DBA sooner than you are aware of.

I am very grateful of the support from my mother and father who have always shown interest and believed in me. I would also thank my two brothers, Rune and Kyrre, for many interesting academic discussions related to the thesis.

My warmest thanks and love go to my wife Julianne and our children Mina and Louise. I know you have sacrificed the most during this working period and that this work would not have materialised without your support. It will be good to have you as my focus of attention again.

Declaration statement

Table of contents

Tables

Figures

Table of abbreviations

ANS	Air Navigation Service
ATCC	Air Traffic Control Centre
BAM	Branch area manager
BBN	Bayesian belief network
CAS	The Causality Actuarial Society
COSO	The Committee of Sponsoring Organizations of the Treadway Commission
CSF	Critical success factor
DBA	Doctor of Business Administration
DNV	Det Norske Veritas
ERM	Enterprise (wide) risk management
EBS	Edinburgh Business School
HR	Human resources
ICRMM	Integrated causal risk management model
IEC	International Electrotechnical Commission
ISO	International Organization for Standardization
IT	Information technology
KD	The Norwegian Ministry of Education and Research
MBA	Master of Business Administration
MSW-model	Making Strategies Work model
NOK	Norwegian krone (the Norwegian currency).
NOKUT	The Norwegian Agency for Quality Assurance in Education
NVH	Norwegian School of Veterinary Science
OAG	The Office of Auditor General
PMI	Project Management Institute
QA1	Quality assurance of the choice of concept. (The Ministry of Finance established the Quality Assurance Scheme year 2000, and pre-qualified external consultants to perform quality assurance of public investment projects exceeding EURO 60 millions. The Quality Assurance Scheme currently includes two separate analyses where QA1 is conducted first).

QA2	Quality assurance of cost estimates and the basis for control and management for the chosen project alternative. (QA2 is the second of the two separate analyses conducted under the Quality Assurance Scheme).
RBS	Risk breakdown structure
RIF	Risk interdependency field
SD	System dynamics
SFW	The Strategic Focus Wheel
SSØ	The Norwegian Government Agency for Financial Management
SW	Software
Take-Off 05	The name of a result improvement programme initiated by the Norwegian Air Navigation Services Provider Avinor. Take-Off 05 was initiated in 2003 and abruptly aborted in 2005 after a period of internal and external conflict. Take-Off 05 led to the resignation of the Director of the Air Navigation Services Division, the dismissal of the Chief Executive Officer, and the subsequent replacement of the Chairman of the Board.
UMB	The University of Life Sciences
VIRT	The Visual Ishikawa Risk Technique, also referred to as Ishikawa diagrams, fishbone diagrams and cause-effect diagrams

Chapter 1 - Introduction

In this chapter the background for the thesis and the research topic is presented. This chapter also provides an outline of the thesis.

1.1 Background for the thesis

Management in all organisations is about aligning the organisation's resources and employee's activities to accomplish the organisation's objectives. To be successful in management, a manager needs competence in several knowledge areas and subjects, such as accounting, finance, economics, marketing, project management, organisational behaviour, strategic planning, strategy implementation, risk management, etc. Risk management is different from the other knowledge areas in that it builds upon and extends the others by adding the perspective that there is uncertainty related to all decisions and activities in an organisation. Risk management thereby improves decision making for management processes where uncertainty is involved.

Managers in organisations have always practiced some form of risk management. Traditionally, risk management has been about each manager dealing with individual risks that might affect one or more of the objectives under the individual manager's responsibility. This is conceptually easy to understand, because it seems logical that any manager would consider applying resources and effort to deal with uncertainty related to the achievement of objectives under the manager's responsibility. In most cases, risk management has been conducted as an informal process, where the managers have not been aware that risk management has been conducted as an integral part of their decision making.

In recent years, risk management academics and practitioners have agreed that the silo based approach to risk management, where each individual department deals with individual risks in isolation, leads to suboptimal solutions. The concept of risk interdependency is a strong argument for moving towards a more integrated risk management approach often referred to as enterprise (wide) risk management or strategic risk management.

The concept of risk interdependency can be divided in four. First, decisions, actions and activities for dealing with an individual risk in one department often affect the achievement of objectives in other departments in the organisation as well. To make the problem even more complex, the effects in the other departments often become apparent much later than when the individual risk was originally dealt with. Second, from finance it is well established that the value of assets and securities tends to correlate, and therefore that isolated risk assessments of each asset and security in a portfolio would lead to suboptimal solutions. Third, safety assessments often show that two risks happening at the same time may cause much worse consequences than if each risk had materialised one at the time. For example, the failure of a main safety system may have no significant negative effects as long as backup systems or back-up procedures function as intended. The same applies for failure of backup systems or back-up procedures as long as the main system or other back-up systems or procedures work as intended. However, the failure of all safety systems and all safety procedures related to an issue happening at the same time may cause severe effects. Finally, a risk may also have impact on the likelihood of other risks in the risk profile. For example, weather conditions such as snow, the condition of the tyres, the car and the driver or the sudden appearance of a moose are all likely to affect the likelihood of risks related to car accidents.

In recent years, the literature, academics and practitioners all agree that the risk profile of an organisation is more than the sum of individual risks facing the organisation, and that an organisation should use an integrated approach to manage its risk profile. Unfortunately, it is much more difficult to find applied research giving clear advice on a best practice methodology for conducting integrated risk management and how to deal with risk interdependency in practise.

1.2 The research topic

This research programme is an applied research programme that studies the design, implementation and use of integrated causal risk management models in two Norwegian institutions. From a theoretical viewpoint, the integrated causal risk management model (ICRMM) is clearly aligned with the knowledge base with a clear objective of dealing with the (interrelated) risk profile of any organisation. However, there is a lack of applied research in the literature on these kinds of risk management models, so the literature doesn't provide evidence on whether or not the use of an ICRMM creates and protects value for an organisation compared to what would be the case if the organisation deals with each risk in isolation (uses the silo based approach) or even ignores risk and uncertainty all together. The research programme is developed to address how the design, implementation and use of an ICRMM affect decision making in an organisation compared to the alternative less sophisticated approaches.

The research topic is:

- The design, implementation and use of an integrated causal risk management model to predict the likely effect of proposed actions on the risk profile.

The research question adopted for the analysis section of this research programme is:

- How can an integrated causal risk management model be designed, implemented and used to predict the likely effect of proposed actions on the risk profile?

1.3 Outline of the thesis

The literature review is divided in two, and presented in two subsequent chapters. The literature review starts in Chapter 2, where the literature on integrated risk management is assessed. The aim of this chapter is to give an overview of themes that are relevant for understanding integrated risk management. Chapter 2 is divided in three main themes; various definitions and descriptions of risk, a brief glance at system theory, and various concepts in integrated risk management.

Chapter 3 is the second part of the literature review. This chapter looks at causal risk management models. The modelling technique of causal risk management models varies, but they are all similar in that the models simulate the dynamics of a specified system by developing cause-effect relationships between all the variables in the system. In the design and choice of input to causal models, it is often used a combination of historical data and expert judgement. Though numerous modelling techniques are briefly presented, the chapter focuses on causal mapping and Monte Carlo simulations.

In Chapter 4 the two literature review chapters are brought together to generate a synthesised outcome acting as the basis for the development of the basic research theory. The literature synthesis concludes that the literature suggests that the use of an ICRMM can improve decision making in organisations in cases where uncertainty is involved. The ICRMM can both be used to establish the current risk profile of an organisation and to predict the likely effect of proposed actions on the risk profile. The ICRMM is particularly useful for difficult trade-off decisions, where an action is expected to improve parts of the overall risk profile but also to worsen other parts of the risk profile. The synthesis section concludes that there is a lack of applied research on the ICRMM, and then a research question is formulated to address this gap in the knowledge base. The research question adopted for the analysis section of this research programme is:

- How can an integrated causal risk management model be designed, implemented and used to predict the likely effect of proposed actions on the risk profile?

Chapter 5 introduces action research as the research methodology used in this research programme. This chapter discusses that positivist science and action research are contrasting conceptions of science with different foundations for the philosophical viewpoints. This chapter also describes that the research programme was conducted in three research cycles, where each research cycle can be understood as discrete experiments. This chapter briefly sketches the three research cycles, and it can be seen that the first research cycle was conducted with the University of Life Sciences as the sample, while the second and third research cycle used the small Norwegian consultancy Terramar as the sample.

The first research cycle, with the University of Life Sciences as the sample, is presented in Chapter 6 and Chapter 7. The research question adopted for the first research cycle is:

- If the candidate designs a qualitative integrated causal risk management model, to what extent can the University of Life Sciences use this model to predict the likely effect of proposed actions on the risk profile?

In Chapter 6 the research methodology is described, while the results of the research cycle are presented in Chapter 7. In the first research cycle a qualitative version of the ICRMM is studied, and the findings of this research cycle indicate that the University of Life Sciences can use the ICRMM to predict the likely effect of proposed actions on the risk profile. However, this section also describes that the candidate is pessimistic about the future use of the ICRMM at the university. It is argued that the main reason for this is the current lack of ownership of the ICRMM at the university.

The second research cycle, which is the first case study with Terramar as the sample, is presented in Chapter 8 and Chapter 9. The research question adopted for the second research cycle is:

- If the candidate designs a semi-quantitative integrated causal risk management model, to what extent can the Terramar telecommunication branch area manager use this model to predict the likely effect of proposed actions on the risk profile?

In Chapter 8 the research methodology is described, while the results of the research cycle are presented in Chapter 9. The second research cycle is very similar to the first research cycle, but this time a semi-quantitative version of the ICRMM is studied. The findings in this research cycle indicate that a semi-quantitative version of the ICRMM can be used to predict the likely effect of proposed actions on the risk profile. As in the case for the first research cycle, the candidate is far from optimistic of the future use of the ICRMM. In this case, the problem is that the main stakeholder of the ICRMM left the organisation.

The third research cycle also uses Terramar as the sample. The research methodology is presented in Chapter 10 and the results are presented in Chapter 11. The research question adopted for the third research cycle is:

- How will Terramar forming an integrated risk management framework project affect the design and implementation of the integrated causal risk management model?

As can be seen from the research question, this research cycle is different from the previous two. In this research cycle, the candidate starts the research by looking at the needs and wants of the most important stakeholders in Terramar related to an integrated risk management initiative from Terramar's managing director. Based on these findings, the candidate aids the managing director in organising and authorising an integrated risk management project. The findings in this research cycle indicate that using project management methodology is effective in organising, authorising and managing an integrated risk management initiative in an organisation. By using project management methodologies, it is ensured that, together, the various stakeholders can cooperate on the design and implementation of the integrated risk management framework, including the

ICRMM. This approach increases ownership, which again is expected to increase the likelihood for the ICRMM becoming an integrated component in Terramar's governance framework.

Chapter 12 provides a brief discussion of issues related to reliability, validity and generalisability. In this chapter the focus is on how the choice of adopting the phenomenological paradigm and an action research methodology influences on how the research results should be interpreted.

Chapter 13 outlines conclusions of the research. The knowledge gained as part of the research is also used for suggestions for further research.

Chapter 2 - Integrated risk management

2.1 Introduction

This section is intended to provide a brief overview of a number of themes related to integrated risk management. First, the literature provides many different definitions and descriptions of what risk actually is. This part of the literature review will look at some of the definitions for risk that are used, and then suggest the use of a definition which suits an integrated approach to risk management. The second section takes a brief glance at system theory, and in particular the argument that organisations should be understood as systems. System theory is relevant, because it gives important insight on how the various elements of an organisation interrelate. System theory links particularly well with the ideas of an integrated approach to risk management. The rest of this part of the literature review looks at various important concepts in integrated risk management, such as risk interdependency, the difference between silo and integrated risk management, risk management principles, the risk management framework and the risk management process.

2.2 Definitions of risk

The literature does not agree on a single definition of the word 'risk', and the understanding of risk can vary significantly from industry to industry, but also from person to person working in the same industry or sector. In this section some of the many definitions of risk will be presented, and it will be argued that there is a need for a common terminology for risk. Finally it will be advocated to adopt the terminology for risk and risk management proposed in "ISO Guide 73 Risk management – Vocabulary" (ISO, 2009a).

In finance it is well established that an investor needs to take risk to increase expected profit. Sharpe (1964) describes that the optimal relationship between the expected rate of return and risk for a portfolio of assets follows the linear Capital Market Line, illustrated in Figure 2.1.

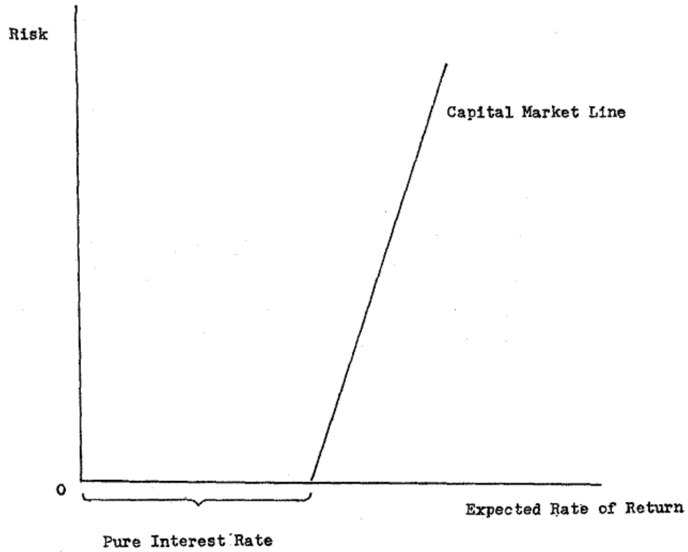


Figure 2.1 The Capital Market Line (Sharpe, 1964)

To understand how the term risk often is understood and used in an investment portfolio theory context, Markowitz (1952) as cited in Holton (2004) states:

> "The concept "yield" and "risk" appear frequently in financial writings. Usually if the term "yield" were replaced by "expected yield" or "expected return", and "risk" by "variance of return", little change of apparent meaning would result (p. 89)." (Holton, 2004: 21)

Holton (2004), seeking a general definition of risk, argues that exposure and uncertainty are two essential components of risk:

> "Risk, then, is exposure to a proposition of which one is uncertain."
> (Holton, 2004: 22)

Interestingly, Holton (2004) argues that his own definition is flawed from an operational viewpoint, because at best it is only the perceptions of exposure and uncertainty that can be defined operationally. The sub-prime mortgage crisis, which became apparent in 2008, has definitely strengthened this argument.

The Committee of Sponsoring Organizations of the Treadway Commission (2004a, 2004b) [COSO (2004a, 2004b)], looking at risk in an integrated risk management context, uses events to define risk:

> "An event is an incident or occurrence from internal or external sources that affects achievement of objectives. Events can have negative impact, positive impact, or both. Events with negative impact represent risks. Accordingly, risk is defined as follows:
>
> Risk is the possibility that an event will occur and adversely affect the achievement of objectives." (COSO, 2004a: 16)

Even though COSO provides a definition of risk that only includes the negative impact of events, it is argued that "enterprise risk management deals with risks and opportunities to create or preserve value" (COSO, 2004a: 16). However, in the risk management framework for the Norwegian public sector developed by The Norwegian Government Agency for Financial Management (2005) [SSØ (2005)], which is based on COSO's "Enterprise Risk Management – Integrated Framework", risk management is limited to deal with negative risks only. In other words, the parts related to opportunity have not been incorporated in the Norwegian risk management framework for the public sector.

The recognised project management guide published by the Project Management Institute (2008) [PMI (2008)] gives a definition of (project) risk that is somewhat in between the definition given by Holton (2004) and COSO (2004a):

> "Risk is an uncertain event or condition that, if it occurs, has an effect on at least one project objective. Objectives can include scope, schedule, cost, and quality. A risk may have one or more causes and, if it occurs, it may have one or more impacts...Project risk has its origins in the uncertainty present in all projects."
> (PMI, 2008: 275)

Ward and Chapman (2003) also look at risk from a project management perspective, and in this article they advocate "transforming existing Project Risk Management processes into Project Uncertainty management". In the abstract to the article they argue that the reason for this is that risk has become associated with events, and that a focus on uncertainty might lead to enhanced focus on opportunity management:

> "…the term 'risk' encourages a threat perspective. In part this is because the term 'risk' has become associated with 'events' rather than more general sources of significant uncertainty. The paper discusses the reasons for this view, and argues that a focus on 'uncertainty' rather than risk could enhance project risk management, providing an important difference in perspective, including, but not limited to, an enhanced focus on opportunity management."
> (Ward and Chapman, 2003: abstract)

The Norwegian research programme Concept, which focuses on Front-end Management of major investment projects, has chosen to give separate definitions of risk and uncertainty:

Risk is defined as:

> "The expression for negative outcome of uncertainty."
> (Concept, 2005a: 16 in Norwegian version)

Uncertainty on the other hand is defined as:

> "The lack of knowledge of the future. The difference between needed information to make a certain decision and the available information at the time the decision is taken. Uncertainty may lead to gains or losses compared to the expected outcome, and entails both risk and opportunities."
> (Concept 2005a: 17 in Norwegian version)

Economists discussing definitions of risk and uncertainty will not likely be convinced by the definitions provided by Concept (2005a). Economists discussing the difference between risk and uncertainty still refer to Knight (1921), and his explanations are in contrast to the definitions given in Concept (2005a). In short, Knight (1921) distinguishes between the two by writing that risk may be quantified in mathematical statistical equations, while uncertainty on the other hand cannot.

The different individual understandings of what risk actually is can cause problems for organisations trying to manage their risk profile. For example, by looking at definitions and understandings of risk found in the project management literature, we find that leading academics (Ward and Chapman, 2003), leading project management guides (PMI

Book of Knowledge, 2008), and major research programmes (Concept, 2005a) provide and use different terminologies and understandings of the concept risk.

By looking at the various definitions and descriptions above it can be concluded that there are at least three major differences in the understanding of risk. The first one is whether risks are associated with events or whether risks are understood as deviations from anticipated outcomes (often but not always caused by events). The second major difference is whether risk is understood as a negative concept or includes opportunities as well. The third difference is whether the definition of risk has its emphasis on the probability (or chance) of the occurrence of the uncertainty or emphasis on the effect of the uncertainty.

As a solution to the confusion in risk terminology, ISO (2009a) has published an updated standard for risk management vocabulary (terminology). "This Guide provides the definitions of generic terms related to risk management. It aims to encourage a mutual and consistent understanding of, and a coherent approach to, the description of activities relating to the management of risk, and the use of uniform risk management terminology in processes and frameworks dealing with the management of risk" (ISO, 2009a: 1).

ISO (2009a) contains a definition of risk that seems to have been developed as a compromise between personnel working in different trades:

"Effect of uncertainty on objectives

- NOTE 1 An effect is a deviation from the expected — positive and/or negative.
- NOTE 2 Objectives can have different aspects (such as financial, health and safety, and environmental goals) and can apply at different levels (such as strategic, organization-wide, project, product and process).
- NOTE 3 Risk is often characterized by reference to potential events and consequences, or a combination of these.
- NOTE 4 Risk is often expressed in terms of a combination of the consequences of an event (including changes in circumstances) and the associated likelihood of occurrence.
- NOTE 5 Uncertainty is the state, even partial, of deficiency of information related to, understanding or knowledge of an event, its consequence, or likelihood." (ISO, 2009a: 1-2)

In this research programme the vocabulary on risk and risk management in ISO (2009a) will be adopted and used. This vocabulary is chosen since the candidate believes it is essential for personnel in organisations to have a joint understanding of the concept of risk and the activities related to management of risk. The ISO (2009a) vocabulary seems to have been developed as a compromise between personnel working in different industries, and the candidate therefore hopes and believes that this terminology can be used and adopted in most industries and working situations.

The candidate wishes to add that he is aware that some practitioners and academics may argue against these definitions, claiming that they are changing the established interpretation of both risk and uncertainty in a particular trade. To conclude, the candidate agrees with the view that ISO (2009a) changes some established interpretations of risk related subjects used in different industries or academic sectors, but in the candidate's view ISO (2009a) is still the best choice for establishing a common vocabulary for organisations.

The next section will look at system theory, arguing that organisations are best understood as systems. The ideas from the system paradigm are useful for developing a greater understanding of integrated risk management and the concept of risk interdependency.

2.3 Organisations understood as systems

Ackoff (1971) has developed a conceptual framework to assist in absorbing and synthesising system concepts. In this framework he provides a useful definition of a system:

> "A system is a set of interrelated elements. Thus a system is an entity which is composed of at least two elements and a relation that holds between each of its elements and at least one other element in the set. Each of a system's elements is connected to every other element, directly or indirectly. Furthermore, no subset of elements is unrelated to any other subset." (Ackoff, 1971: 662)

In the same article, Ackoff argues that organisations are purposeful systems:

> "A purposeful system is one which can produce the same outcome in different ways in the same (internal or external) state and can produce different outcomes in the same and different states. Thus a purposeful system is one which can change its goals under constant conditions; it selects ends as well as means and thus displays will. Human beings are the most familiar examples of such systems." (Ackoff, 1971: 666)

> "An organization is a purposeful system that contains at least two purposeful elements which have a common purpose relative to which the system has a functional division of labor; its functionality distinct subsets can respond to each other's behavior through observation or communication; and at least one subset has a system-control function." (Ackoff, 1971: 670)

System dynamics (SD) is a methodology for studying and managing complex feedback systems. Forrester (1998), who is the founder of the field of SD, argues that organisations are social systems and that employees exist in an on-going circular environment where numerous feedback loops and policies affect the decisions and actions taken by the individual:

> "The idea of a social system implies that relationships between its parts strongly influence human behavior. A social system strongly confines behavior of individual people. In other words, the concept of a system contradicts the belief that people are entirely free agents. Instead, people are substantially responsive to their changing surroundings… We do not live in a unidirectional world in which a problem leads to an action that leads to a solution. Instead, we live in an on-going circular environment. Each action is based on current conditions, such actions affect future conditions, and changed conditions become the basis for later action. There is no beginning or end to the process. Feedback loops interconnect people. Each person reacts to the echo of his past actions, as well as to the past actions of others." (Forrester, 1998: 2-3)

> "Decisions are made moment by moment as time progresses. Decisions control present action. One can act only at the present time. One cannot act yesterday or tomorrow. By contrast, policies are the rules that determine the making of

> decisions. If one knows the policy governing a point in a system, one then knows what decision will result from any combination of information inputs. Unlike decisions, policies are timeless and enduring. If a policy is sufficiently comprehensive, it can continue to apply over an extended interval of time. Depending on the objectives of a model, policies might remain unchanged and effective as long as years, decades, or even centuries." (Forrester, 1998: 5)

Forrester (1994) writes that our experiences from earliest childhood teach us that cause and effect are closely related in time and space. However, our experiences are misleading when it comes to complex (social) systems such as organisations:

> "…the idea that the cause of a symptom must lie nearby and must have occurred shortly before the symptom is true only in simple systems. In more realistic complex systems, causes may be far removed in both timing and location from their observed effects…In systems composed of many interacting feedback loops and long time delays, causes of an observed symptom may come from an entirely different part of the system and lie far back in time." (Forrester, 1994: 12)

System theory brings important new insight to some of the publications related to choice under risk and uncertainty, which examine different aspects of Knight (1921). For example, Butcher et al. (2006) write that many experts argue that assets and financial risks resist quantification due to the fact that they appear to be non-normally distributed and are not independent. Butcher et al. (2006: 77) argue for that "many of what we once thought were "risks" are turning out to be uncertainties —and the list of both risks and uncertainties appears to be expanding continuously", and this argument would come as no surprise to those who are familiar with the system paradigm. For example, according to system theory the different elements in the system interrelate, and thereby the different elements will neither be normally distributed nor independent. Feedback-loops also gives important insight to why it is impossible to find statistical distributions capable of giving reliable representations of various risks, and thereby why these risks are re-classified as uncertainties according to the definition provided by Knight (1921). The complexity involved in modelling systems also gives us an insight of why the number of both risks and uncertainties appears to be expanding continuously.

The idea that organisations should be understood as systems brings interesting questions related to how organisations should organise their risk management function. On one hand, it is necessary to make sure that departments take ownership of issues, risks and uncertainties that may affect their objectives, while on the other hand it also seems necessary for organisations to make sure that someone in the organisation monitors how risks and risk management activities in one department may cause effects in other departments as well.

The ideas from system theory link well with the most recent literature on risk management. As will be seen in the next section, the risk management literature presents the view that organisations should move away from a silo based risk management approach to a more integrated risk management approach often referred to as enterprise (wide) risk management or strategic risk management. However, it should be noted that in practice it is a major task to move from a silo based approach to an integrated approach to risk management.

2.4 The concept of risk interdependency

Risk interdependency is an important concept in risk management. The literature points to the fact that risks do not necessarily work in isolation, and that those risks that are interrelated can pose considerable threats and opportunities to organisations. The concept of risk interdependency is also one of the key findings in a risk management study conducted by Deloitte Research (2005):

> "Eighty percent of the companies that suffered the greatest losses in value were exposed to more than one type of risk. But firms may fail to recognize and manage the relationships among different types of risks. Actions taken to address one type of risk, such as strategic risk, can often increase exposure to other risks, such as operational or financial risks.
>
> Recommended Response: Companies need to implement an integrated risk management function to identify and manage interdependencies among all the risks facing the firm." (Deloitte Research, 2005: 1)

The relationships between risks do not necessarily have the same meaning for people working in different disciplines. In finance it is well accepted that each asset has two risk components; the systemic risk component and the unsystemic risk component (Sharpe 1964: 439). The difference between the two components is that the unsystematic risk component can be diversified away, while the systematic risk component cannot. In an optimal diversified portfolio of assets the total effect of unsystematic risk will be reduced to zero, and then the relationship between risk and expected return will be positioned on the Capital Market Line in Figure 2.1. However, if the portfolio includes unsystemic risk, then the relationship between the total risk of the portfolio and the expected return of the portfolio will in all cases be positioned to the left of the Capital Market Line (representing a sub-optimal investment).

Markowitz (1999) refers to Markowitz (1959), when he describes how correlated returns affect the efficacy of diversification:

> "…the existence of correlated returns has major implications for the efficacy of diversification. With uncorrelated returns, portfolio risk approaches zero as diversification increases. With correlated returns, even with unlimited diversification, risk can remain substantial. Specifically, as the number of stocks increases, the variance of an equally weighted portfolio approaches the "average covariance" (i.e., portfolio variance approaches the number you get by adding up all covariances and then dividing by the number of them)." (Markowitz, 1999: 8)

Some writers seem to suggest that risk interdependence is limited to correlation between financial risks:

> "Another difference between hazard risk and financial risk is the degree of independence among separate elements. In hazard risk management, risks are frequently independent of each other. Thus, the calculation of the number of accidents that a pool of vehicles is likely to be involved in during a year is determined by assuming that each accident is independent of every other accident. Financial risks, on the other hand, are not considered to be independent. In many cases, the correlation between different financial transactions forms the basis of the risk management strategy." (D'Arcy, 2001: 15)

However, risk interdependency is not limited to correlated returns between assets and securities. The literature on risk interdependency is particularly well covered by specialists working in project risk management. Williams (2004) refers to the body of work from Strathclyde University and PA Consulting when he discusses how management action designed to recover slippage in a project generally has disadvantages as well as benefits. The unexpected disadvantages are particularly important, because these disadvantages, in fact, change the risk profile in a negative manner through risk interdependency. This kind of risk interdependency is clearly aligned with system theory, which argues that any organisation is a kind of system that contains at least two interrelated elements (Ackoff, 1971) and that people by participating in the system affect the system (Banathy, 2000).

Risk interdependency is also a well established concept for people working with safety issues, even though they use different terminology. In safety there are two approaches for dealing with human errors; the person approach and the system approach (Reason, 2000). The person approach focuses on the errors of individuals. The system approach accepts and expects that human conduct errors, and builds safety mechanisms according to this premise. In the system approach, safety is achieved by designing and implementing several defensive layers into the system, where it is accepted that each layer of defence will have shortcomings:

> "In an ideal world each defensive layer would be intact. In reality, however, they are more like slices of Swiss cheese, having many holes - though unlike in the cheese, these holes are continually opening, shutting, and shifting their location. The presence of holes in any one "slice" does not normally cause a bad outcome. Usually, this can happen only when the holes in many layers momentarily line up to permit a trajectory of accident opportunity - bringing hazards into damaging contact with victims (Figure 2.2)." (Reason, 2000: 769)

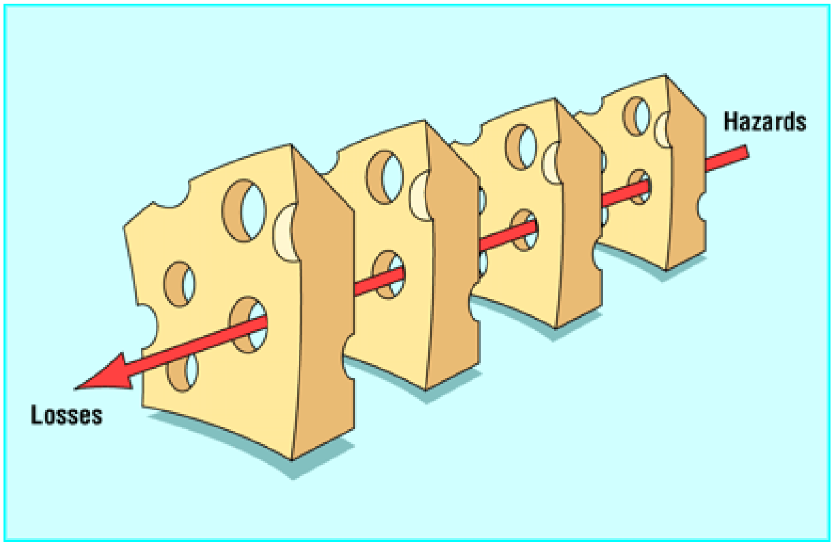


Figure 2.2 The Swiss cheese model (Reason, 2000)

The Swiss cheese model can be used to explain how two risks occurring at the same time may cause much worse consequences than if each risk had materialised one at the time. For example, the failure of a main safety system may have no significant negative effects as long as backup systems or back up procedures function as intended. The same applies for failure of backup systems or back up procedures as long as at least one of the other layers of defence is intact. However, the failure of all systems and all procedures at the same time may cause severe effects for the organisation in question, because this time there is no protective layers in place.

The Swiss cheese model can be used for opportunities (or positive risk outcomes) as well. For example, the combination of increased globalisation and development of information and communication technology has changed the education market considerably. Some organisations have identified the combination of these changes in the environment as new opportunities that can be exploited (the two cheese slices have holes in the same place and thereby creating the opportunity), while other organisations still prefer to ignore the (unanticipated) effects of these changes.

Risks may also affect the likelihood of other risks in the risk profile. For example, weather conditions such as snow, the condition of the tyres, the car and the driver or the sudden appearance of a moose are all likely to affect the likelihood of risks related to car accidents. Another example of a risk affecting the likelihood of other risks in an organisation's risk profile can be a delay in a project, which causes the project supplier to become under financial pressure. This again can result in the supplier taking short-cuts in the design to cut costs, which again causes the end product of the project not being according to the quality objectives defined by the organisation. The shortcomings of the end product of the project may again cause other unanticipated effects for the organisation in question.

Risk interdependency is sometimes referred to as risk systemicity (Ackermann et al., 2006). This article provides credible arguments as to why it is important to consider risks as systemic and that this view:

- "allows investigation of the interactions between risks, and so encourages the management of the causality of relationships between risks, rather than just risks.
- focuses attention
    - on those risks and causality that create the most frightening ramifications;
    - on clusters of risks, as a system, rather than single items. Thus, forcing conversation about risk mitigation across disciplines within the organization." (Ackermann et al., 2006: 2)

Even though the article represents a project risk view, the article's key learning points on risk interdependency are just as relevant for risk interdependency in integrated risk management. In fact, the exact wording of the citation above could have been used as arguments for why risk interdependency is one of the main reasons that organisations should change from a silo-based approach for managing risks to an integrated risk management approach.

The literature on risk interdependency focuses mostly on the downside of risk interdependency. However, risk interdependency includes opportunities as well, and the concept of risk interdependency should therefore be understood in a balanced manner:

> "A company that insists on taking account of individual risks in isolation has no way of capturing a global economy and the interdependence among different risks, including the opportunities such risks may represent for alert and nimble competitors." (Butcher et al., 2006: 80)

2.4.1 Short case study: The importance of managing risk interdependency

Avinor is the Norwegian Air Navigation Services Provider. In 2003, the Avinor Board of Directors decided to initiate a result improvement programme (Take-off 05), due to the fact that the income levels were low compared to the cost level of the company. The result improvement programme, initiated to improve Avinor's financial risk profile, led to the CEO being forced to resign in December 2005. Related to this research programme, the interesting part is that the main reason for the downfall of the CEO is that she failed in managing risk interdependency. The following description of the events related to the result improvement programme Take off 05 at Avinor is based on Lofquist (2008) and The Accident Investigation Board/Norway (2005).

As previously mentioned, Take-off 05 at Avinor was initiated to improve the organisation's financial risk profile. In the early phases of Take-off 05, Avinor announced that the programme intended to use participative processes where employees and union representatives were involved in the programme processes. The employees, including representatives from the powerful air traffic controllers union, have confirmed that they felt involved in the early phases of the project. However, the feeling of involvement would prove to change to frustration in the later parts of the project:

> "I must say that I thought the evaluation process was quite good up until the decisions were made. I was not allowed to take part in that process. And I must say that I was rather surprised when I read the decisions of the group that I was a part of…" (Lofquist, 2008: 99)

> "I was not satisfied with the process. It started off fine, but I was under the impression that we were constantly under-evaluating the complexity of the whole …" (Lofquist, 2008: 99)

From the quotes above it is clear that the processes ended up less participative than what was signalled by management at the beginning of Take-off 05. From the information above, it is likely that risks related to the power of the air traffic controller union had been identified before the result improvement programme started up, and that the communication of participative processes was a chosen risk treatment action. However, the quotes above also indicate that the decision makers in the Avinor management group were not particularly concerned with the operational issues and operational risks that appeared compared to the focus on improving the financial risk profile.

In August 2003, the company Det Norske Veritas (DNV) was engaged to carry out impact assessment of safety, health and the working environment at Avinor. The findings of this work are summarised in "Report 1232 - Take-off 05, Impact Assessment of Safety, Health and the working environment". The Accident Investigation Board/Norway (2005) looks at the findings in this report, and some of the most important findings are repeated below:

> "It is the opinion of DNV that there is too much focus on sub-elements and too little assessment of the total safety aspects of the aviation sector, both within Take-Off-05, and in Avinor in general. DNV disagrees with, e.g., the claim that accessibility of the various services is not safety-related, but is only related to regularity. This is an example of a lack of a holistic assessment of total safety in the system." (The Accident Investigation Board/Norway, 2005: 74)

> "The Take-Off-05 project has worked within very limited time constraints. Given the pressure of time, there is reason to question whether all of the measures have been sufficiently considered and their impact assessed. The extent and reach of the planned measures as laid out in Take-Off-05 may lead to unpredictable consequences both in regard to safety and occupational health and safe working environment. This applies to measures within each of the subprojects, but is primarily related to cumulative effects, i.e. the consequences of major changes to systems that are closely interlocked."
> (The Accident Investigation Board/Norway, 2005: 74)

The quotes from the DNV report make it clear that already in the first year of Take-off 05 there were obvious warning signals that management was too focused on dealing with financial issues and uncertainties compared to managing the operational risk profile. Basically, it seems that management was unaware that the operational risk profile was getting worse due to the different projects/activities in the programme to improve the financial risk profile.

In the period from late 2003 until 2005 the result improve programme turned into a war between Avinor management and the air traffic controller union, which again resulted in many strange and interesting events:

- In late 2003, a Board meeting where the three employee representatives voted for a reality check of the figures laid out in the Take-off 05 planning document, and the five other Board members voted against.
- Management's provoking employment of a new director of the newly formed Air Navigation Service (ANS) division responsible for all operative air navigation services, including air traffic control in Norway. The provoking part was that the new director had no civil aviation experience.
- Mid 2004, the seven trade unions, with the air traffic controller union in the lead, sending a joint letter of no confidence in the CEO or the rest of the top management to the Avinor board of directors.
- 3 quarter 2004, when the new director of ANS personally delivered the news that the Oslo Air Traffic Control Centre (ATCC) would be closed down, and relocated to ATCC South in Stavanger. The news came as a total surprise to the air traffic controllers working at the largest and most modern air traffic control centre in Norway. Their collective reaction was swift and dramatic, all of the air traffic controllers on duty declared themselves unfit to safely control aircraft, diverted all airborne aircraft for immediate landing, and then they left their positions. This resulted in the shutdown of all air travel in southern Norway for nearly two days, stranding many thousands of passengers.
- Media becoming the primary communications channel between Avinor management, the employees and external stakeholders.
- Chaos in the Norwegian civil aviation lasting in 15 months (mostly due to numerous sick notes from the air traffic controllers). The chaos resulted in the departure of the CEO in December 2005 and the replacement of the Chairman of the Board in early 2006.

The period from 2003 to 2005 at Avinor provides a good example of how important it is to manage risk interdependency. The drastic consequences of the result improve programme show how actions and activities chosen for treating risk affecting one type of organisational objective can affect the achievement of other types of objectives, in a manner not anticipated by the decision makers, as well.

2.5 From silo to integrated risk management

Managers have always practiced some form of risk management. However, according to the literature (Lam, 2000; Meulbroek, 2001, 2002b; Acharyya, 2007; Layton and Garitte, 2008) the risk management practices are currently changing from managing risks departmentally, in silos, to a more integrated approach to risk management that is commonly referred to as enterprise (wide) risk management (ERM) or strategic risk management. Roberts et al. (2003c: 6/23 - 24) point at three of the key weaknesses of the silo-based approach:

- Problems related to omissions and duplications
- Risks are considered in isolation rather than in a business objective context
- Lack of understanding, which again lead to managers not actually managing risks/taking responsibility for managing risks

The weaknesses of the silo-based approach together with some recent changes in the consideration of risks work as driving forces towards integrated risk management. The Causality Actuarial Society Enterprise Risk Management Committee (2003: 3-6) has looked at these driving forces and these include:

- More complicated risks (recognition of the variety, the increasing numbers and the interaction of the risks facing organisations)
- External pressure (from regulators, rating agencies, stock exchanges, institutional investors and corporate governance oversight bodies)
- Portfolio point of view (the entire collection of risks can be managed in a portfolio inspired by the portfolio theory from finance)
- Quantification (advances in technology and expertise have made quantification easier)
- Boundary-less benchmarking (the process, tools and procedures are not limited to specific sectors, but are common to many organisations)
- Risks as opportunity (in the past organisations tended to take a defensive posture towards risks, organisations have increasingly recognised the opportunity side)

The drive towards integrated risk management is likely to be one of the main reasons why, in November 2009, ISO published "ISO 31000 Risk management – Principles and guidelines" (ISO, 2009b), which is a risk management standard that is generic and can be applied to a wide range of activities, decisions, and operations of any public, private or community enterprise, association, group or individual.

An overview of how ISO considers the relationships between risk management principles, framework and process are presented in Figure 2.3. ISO also published a new edition of a Risk management - Vocabulary standard (ISO, 2009a), which provides a basic vocabulary of the definitions of risk management generic terms that is closely related to ISO 31000.

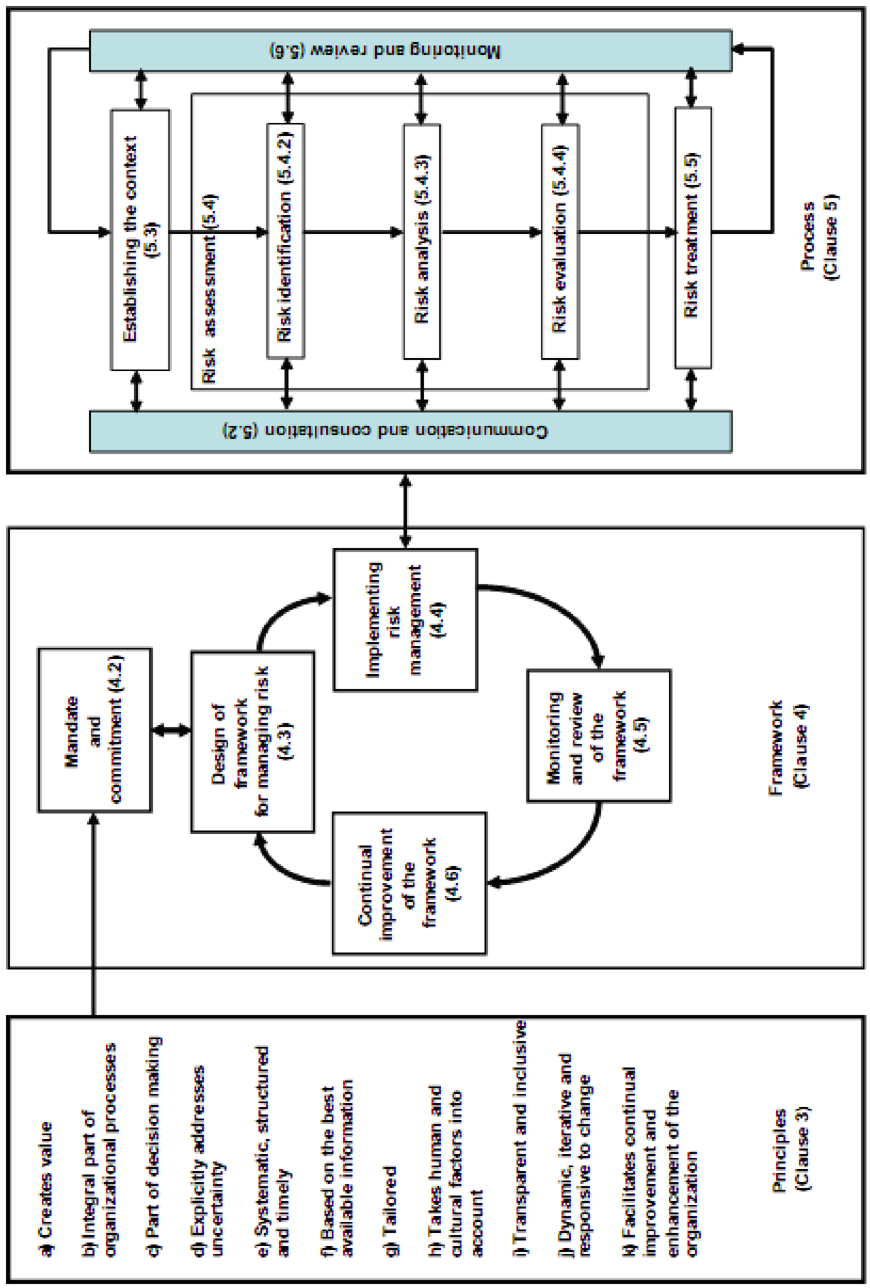


Figure 2.3 Overview of ISO 31000 (ISO, 2009b)

ISO (2009a, 2009b) does not use or define the term enterprise risk management (ERM), and even though the term ERM is commonly used by academics and practitioners, the literature does not agree upon a single definition of the term. Below are two of the perhaps best known and accepted definitions of ERM.

> "Enterprise risk management is a process, effected by an entity's board of directors, management and other personnel, applied in strategy setting and across the enterprise, designed to identify potential events that may affect the entity, and manage risk to be within its risk appetite, to provide reasonable assurance regarding the achievement of entity objectives." (COSO, 2004a: 4)

> "ERM is the discipline by which organizations in any industry assesses, controls, exploits, finances and monitors risks from all sources for the purpose of increasing the organization's short- and long- term value to its stakeholders." (Causality Actuarial Society Enterprise Risk Management Committee, 2003: 8)

The Causality Actuarial Society Enterprise Risk Management Committee advocates taking a look at the work of Lisa Meulbroek for additional thoughts and description of ERM. Meulbroek (2001, 2002a, 2002b) avoids using the term ERM in her work, but refers to "integrated risk management" instead. Meulbroek (2002a, 2002b) writes that there are three fundamental ways of implementing risk management objectives: modifying the firm's operation, adjusting its capital structure and employing targeted financial instruments. Integrated Risk management refers to the idea that managers must weigh the advantages and disadvantages of the different approaches, and that they also must consider the aggregation of all the risks faced by the organisation for choosing the optimal solutions.

The candidate's view is that the definitions of enterprise risk management provided by COSO (2004a) and CAS (2003) do not improve the understanding of what enterprise risk management actually is. One problem with both definitions is that they are too long. However, more importantly both definitions seem to miss what the candidate believes is the core of integrated risk management, which is that organisations should conduct coordinated activities to manage the effect of uncertainty on all their objectives.

In the candidate's view, there is no need for defining the terms enterprise wide risk management, enterprise risk management or strategic risk management. What is needed is a short, precise, understandable, practical and accepted definition of the term risk management. ISO (2009a: 2) defines risk management as "coordinated activities to direct and control an organization with regard to risk", which suits this purpose. This short and precise definition of risk management also captures the essence of integrated risk management in contrast to the definitions provided by COSO (2004a) and CAS (2003).

2.6 Risk management principles

ISO (2009b) lists and describes 11 principles that organisations must comply with for conducting effective risk management. These principles are:

- Risk management creates and protects value.
- Risk management is an integral part of all organizational processes.
- Risk management is part of decision making.
- Risk management explicitly addresses uncertainty.
- Risk management is systematic, structured and timely.
- Risk management is based on the best available information.
- Risk management is tailored.
- Risk management takes human and cultural factors into account.
- Risk management is transparent and inclusive.
- Risk management is dynamic, iterative and responsive to change.
- Risk management facilitates continual improvement of the organization. (ISO, 2009b: 7-8)

The candidate has not identified any flaws with the principles in ISO (2009b). However, this research programme is not about creating a complete risk management system, but to design, implement and use an ICRMM to predict the likely effect of the proposed actions on the risk profile. Based on this, the candidate has chosen to focus on 5 of the ISO principles that will be further investigated in the context of the ICRMM.

2.6.1 Risk management creates and protects value

> "Risk management contributes to the demonstrable achievement of objectives and improvement of performance in, for example, human health and safety, security, legal and regulatory compliance, public acceptance, environmental protection, product quality, project management, efficiency in operations, governance and reputation." (ISO, 2009b: 7)

Most organisations, both public and private organisations, starting the "integrated risk management journey" are motivated by penalty avoidance or to comply with rules and regulations in the beginning. Some organisations move on the risk management maturity continuum and realise that risk management is not about just complying with rules and regulations, but rather about improving stakeholder value by creating a competitive advantage. This concept is illustrated in Figure 2.4.

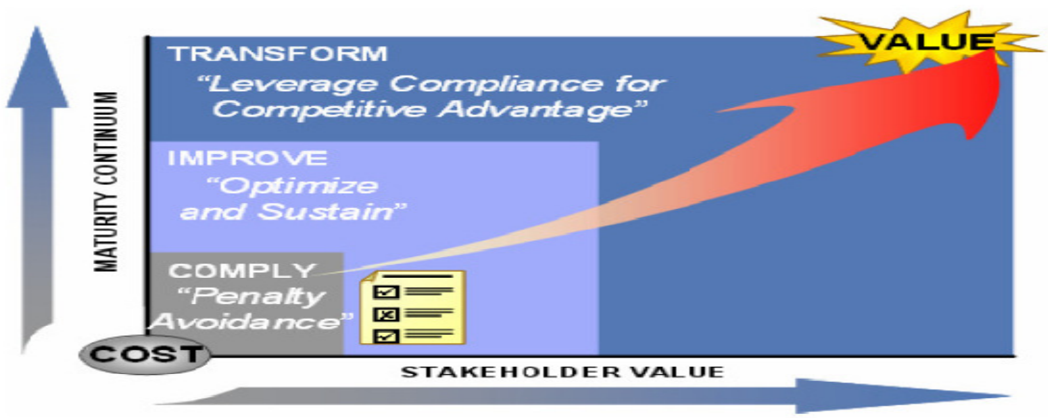


Figure 2.4 Risk management maturity continuum (Abrams et al., 2007)

The ICRMM is not for organisations just seeking to comply with rules and regulations related to risk management at a minimum cost. The ICRMM is a model for those organisations that want to move along the risk management maturity continuum to adhere to the risk management principle that risk management creates and protects value.

2.6.2 Risk management is an integral part of organizational processes

> "Risk management is not a stand-alone activity that is separate from the main activities and processes of the organization. Risk management is part of the responsibilities of management and an integral part of all organizational processes, including strategic planning and all project and change management processes."
> (ISO, 2009b: 7)

This view is supported in Fraser and Simkins (2007), which aim to correct what the authors believe to be the ten most common corporate misconceptions that now stand in the way of successful applications of ERM. In the article, Mistake #2 is presented as "Risk Management is an End unto Itself, Independent of Business Objectives Management". In project management, project risk management is neither considered to be a stand-alone activity, but rather that project risk management "builds upon and extends other project management processes" (PMI, 2009: 4).

The thoughts that risk management and business processes should be integrated can also be found in IBM Research's ERM framework presented in Abrams et al. (2007). IBM Research's ERM framework models an enterprise and its environment in five layers. The enterprise itself spans the three middle layers (strategy, deployment and operation), while the external world is represented through the jurisdictional layer and the events layer. An overview of this model is presented in Figure 2.5.

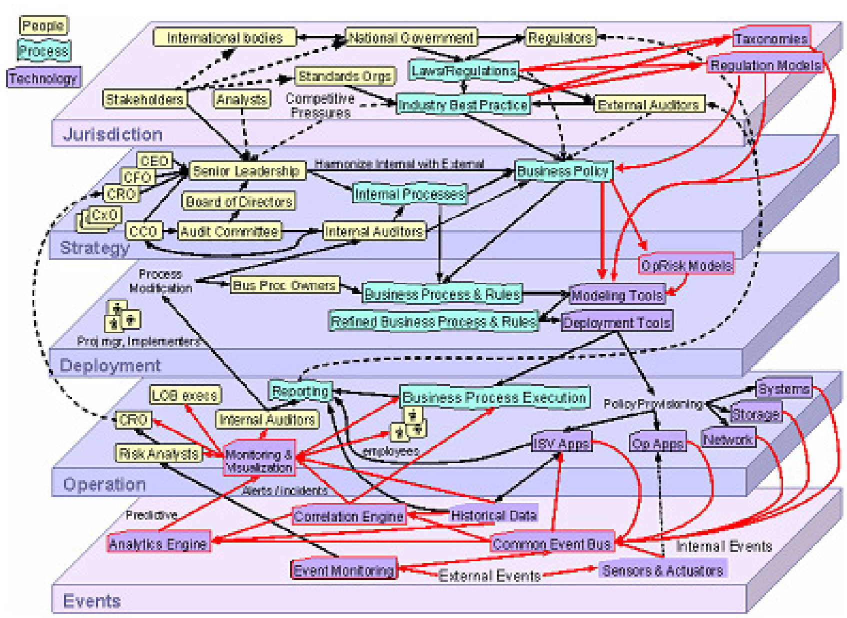


Figure 2.5 Overview of IBM's ERM framework (Abrams et al., 2007)

To conclude, risk management is integrated with other management disciplines, so the use of the ICRMM is intended to be an integral part of an organisation's strategic planning, strategy implementation, operational processes, and for all project and change management processes.

2.6.3 Risk management is part of decision making

> "Risk management helps decision makers make informed choices, prioritize actions and distinguish among alternative courses of action." (ISO, 2009b: 7)

There is uncertainty related to almost all difficult management decisions. The perhaps greatest challenge for assessing the uncertainty related to decisions, is to take into account that management actions often has unintended disadvantages due to chains of causality of effect (Williams 2004). A natural aim for the ICRMM is to model these causal chains, and thereby offer a predictive facility that can be used to improve decision making in an organisation. This will be examined further in "Chapter 3 - Causal risk management models".

2.6.4 Risk management is tailored

> "Risk management is aligned with the organization's external and internal context and risk profile." (ISO, 2009b: 7)

What is meant with this principle is well illustrated in the Risk interdependency field model (RIF-model) described in Roberts et al. (2003c: Chapter 8). The RIF-model is divided in two primary components. The first component is a generic component, which works as a model of the risk management process in any application. The second component is a risk interdependency field assessment that takes into account the characteristics of the individual organisation, and the second component is thereby a tailored component. The same applies for the international risk management standard ISO 31000. The standard provides generic guidelines on risk management, but the results from using the ISO 31000 risk management framework and risk management process will be different for all organisations.

2.6.5 Risk management explicitly addresses uncertainty

> "Risk management explicitly takes account of uncertainty, the nature of that uncertainty, and how it can be addressed." (ISO, 2009b: 7)

All types of risks must be included in an integrated risk management model. One type of risks that is particularly difficult to deal with is unforeseeable risks, because they are just that - unforeseeable. However, management of the unforeseeable risks should not be taken lightly:

> "Some of the greatest value losses were caused by exceptional events such as the Asian financial crisis, the bursting of the technology bubble, and the September 11th terrorist attacks. Yet many firms apparently fail to plan for these rare but high-impact risks." (Deloitte Research, 2005: 1)

> "Firms should employ "stress testing" to ensure that their internal controls and business continuity plans can withstand the shock of a high-impact event. Companies should proactively plan and acquire the strategic flexibility to respond to specific scenarios." (Deloitte Research, 2005: 1)

Roberts et al. (2003c) are aligned with the thoughts of stress testing and refer to the use of business continuity planning ("an approach to maintaining the continuity of the business through adverse and disruptive events"), contingency planning ("concerned with identifying and dealing with the disruptive impact on an organisation wide basis") and crisis planning ("concerned with the emergency procedures necessary to maintain the survival of the organisation where the level and impact of the risk reaches critical levels") to manage unforeseeable risks.

The sub-prime mortgage crisis, which became apparent in 2008, triggered a financial crisis around the globe, and this has led to the word stress testing being (now) well known in the banking industry. For example in Norway, Norges Bank (Norway's central bank) has developed a suite of models to stress test financial stability (Andersen et al., 2008), and the Obama administration in USA has included stress tests of the largest banks as parts of the financial rescue plan. The major difference between the stress tests of the American banks and the stress tests advocated by Deloitte Research (2005) and Roberts et al. (2003c) is that the former are conducted by the regulators while the latter are advocated to be conducted by the organisations themselves as part of their risk management system.

Though it is easy to argue for stress testing, scenario planning, business continuity planning, contingency planning and crisis planning, it should be remembered that management of unforeseeable risks also has a cost side. The challenge is to find the correct balance between cost and benefits, which is difficult since most of the unforeseeable risks in the risk profile are extremely difficult to express in reliable numerical terms. Therefore it is not possible to define an optimal level of how much resources an organisation should use for managing unforeseeable risks. Generally, it can be said that a risk-taking organisation is willing to live with much more uncertainty than a risk-averse organisation. This applies for risks in the strategic, change and operational category as well as for unforeseeable risks.

2.7 The risk management framework

A risk management framework is a:

> "Set of components that provide the foundations and organizational arrangements for designing, implementing, reviewing and continually improving risk management throughout the organization
>
> - NOTE 1 The foundations include the policy, objectives, mandate and commitment to manage risk
> - NOTE 2 The organizational arrangements include plans, relationships, accountabilities, resources, processes and activities.
> - NOTE 3 The risk management framework is embedded within the organization's overall strategic and operational policies and practices."
>
> (ISO, 2009a: 2)

The importance of establishing the foundation for risk management cannot be overemphasised. A solid foundation will ensure that all relevant stakeholders are aligned in terms of what the purpose of the risk management framework actually is. A solid foundation will also ensure that management and employees working with the risk management framework are aligned in terms of the design, implementation and use of the risk management framework.

The candidate is a firm believer in that it is essential that organisations understand the difference between the design and implementation phases of a risk management framework in the organisation, and the phase when the risk management framework is operational. The design and implementation of a risk management framework should be initiated, planned, executed monitored, controlled and closed according to established project management techniques and standards such as PMI (2008). The foundation of the project consists of two main elements. The first element is the project management charter (also often referred to as project management mandate), which describes the purpose of the project. The second element is the project management plan, which describes how the project will be managed. When the project is closed, the risk management framework is "handed" over to the line organisation. The line organisation therefore needs a new and completely different mandate than what has been used for managing the project.

As can be seen in Figure 2.6, the ISO risk management framework uses a design, implement, monitor and review and continual improvement of the risk management framework cycle. This structure suggests that the risk management framework should not be understood as a static framework in an organisation, but rather that the framework will continuously be improved in iterative processes.

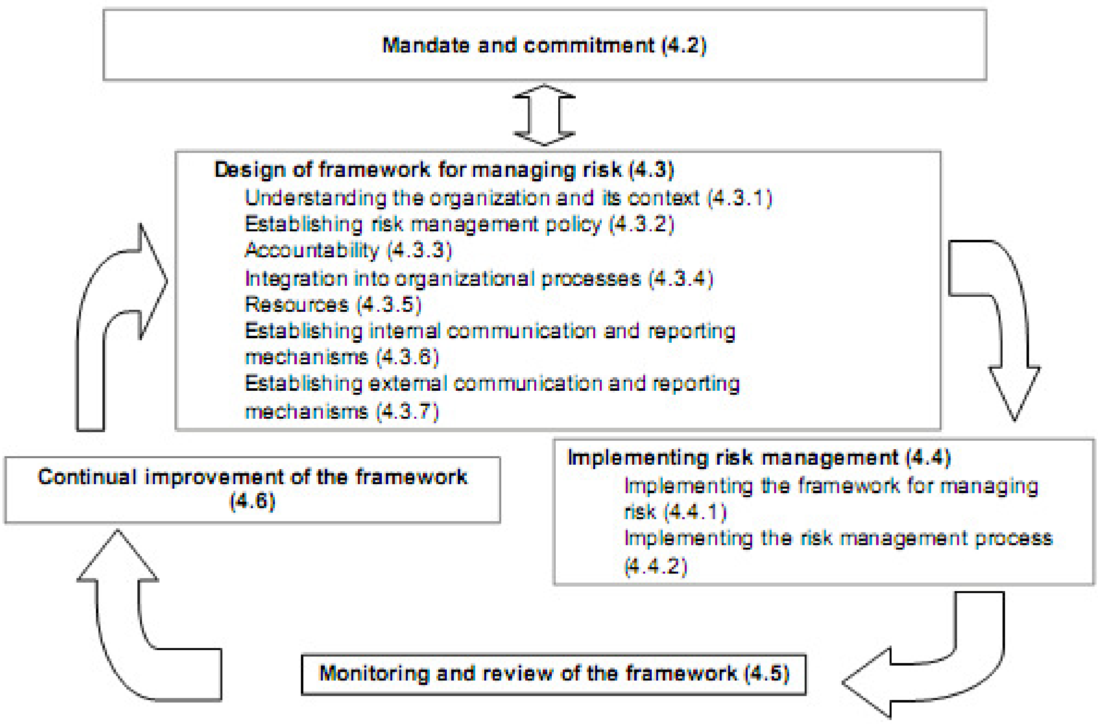


Figure 2.6 Relationship between the components of the framework for managing risk (ISO, 2009b)

2.8 The risk management process

The risk management process is a:

> "Systematic application of management policies, procedures and practices to the activities of communicating, consulting, establishing the context, and identifying, analyzing, evaluating, treating, monitoring and reviewing risk." (ISO, 2009a: 3)

The risk management process is a core element of ISO 31000 (ISO, 2009b), and the elements in the process and their relationships can be seen in Figure 2.7. To create a full scale integrated risk management system all the activities mentioned are relevant. However, this research programme is limited to deal with establishing the context, risk assessment (which includes identifying, analysing and evaluating risks) and risk treatment.

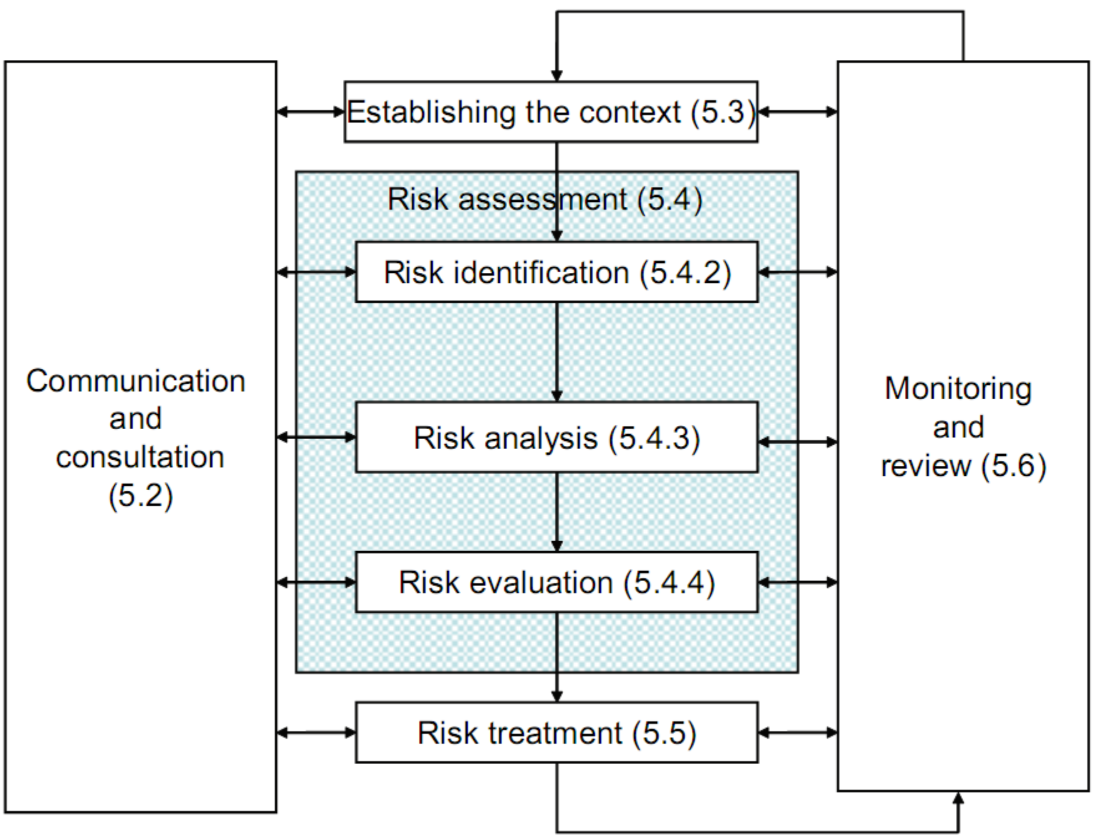


Figure 2.7 The ISO risk management process (ISO, 2009b)

2.8.1 Establishing the context

> "By establishing the context, the organization articulates its objectives and defines the external and internal parameters to be taken into account when managing risk, and sets the scope and risk criteria for the remaining process." (ISO, 2009b: 15)

In ISO 31000, establishing the context is split in four main parts. The two first parts are establishing the external context and establishing the internal context. Together these two parts are mainly about making sure that the risk management process is aligned with the objectives, strategies and governance structure of the organisation. The third part is establishing the context of the risk management process. This part is mainly about securing that the stakeholders of the risk management framework is aligned in terms of resources to be used and other practicalities related to risk management process activities.

The fourth part of establishing the context is defining risk criteria, and it is useful to take a closer look on what this is about. ISO (2009a) defines risk criteria as:

> "Risk criteria: terms of reference against which the significance of a risk is evaluated
>
> - NOTE 1 Risk criteria are based on organizational objectives, and external and internal context
> - NOTE 2 Risk criteria can be derived from standards, laws, policies and other requirements" (ISO, 2009a: 5)

The perhaps most usual way of characterising and measuring risk is to use likelihood and consequences. However, it is important to understand what the likelihood is related to:

> "Risk is characterised and 'measured' by considering consequences and the likelihoods of those consequences, not the abstract likelihoods of events that might be detached from your organisation's objectives. Consequences and their likelihoods are often combined to define a level of risk."
> (Broadleaf Capitol International PTY LTD, 2009: 2)

Particularly for qualitative risk assessments it is usual to use some form of risk map to study the results:

> "A risk map is a graphic representation of likelihood and impact of one or more risks. Risk maps may take the form of heat maps or process charts that plot quantitative or qualitative estimates of risk likelihood and impact. Risks are depicted in a way that highlights which risks are more significant (higher likelihood and/or impact) and which are less significant (lower likelihood and/or impact). Depending on the level of detail and depth of analysis, risk maps either can present the overall expected likelihood and/or impact or can incorporate an element of variability of likelihood and/or impact." (COSO, 2004b: 47)

The Norwegian Government Agency for Financial Management (2005), which has based their risk management framework on COSO's "Enterprise Risk Management - Integrated Framework" (COSO, 2004a, 2004b), has provided a risk criteria matrix that can be used to assess risks (please refer to Table 2.1).

Though this use of risk criteria matrix and likelihood-impact assessments is common, the technique also receives considerable critics by some risk management experts:

> "…From the above discussion it should be evident that the risk result under the likelihood-impact approach equates to mean severity, which is completely unrelated to the term risk as it is defined by the risk management industry and the BIS. In fact, mean severity multiplied by mean frequency gives you the mean aggregate loss – the expected loss. Whereas the real measure of risk is the unexpected aggregate loss." (Samad-Khan, 2005: 4)

By following the arguments in this article it can be argued that if the risk criterion is only based on the product of likelihood and impact, then the risks would not be related to uncertainty, but rather to the identified issues (expected losses and gains).

	Very High	Large risk	Large Risk	Critical risk	Critical Risk	Critical Risk
	High	Moderate risk	Large Risk	Large risk	Critical Risk	Critical Risk
	Moderate	Low Risk	Moderate risk	Large risk	Critical Risk	Critical Risk
	Small	Low risk	Low Risk	Moderate risk	Large Risk	Critical Risk
	Minor	Low Risk	Low Risk	Moderate risk	Large Risk	Large Risk
Likelihood		Minor	Small	Moderate	High	Very high
	Consequence					

Table 2.1 Example of risk criteria matrix from The Norwegian Government Agency for Financial Management

2.8.2 Risk assessment

In ISO (2009b) risk assessment is described as the overall process of risk identification, risk analyses and risk evaluation. There exist several different risk assessment tools and techniques, and some of these are of particular interest, because they have similarities with the risk management approach used in this research programme.

The Visual Ishikawa Risk Technique

The Visual Ishikawa Risk Technique (VIRT) also referred to as Ishikawa diagrams, fishbone diagrams and cause-effect diagrams, combines the use of risk breakdown structures (RBS) with cause-effect diagrams. The VIRT visualises the causes (the elements in the RBS), which contribute to an effect in a diagrammatic form. The idea behind this technique is that all the main causes (the top level of the RBS) that may affect an objective are explored by splitting each cause into further sub-causes by "drilling" down the RBS. An example of this kind of diagram can be found in Figure 2.8.

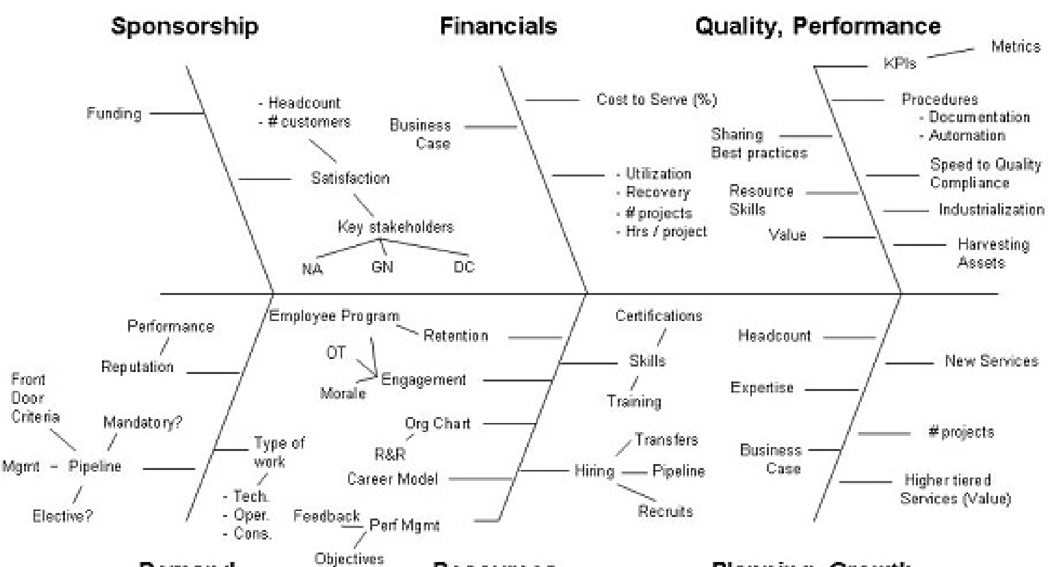


Figure 2.8 Example of Ishikawa diagram (Jen, 2009)

An aspect of the VIRT is that this technique is just as good to identify issues (certain causes of impacts) as risks. PMI (2009: 77) advices users to take care to distinguish between risks and issues, but the candidate would rather focus upon a combination of issues and risks in the same diagram as a positive aspect of the diagram. The reason for this is that both issues and risks affect objectives, and therefore decision makers need to reflect on both issues and risks in their decision making.

Influence diagrams

Influence diagrams are similar to the VIRT in that they establish cause-effect relationships as well. A major difference between the two is that the VIRT is closely related to the RBS, while the Influence diagrams are used to understand how different issues, uncertainties and decisions influence on each other in a given situation. Some of the main characteristics of Influence diagrams are:

> "An influence diagram offers a graphic map of the web of interrelationships bearing on an issue. Its purpose is to make the dynamics of the interrelationships more visible, more explicit, and thus more comprehensible."
> (Diffenbach, 1982: 133)

> "A link represents two factors related such that a change in one influences or exerts pressure on the other to change…A link is depicted graphically as a line connecting the two factors with an arrow pointing to the influenced factor."
> (Diffenbach, 1982: 135)

In a risk management perspective the main advantages of the influence diagram are that it exposes key drivers and that the diagram can generate counterintuitive insights to complex issues (PMI, 2009). In risk management, influence diagrams are particular useful in combination with other tools and techniques such as Monte Carlo simulations, system dynamics simulations and scenario analysis.

Bow-tie diagram

The Bow-tie diagram is useful for improving the understanding of a risk. The diagram is called the Bow-Tie diagram, because it looks like a bow-tie. In the middle of the diagram, the risk is presented. On the left side of the diagram, the various causes of the risk are listed, and on the right side of the diagram, the various effects or consequences of the risk are listed.

In the Bow-tie diagram, it is also possible to add existing or possible new control mechanisms. An example of such a diagram is illustrated in Figure 2.9.

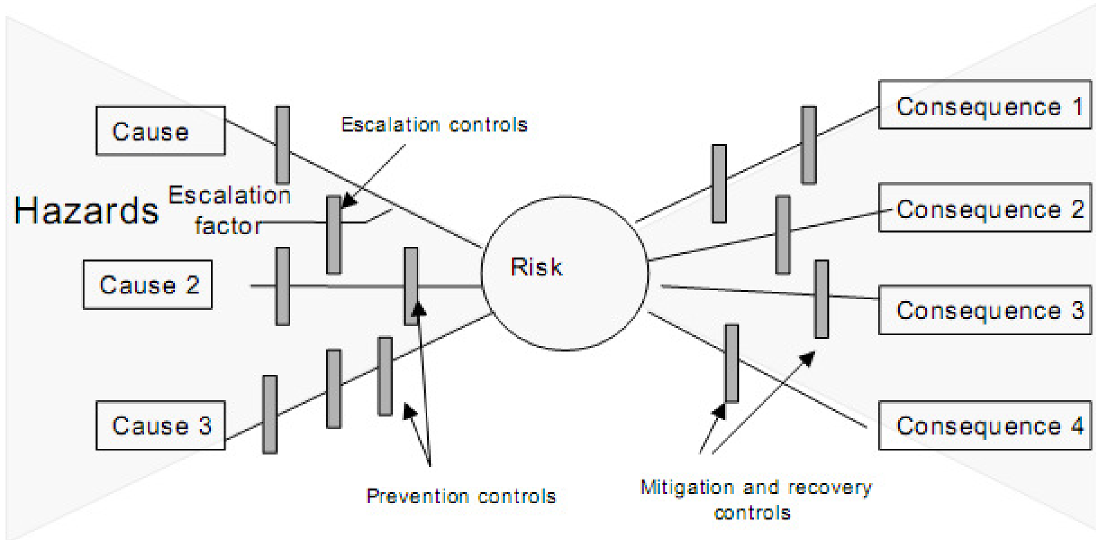


Figure 2.9 Bow tie diagram (IEC, 2009)

The Bow-tie diagram is very useful for visualising risks. A limitation of the diagram is that it cannot depict the cases where multiple causes must occur simultaneously for the risk to take place and thereby cause the effects (IEC, 2009: 66).

2.8.3 Risk treatment

> "Risk treatment involves selecting one or more options for modifying risks, and implementing those options. Once implemented, treatments provide or modify the controls.
>
> Risk treatment involves a cyclical process of:
>
> - Assessing a risk treatment;
> - Deciding whether residual risk levels are tolerable;
> - If not tolerable, generating a new risk treatment; and
> - Assessing the effectiveness of that treatment." (ISO, 2009b: 18-19)

Scenario analysis, where different scenarios are influenced by different actions, can be a very useful risk treatment approach to improve understanding of how different actions may affect the organisation's risk profile. Scenario analysis is particularly useful if an integrated risk management model assessing the total risk profile of the organisation has been established, since actions often cause unanticipated effects in addition to the wanted effects. By modelling different scenarios it can be investigated how the different risk treatment actions are expected to change the total integrated risk profile of the organisation.

2.9 Summary

The literature on risks presents at least three major differences in the understanding of the concept of risk. The first one is whether risks are considered to be potential events with effect on the achievement of objectives or rather associated with deviations from the anticipated outcome. The second major difference is whether risk is understood as a negative concept or includes opportunities as well. The third difference is whether the definition of risk has its emphasis on the probability (or chance) of the occurrence of the uncertainty or emphasis on the effect of the uncertainty. To avoid confusion related to the many definitions of risk, the candidate has chosen to adopt the terminology given by ISO (2009a), which defines risk as "effect of uncertainty on objectives".

The literature on systems suggests that organisations should be considered as a form of complex system working towards the achievement of some common purpose. The field of system dynamics argues that in complex systems, such as organisations, it can be difficult to establish simple cause and effect relationships, because the causes may be far removed in both timing and location from their observed effects. By accepting the arguments presented above, it seems problematic to run different departments in an organisation in isolation, since the activities in one department may cause (unwanted) effects in other departments and because there may also be a considerable time delay between the different causes and effects.

The idea that organisations should be understood as systems also raises interesting questions related to how organisations should organise their risk management function. On one hand, the organisation wants its departments to have some degree of autonomy from the organisation as a whole, but, on the other hand, the organisation wants each department to act in a manner that is aligned with what is best for the organisation as a whole as well. In a risk management context it is necessary to make sure that departments take ownership of risks that may affect their objectives, however, it also seems necessary for organisations to make sure that someone in the organisation keeps an eye on how risks and risk management activities in one department may cause effects in other departments as well. These ideas link well with the literature on risk management. The risk management literature presents the view that organisations should move away from a silo based risk management approach to a more integrated risk management approach often referred to as enterprise (wide) risk management or strategic risk management.

Risk interdependency is an important topic in integrated risk management. The concept of risk interdependency can be divided in four. First, decisions, actions and activities for dealing with an individual risk in one department often affect the achievement of objectives in other departments in the organisation as well. To make the problem even more complex, the effects in the other departments often become apparent much later than when the individual risk was originally dealt with. Second, from finance it is well established that the value of assets and securities tends to correlate, and therefore that isolated risk assessments of each asset and security in a portfolio would lead to suboptimal solutions. Third, safety assessments often show that two risks happening at the same time may cause much worse consequences than if each risk had materialised one at the time. Fourth, risks may also affect the likelihood of other risks in the risk profile. The literature on risk interdependency focuses mostly on the downside of the concept, but organisations are advised to understand that risk interdependencies provide opportunities as well.

The part of the literature review makes it apparent that integrated risk management is a challenging task. The complexity related to the concept of risk interdependency also explains why organisations need some kind of integrated risk management model to be capable of managing their overall risk profile.

The next chapter of the literature review looks at causal risk management models.

Chapter 3 - Causal risk management models

3.1 Introduction

The aim of this chapter is to give an overview of the literature on causal risk management models, and in particular the modelling techniques causal mapping and Monte Carlo simulations.

3.2 Causal mapping

In the foreword of Bryson et al. (2004) a causal map is described as "a word-and-arrow diagram in which ideas and actions are causally linked with one another through the use of arrows". Bryson et al. (2004) make a distinction between individual causal maps and causal maps created by groups:

> "When an individual uses causal mapping to help clarify their own thinking, we call this technique cognitive mapping, because it is related to personal thinking or cognition. When a group maps their own ideas, we call it oval mapping, because we often use oval-shaped cards to record individuals' ideas so that they can be arranged into a group's map." (Bryson et al., 2004: xii)

An introduction to the type of cognitive mapping technique used in this research programme can be found in Ackermann et al. (1992). This type of cognitive mapping technique is developed by Colin Eden, Sue Jones and David Sims (Bryson et al., 2004: 333) and built on the repertory grid founded by Kelly (1955):

> "Cognitive mapping in the style of Kelly builds on three key assertions of the theory. Firstly, man makes sense of his world through contrast and similarity, that is meaning in the context of action derives from relativism. Secondly, man seeks to explain his world--why it is as it is, what made it so. And thirdly, man seeks to understand the significance of his world by organising concepts hierarchically so that some constructs are superordinate to others. Within a problem finding/ solving context this last assertion argues that man values some outcomes over others, sees some outcome as contributing to others, and some beliefs about the situation he faces as means to an end." (Eden, 1988: 3-4)

Bryson et al. (2004) and Ackermann et al. (2005) give a good introduction as to how cognitive mapping, oval mapping and causal mapping can be used to solve problems and in strategy making. Work and literature from Strathclyde University show how mapping can be used in complex problem finding/solving situations (Ackermann et al., 2006; Eden and Ackermann, 2004; Ackermann et al., 1997; Williams et al., 2003).

3.3 Structural simulation models

Risk management models can be divided into two categories and these are statistical analytic models and structural simulation models (Miccolis and Shah, 2001). The major difference is that the statistical analytical models are based on the use of historical data and the correlation between different variables in the model, while the structural simulation models aim to simulate the dynamics of a specified system by developing cause-effect relationships between all the variables of that system by the use of a combination of historical data and expert judgement. Miccolis and Shah (2001) argue that the structural simulation models are superior to the statistical analytical models for modelling operational risks, and this argument is supported both by the body of the work from Strathclyde University (Ackermann et al., 2006) and the work from Deloitte Research (2005). The structural simulation models:

> "…can range from the very mathematically rigorous, such as stochastic differential equations (particularly useful in modelling complex financial risks), to methods that rely on a mixture of mathematical calculations and expert opinion, such as system dynamics simulation, fuzzy logic, and Bayesian belief networks (BBNs)." (Miccolis and Shah, 2001: 2)

Causal mapping is similar to the structural simulation models, system dynamics simulation models, fuzzy logic and Bayesian belief networks (BBNs), in that they all aim to establish causal relationships between concepts. The causal mapping technique does also provide a good starting point for the development of the numerical structural simulation models. In the next section it can be seen that a cascade modelling process, which begins with cognitive and causal maps and ends with system dynamics simulation models, has already been established.

3.4 From causal maps to quantitative structural simulation models

A cascade modelling process that shows the relationship between qualitative (cognitive and causal) maps and quantitative system dynamics simulation models can be found in Howick et al. (2008). This relationship is of particular interest, because from the material on system dynamics (SD) presented in Section "2.3 Organisations understood as systems" it seems like SD is a very suitable methodology for building a quantitative model that can both handle the effect of management actions and the feedback loops resulting from chains of causality from management actions.

The cascade model in Howick et al. (2008) starts with the development of cognitive and causal maps in stage 1. In stage 2 an influence diagram is developed by filtering/reducing the content of the maps created in stage 1. In stage 3 all qualitative ideas are placed in a format ready for quantification in a system dynamics influence diagram (this diagram includes all stocks flows and variables that will appear in the system dynamics model). The fourth stage is the creation of a quantifiable system dynamics simulation model.

System dynamics simulation models give insight of how causal relationships of the elements in the model affect the overall outcome. System dynamics simulation models can be used to analyse feedback loops and feed-forward loops, and by introducing new assumptions or changes in the model it can also be used to analyse how sensitive the system is to specific events and risks (PMI, 2009: 85).

The development of a system dynamics model is not the only option for developing a causal quantitative risk model. Other alternative methods to model operational risks include fuzzy logic and Bayesian belief networks (BBNs) (Acharyya, 2007; Miccolis and Shah, 2001). In addition to these, Monte Carlo simulation is a very useful simulation technique for risk assessments.

3.5 Monte Carlo simulations

Compared with system dynamics, Monte Carlo simulations is relatively easy to use for assessing how a number of risks may affect an objective. The idea is that a model including all factors and all uncertainties is designed, and then simulations are run to assess likely outcomes for an objective. The factors in the model are described with deterministic mathematical functions and numbers. The uncertainties, on the other hand, are described with statistical distributions. Random numbers are used for each uncertainty in the simulation, and thereby will the various simulations give different outputs. By studying the results of all the simulations, the outcome range for the objective can be found.

The Concept report "No 12 Uncertainty analysis – Methods" (Concept, 2005b: 167-177) includes information about how the Norwegian consultancy Terramar AS uses influence diagrams to get quantitative project risk analysis related to cost objectives (candidate note: as can be seen in Section "2.2" Concept uses the term uncertainty in a similar manner to how ISO defines risks). The method contains the following six steps: 1 Decide the context, 2 Identification, 3 Structuring, 4 Modelling, 5 Communication and 6 Response. In particular step 4 Modelling gives some interesting insights on how Terramar uses Monte Carlo simulations and deals with risk interdependency.

In step 4 Modelling, Terramar distinguishes between two types of risks. The first category is risks related to estimation. To model this category of risks Terramar uses triple quantitative estimates (a negative estimate representing 90 % chance of being equal or less than, a neutral estimate and an optimistic estimate representing 10 % chance of being equal or less than) on each factor (node). These estimates are then used as inputs in a Triang3 distribution or other distributions that are more applicable. For example, if all values in the range are considered to be equally likely to occur, the Uniform distribution is used instead of the Triang3 distribution.

The second category is risk related to events. These risks are modelled by using the equation Risk = likelihood x consequence (where the consequence is either set as a single estimate or by using triple estimates in the same manner as for risks related to estimation). After this quantification process, the project is simulated in the SW-program Riscue, which uses Monte Carlo simulations. In this manner, a model of the cost risk profile of the project is simulated. In Riscue it is also normal practice to quantify links and include logical expressions.

Definitions of both the Triang3 distribution and the Uniform distribution can be found in Section "8.4 Software programs used: Riscue". The Triang3 and the Uniform distribution are rather uncomplicated and well behaved distributions. The practical difference between these two distributions can be better understood by running a Monte Carlo simulation in Riscue and comparing the results. In our test simulation, it is used two nodes that are independent of each other. The first node contains a Triang3 distribution using the format Triang3 (P10; Mode; P90), where the values Triang3 (0.1; 0.5; 0.9) are chosen. The second node contains a Uniform distribution using the format Uniform (Minimum; Maximum), where the values Uniform (0; 1) are used. The outputs from 100,000 simulations are shown in Figure 3.1 and Figure 3.2.

Figure 3.1 shows smooth estimates of the probability density functions. The probability of getting values in a given interval on the X-axis can be estimated as the area under the density curve over this interval. Figure 3.2 shows the estimated cumulative probability functions, often referred to as S-curves. For each value, x, on the X-axis the S-curve shows the corresponding cumulative probability, that is the probability of getting a value less than or equal to X.

These test simulations indicate that both the Triang3 and the Uniform distribution are valid and useful distributions if the expected output range of an uncertainty is known, two-sided and "well behaved".

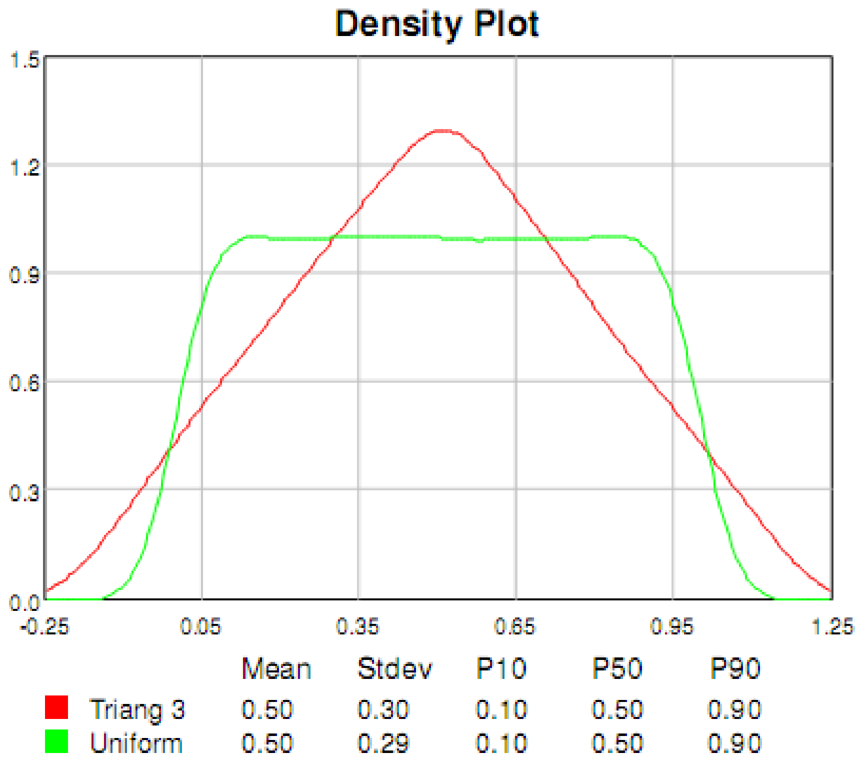


Figure 3.1 Density plot of Triang3 (0.1; 0.5; 0.9) and Uniform (0; 1)

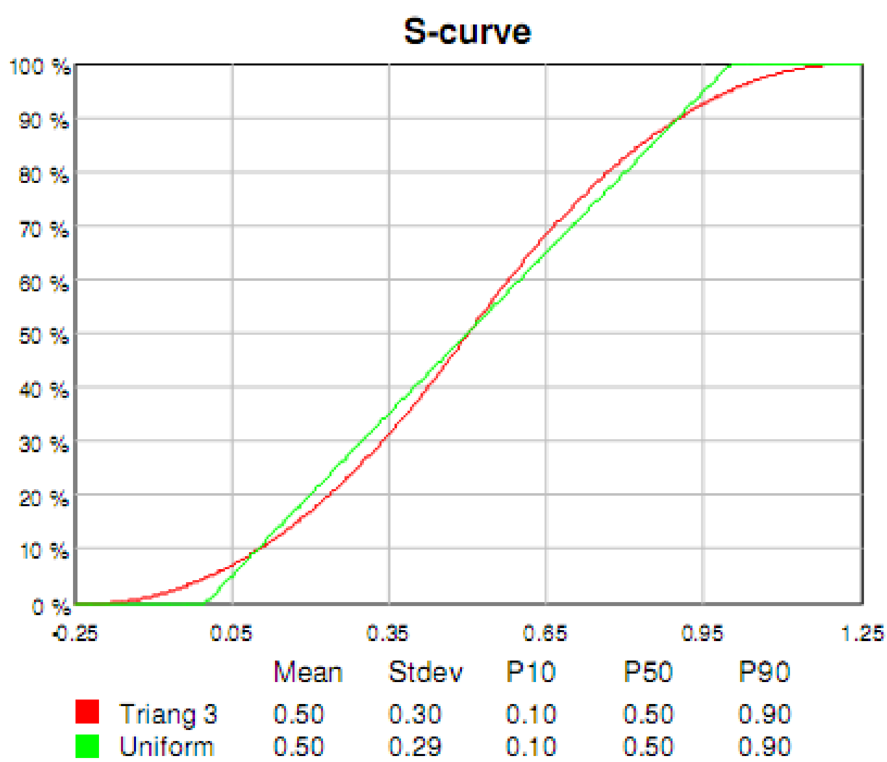
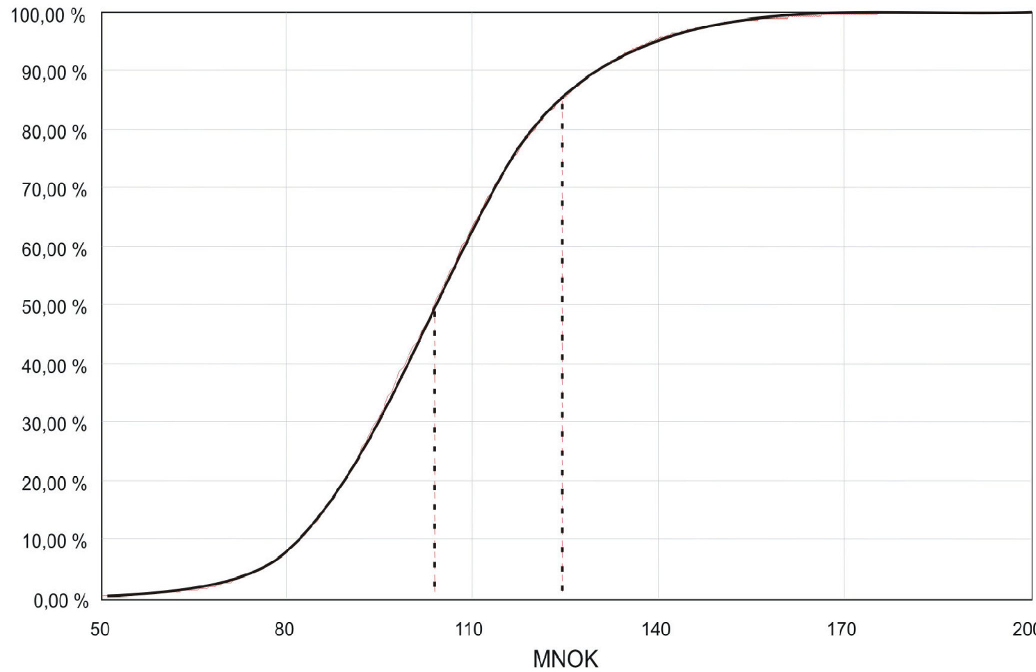


Figure 3.2 S-curve of Triang3 (0.1; 0.5; 0.9) and Uniform (0; 1)

Under step 4 Modelling in Concept (2005b: 173) it is also referred to that Terramar believes that "in all major projects there will be risk interdependency (systematic risks) between some of the risk elements". Terramar expresses these relationships by using correlation and functional relationships between the risk elements in the model.

The candidate would like to add that neither Monte Carlo simulations in general nor the SW-program Riscue require the use of simple distributions such as Triang3 and Uniform. The modeller can use a wide variety of different distributions dependent on the specific problem being modelled. Though, it is possible to generate large and complex models using complex distributions, it is an extremely challenging task for modellers to design such complicated models accurate. This might also explain why in general it is considered to be a limitation of Monte Carlo simulation models that they may "not adequate weight high consequence, low likelihood events" (IEC, 2009: 75). The recent financial crisis has increased the awareness of this limitation, but the practical problem of designing accurate models remains.

In the Concept report, step five communication is also described. In this step a quantitative representation of the cost risk profile of the project is expressed by the use of an S-curve, where the horizontal axis presents total cost and the vertical axis presents the likelihood in percentage. The S-curve represents the likelihood of delivering/finishing the project below or equal to the cost stated in the horizontal axis (see Figure 3.3). Terramar also uses Tornado diagrams to show which factors are contributing the most to the cost risk profile of the project (see Figure 3.4).



	Mean	Base	P10	P50	P85	P90
Total	105	100	82	104	124	130

Figure 3.3 Example of S-curve for total cost (Concept, 2005b)

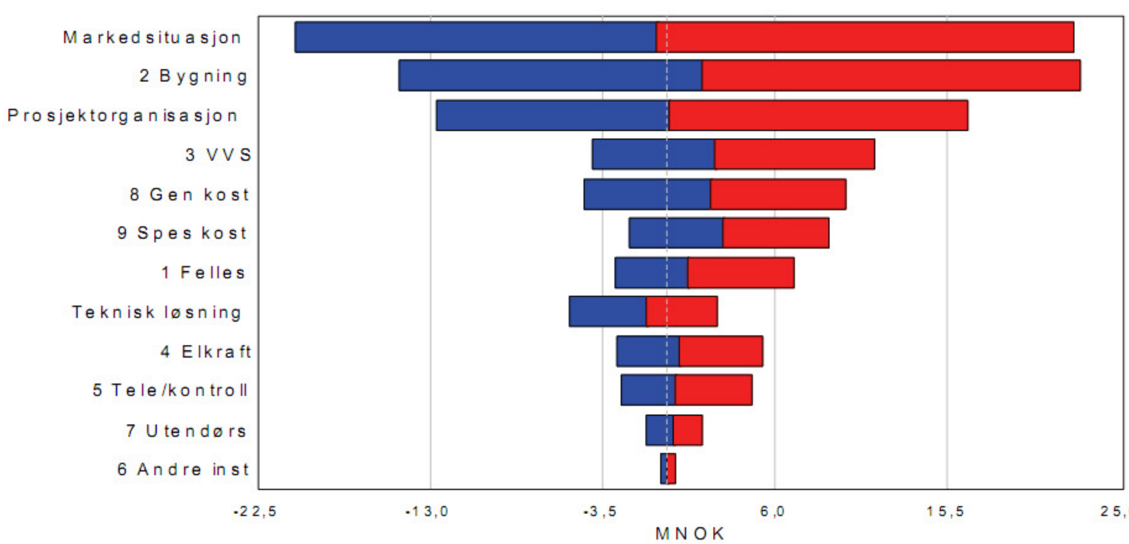


Figure 3.4 Example of Tornado diagram (Concept, 2005b)

The technique described is limited to risk assessments related to single cost objectives of the project (Terramar also conduct similar analysis for time objectives). The perhaps most important finding from the Concept report is that the modelling approach of Terramar uses the idea of cause – effect to simulate risks and uncertainty, and uses functional relationships and correlation between elements to represent risk interdependency (risk systemicity) between risk elements.

By comparing the information above with Miccolis and Shah (2001) on statistical analytical risk models and structural simulation risk models, it appears that Terramar's modelling approach has one foot in the statistical analytical risk model family (to simulate risk interdependency) and one foot in the structural simulation risk model family (to simulate risk and uncertainty).

Williams (2004) also looks at the use of Monte Carlo simulations on projects. This article points at two specific flaws, which may lead to Monte Carlo simulations of project networks being misleading:

> "Monte Carlo simulation of project networks is a standard project-modelling technique. However, much of this analysis is inadequate, as project managers always take action to recover late-running projects, which is ignored in most models. …The paper also notes a second flaw, explaining why risk-analyses rarely predict catastrophic overspends that sometimes occur, namely the inability to capture feedback loops resulting from chains of causality from management actions." (Williams, 2004: abstract)

Regarding the first problematic area Williams (2004: 60) concludes that "Modelling management actions within the context of a Monte Carlo simulation of a network is quite feasible, requiring the establishment and then coding of the decision- rules, and modelling of the consequences of these decisions" and that "Starting to model the behaviour of project managers can bring realism, and both usefulness and credibility, to our Monte Carlo simulations".

Regarding the second flaw this can be related to the fact that management action usually has both positive and negative effects, and that these immediate effects will cause secondary effects which again will cause new effects and so on. These relations are usually referred to as causal chains of effects. Williams (2004) conclusions related to chains of causality of effects are of particular interest for the development of an ICRMM:

- "(iv) Management actions have disadvantages as well as benefits, and both must be modelled. Not only the immediate effects, but any secondary effects and so on, must be modelled.
- (v) If a chain of causality found in (iv) "circles around" to become a positive feedback loop, the potential of major overspends is generated. While this cannot be modelled easily within the context of a network model, this is nevertheless an unacceptable scenario, and policies or action-plans must be established to ensure that such feedback is not set up. Flagging this is up to management and ensuring such planning is done can, in itself, be valuable in avoiding major overspends.
- (vi) Conclusion (v) means that rigorous analysis of the actions management would be likely to take in the case of a late-running project should enable decision-rules to be defined that would indicate what would be likely to happen in particular scenarios, and thus a simulation can be modified to include these." (Williams, 2004: 60)

Eden et al. (2000) examine how small delays may cause serious consequences for projects. The article focuses on "the variety of ways in which disruptions occur, and the variety of consequences that may unfold". This article provides a particularly good overview on how management actions taken to accelerate a project may actually disrupt and delay the project due to unexpected cause-effect relationships forming feedback-loops. An example of how this may occur is presented in the influence diagram in Figure 3.5. The scenario in this figure is that the project is behind the schedule, and this figure shows how the managerial actions (i) using overtime and (ii) placing pressure on staff in an attempt to increase work rate may create negative side effects. In the influence diagram in the figure there are actually 22 feedback loops linked together in cause-effect relationships.

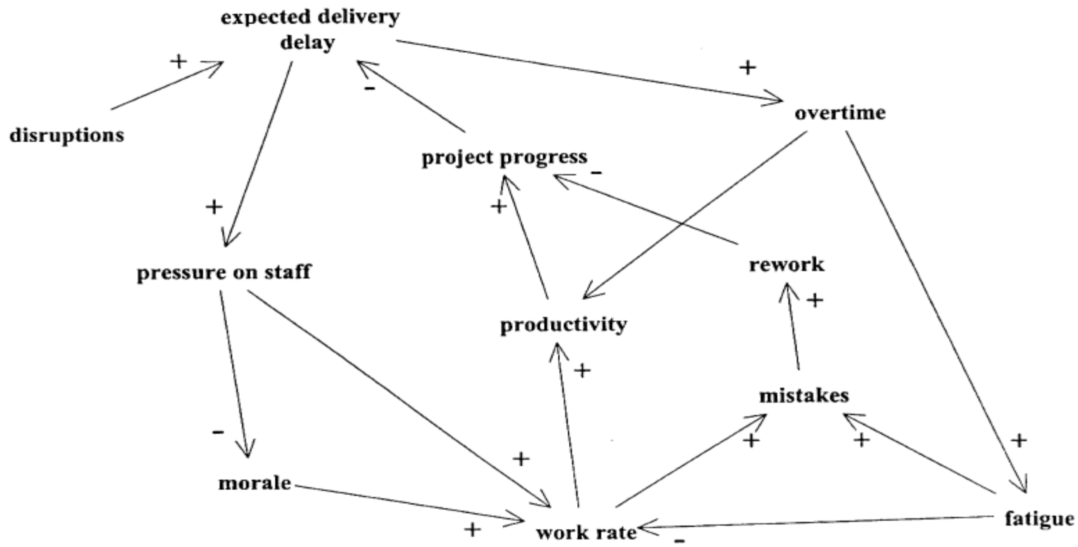


Figure 3.5 Example of influence diagram with feedback loops (Eden et al., 2000)

Figure 3.5 can also be used to illustrate the difference between statistical analytical models and structural simulation models. To do this it is helpful to first look at what Miccolis and Shah (2001) write about statistical analytical models used to model operational risks:

> "...What is not so simple, managers find, is using the statistical modelling tools with operational risks. Those are the risks that arise from such things as the entry of a new product or company into a market, poor business judgment on the part of a senior manager, or the decision to use a new product distribution system such as the Internet (or even direct telemarketing). Financial managers who are comfortable with using statistical tools to model financial risks find themselves frustrated when trying to use those tools with these sorts of risks. The problem, they say, is that there is not enough historical data on operational risks to build valid statistical models. The solution, they say, is to start building databases of operational risks - and many of them, especially in the banking industry, have begun to do exactly that." (Miccolis and Shah, 2001: 1)

To build a valid statistical analytical model related to "expected delivery delay" of a project it is needed a considerable amount of historical data. A problem in the collection of data is that

> "...every project creates a unique product, service, or result. Although repetitive elements may be present in some project deliverables, this repetition does not change the fundamental uniqueness of the project work. For example, office buildings are constructed with the same team, but each location is unique – with a different design, different circumstances, different contractors, and so on."
> (PMI, 2008: 5)

The statistical analytical model cannot consider the uniqueness element of the project to be simulated, because this would result in lack of comparable data to build the model. The action "pressure on staff" is not unique, but the expected result of this action would be influenced by many different factors such as the status of the project, the status of the project manager, the project organisation, the financial position of the company, worker loyalty, etc. To complicate matters even more, the different factors that affect the success of the action "pressure on staff" will also influence on each other.

Miccolis and Shah (2001: 2) state that "Structural methods differ from statistical models because they simulate the dynamics of a specific system by developing cause-effect relationships between all the variables of that system". The structural modelling approach accepts that there is often a lack of reliable statistical data, and in these cases expert judgements are used instead. The structural simulation models are built on the premises that expert judgements are a more valid representation of unique conditions than statistical data of generalised conditions. In the cases where relevant historical statistical data of relevant conditions or factors (such as currency exchange rates, temperatures, prices of a particular service, product, etc.) are available, the historical statistical data are either used directly or in combination with the expert judgement as inputs to the model. The candidate agrees with Miccolis and Shah (2001) that the structural simulation modelling approach is much better suited to create risk management models for organisations than statistical models.

3.6 Qualitative or quantitative: that is the question

Causal maps and Influence diagrams express causal relationships in a qualitative manner. The structural simulation models, such as system dynamics simulation models, fuzzy logic and Bayesian belief networks, takes the analysis a step further and aim to quantify the concepts and the causal relationships between the concepts. The three structural simulation models mentioned are similar in that they use a combination of historical data and expert opinion to assess the numerical values.

The idea of having a quantified integrated causal risk management model (ICRMM) sounds attractive. However, there are some major challenges when it comes to the design of a reliable quantitative ICRMM. First, in Butcher et al. (2006: 76) it is observed that "many experts argue today that asset and financial risk resist quantification" and that "many of what we once thought were "risks" are turning out to be uncertainties - and the list of both risks and uncertainties appears to be expanding continuously" [Butcher et al. (2006) uses the descriptions of risk and uncertainty provided by Knight (1921) which is presented in Section 2.2]. Clearly if several of the concepts in the ICRMM resist quantification, an attempt to design an accurate quantitative ICRMM covering the total risk profile of an organisation in a precise manner is doomed to failure.

In the candidate's view, the correct question is not about whether or not the ICRMM provides the exact quantitative risk profile of the organisation, but rather whether or not the quantitative ICRMM can be aligned with the principles for managing risk presented in ISO (2009b: Chapter 3), and in particular clause 3c "Risk management is part of decision making". If the ICRMM provides reliable enough information such that "risk management helps decision makers make informed choices, prioritize actions and distinguish among alternative courses of action" (ISO, 2009b: 7) then the necessary accuracy of the ICRMM has been achieved. Based on this, the candidate's conclusion is that the identified problem can be overcome, but the candidate believes that it is necessary to incorporate qualitative information in the ICRMM to comply with the ISO principles in an integrated risk management context.

A second challenge is related to modelling "feedback loops resulting from chains of causality from management actions" (Willams, 2004). Though both system dynamics and fuzzy logic are methodologies developed to deal with feedback-loops, it should be clear that the inclusion of feedback-loops considerably increase the complexity with regards to developing a reliable quantitative ICRMM.

The cascade model presented in Howick et al. (2008) shows how a reliable system dynamics simulation model with feedback loops can be developed. However, it is necessary to understand that in that particular case the situation to be modelled was an event from the past, and thereby the model could be tested and evaluated against the actual event that had occurred. The ICRMM on the other hand needs to be a reliable representation of the future where the model gives a reliable prediction of the likely effect of proposed actions on the risk profile of the organisation. The design of a reliable ICRMM thereby becomes considerably more complex than the case presented in Howick et al. (2008).

Monte Carlo simulation and Bayesian belief network models are acyclic and cannot capture feedback loops. However, as mentioned in Section "3.5 Monte Carlo simulations", this problem can be overcome by the coding of the decision-rules and the modelling of the consequences of these decisions for Monte Carlo simulations (Williams, 2004). In the candidate view, the same applies for Bayesian belief networks and therefore the second challenge can be overcome for this simulation method as well.

A third challenge is that the objectives of an organisation are not necessarily stated in measurable terms. This difficulty can be illustrated by comparing a measurable financial/budget objective of a project and a qualitative operational objective. As described in Section "3.5 Monte Carlo simulations" simulations can be conducted to present an S-curve for the financial/budget objective of a project, where the S-curve represents the likelihood of delivering/finishing the project below or equal to the cost stated in the horizontal axis (see Figure 3.3). These types of simulations are regarded as quantitative simulations.

In Subsection "6.3.1 Introduction to the sample: the University of Life Sciences", it is presented that the University of Life Sciences' operational objective 1.1 is "The universities shall educate candidates who are highly qualified and have competences relevant for the needs of the society". To assess whether or not this objective has been achieved the personnel in the organisation must use subjective and qualitative evaluation criteria. Since the evaluation criteria are subjective and qualitative, people may reach different conclusions about the status of an objective even though they are presented with the same facts. Thereby it is impossible to conduct an objective and quantitative simulation to obtain the risk profile of the objective.

The literature indicates that it may be very difficult to design a pure quantitative ICRMM. An alternative solution for the design and use of the ICRMM may be to combine qualitative and quantitative data or mixed-mode modelling as advocated by Eden et al. (1986). To combine qualitative and quantitative data is also the likely interpretation of what ISO (2009b) refers to as the use of semi-quantitative analysis. The mixed-mode modelling or semi-quantitative analysis may for example be a combination of causal mapping and any of the structural simulation models presented in Shah (2002), or to use a model which is designed to combine qualitative and quantitative information. In the case of mixed-mode modelling or semi-quantitative analysis the use of Monte-Carlo simulation may also prove to be a reliable and good choice for a simulation technique for an ICRMM.

3.7 Summary

This section of the literature review has looked at causal risk management models. It is apparent that there are some major design challenges related to designing a reliable quantitative ICRMM representing the total risk profile of an organisation. Alternative solutions to the development of a pure quantitative representation of the risk profile may be to use a qualitative or a mixed qualitative and quantitative representation of the risk profile. The literature seems to suggest that causal mapping can be a viable technique to create a qualitative ICRMM, but also that such maps provide excellent starting points for the development of semi-quantitative structural simulation ICRMM.

Chapter 4 - Literature synthesis and the development of a basic research question

4.1 Introduction

The aim of this chapter is to synthesise the main outcomes of each chapter in the literature review. The outcome of this synthesis is then used to develop a basic research question.

4.2 The Literature Synthesis

The literature indicates the following observations related to the design, implementation and use of an integrated causal risk management model to predict the likely effect of proposed actions on the risk profile:

- Effective integrated causal risk management models can be designed and implemented
- Organisations need to establish the risk profile facing the organisation
- Integrated causal risk management models can be used to predict the likely effect of proposed actions on the risk profile

4.2.1 Effective integrated causal risk management models can be designed and implemented

Managers have always practiced some form of risk management. However, according to the literature (Lam, 2000; Meulbroek, 2001, 2002b; Acharyya, 2007; Layton and Garitte, 2008) the risk management practices are currently changing from managing risks departmentally, in silos, to a more integrated approach to risk management that is commonly referred to as enterprise (wide) risk management (ERM) or strategic risk management.

The drive towards integrated risk management is likely to be one of the main reasons for the ISO work on a risk management standard that is generic and can be applied to a wide range of activities, decisions, and operations of any public, private or community enterprise, association, group or individual. The new ISO risk management standard, named Risk management – Principles and guidelines (ISO, 2009b), was published 15/11-2009. An overview of how ISO considers the relationships between risk management principles, framework and process are presented in Figure 2.3.

Establishing the risk profile facing an organisation is a challenging task due to the concept of risk interdependency. The literature on risk interdependency is particularly well covered by specialists working in project risk management. An important article on the interaction between project risks is written by Ackermann et al. (2006). In this article they write that "risks can be seen as a network of interrelated possible events, which may be referred to as risk systemicity". This article gives references to previous work of the authors that "show that it is the interaction between different types of risk that can cause the most damage to a project" (Williams et al., 1997; Eden et al., 2000, 2005).

Ackermann et al. (2006) link well with the results found in the "Disarming the Value Killers" study by Deloitte Research (2005) that presents one of the key findings as:

> "Manage Critical Risk Interdependencies
>
> - Critical Concern: Eighty percent of the companies that suffered the greatest losses in value were exposed to more than one type of risk. But firms may fail to recognize and manage the relationships among different types of risks. Actions taken to address one type of risk, such as strategic risk, can often increase exposure to other risks, such as operational or financial risks.
>
> - Recommended Response: Companies need to implement an integrated risk management function to identify and manage interdependencies among all the risks facing the firm." (Deloitte Research, 2005: 1)

Risk management models can be divided in two categories and these are statistical analytic models and structural simulation models (Miccolis and Shah, 2001). The major difference is that the statistical analytical models are based on the use of historical data and the correlation between different variables in the model, while the structural simulation models aim to simulate the dynamics of a specified system by developing cause-effect relationships between all the variables of that system by the use of a combination of historical data and expert judgement. Miccolis and Shah (2001) argue that the structural simulation models are superior to the statistical analytical models for modelling operational risks, and this argument is supported both by the body of the work of Strathclyde University (Ackermann et al., 2006) and the work of Deloitte Research (2005). The integrated causal risk management model (ICRMM) in this research programme is part of the structural simulation model family.

Roberts et al. (2003c) have developed a process model for strategic risk management, which is an ICRMM developed to deal with the concept of risk interdependency. The strategic risk management model consists of two primary components. The first component is a generic component, which works as a model of the risk management process in any application, and the second component is a plug in risk interdependency field assessment that takes into account the characteristics of the individual organisation. Regarding the risk interdependency field (RIF) concept they write:

> "The RIF concept is based on the idea of risks having different magnitudes in relation to each other, and of the risks that an organisation is exposed to being interlinked. Risk events in one part of the organisation can have a direct impact on risk events elsewhere in the organisation. A particular decision affecting one risk could impact directly on other risks in the profile. The RIF is a form of matrix that shows the risk present at each section of organisational horizontal risk level and at each section of the organisational vertical functional divisions." (Roberts et al., 2003c: 8/37)

Roberts et al. (2003c) have not presented any applied research which shows that organisations are capable of using the RIF concept in practice. In addition, the literature does not present a clear answer to what degree an effective quantitative ICRMM can be designed. The literature provides evidence that quantitative models are used to develop quantitative silo risk management models related to financial objectives (Froot et al., 1994), project objectives (Williams 2004; Concept 2005b) and operational objectives (Acharyya, 2007). Regarding the operational objectives, it should be noted that Acharyya (2007: 17) advocates for "a suitable balance between qualitative and quantitative approaches towards measuring and managing operational risk and integrating operational risk with financial risk".

An alternative solution for the design of an ICRMM may be to look for a suitable balance between use of quantitative and qualitative data as advocated by Acharyya (2007) or what is referred to as "mixed-mode modelling" advocated by Eden et al. (1986). The mixed model may, for example, be a combination of causal maps and Monte-Carlo simulation or any of the structural simulation models presented in Shah (2002).

The design, implementation and use of an ICRMM should be conducted in iterative cycles, where the design criteria for each iterative cycle are based on the needs of the organisation. The first design, can for example, use the causal mapping approach, which provides a qualitative representation of the risk profile of the organisation. The next iterative designs of the ICRMM will be based on the new needs and wants of the sample organisations, and these processes may prove that part of the total risk profile must be expressed either semi-quantitative or quantitative. The semi-quantitative and quantitative models may be designed by the use of the system dynamics approach, the fuzzy logic approach, Bayesian belief networks or Monte Carlo simulations. The end design of the ICRMM for the sample organisations may therefore prove to be:

- a qualitative ICRMM where all the information is expressed in qualitative causal maps
- a quantitative ICRMM where all information is expressed numerically in a structural simulation model
- a semi-quantitative ICRMM where the information is expressed by using a combination of qualitative and quantitative information

Conclusion: The literature indicates that an effective integrated causal risk management model can be designed and implemented.

4.2.2 The risk profile facing an organisation can be established

The literature does not agree on a single definition of either risk or risk related subjects. Therefore ISO (2009a: 1) has published an updated standard for risk management vocabulary (terminology) that "aims to encourage a mutual and consistent understanding of, and a coherent approach to, the description of activities relating to the management of risk, and the use of uniform risk management terminology in processes and frameworks dealing with the management of risk". The standard contains the following definitions of risk, risk profile and risk management process:

Definition of risk:

> "Effect of uncertainty on objectives
>
> - NOTE 1 An effect is a deviation from the expected — positive and/or negative.
> - NOTE 2 Objectives can have different aspects (such as financial, health and safety, and environmental goals) and can apply at different levels (such as strategic, organization-wide, project, product and process).
> - NOTE 3 Risk is often characterized by reference to potential events and consequences, or a combination of these.
> - NOTE 4 Risk is often expressed in terms of a combination of the consequences of an event (including changes in circumstances) and the associated likelihood of occurrence.
> - NOTE 5 Uncertainty is the state, even partial, of deficiency of information related to, understanding or knowledge of an event, its consequence, or likelihood." (ISO, 2009a: 1-2)

Definition of risk profile:

> "Description of any set of risks
>
> - NOTE The set of risks can contain those that relate to the whole organization, part of the organization, or as otherwise defined." (ISO, 2009a: 12)

Definition of risk management process:

> "Systematic application of management policies, procedures and practices to the activities of communicating, consulting, establishing the context, and identifying, analyzing, evaluating, treating, monitoring and reviewing risk." (ISO, 2009a: 3)

The risk management process is a core element of ISO 31000 (ISO, 2009b), and the elements in and their relationships can be seen in Figure 2.7. The risk profile facing an organisation can be established by conducting the risk management processes establishing the context and risk assessment.

The ISO 31000 "Establishing the context" section includes four main themes and these are establishing the external context, establishing the internal context, establishing the context of the risk management process and developing risk criteria. This section in ISO 31000 effectively describes what has to be considered and conducted to establish the context for a full-scale integrated risk management system. However, this research programme focuses on the ICRMM and therefore establishing the context has been reduced to two themes: "establishing the external and internal context" and "developing risk criteria". The theme "establishing the context of the risk management process" has been considered as outside the scope of this work, except for defining the risk assessment methodology.

A particular useful approach to establish the external and internal context is to use an approach with causal maps. These causal maps can be created by using cognitive mapping and oval mapping as presented in Ackermann et al. (2004) and Bryson et al. (2004). The context can also be established by creating causal maps from documents covering strategic plans, operational processes and project plans.

Risk management is an integral part of all organisational processes (ISO, 2009b: 7). This risk management principle suggests that the external and internal context can be established by using information from other organisational processes. The first step of establishing the external and internal context is to create causal maps related to strategy processes in the organisation. Examples of strategy processes that work well the ICRMM include the approach advocated in Ackermann et al. (2004: tasks 1a to 7c), by combining the Strategic Planning process in Scott (2003) and the Making Strategies Work process in Roberts and MacLennan (2003), and the Balanced Scorecard framework developed by Kaplan and Norton (1992). The next step for establishing the external and internal context is to create causal maps related to the organisation's projects and operational processes. The different maps should be merged together in one master-map with causal relationships between all statements. The end result of this process will be a causal map covering aims and objectives, external and internal environmental factors, strategies, critical success factors, critical actions, issues, etc.

The second part of the risk management process establishing the context is developing risk criteria. This activity can be understood as:

> "Risk criteria: terms of reference against which the significance of a risk is evaluated
>
> - Note 1 Risk criteria are based on organizational objectives, and external and internal context
> - NOTE 2 Risk criteria can be derived from standards, laws, policies and other requirements" (ISO, 2009a: 5)

A common approach to develop the risk criteria for qualitative risk assessments is to use a risk criteria matrix (please refer to Table 2.1). Though this use of risk criteria matrix and likelihood-impact assessments is common, the technique also receives considerable criticism from some risk management experts:

> "…it should be evident that the risk result under the likelihood-impact approach equates to mean severity, which is completely unrelated to the term risk as it is defined by the risk management industry and the BIS. In fact, mean severity multiplied by mean frequency gives you the mean aggregate loss – the expected loss. Whereas the real measure of risk is the unexpected aggregate loss." (Samad-Khan, 2005)

By following the arguments in this article it can be argued that if the risk criterion is only based on the product of likelihood and impact, then the risks would not be related to uncertainty, but rather to identified issues (expected losses and gains). A solution to this problem is to establish several risk criteria for each objective when numerical simulations are conducted. For example, there can be established a risk criterion for the mean value of the simulation, a risk criterion for the standard deviation and also a number of risk criteria for chosen percentages of simulations (for example 10 percent of the simulations should not result in cost exceeding £ X). If the simulations are rather simple and "well behaved" then it will typically be enough to establish one risk criterion in the region P5 to P20 and one risk criterion in the area of P80 to P95 in addition to risk criteria for P50 and the mean value. For more complex models and simulations risk criteria for further P-values may be appropriate.

In the ISO 31000 risk management process, risk assessment follows establishing the context. Risk assessment is an overall process of risk identification, risk analyses and risk evaluation. To find the risk profile facing an organisation, all the results from the risk assessment process must be integrated in one common model where the concept of risk interdependency has been assessed as well. There exist numerous of risk assessments methods and techniques and some of these, such as the Visual Ishikawa Risk Technique (VIRT) and Influence diagrams, use causality to represent risks. These risk assessment methods are in particular useful to find the overall risk profile of the organisation.

Conclusion: The literature indicates that the risk profile facing an organisation can be established.

4.2.3 The integrated causal risk management model can be used to predict the likely effect of proposed actions on the risk profile

To predict the likely effect of proposed actions on the risk profile is closely related to the risk management process risk treatment:

> "Risk treatment involves selecting one or more options for modifying risks, and implementing those options. Once implemented, treatments provide or modify the controls.
>
> Risk treatment involves a cyclical process of:
>
> - Assessing a risk treatment;
> - Deciding whether residual risk levels are tolerable;
> - If not tolerable, generating a new risk treatment; and
> - Assessing the effectiveness of that treatment." (ISO, 2009b: 18-19)

The ICRMM is useful for establishing the risk profile facing an organisation, but the ICRMM's main strength can be found by using it to improve decision making for the risk management process risk treatment. To understand the strength of the ICRMM it is useful to look at three of the risk management principles in ISO (2009b):

> **"Principle b) Risk management is an integral part of organizational processes.**
> Risk management is not a stand-alone activity that is separate from the main activities and processes of the organization. Risk management is part of the responsibilities of management and an integral part of all organizational processes, including strategic planning and all project and change management processes." (ISO, 2009b: 7)

> **"Principle c) Risk management is part of decision making.**
> Risk management helps decision makers make informed choices, prioritize actions and distinguish among alternative courses of action." (ISO, 2009b: 7)

> **"Principle g) Risk management is tailored.**
> Risk management is aligned with the organization's external and internal context and risk profile." (ISO, 2009b: 8)

The ICRMM is fully aligned with these principles. In the ICRMM all factors, including deterministic factors and factors with uncertainty, relevant for the achievement of the organisation's objectives are included in the model. The interdependencies between the factors are included in the ICRMM as well. The inclusion of all relevant factors and their interdependencies are to make the ICRMM holistic, which clearly is aligned with the ISO principle b and g.

To understand why this is so important, we can look back at the short case study about Avinor presented in Subsection "2.4.1". In this case study, the Norwegian Air Navigation Services Provider Avinor had initiated a result improvement programme (Take-off 05) to improve the financial position of the organisation (to improve the financial risk profile). The case study describes how Avinor's lack of holistic assessments of the impact of the changes led to 15 months of chaos in the Norwegian civil aviation, including the departure of the CEO and the replacement of the Chairman of the Board. The drastic consequences of the result improve programme in Avinor demonstrate how actions chosen for treating risk affecting one type of organisational objective can affect the achievement of other types of objectives, in a manner not anticipated by the decision makers, as well. As the ISO risk management principle c, the ICRMM is designed to help “decision makers make informed choices, prioritize actions and distinguish among alternative courses of action,” by taking a holistic view of all risk management decisions.

The ICRMM in this research programme is closely related to the Risk interdependency field model (RIF-model) in Roberts et al. (2003c: Chapter 8). The authors write that the RIF concept is useful for decision making, because the RIF-model has a predictive element in addition to the representation of how the risk profile of the organisation is structured. This predictive element is particularly useful because:

> “It offers a predictive facility that shows the interrelationships and interdependencies between risks, at the stage when risk related decisions are being made. It can also demonstrate alternative possible scenarios and outcomes in relation to the risks involved.” (Roberts et al., 2003c: 8/6)

The predictive facility of the RIF is particular useful for considering how risk related decisions may lead to unintended outcomes due to risk interdependency as described in the Avinor case study.

The literature on project risk management shows that organisations are using similar ideas as the RIF concept to predict how management actions affect other parts of the risk profile for projects (Eden et al., 2000; Concept, 2005b; Ackermann et al., 2006). However, neither Roberts et al. (2003c) nor the remainder of the literature seem to present any applied research, which provides evidence that organisations use similar models in an integrated risk management context to predict the likely effect of proposed actions on the total risk profile of the organisation considering risks related to strategic-, project- and operational objectives. If an organisation is able to use the RIF concept to predict the likely effect of proposed actions on the risk profile, then this would definitely be a powerful tool which could be the decisive element that makes it possible to conduct integrated risk management for real for any given organisation.

Conclusion: The literature indicates that the integrated causal risk management model can be used to predict the likely effect of proposed actions on the risk profile.

4.3 The development of a research question

Most organisations, both public and private organisations, starting the "integrated risk management journey" are motivated by penalty avoidance or to comply with rules and regulations in the beginning. Some organisations move on the risk management maturity continuum and realise that risk management is not about just complying with rules and regulations, but rather about improving stakeholder value by creating a competitive advantage. The ICRMM is suitable for organisations wanting to create competitive advantage by using the ICRMM to improve risk management decision making.

The literature indicates that the design, implementation and use of an ICRMM are valid research areas, and that the key element is the extent to which the studied organisations succeed in using the ICRMM to predict the likely effect of proposed actions on the risk profile.

Based on the information above, it seems reasonable to formulate the research question as:

- How can an integrated causal risk management model be designed, implemented and used to predict the likely effect of proposed actions on the risk profile?

Chapter 5 - Action research as the overall research methodology

5.1 Introduction

The aim of this chapter is to describe the approach to data collection and processing used in generating the research data and results. The methodology was designed to allow the candidate to address the following research question:

- How can an integrated causal risk management model be designed, implemented and used to predict the likely effect of proposed actions on the risk profile?

This research programme was inspired by action research. The candidate decided to collaborate with the research sample organisations in their initiative to design, implement and use the ICRMM to predict the likely effect of proposed actions on the risk profile.

The research programme was conducted in three research cycles. Each research cycle can be understood as a discrete experiment, where the effects of the different actions conducted were studied. As such, each research cycle had its own research cycle question, which was developed from the literature, information gathered from the interaction with the sample organisations, as well as, reflections from previous research cycles.

This chapter only contains information about the overall research programme. There are also individual research methodology chapters for each research cycle. The choice of using separate chapters for the different research cycles was taken to show how the results of previous research cycles affected the research methodology for the next research cycle.

5.2 Study philosophy

Susman and Evered (1978) have written an important action research article where they criticise positivist science for being of little use when solving practical problems:

> "There is a crisis in the field of organizational science. The principal symptom of this crisis is that as our research methods and techniques have become more sophisticated, they have also become increasingly less useful for solving the practical problems that members of organizations face.
>
> Many of the findings in our scholarly management journals are only remotely related to the real world of practicing managers and to the actual issues with which members of organizations are concerned, especially when the research has been carried out by the most rigorous methods of the prevailing conception of science...
>
> What appears at first to be a crisis of relevancy or usefulness of organizational science is, we feel, really a crisis of epistemology. This crisis has risen, in our judgment, because organizational researchers have taken the positivist model of science which has had great heuristic value for the physical and biological sciences and some fields of the social sciences, and have adopted it as the ultimate model of what is best for organizational science. By limiting its methods to what it claims is value-free, logical, and empirical, the positivist model of science when applied to organizations produces a knowledge that may only inadvertently serve and sometimes undermine the values of organizational members."
> (Susman and Evered, 1978: 582-583)

The candidate believed, and still believes, that the positivist paradigm has an important place in business research, but, like Susman and Evered (1978), the candidate thinks that positivism has limitations when it comes to generating new knowledge. In this research programme the candidate decided to interact with the research sample organisations to generate knowledge about the risk management issues that the research sample organisations were facing, and this approach to research is not aligned with the positivist paradigm. Based on this, the candidate decided to reject the hypothesis-based approach often used in positivist research.

The research adopted the phenomenological paradigm primarily. The phenomenological paradigm with its underlying philosophy was chosen because the candidate felt it was important to use the research approach that would give the best understanding of the wide range of variables and the linkages between the variables that influence the samples. This research approach is often referred to as exploratory-based research.

5.2.1 Action research

The underlying philosophy in the research programme was based on action research. The phenomenological paradigm is aligned with the idea that the researcher is directly involved with the samples, which is the case in action research. The candidate was aware that such interaction with the samples may lead to reactance between the samples and the candidate, which is considered problematic in positivistic research. The candidate was also aware that some positivist researchers may define the action research methodology unscientific. The candidate, however, was aligned with Susman and Evered (1978: 594) in that action research is scientific, but that positivist science and action research are contrasting conceptions of science with different foundations for the philosophical viewpoints.

Susman and Evered (1978: 600) compare positivist science with action research, and the results from this comparison were presented in a table. This table can also be seen in this thesis as Table 5.1.

Susman and Evered (1978: 589-590) describe six important characteristics of action research, which provide a corrective to the deficiencies of positivist sciences. These six characteristics are that action research is future oriented, is collaborative, implies system development, generates theory grounded in action, is agnostic and, finally, that action research is situational. Reason and Torbert (2001: 3) refers to these six characteristics, when they argue for an "action turn" in research, since positivism "does not even address, much less provide guidance for, the question each of us can potentially ask at any time we are acting, namely, "How can I act in a timely fashion now?""

Comparisons of Positivist Science and Action Research		
Points of Comparison	Positivist Science	Action Research
Value position	Methods are value neutral	Methods develop social systems and release human potential
Time perspective	Observation of the present	Observation of the present plus interpretation of the present from knowledge of the past, conceptualization of more desirable futures
Relationship with units	Detached spectator, client system members are objects to study	Client system members are self reflective subjects with whom to collaborate
Treatment of units studied	Cases are of interest only as representatives of populations	Cases can be sufficient sources of knowledge
Language for describing units	Denotative, observational	Connotative, metaphorical
Basis for assuming existence of units	Exist independently of human beings	Human artifacts for human purposes
Epistemological aims	Prediction of events from propositions arranged hierarchically	Development of guides for taking actions that produce desired outcomes
Strategy for growth of knowledge	Induction and deduction	Conjecturing, creating settings for learning and modelling of behavior
Criteria for confirmation	Logical consistency, prediction and control	Evaluating whether actions produce intended consequences
Basis for generalization	Broad, universal, and free of context	Narrow, situational, and bound by context

Table 5.1 Comparisons of Positivist Science and Action Research (Susman and Evered, 1978)

Action research is different from "conventional research". Conventional research starts with a hypothesis (point A) and proceeds along a straight line to a conclusion (point B) (Wadsworth, 1998: 4). Action research is different in that it "proceeds through cycles, 'starting' with reflection on action, and proceeding round to new action which is then further researched. The new actions differ from the old actions - they are literally in different places" (Wadsworth, 1998: 5). The difference between "conventional research" and action research is illustrated in Figure 5.1 and Figure 5.2.

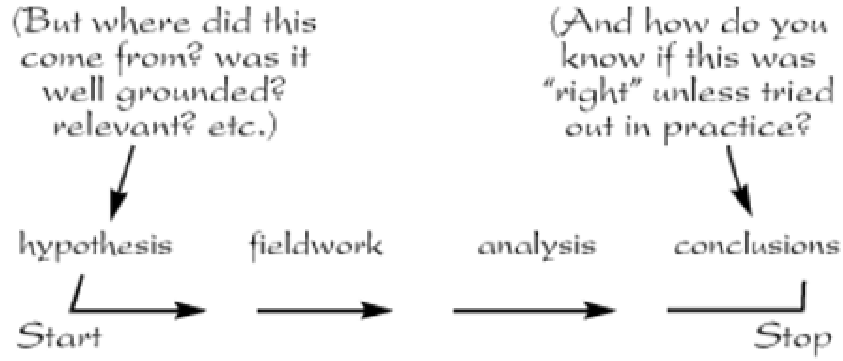


Figure 5.1 Convential Research Process (Wadsworth, 1998)

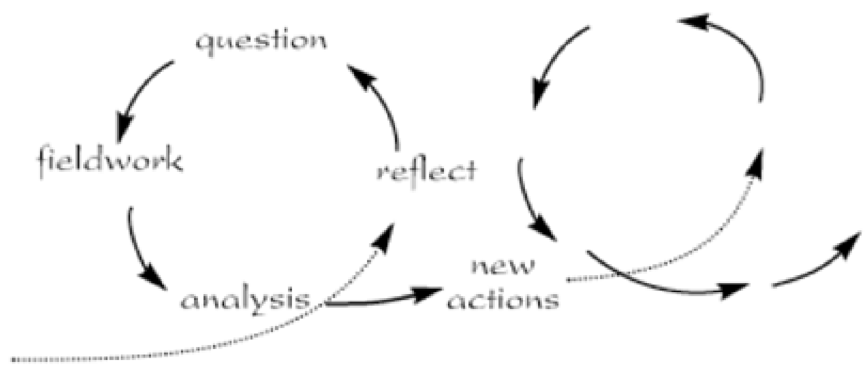


Figure 5.2 Cyclical Research Process (Wadsworth, 1998)

Susman and Evered (1978) share the view that action research is conducted as a cyclical process with phases. In addition Susman and Evered focus on the collaboration between the client system and the researcher:

> "... action research can also be viewed as a cyclical process with five phases: diagnosing, action planning, action taking, evaluating, and specifying learning. The infrastructure within the client system and the action researcher maintain and regulate some or all of these five phases jointly (Figure 5.3).
>
> We consider all five phases to be necessary for a comprehensive definition of action research. However, action research projects may differ in the number of phases which is carried out in collaboration between action researcher and the client system." (Susman and Evered, 1978: 588)

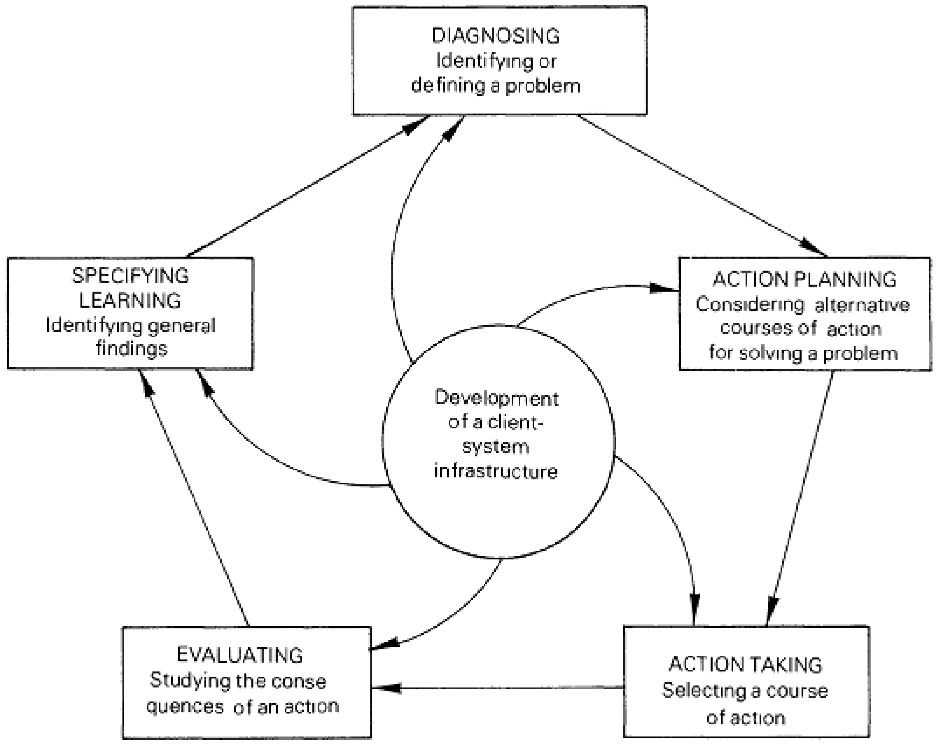


Figure 5.3 The cyclical process of action research (Susman and Evered, 1978)

The collaboration characteristic, the interdependence between the client system and the action researcher, and that action research implies system development, can also be found in Roberts et al. (2003a):

> "…The action researcher therefore identifies the problem, suggests a solution, sees what effect this solution has, and proposes further solutions as necessary in order to address the problem fully. The action researcher becomes part of the subject that he or she is trying to improve." (Roberts et al., 2003a: 5/31-32)

When the candidate started the research programme, he looked at action research as a neat progressive problem solving approach. The candidate had a clear vision that he would work together with the research sample, designing and implementing new improved ICRMMs in an iterative manner through the research cycles. The essence of the candidate's vision of how the research programme would progress is captured by Riel (2007):

> "The researchers examine their work and seek opportunities for improvement. As designers and stakeholders, they work with colleagues to propose new courses of

action that help their community improve work practices. As researchers, they seek evidence from multiple sources to help them analyze reactions to the action taken. They recognize their own view as subjective, and seek to develop their understanding of the events from multiple perspectives. The researcher uses data collected to characterize the forces in ways that can be shared with practitioners. This leads to a reflective phase in which the designer formulates new plans for action during the next cycle.

Action Research is a way of learning from and through one's practice by working through a series of reflective stages that facilitate the development of a form of "adaptive" expertise. Over time, action researchers develop a deep understanding of the ways in which a variety of social and environmental forces interact to create complex patterns." (Riel, 2007)

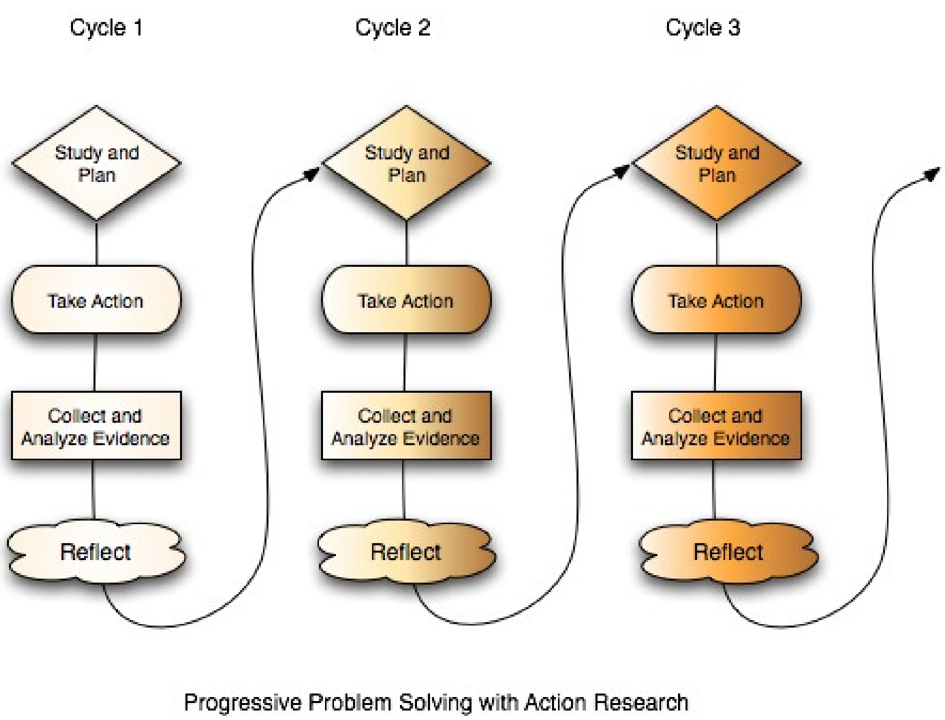


Figure 5.4 Progressive problem solving with action research (Riel, 2007)

During the research programme, the candidate realised another important characteristic of action research, which is that "action research, like the discovery phase of any science, knows it is coming from somewhere and going to somewhere, even though it does not know in advance where precisely it is going to end up or what the new state will look like" (Wadsworth, 1998: 6). The reason for this is that in an action research programme, the researcher usually only plans one research cycle ahead. The results of the analysis of the research cycle will affect the planning of the next research cycle, and thereby the results of the previous research cycle will affect the direction of the next research cycle. In practice, this means that an action research programme is planned in an iterative manner, where each research cycle is planned and conducted as a discrete experiment.

5.2.2 The research cycles of this research programme

The candidate had, in the research proposal stage, already considered how various cyclical processes would improve UMB's ICRMM in an iterative manner. The candidate was at this early stage happily unaware of the nature of the challenges a researcher is likely to experience, when conducting action research in a real environment. Unforeseeable events during the research cycles and unexpected learning outcomes from the research cycles led the candidate in directions that were not planned. Below is a short introduction to the three research cycles of this research programme.

In the research proposal stage, the candidate worked together with the University of Life Sciences to identify and define the problem to be studied. During the research proposal stage, the courses of action for solving the problem were also considered. As a result of this work during the research proposal stage, the university, represented by the managing director, and the candidate agreed on the following in a Letter of support attached to the research proposal:

> "UMB and the candidate have agreed that the research shall be conducted as action research. The university and the candidate have discussed that in this methodology the candidate identifies problems, suggests a solution, sees what effect this solution has, and proposes further solutions as necessary in order to address the problem fully.
>
> The university is aware that conducting research in this manner will increase the level of support needed from the university. However, UMB also expect that the interaction between the university and the candidate will make it easier for UMB to improve our risk management practices and also help us to change from a silo risk management approach to enterprise risk management.

> UMB has read and understood the research proposal. UMB does with this letter of support commit the university in the following manner:
>
> The RIF model [Candidate note: in the research stage the "RIF model" was renamed to the integrated causal risk management model] will be operated in a real business environment used by the members of the managing director's management group. The candidate will be embedded in this management group where he can study whether or not the RIF model can be used to predict the likely effect of proposed actions on the risk profile of the university. The candidate will also be allowed to conduct detailed interviews with the managers. The candidate and the undersigned will at a later stage agree whether or not to include the Head of the institutes which reports directly to the Rector in the study." (Dugstad, 2008)

After the research proposal had been accepted, the university and the candidate refined the actions for solving the problem and then the actions were implemented. The consequences of the actions were evaluated, and after this the candidate considered general findings. The most important learning outcomes of this research cycle, was that the research results indicated that the ICRMM worked as intended, but also that the ICRMM would never be used as intended due to lack of stakeholder ownership. This ended the first cycle of the research.

The candidate had originally planned to conduct further action research cycles together with the university, but due to reflections and learning from the first research cycle the candidate wanted to introduce a second sample in the research programme for the second research cycle. The new sample organisation was the small consultancy Terramar. The candidate found it unproblematic to use two so different organisations as samples in the research due to the integrated causal risk management model's generic character. The ICRMM is just as relevant whether the organisation is small or large, public or private as long as the organisation wants to manage its risk profile.

The second research cycle started with Terramar's branch area manager (BAM) for the telecommunication market and the candidate defining the problem and agreeing on the courses of action for solving the problem. The actions were then implemented, and the research cycle ended with joint reflection of the general findings. Again, the learning outcome was different from what was expected. Once again the research results indicated that the ICRMM worked as intended, but this time the user organisation also had a stakeholder (the telecommunication BAM) who felt ownership for the ICRMM. However, when the telecommunication BAM left the company, it became apparent that none of the remaining managers felt any ownership for the ICRMM. This research cycle indicated that the ICRMM must be integrated with the user organisation's overall risk management framework, if the model was to be used as intended.

The third research cycle had a very different focus than the two previous research cycles. While the two first research cycles focused on the design of the ICRMM, the third research cycle focused on how to secure stakeholder involvement and ownership of the ICRMM. The third research cycle started with the candidate meeting with the managing director of Terramar to discuss integrated risk management in general. This meeting resulted in a draft project charter (Bastviken, 2009) for designing and implementing an integrated risk management framework for Terramar. The ICRMM was included as part of the integrated risk management framework in this draft project charter. The draft project charter was further discussed in separate meetings with various key stakeholders in the organisation, and these meetings resulted in a course of actions to be taken. The candidate then studied how the key stakeholders in the project affected the design and implementation of the ICRMM. The third research cycle ended with the candidate reflecting on the general findings.

5.2.3 Case study research design

The candidate chose to use a case study research design for all of the three research cycles. The individual research methodology chapters for each research cycle describe the details of the case study research designs that were used. The use of a case study design is well established in the literature. Whitehead (2009) refers to Cresswell (2007: 73) for a brief and useful introduction to the case study research design:

> "… case study research involves the study of an issue explored through one or more cases within a bounded system (i.e., a setting, a context). Although Stake (2005) states that case study research is not a methodology but a choice of what is to be studied (i.e., a case within a bounded system), others present is a strategy of inquiry, a methodology, or a comprehensive research strategy (Denzin & Lincoln, 2005; Marriam, 1998; Yin, 2003). I choose to view it as a methodology, a type of design in qualitative research, or an object of study, as well as a product of the inquiry. Case study research is a qualitative approach in which the investigator

> explores a bounded system (a case) or multiple bounded systems (cases) over time, through detailed, in-depth data collection involving multiple sources of information (e.g., observations, interviews, audiovisual material, and documents and reports), and reports a cased description and case-based themes. For example, several programs (a multi-site study) or a single program (a within-site study) may be selected for study. (p.73)" (Whitehead, 2009: 4-5)

The candidate's case study research design was inspired by Yin (2003), where the case study research design can be understood as "a logical plan for getting from here to there, where here may be defined as the initial set of questions to be answered, and there is some set of conclusions (answers) about these questions" (Yin, 2003: 20).

5.3 Conclusion

This chapter has described that the candidate used an action research methodology. In this chapter it can be found that the research consists of three different research cycles, where a case study research design was used in each research cycle. The details of the methodology for each of the research cycles and the results and findings from the three research cycles follow next.

Chapter 6 - Research methodology for the first research cycle

6.1 Introduction

The aim of this chapter is to describe the approach to data collection and processing used in generating the research data and results for the first research cycle. The research question for the first research cycle was:

- If the candidate designs a qualitative integrated causal risk management model, to what extent can the University of Life Sciences use this model to predict the likely effect of proposed actions on the risk profile?

6.2 Research design

To answer the research question, the candidate decided to use a case study research design inspired by Yin (2003). The case study research design consists of five components and these are 1: a study's question, 2: its propositions if any, 3: its units(s) of analysis, 4: the logic linking the data to the propositions, and 5: the criteria for interpreting the findings (Yin, 2003: 21-28). The research design of this research cycle was based on Yin's five components.

The first component is the research question, which in this research cycle was:

- If the candidate designs a qualitative integrated causal risk management model, to what extent can the University of Life Sciences use this model to predict the likely effect of proposed actions on the risk profile?

Yin explains the second component study propositions as "…each proposition directs attention to something that should be examined within the scope of study". For this research cycle the propositions were stated as research objectives. The research objectives were:

- To design a qualitative integrated causal risk management model that can be used to predict the likely effect of proposed actions on the risk profile
- To establish the risk profile facing the University of Life Sciences
- To use the qualitative integrated causal risk management model to predict the likely effect of proposed actions on the risk profile

To define the third component, the unit(s) of analysis, was a difficult decision for the candidate. The candidate considered defining individual managers as different unit(s) of analysis, since each manager would have their own interpretation of the ICRMM. However, the research question was about the ICRMM and the candidate therefore concluded that the unit of analysis had to be the ICRMM in the context of the research objective. This idea is also aligned with Susman and Evered (1978), where the ICRMM can be understood as the "client system infrastructure".

The fourth and fifth components, which are "the logic linking the data to the propositions" and "the criteria for interpreting the findings", turned attention to what research activities should be conducted after the data have been collected. According to Yin (2003: 26) "the fourth and fifth components have been the least well developed in case studies. These components foreshadow the data analysis steps in case study research, and a research design should lay a solid foundation for this analysis".

The candidate decided that the most effective way of dealing with the fourth and fifth components was to study and evaluate each research objective in an "ISO 31000 Risk management - Principles and guidelines" (ISO, 2009b) context. The reasoning for this was that the research cycle question and objectives were created to look at the practical use of the ICRMM in a real environment, and that the international ISO risk management standard gives guidelines on how organisations should organise their risk management initiatives.

ISO (2009b) states that an organisation should comply, at all levels, with the principles listed in the guide. Based on this, the candidate decided that to meet the research objectives a minimum was to comply with the listed principles that were relevant for this research. In addition to meeting the relevant principles, the different research objectives were studied in the context of the relevant parts of the ISO-standard.

The first research objective "to design an integrated causal risk management model to predict the likely effect of proposed actions on the risk profile" was studied in the context of the ISO 31000 risk management framework.

The second research objective "to establish the risk profile facing the University of Life Sciences" was studied in the context of the ISO 31000 risk management process. The relevant risk management processes for this research objective was establishing the context and risk assessment.

The third research objective "to use the integrated causal risk management model to predict the likely effect of proposed actions on the risk profile" was, as the second research objective, studied in the context of the ISO 31000 risk management process. However, this research objective was studied in the context of the risk management process risk treatment.

6.3 Sources of data

6.3.1 Introduction to the sample: the University of Life Sciences

The University of Life Sciences (UMB) began in 1859 as the only Norwegian agricultural post-graduate college. In the beginning it was a mainly an educational institution, and research achieved a primary function nearly 40 years later. In January 2005 the institution received Norwegian university status. In the beginning of 2008, UMB had approximately 2,600 students, and close to 300 of these were PhD students. The number of international students at the university contributed to approximately 10% of the total number of students. The University staff counted close to 870, and more than half of the staff held scientific positions (work in education and research, and have doctoral degrees).

UMB comprised of 8 departments [Dept. of Animal and Aqua cultural Sciences (IHA), Dept. of Chemistry, Biotechnology and Food Science (IKBM), Dept. of Ecology and Natural Resource Management (INA), Dept. of Economics and Resource Management (IØR), Dept. of Landscape Architecture and Spatial Planning (ILP), Dept. of Mathematical Sciences and Technology (IMT), Dept. of Plant and Environmental Sciences (IPM) and Dept. of International Environment and Development Studies, Noragric].

In the annual plan for 2009 (UMB, 2008b), the following budget was presented for 2009:

Budget unit	Net 2008 (NOK 000s)	Net 2009 (NOK 000s)	% change 2008 - 2009
Dept. of Landscape Architecture and Spatial Planning, ILP	22,905	24,724	7.9
Dept. of Ecology and Natural Resource Management, INA	36,063	36,170	0.3
Dept. of Animal and Aqua cultural Sciences, IHA	30,089	33,170	10.2
Dept. of Chemistry, Biotechnology and Food Science, IKBM	41,736	43,103	3.3
Dept. of Plant and Environmental Sciences, IPM	48,293	50,021	3.6
Dept. of Mathematical Sciences and Technology, IMT	41,551	43,884	5.6
Dept. of Economics and Resource Management, IØR	21,314	22,603	6.0
Dept. of International Environment and Development Studies, Noragric	12,043	13,299	10.4
Posts for central academic activities	72,335	84,071	16.2
Sum UMB- departments	326,329	351,045	7.6
Centre for Continuing Education, SEVU	2,306	2,390	3.6
Animal Production Experimental Centre, SHF	9,219	12,253	32.9
Centre for Plant Research in Controlled Climate, SKP	11,405	11,817	3.6
Sum centres	22,930	26,460	15.4
Dept. of Building Service and Maintenance	59,714	59,383	-0.6
Dept. of Property Planning and Development	-491	0	NA
Dept. of information	28,050	29,065	3.6
Administration	29,318	31,678	8.0
Sum central administration	116,591	120,126	3.0

Sum	465,850	497,631	6.8
Common measures / provisions	38,807	45,687	17.7
Development of the building Sørhellinga	15,300	-	NA
Development of the buildings Tårn and Ur	-	13,000	NA
Maintenance and investments in buildings	20,000	20,000	0.0
Sum	74,107	78,687	6.2
SUM	539,957	576,318	6.7

Table 6.1 Budget for the University of Life Sciences

There is no fixed exchange rate between the Norwegian currencies (NOK) and the British Pound or Euro. Table 6.2 shows the exchange rate for two random days, which can give the reader an idea of the budget for UMB in GBP and Euro.

	29. May 2009	24. June 2010
GBP	10.171	9.747
EURO	8.8785	7.9780

Table 6.2 Currency exchange - the price in NOK for 1 GBP and 1 Euro

UMB reports to the Ministry of Education and Research (Norwegian acronym KD). In the letter of allotment for 2008 (The Ministry of Education and Research, 2007) it was required that all the Norwegian universities reported on sector aims and operational objectives that were common for all the universities. KD also required that each university developed additional operational objectives that were relevant to the university's current situation and chosen strategy.

The sector aims and operational objectives stated by KD and the additional operational objectives stated by UMB together formed UMB's purpose or mission. This purpose/mission can be understood as the purpose if UMB is considered as a purposeful system [as in Ackoff (1971), see Section "2.3 Organisations understood as systems"] or as the starting point in the Making Strategies Work model (MSW-model) presented in Roberts and MacLennan (2003).

According to the information above the purpose or mission of UMB was:

Sector aim 1	The universities must offer education of good international quality that is based upon the best within research, the development in the different subjects/disciplines and art, and knowledge from experience.
Operational objectives 1.1	The universities must educate candidates who are highly qualified and have competences relevant for the needs of the society.
Operational objectives 1.2	The universities must offer a good learning environment with education and assessment methods that secure the content, that achieve full value out of the learning and that ensure that the students finish on time.
Operational objectives 1.3	The universities must engage in a significant level of international cooperation on education. This will contribute to increased education quality and secure highly qualified candidates for the community and the private/business sector.
Sector aim 2	The universities must attain results of good international quality within research, specialist disciplines/subjects and art. The universities have a national responsibility when it comes to basic (scientific) research and researcher education in the disciplines/ subjects in which the universities offer doctoral degrees.
Operational objectives 2.1	The universities must adhere to the national needs for broad basic (scientific) research. At the same time the universities must focus their research effort to attain results of good international quality for chosen specialist disciplines/subjects, and cooperate internationally in research and development.
Operational objectives 2.2	The universities must, by cooperating nationally and internationally, offer researcher education of good quality. The researcher education must be arranged and dimensioned to meet the needs in the sector and the community in general.

Sector aim 3	The universities must be conducive towards disseminating on results from research, and the development in the different disciplines/subjects and arts. The universities must contribute to innovation and creation of value based on these results. The universities must ensure that employees and students participate in discussions about or relevant to the society.
Operational objectives 3.1	The universities must, through the disseminations of knowledge and participation in public debates, supply the society with results from research and development.
Operational objectives 3.2	The universities must contribute to the positive development of both the society and business sectors through innovation and enhancement of value.
Operational objective 3.3 (developed by UMB)	UMB must offer education for post-graduates in accordance with the need for competence in the business sector.
Sector aim 4	The universities must have the personnel and financial operations that secure the effective use of resources.
Operational objectives 4.1	The employer politics/policies of the universities must contribute to the recruitment and the development of competences, which again reflects the institution's assignments and areas of responsibility.
Operational objectives 4.2	The personnel politics/policies of the universities must contribute to a good working environment and a less divided work life by the sexes.
Operational objectives 4.3	The universities must maintain good quality in the financial/ administrative operations with focus upon internal control and effective resource operations, which attend to the strategic priorities of the institution.
Operational objective 4.4 (developed by UMB)	UMB must have value-based maintenance of the building facilities, which secures that the buildings are used in a manner that ensures both cultural and historical considerations and environmental perspectives.

UMB seemed to be using the sector aims and operational objectives stated by KD and the additional operational objectives stated by UMB as their purpose or mission. However, in Ackermann et al. (2004) it is argued that not all public organisations view the mandate as the basis for the mission or purpose:

> "Sometimes the mandate acts as a goal and sometimes as a constraint, depending on the point of view of the managers." (Ackermann et al., 2004: 87)

The viewpoint that the mandate acted as a constraint can also be considered in an UMB context. The candidate has not heard anyone state such a viewpoint in public nor seen any official strategic or operational plans that indicated such a viewpoint, but the candidate still does not want to dismiss the thought that some of the managers were closer to the "constraint thought" compared to the view that the letter of allotment provided the basis for the university's mission or purpose.

The political decision to merger NVH and UMB

On 11/1-2008 the government advised the Norwegian Parliament to move the localization of the Norwegian School of Veterinary Science (Norwegian acronym NVH) and the National Veterinary Institute to UMB, and to merge NVH and UMB. The political process regarding the future of NVH had been started already in 2001, and UMB has continuously during this period made it clear that merging NVH and UMB is a decision that UMB supports. The strategic consequences, the timescale or possible political issues related to the Norwegian Parliament's final decision related to the government's advice was not clear at the time of the research, but this decision will definitely have a serious impact on the future strategic plan and risk profile of UMB. NVH had at the time the research was conducted a student body of 470, including 80 doctoral students, and approximately 450 employees.

6.3.2 The integrated risk management initiative

UMB is a public university and thereby has to comply with the Norwegian regulations for financial management for public organisations (Økonomiregelverket in Norwegian). These regulations require the use of risk management (from 1/1-2004) and internal control, but the regulations do not state how such governing frameworks should be designed or implemented.

The Norwegian Government Agency for Financial Management (Norwegian acronym SSØ) was established by the Ministry of Finance 1/1-2004 to strengthen financial management and to improve resource efficiency in the public sector. As part of this mission, SSØ has established one guide that focuses on the use of objectives in the governance framework and one risk management guide. Public organisations are not required to use these guides, but SSØ states that by following the recommendations in these guides public organisations comply with the Norwegian regulations for financial management for public organisations.

In the 2006 audit, the Office of Auditor General (OAG) stated that UMB did not comply with the Norwegian regulations for financial management for public organisations. The audit included significant criticism of the current state of both the internal control routines and the risk management framework at UMB (letter dated 21/3-2007, reference 3.2 2007/681- MAV/LOE). Regarding the risk management framework, OAG referred to a meeting dated 9/9-2005 when OAG first started to question the state of the risk management framework at UMB. In the 2006 audit, OAG questioned the progress of the development and implementation of a risk management framework. In the audit letter, OAG referred to the guides from SSØ, but OAG did not require UMB to use these guides as part of the governance framework.

The Office of Auditor General report for the total public sector audit in 2006, Chapter on the Ministry of Education and research, concluded that most of the Norwegian universities lacked a satisfactory risk management framework at the time of the 2006 audit (The Office of Auditor General, 2007). From the OAG report it can be concluded that the other Norwegian universities were in a similar position to UMB when it came to complying with the risk management regulations in the Norwegian regulations for financial management for public organisations.

The external criticism from OAG combined with UMB's internal consideration of the internal governance framework led to a project charter for an integrated risk management project at UMB.

The recent focus on risk management has also been a hot topic for the managing director's management group. According to the financial director Jan-Olav Aasbø, formal risk assessments has not previously been conducted for major strategic or operational decisions at UMB, but it has now been agreed by the group members that such risk assessments should be included for any major decisions. However, at present (September 2008) it is still not common practice to include risk assessments as decision support material.

The focus on risk management at UMB has also led to a positive audit report from OAG for 2007 when it comes to risk management. In this audit report risk management was not mentioned, which was interpreted by the financial director that OAG was satisfied with the current status of the risk management framework at UMB.

Most organisations that start the "ERM journey" are motivated by penalty avoidance or to comply with rules and regulations in the beginning and then focusing more on increasing stakeholder value as risk maturity increases in the company as illustrated in Figure 2.4. In the case of UMB the integrated risk management project was clearly motivated by complying with rules and regulations. However, the managing director of UMB was in 2007-2008 not satisfied with "just" complying with the rules and regulations related to risk management and UMB therefore decided to design and implement an ICRMM as part of the integrated risk management project. The decision to design and implement an ICRMM to improve decision making at the university supports the argument that the managing director of UMB had moved from the "Comply stage" and had entered what Abrams et al. (2007) refers to as the "Improve" or even possibly the "Transform stage".

UMB's own interpretation on how risk management fitted together with sector aims, different kinds of objectives, critical success factors and the governance structure is presented in Figure 6.1. According to this figure, it appears that UMB has started to integrate risk management in the governance structure of the university, and if this is the actual case then it should come as no surprise that OAG's audit went well. However, when the actual work on the design and implementation of the ICRMM starts, it will be easier to assess to what degree risk management actually has become an integral part of the organisational processes at UMB.

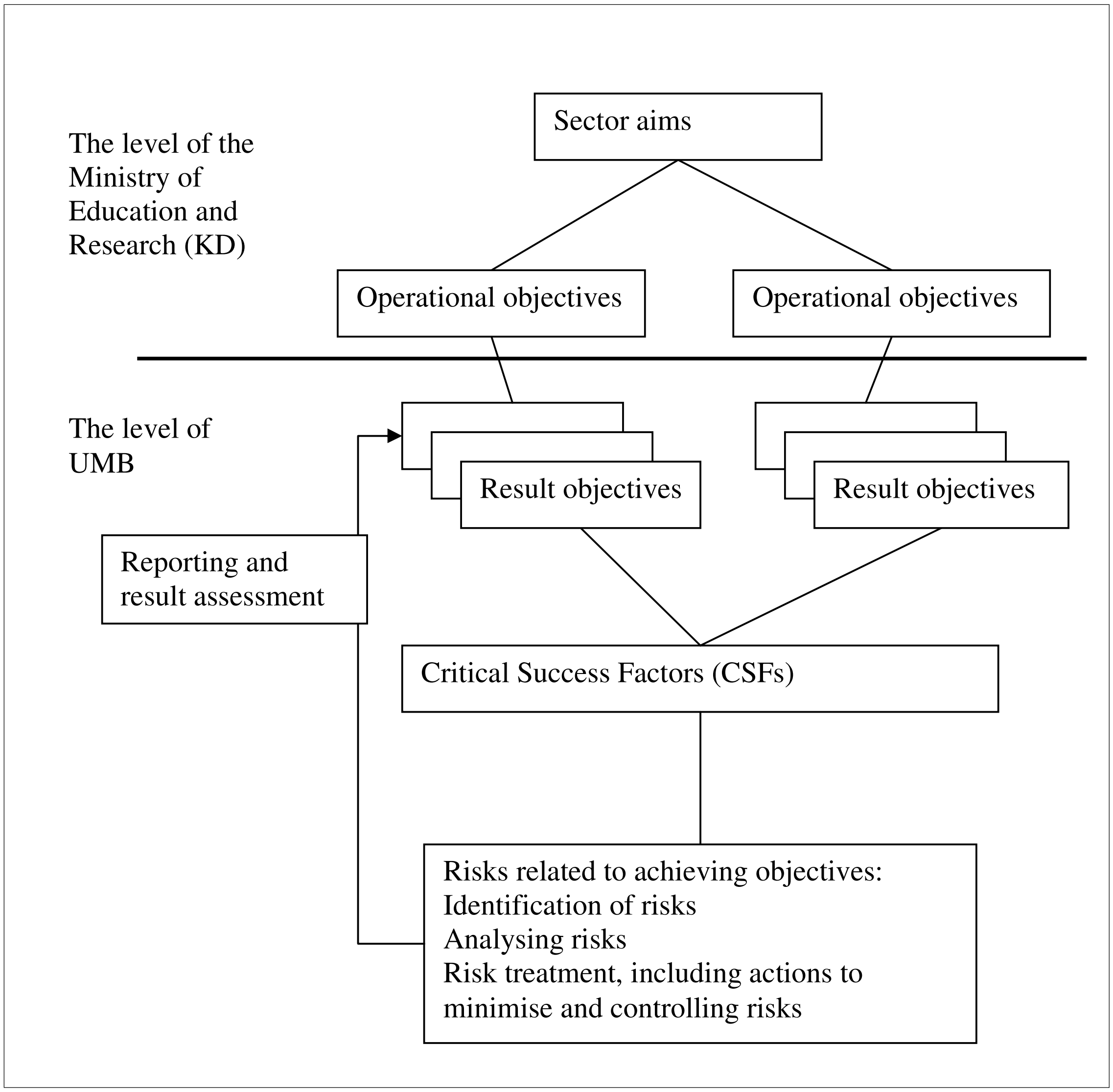


Figure 6.1 An overview of the risk concept of UMB (UMB, 2008b)

Reduced focus on risk management affecting the availability of interviewees

UMB's focus on risk management and the ICRMM decreased at the end of 2008 and at the beginning of 2009. The likely reasons for this were probably a combination of the factors that there was significant extra work related to the merger, that the OAG audit went well, and that most of the key stakeholders at the university were in the "comply stage" and did not consider risk management as something that could add value for the university. For these key stakeholders it seemed illogical to expend energy on risk management as long as OAG was satisfied with the current status of the risk management framework at UMB, and as long as the merger needed a considerable amount of immediate attention. The candidate has not looked further into this issue, since this has been considered outside the scope of this research programme.

The switch in management attention from risk management to the merger with NVH at the end of 2008 and at the beginning of 2009, resulted in the managers downgrading the priority of the candidate's research and the candidate was therefore unable to schedule an oval mapping exercise with the key stakeholders [please refer to Ackermann et al. (2004: Chapter 4) and Bryson et al. (2004: Part III) for details about oval mapping] nor was the candidate able to schedule interviews with all the key stakeholders in this period.

There had been early warning signs about the potential data source problem. The candidate knew that some powerful key stakeholders were in the "comply stage" in the risk management maturity continuum, and that their only interest in risk management was related to the negative Office of the Auditor General of Norway (OAG) report for 2006. The candidate was therefore aware that the positive OAG report for 2007 was likely to reduce these stakeholders attention to risk management. The candidate was also well aware that the (likely) decision to move the localisation of the Norwegian School of Veterinary Science (Norwegian acronym NVH) and the National Veterinary Institute to UMB, and to merge NVH and UMB would require considerable managerial attention in the same period as the candidate planned to collect data for the research programme.

The candidate's contingency plan was to find and use alternative sources of data. The candidate was aware that the administration sends an annual plan to the board in October/November each year. In this annual plan the administration outlines the prospects for the next year, and the annual plan also includes a section on risk assessments for the coming year. The candidate was also aware that the financial director expected the candidate to be one of the contributors to this document, particularly in the section on risk assessments. The candidate's contingency plan was therefore to use this document as the primary source of data for the first research cycle.

During the development of the annual plan for 2009 the candidate became aware of two additional sources of data that were relevant for the research. These sources were "The Annual Report on the Quality of Education 2007" published by UMB and the "Report on Science & Technology Indicators for Norway" published by The Research Council of Norway. These three sources of data are further described next.

6.3.3 Written sources of data

The annual plan for 2009 for the University of Life Sciences

The main source of data used for this case study was an internal UMB document named "Årsplan 2009" (translated as "The Annual Plan for 2009") (UMB, 2008b). This document was written by the administration and sent to the board for acceptance. The candidate was one of the contributors to this document as described in Section "6.5 Data collection and processing from the University of Life Sciences". The summary of the document is translated below:

> "Årsplanen (The Annual Plan for 2009) is based on the Strategic Plan 2005 - 2008 for the University of Life Sciences (UMB) that was adopted in November 2004, and the aims and objectives for the universities stated by The Ministry of Education and Research.
>
> The vision of UMB is "through education and research to help secure the livelihoods of the present and future generations."
>
> The University has the following primary objectives:
>
> - UMB will be a central player in the Life Sciences with emphasis on the core areas; biology, food, environment, land and natural resource management with its aesthetic and technological subjects.
> - UMB will actively contribute to business development and enhance the scientific foundation for agriculture, aquaculture and other biology based industries.
>
> Årsplanen (The Annual Plan for 2009) is threefold; Part 1 discusses UMBs economy for 2009 including the University Board's allocation to the various budget units, part 2 deals with UMBs performance for 2009, while Part 3 deals with the risks for 2009. " (UMB, 2008b: 4)

The Annual Report on the Quality of Education 2007

An additional data source used related to "education of students" was The Annual Report on the Quality of Education 2007 (UMB, 2008a). In the summary section of this report the following can be found about this report:

> "The Annual Report on the Quality of Education 2007 is a report to the board of the Norwegian University of Life Sciences (UMB). It is the fifth annual report on the quality of education, thus complying with the criteria issued by the Norwegian Agency for Quality Assurance in Education (NOKUT), which state that the quality assurance systems in institutions of higher education are to include the presentation of an annual report to the board of the institution, offering a coherent and overall assessment of educational quality and an overview of plans and measures for continued enhancement work…
>
> The Report on the Quality of Education is primarily a tool for increasing awareness for the efforts aimed at improving the quality of education and for UMB's strengths and challenges in that respect. Before it is discussed in the Education Committee and finally approved by the University Board, the report is submitted for comments to the department heads, the heads of Education at the departments and the university's central management team. The University Board also sets up a list of priorities for which areas to follow up in the years ahead." (UMB, 2008a: 7)

Report on Science & Technology Indicators for Norway, published by The Research Council of Norway

The "Report on Science & Technology Indicators for Norway" published by The Research Council of Norway (The Research Council of Norway, 2007) was used as the main source of written information on the Norwegian system of education and research. The introduction of the report "The Research Council of Norway" gives a good summary of the content of the report:

> "The report is organized as follows: It opens with a brief presentation of the Norwegian system of education, research and innovation, following Highlights and Key Indicators. Chapter 1 then presents the main results from the 2005 R&D survey conducted among the three performing sectors in Norway: the Industrial sector, the Institute sector, and the Higher Education sector. The chapter also includes results from the 2004 Innovation survey conducted in the Industrial sector as well as time series and international comparisons. Chapter 2 draws on R&D and employment statistics and education statistics in order to look at the human resources of science and technology. Chapter 3 focuses on cooperation and collaboration in S&T by utilizing data on Norwegian participation in the EU Framework programme, R&D cooperation in the Industrial sector and collaboration in publications and patenting. The report rounds off with Chapter 4 which introduces output measures of R&D and innovation. The last chapter deals with indicators for Norwegian scientific publishing in international journals, patent applications, results from the research institutes and the Industrial sector, as well as trade in high, medium and low technology industries."
> (The Research Council of Norway, 2007: 7)

6.4 Software programs used: Decision Explorer

For the first research cycle, the data collected was processed in the software program Decision Explorer. This section aims to give a brief introduction to this software. Decision Explorer has been developed by academics at the universities of Bath and Strathclyde and currently by Banxia Software, in conjunctions with major organisations. Decision Explorer is a proven tool for structuring qualitative information that surrounds complex or uncertain situations. Decision Explorer has been developed to support cognitive mapping, oval mapping and to establish causal maps.

Banxia software promotes a variety of advantages of using the software, and the candidate has no problem agreeing with the list provided by Banxia below:

> "Using Decision Explorer you can
>
> - Develop a clear picture of an issue that shows the interrelatedness and interdependencies between different aspects of the issue, so that it can be explored and debated.
> - Effectively present reasoning through the structure of the lines of argument in the map.
> - Discover the real issues behind the headline information using the advanced analysis functions.
> - Maintain the richness of your data by managing the complexity instead of having to use a weaker overview of the information.
> - Maintain the focus in group meetings by reducing the need to repeat ideas, while building on and around the information already on display.
> - Build feasible, practical and acceptable solutions by combining the opinions of different people and negotiating a shared understanding"

Below are the descriptions of two of the most important commands that were used in this research programme (the descriptions of the commands have been copied from the help-menu in Decision Explorer):

> BRING <Concept>:
>
> This command is used to display the specified concepts on the current map display. If any specified concept already exists on the map display then it will remain. If there is a selected concept on the map, then Bring will attempt to position any concepts which have been specified around the selected concept.
>
> EXPLORE <Concept>:
>
> This menu option is only available when a single concept is selected. It causes a new map to be generated, based on the selected concept. The map will consist of all the concepts connected to the selected concept.

6.5 Data collection and processing from the University of Life Sciences

This section will show that the University of Life Sciences chose to establish a qualitative ICRMM.

The work related to data collection and data processing was not a linear phased process, but it is better described as an iterative process. The data collected from UMB was immediately processed in the software Decision Explorer, which was used to organise the data in the ICRMM.

The data collection and processing related to the University of Life Sciences must be divided in three parts. The first part of the process lasted approximately from 1/6-2008 to 20/10-2008. In this period the candidate more or less worked as a consultant for UMB. In this period the candidate did not focus directly on the research programme, but rather on aiding the university to develop a suitable integrated risk management system and also contributing on the development of the annual plan for 2009. The first part of the data collection and processing ended 20/10-2008, when the managing director signed the annual plan for 2009.

The reasoning for including the first part of the data collection and processing process (conducting risk management related work for UMB) was that this would help the candidate to get a better overview of UMB risk issues relevant for the candidate's research programme. This thought is aligned with the phenomenological paradigm:

> "The phenomenologist adopts a very different research approach from that of the positivist. The phenomenologist seeks to involve himself or herself directly with the sample. Ideally the phenomenological researcher becomes a member of any teams that form the sample. The more the researcher can be accepted as part of the team and embedded within it, the greater his or her level of understanding and appreciation of what is going on within the team." (Roberts et al., 2003a: 3/18)

The second part of the process was about collecting and processing data to establish the risk profile facing the University of Life Sciences. This part started 20/10-2008 (when the managing director had signed the annual plan) and lasted approximately to 15/6-2009. The difference from the first and second part of the process was that the single purpose of the latter was to collect and process data for the candidate's research programme. The second part of the data collection and processing process was conducted by reading the formal documents stated in Subsection "6.3.3 Written sources of data" and using the data the candidate found relevant to establish the risk profile of the University of Life Sciences. The data collected was analysed by using the software program Decision Explorer from Banxia Software. The use of Decision Explorer allowed the candidate to organise the data in causal models (visualised as causal maps). The use of causal maps made it possible to present how the different elements in the models were related to each other.

The third part of the data collection and processing process was conducted in the same period as the second. The third part of the process was about collecting and processing data to "use the integrated causal risk management model to predict the likely effect of proposed actions on the risk profile". Proposed actions to change the risk profile of the university can be found in The Annual Plan for 2009 (UMB 2008b) and proposed actions to improve student education at the university can be found in UMB (2008a). All these proposed actions are directly related to the third objective of the study, and the candidate therefore "collected" the proposed actions including the effects the university anticipated. The proposed actions and anticipated effects were stored and analysed in the same Decision Explorer causal models that had been created to establish the risk profile for the university. The use of Decision Explorer allowed the effect of each proposed action on the risk profile to be evaluated.

The candidate would like to comment that it was planned to use Oval mapping as described in Ackermann et al. (2004: Chapter 4) and Bryson et al. (2004: Part III) as the main data collection technique, supported by the reading of the documents. This data collection process was agreed with the managing director and the financial director, but due to the upcoming merger the management group at the university were no longer in a position to give a higher priority to the candidate's research programme than other emerging issues at the university.

6.6 Conclusion

This chapter has presented the methodology of the first research cycle. Next the results and conclusions of this research cycle will be examined.

Chapter 7 - Results and reflections for the first research cycle

7.1 Introduction

The research question of the first research cycle was:

- If the candidate designs a qualitative integrated causal risk management model, to what extent can the University of Life Sciences use this model to predict the likely effect of proposed actions on the risk profile?

To answer this research question, the candidate defined the following research objectives:

- To design a qualitative integrated causal risk management model that can be used to predict the likely effect of proposed actions on the risk profile
- To establish the risk profile facing the University of Life Sciences
- To use the qualitative integrated causal risk management model to predict the likely effect of proposed actions on the risk profile

This chapter summarises the findings and results of the first research cycle, also referred to as the University of Life Sciences case study. When reading the results and conclusions of this research cycle, the reader must be aware that the research results should be understood as indicative rather than definitive. The implications of the choice of research paradigm and research methodology are further discussed in "Chapter 12 - Reliability, validity and generalisability".

7.2 Results for the first objective of the first research cycle

7.2.1 Introduction

The first research objective of this research cycle was:

- To design a qualitative integrated causal risk management model that can be used to predict the likely effect of proposed actions on the risk profile.

The candidate chose to base the design of the ICRMM on the risk management process described in ISO 31000. The ICRMM was restricted to deal with the risk management processes establishing the context, risk assessment and risk treatment (ISO 31000: Sections 5.3 – 5.5). The reasoning for this was that these risk management processes were directly related to the objectives of this research cycle. Even though the other risk management processes in the ISO 31000 risk management process (communication and consultation and monitoring and review) are essential for a risk management system, these risk management processes were not directly related to the objectives of the research cycle and were therefore considered outside the scope of this research cycle.

The reader should be aware that the risk management processes described in ISO 31000 are interlinked. For organisations wanting to design a full-scale integrated risk management system, covering all risk management process activities described in ISO 31000 for the total organisation, there is much additional work compared to what was needed to achieve this research cycle objective.

7.2.2 Establishing the context

The ICRMM is designed to use causal maps to establish the external and internal context. These causal maps are preferably created by using cognitive mapping and oval mapping as presented in Ackermann et al. (2004) and Bryson et al. (2004), but the context can also be established by drawing causal maps from documents covering strategic plans, operations and project plans. The end result of the establishing the context process will be a causal map covering aims and objectives, external and internal environmental factors, strategies, critical success factors, (proposed) actions, issues, risks, etc.

The layout of the causal map should basically be the same as the layout of the causal maps described in Ackermann et al. (2004) where:

- Aims and objectives are placed at the top of the map
- External environmental factors (threats and opportunities) are placed at the bottom left of the map
- Internal environmental factors (strengths and weaknesses) are placed at the bottom right of the map

The statements in the middle part of the map should be categorised as issues, key issues, critical success factors or actions dependent on what the organisation labels these elements in other documents. Previous identified risks should be categorised as issues or key issues.

To be able to process the data effectively, the software Decision Explorer should be used to draw the causal maps to “establish the context”. The use of Decision Explorer gives, for example, the user the possibility of creating views where only parts of the total causal map may be studied. This is helpful because it allows the user the possibility of showing only relevant statements (information) when an issue is being studied.

7.2.3 Risk assessment

In ISO (2009b), risk assessment is described as the overall process of risk identification, risk analysis and risk evaluation. The same interpretation of risk assessment is used in the design of the ICRMM.

The causal maps, drawn to establish the context, will show the cause-effect relationships between the statements in the model. These maps can be used for risk assessment. The typical working process is designed to begin with establishing “a risk assessment view” in Decision Explorer. In this view each of the statements in the model can be studied by using the following working method. First the statement is brought into the “risk assessment view” by using the BRING <concept> command in Decision Explorer. Next the inputs and outputs to the statement are brought into the same view by using the EXPLORE <concept> command in Decision Explorer. The risk assessment view will now look similar to Figure 7.1. This working method was inspired by the Bow-tie diagram.

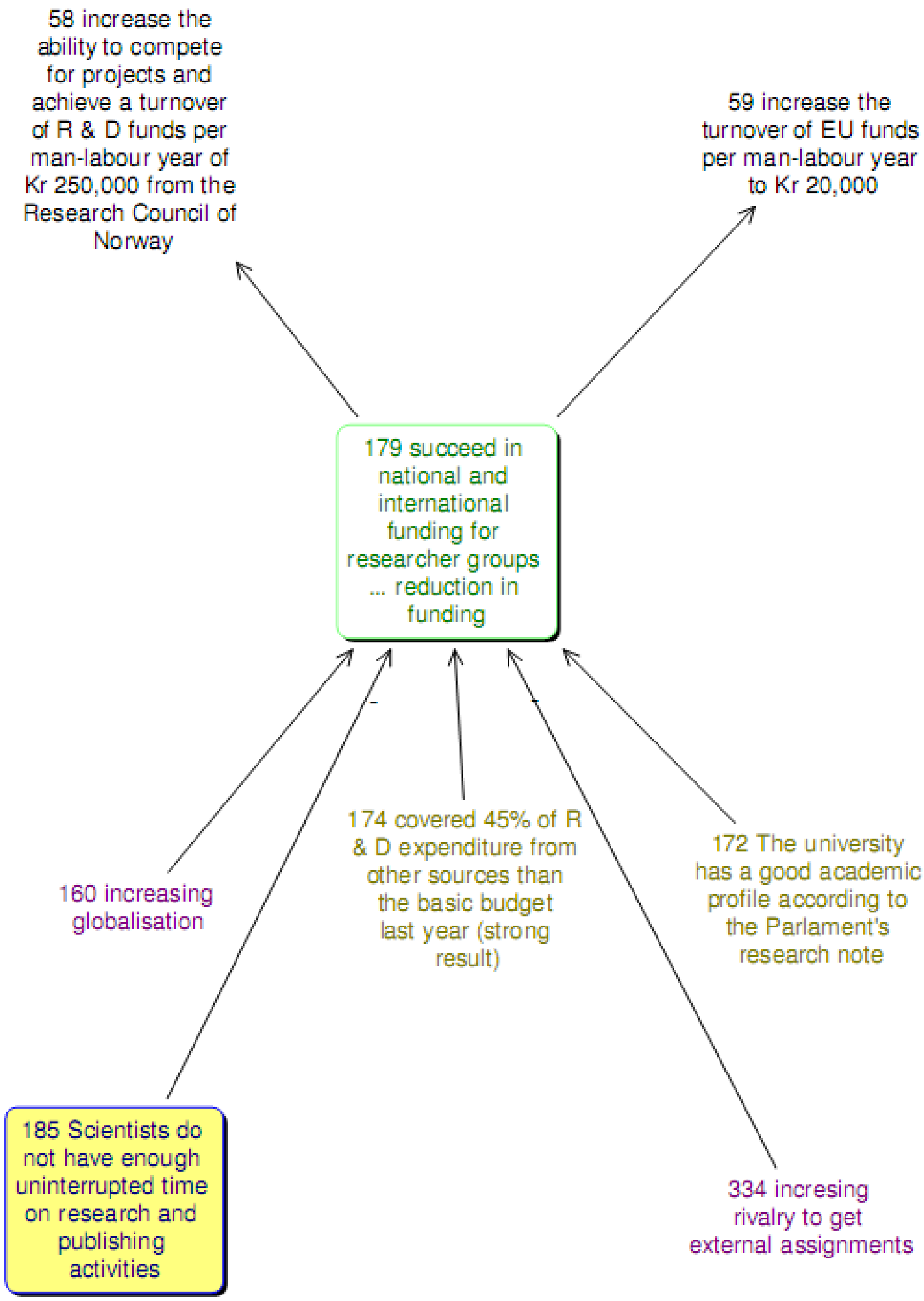


Figure 7.1 Example of Risk assessment diagram

The aim of the risk identification process "is to generate a comprehensive list of risks based on those events that might create, enhance, prevent, degrade, accelerate or delay the achievement of objectives. It is important to identify the risks associated with not pursuing an opportunity" (ISO, 2009b: 17).

However, there are more to the identification of risks than just generating a comprehensive list of risks:

> "Risk identification should include examination of the knock-on effects of particular consequences, including cascade and cumulative effects. It should also consider a wide range of consequences even if the risk source or cause may not be evident. As well as identifying what might happen, it is necessary to consider possible causes and scenarios that show what consequences can occur. All significant causes and consequences should be considered." (ISO, 2000b: 17)

In the ICRMM, the risk assessment diagrams for the statements (please refer to Figure 7.1) should be used as an aid to conduct the risk identification process. The working process is designed to begin with establishing a risk assessment diagram for each statement (in a risk assessment view) and to use this diagram to identify risks. The risk assessment diagram should be expanded by bringing in additional related statements if this is needed to increase the understanding of sources of risk, areas of impacts, events, scenarios or consequences.

The expanded risk assessment diagrams are particularly useful for the risk analysis process:

> "Risk analysis involves consideration of the causes and sources of risk, their positive and negative consequences, and the likelihood that those consequences can occur. Factors that affect consequences and likelihood should be identified. Risk is analyzed by determining consequences and their likelihood, and other attributes of the risk. An event can have multiple consequences and can affect multiple objectives. Existing risk controls and their effectiveness should be taken into account." (ISO, 2009b: 18)

The method for risk analysis in the ICRMM is designed to be supported by using functionality in the Decision Explorer software. The key functions used in this research programme are described in Section "6.4 Software programs used: Decision Explorer".

The risk assessment process is finalised by conducting risk evaluation:

> "The purpose of risk evaluation is to assist in making decisions, based on the outcomes of risk analysis, about which risks need treatment to prioritize treatment implementation." (ISO, 2009b: 18)

The ICRMM complies fully with the description of risk evaluation in ISO (2009b).

7.2.4 Risk treatment

In the qualitative ICRMM, the design is that the proposed actions to change the risk profile are included in the risk assessment diagrams, and thereby the diagrams become risk treatment diagrams. The idea is to improve organisational risk management decision making by making it easier to assess what actual effect a proposed action has on a risk and on the total risk profile. The ICRMM is thereby designed to be used to predict the likely effect of proposed actions on the risk profile.

7.2.5 Conclusion

The first research objective of this research cycle was:

- To design a qualitative integrated causal risk management model that can be used to predict the likely effect of proposed actions on the risk profile.

This section describes that the candidate has aligned the design of the ICRMM with the ISO 31000 risk management process described in ISO 31000. This section also describes that the ICRMM uses causal maps to establish qualitative and causal information about the risks affecting the risk profile of the organisation.

7.3 Results for the second objective of the first research cycle

7.3.1 Introduction

The second objective of this research cycle was:

- To establish the risk profile facing the University of Life Sciences.

This section will describe that the candidate used the ICRMM to conduct the risk management processes establishing the context and risk assessment to achieve the objective.

7.3.2 Establishing the context for the University of Life Sciences

The context was established by creating a causal map from the data sources presented in Section "6.3 Sources of data". The causal map was created by following the description given in Subsection "7.2.2 Establishing the context".

The context causal map became a dynamic map that was continuously improved due to new information or new understanding from the candidate's point of view. The final context causal map, including all risks and proposed actions, consisted of 427 concepts and 542 links. This gives a ratio of links to nodes of 1.27.

For further information on the organisation of the data (statements/concepts/nodes) for this research cycle (the University of Life Sciences case study), please refer to "Appendix A: Organisation of the causal maps for the University of Life Sciences".

7.3.3 Risk assessment of the University of Life Sciences

Attachment 4 of UMB's annual plan for 2009 (UMB, 2008b) describes the identified risks that were considered as the most important by the university. In this section, two of the four risks related to education stated in this document are examined. To achieve the research objective, the ICRMM was used to assess these risks, and from this usage it was evaluated whether or not the ICRMM aided in establishing the risk profile facing the University of Life Sciences.

The risks related to education in UMB (2008b) are:

- Risk that UMB is unable to recruit and strengthen the scientific competence due to the fact that it is an employee's market and competition to recruit the best employees is tough.
- Risk for inadequate numbers of student applications for many of the educational programmes due to changes in the preferences of potential students.
- Risk that UMB is unable to change the education offered when the number of student applications, the needs from the society or the relevance of the educational programmes, signal that it is time to change them.
- Risk of reduced number of applications and throughput of students due to a poor physical learning environment.

Risk assessment: "UMB is unable to recruit and strengthen the scientific competence due to the fact that it is employee's market and competition to recruit the best employees is tough"

To assess the risk in question, a risk assessment diagram was created. This risk assessment diagram is presented in Figure 7.2.

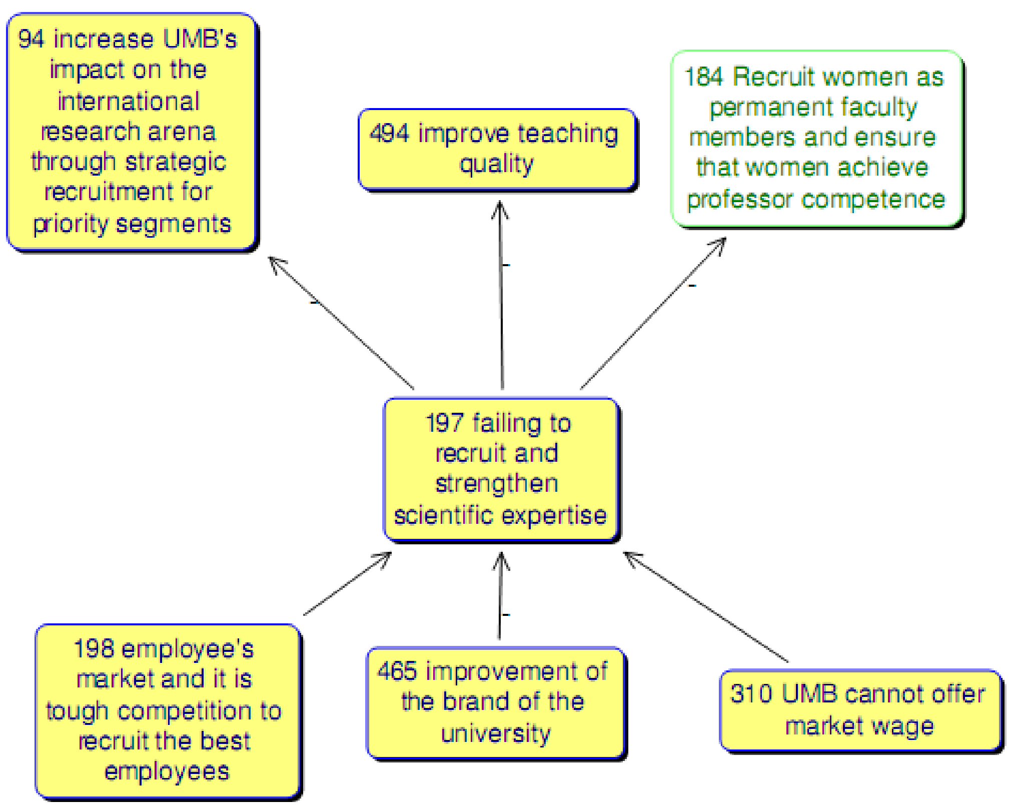


Figure 7.2 Risk identification – UMB is unable to recruit and strengthen the scientific competence...

The risk assessment diagram suggests that the recruitment and strengthening of scientific expertise is not only influenced by node 198 “employee’s market and it is tough competition to recruit the best employees”, but also by node 465 “improvement of the brand of the university” and node 310 “UMB cannot offer market wage”.

According to the risk assessment diagram, node 197 “failing to recruit and strengthen scientific expertise” can negatively influence on the three nodes: node 94 “increase UMB’s impact on the international research arena through strategic recruitment of priority segments”, node 494 “improve teaching quality” and node 184 “recruit women as permanent faculty members and ensure that women achieve professor competence”. By studying the figure it was seen that neither node 94 nor node 184 is directly related to education, so the focus for the education risk assessment was on node 494.

The risk assessment diagram suggests that the original name/description of the risk is unhelpful, since “failing to recruit and strengthen scientific expertise” is much more of a cause than a consequence. By examining the risk assessment diagram it appears that the education risk that UMB actually had identified was “teaching quality is reduced due to failing to recruit and strengthen scientific expertise”.

The causes and sources of the risk were better understood by “laddering down” the causal map (examining the causes and sources of the “causes and sources of the risk”), and the understanding of the consequences was improved by “laddering up” (examining the outputs/consequences/effects of “the consequence of the risk”). An example of an expanded risk assessment diagram is shown in Figure 7.3.

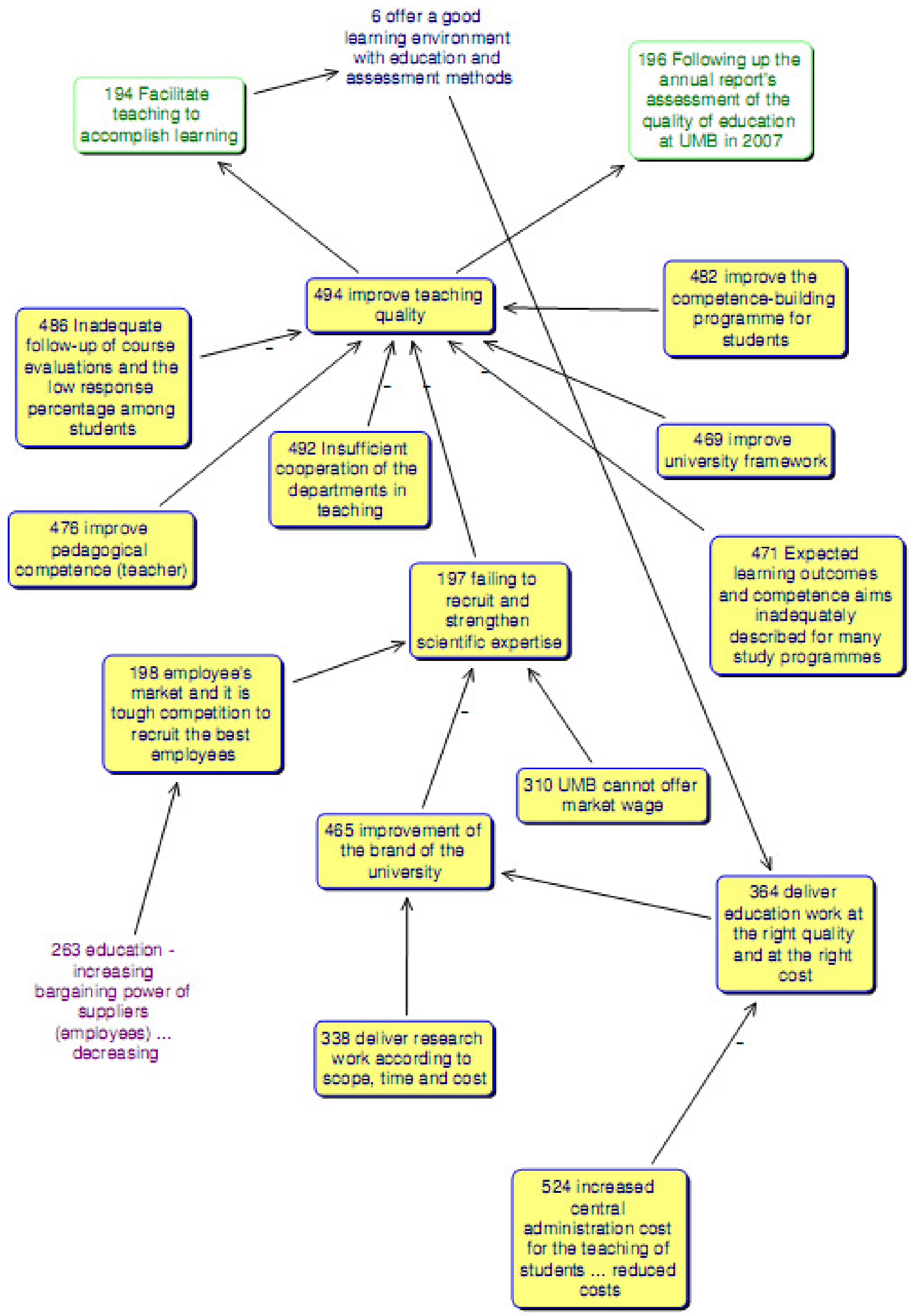


Figure 7.3 Risk analysis – Teaching quality is reduced due to failing to recruit and strengthen scientific expertise

Risk analysis

The expanded risk assessment diagram (Figure 7.3) suggests that the teaching quality (node 494) is influenced by many further factors than just the recruitment and strengthening of scientific expertise (node 197). This suggests that the risk cannot be fully analysed in isolation, but that the risk has to be considered in a full context to be understood.

The expanded risk assessment diagram contains a positive feedback loop (Node 197 – Node 494 + Node 194 + Node 6 + Node 364 + Node 465 – Node 197). According to Bryson et al. (2004: 239) "Positive feedback loops are very important; because they are self-sustaining they may be very important resources for the future of the business". Regarding feedback loops Bryson et al (2004) also write:

> "...an even number of negative links or all positive links suggests regenerative or degenerative dynamics, where a perturbation results in exponential growth or decline. In many studies loops relate to a small number of nodes and it is possible that the implications of the loop are well known to individual whose issue is depicted. However, where maps contain the views of a number of people, both the identification and exploration of the loops can be of significant interest, as in these cases the loops are not recognized by any one person and can often be counter-intuitive." (Bryson et al., 2004: 322)

This research programme did not assess the strength of the feedback loop, but this should be conducted as part of a more complete risk analysis for organisations. During the risk analysis it should be considered whether the feedback loop is considered to be a virtuous circle or vicious circle. Bryson et al. (2004) suggests the following interventions dependent on the conclusions of the risk analysis:

> "Positive feedback loop
>
> - Virtuous circle: reinforce one or more of the nodes by exploring influences on each node in turn.
> - Vicious circle: "rub out" one of the arrows by a change in policy or by changing the nature of one of the beliefs (make the loop into a controlling loop (negative) by changing the direction of causation, or by destroying the causation); find a number of influences on nodes that can shift the direction of behavior so that a vicious circle becomes a virtuous circle." (Bryson et al., 2004: 322)

Risk evaluation

In Figure 7.3 the risk is influenced by many internal factors and the only external factor is Node 198 "employee's market and it is tough competition to recruit the best employees". The diagram thereby suggests that UMB was in danger of focusing on the factor that was the most difficult to treat. A better choice to make sure the teaching was conducted at the correct quality would have been to focus on the internal factors that were easier to treat.

Though UMB (2008a) is not about risks, it describes various activities to be conducted to improve the quality of the teaching. Interestingly, the prioritised measures presented in UMB (2008a) are about treating the internal factors shown in the expanded risk assessment diagram. The risk evaluation of "Teaching quality is reduced due to failing to recruit and strengthen scientific expertise" therefore suggested that the risk should not be treated directly, but rather that the internal factors that may reduce the quality of teaching should be treated. The risk treatment of the uncertainty related to teaching quality is further looked at in Subsection 7.4.2.

As part of risk evaluation, a strategy related to the feedback loop had to be chosen. The chosen strategy was to focus on strengthening nodes that have positive influence on node 494 to "shift the direction of behaviour so that the positive feedback loop would become a virtuous circle instead of a vicious circle". This strategy for handling positive feedback loops is one of the options presented by Bryson et al. (2004: 322).

Risk assessment: "Inadequate numbers of student applications for many of the educational programmes due to changes in the preferences of potential students"

> "When developing causal chains and hierarchies, it is common for people to skip through many causal links in one leap, because so much of our thinking in business is embedded and not questioned…Also – and this is important – leaps of logic tend to mean that alternative choices are ignored."
>
> (Roberts and MacLennan, 2003: 4/17)

The risk assessment diagram that was created for the risk "Risk for inadequate numbers of student applications for many of the educational programmes due to changes in the preferences of potential students" is presented in Figure 7.4.

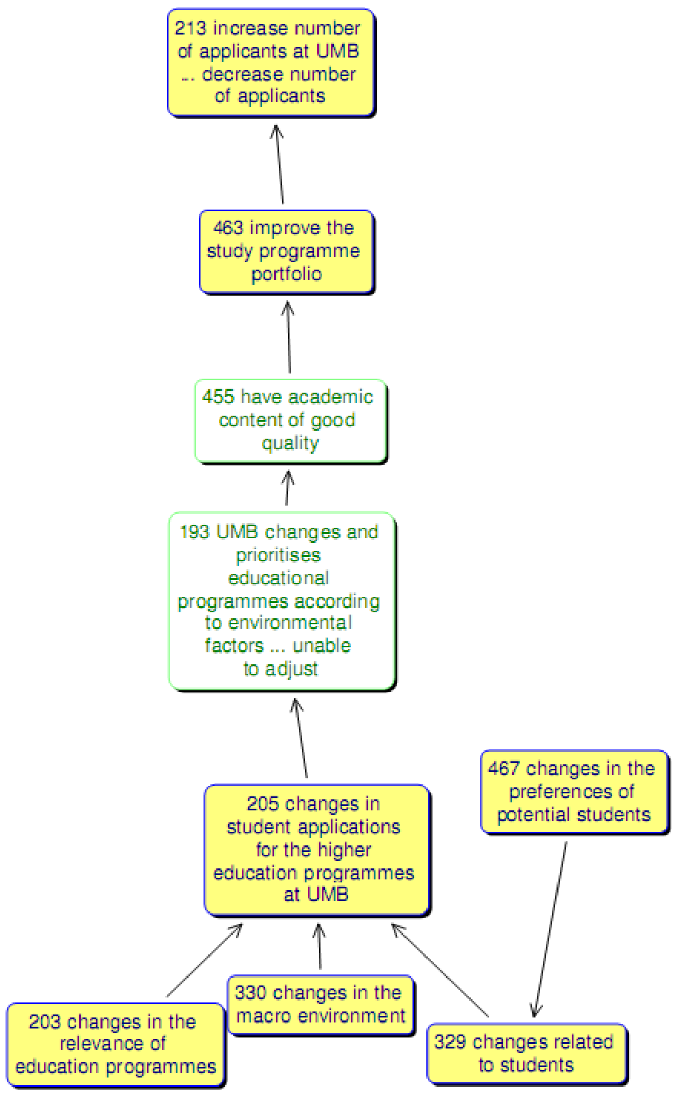


Figure 7.4 Risk identification – Risk for inadequate numbers of student applications for many of the educational programmes...

Figure 7.4 suggests that the original description of the risk had skipped some of the nodes in the causal chain (leap of logic from node 467 to node 213), which can result in the risk not being fully assessed and that potential risk treatment alternatives being ignored.

Risk analysis

To analyse the risk “Risk for inadequate numbers of student applications for many of the educational programmes due to changes in the preferences of potential students” two methods were used. The first one was laddering down from node 329 “changes related to students” to increase the understanding of the node.

The second method was to focus on the input nodes to node 213 “increase number of applicants at UMB...decrease number of applicants” to improve the understanding of the sources that influence on the result of node 213.

Risk analysis – method 1

The expanded risk assessment diagram used for this analysis is presented in Figure 7.5.

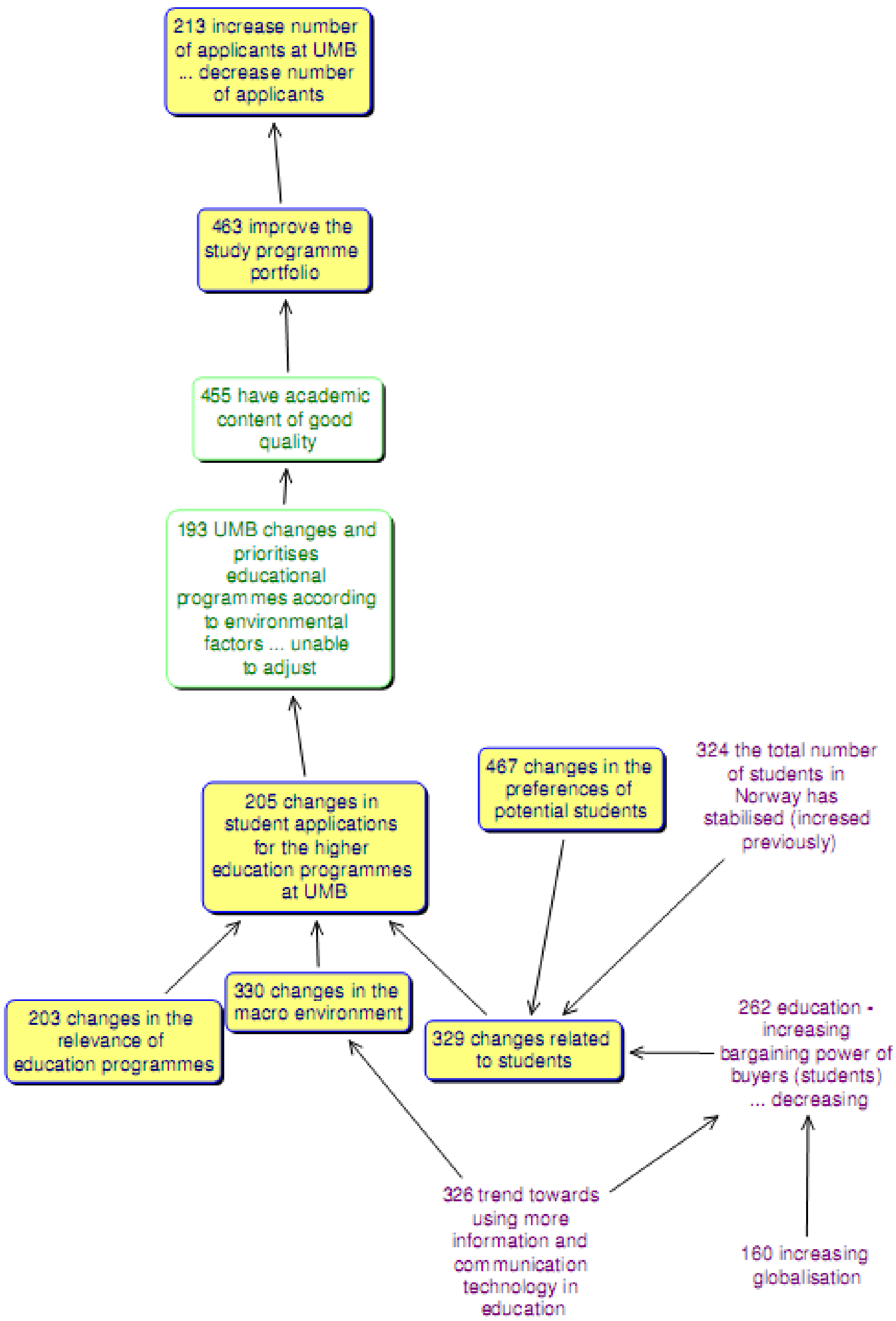


Figure 7.5 Risk analysis - changes related to students

Figure 7.5 suggests that node 329 is influenced by node 467 “changes in the preferences of potential students”, node 324 “the total number of students in Norway has stabilised (increased previously)” and node 262 “increasing bargaining power of students...decreasing”, which again is linked to both node 160 “increasing globalisation” and node 326 “trend towards using more information and communication technology in education”.

The combination of node 262 “increasing bargaining power of students...decreasing” and node 324 “the total number of students in Norway has stabilised (increased previously)” was interpreted as a strong indication of that the competition for students in Norway will increase in the future. However, the increased bargaining power of students was interpreted as an opportunity as well, because increasing globalisation provides an opportunity to expand the market for potential students from just Norway to the whole world. In addition, the trend towards using more information and communication technology in education was interpreted as an opportunity to develop distance-learning programmes (or provide distance-learning in individual subjects) where UMB has a competitive advantage compared to other universities.

Risk analysis – method 2

The expanded risk assessment diagram used for this analysis is presented in Figure 7.6.

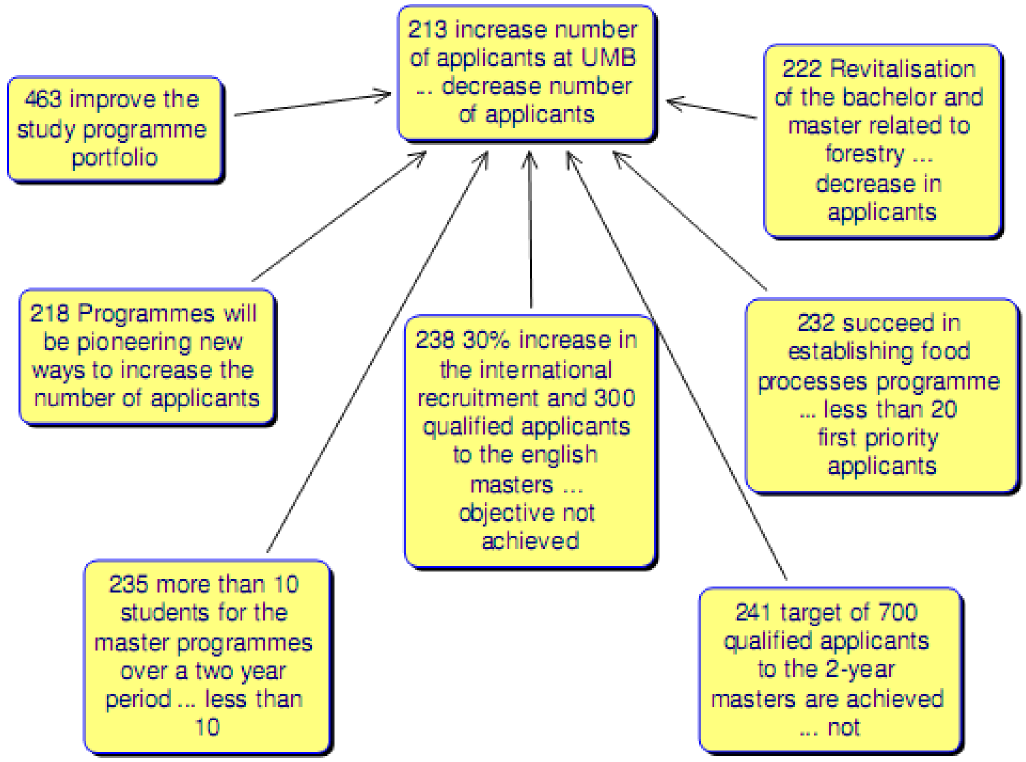


Figure 7.6 Risk analysis - focus on increase number of applicants at UMB

Figure 7.6 suggests that node 213 is influenced by many factors. Node 238 "30 % increase in the international recruitment and 300 qualified applicants to the English masters...objective not achieved" indicates that UMB had caught the signal of increased globalisation. Node 218, node 222, node 232, node 235 and node 241 are all about getting more students into existing programmes, which suggest that UMB was well aware of the uncertainty related to the number of applicants for study programmes at UMB.

Node 463 is about improving the study programme portfolio. Further analysis of node 463 suggests that this node probably won't have an immediate impact on node 213, but rather that an improved study programme portfolio will have an impact on the number of applicants to the study programmes at UMB in the long term.

Risk evaluation

The causal chain developed as part of risk analysis method 1 (Figure 7.5) suggests that changes and uncertainties in the environment have impact on UMB's objectives through causal chains. The risk analysis of the factors that may influence on the number of applicants at UMB (Figure 7.6) suggests that the uncertainty of the number of applicants at UMB is a function of the uncertainty of

- the number of applicants to the different programmes
- programmes' success in pioneering new ways to increase the number of applicants
- UMB's ability to improve the study programme portfolio

The risk analyses showed that the name of the risk "Risk for inadequate numbers of student applications for many of the educational programmes due to changes in the preferences of potential students" was unhelpful because it jumped over many logical steps in a causal chain. The risk analyses also provided evidence that there were many factors that influence on the "risk for inadequate number of student applications for many of the educational programmes" in addition to "changes in the preferences of potential students". To be as specific in the name (and description) of the risk as UMB had chosen to be, it would be absolutely necessary that the other risk factors had been analysed as well. Based on this, the name of the risk was changed to "Uncertainty related to the number of student applications for many of the educational programmes".

7.3.4 Conclusion

This section has demonstrated how a qualitative representation of UMB's risk profile was established. The qualitative risk profile established included UMB's risks and their interdependencies. There was not made any attempt to quantify either the risks or their interdependencies.

7.4 Results for the third objective of the first research cycle

7.4.1 Introduction

The third research objective of this research cycle was:

- To use the qualitative integrated causal risk management model to predict the likely effect of proposed actions on the risk profile.

This section will describe that the candidate used the ICRMM to conduct the risk management process risk treatment.

7.4.2 Risk treatment of "Uncertainty related to the quality of teaching"

In Figure 7.7 and in Figure 7.8 different proposed actions to treat the risk have been included in the risk assessment diagram. The proposed actions are the same actions that are discussed in UMB (2008a).

The risk assessment of this risk discovered that many factors influenced on each other, and a positive feedback loop was also discovered. By succeeding in executing actions that strengthen nodes that influence on node 494, it was predicted that the likely effect of the proposed actions was to "shift the direction of behaviour so that the positive feedback loop becomes a virtuous circle instead of a vicious circle" (Bryson et al., 2004: 322). As can be seen from Figure 7.7 and Figure 7.8, the chosen risk treatment strategy follows this recommendation by looking at risk treatment actions that improve teaching quality.

Figure 7.7 and Figure 7.8 visualise that the downside of the proposed risk treatment actions are that they have associated costs (node 524). The risk treatment process did not address the consequences of these increased costs except for the negative link to node 364, which is included in the diagrams. A more fully analysis could have been conducted by establishing potential causal chains from node 524 to other objectives as well. For example, if the proposed actions are accepted and the costs are proved to be considerable, then the university can expect increased central administration costs for the university, which again is likely to affect the departments' budgets negatively. Cuts in departments' budgets might again result in important research activities being delayed until money is available. To conclude, risk management is integrated with other managerial processes, decisions and actions, and therefore risk management treatment must be considered in the context of other organisational processes.

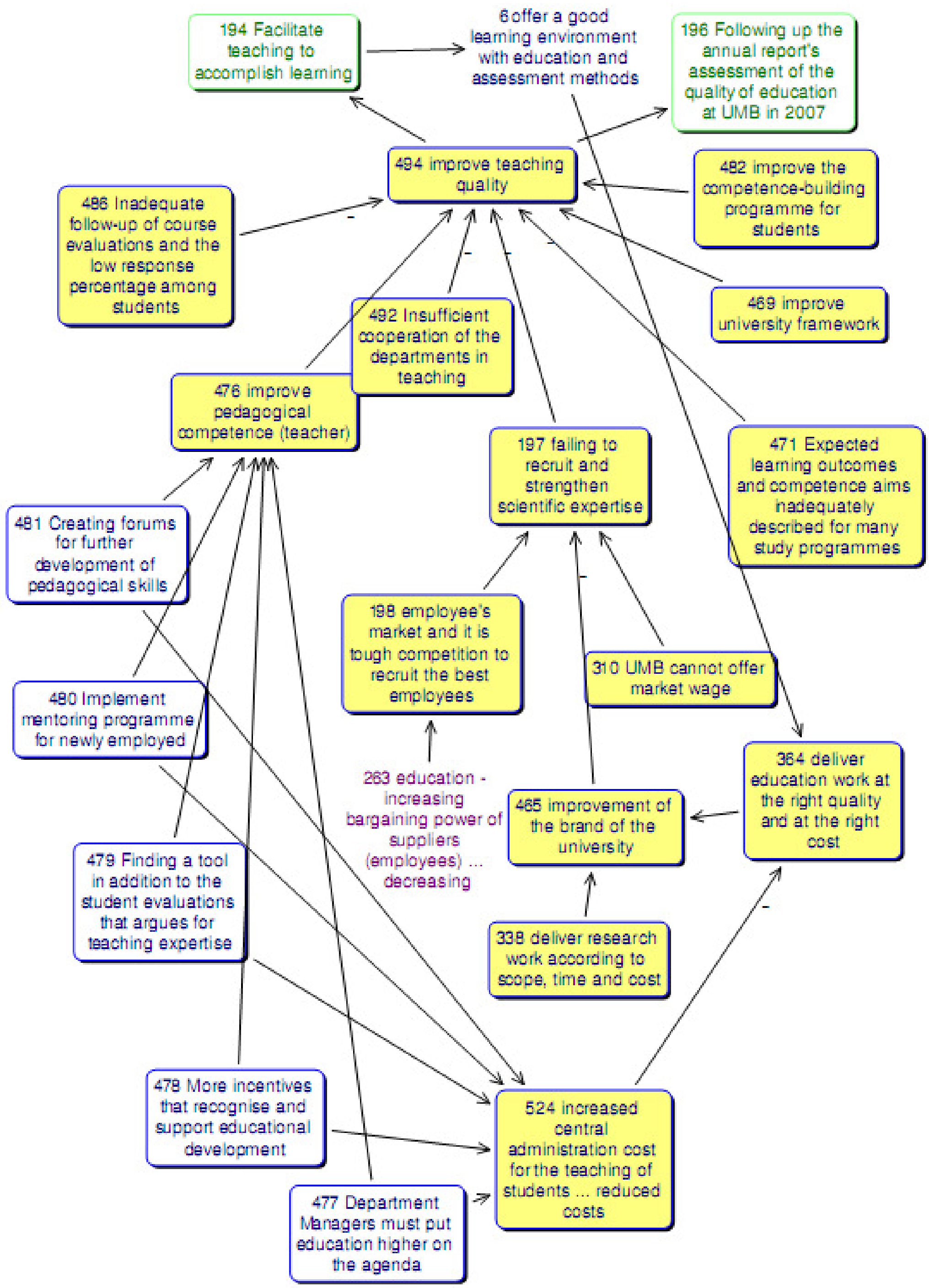


Figure 7.7 Risk treatment – proposed actions to improve pedagogical competence (teachers)

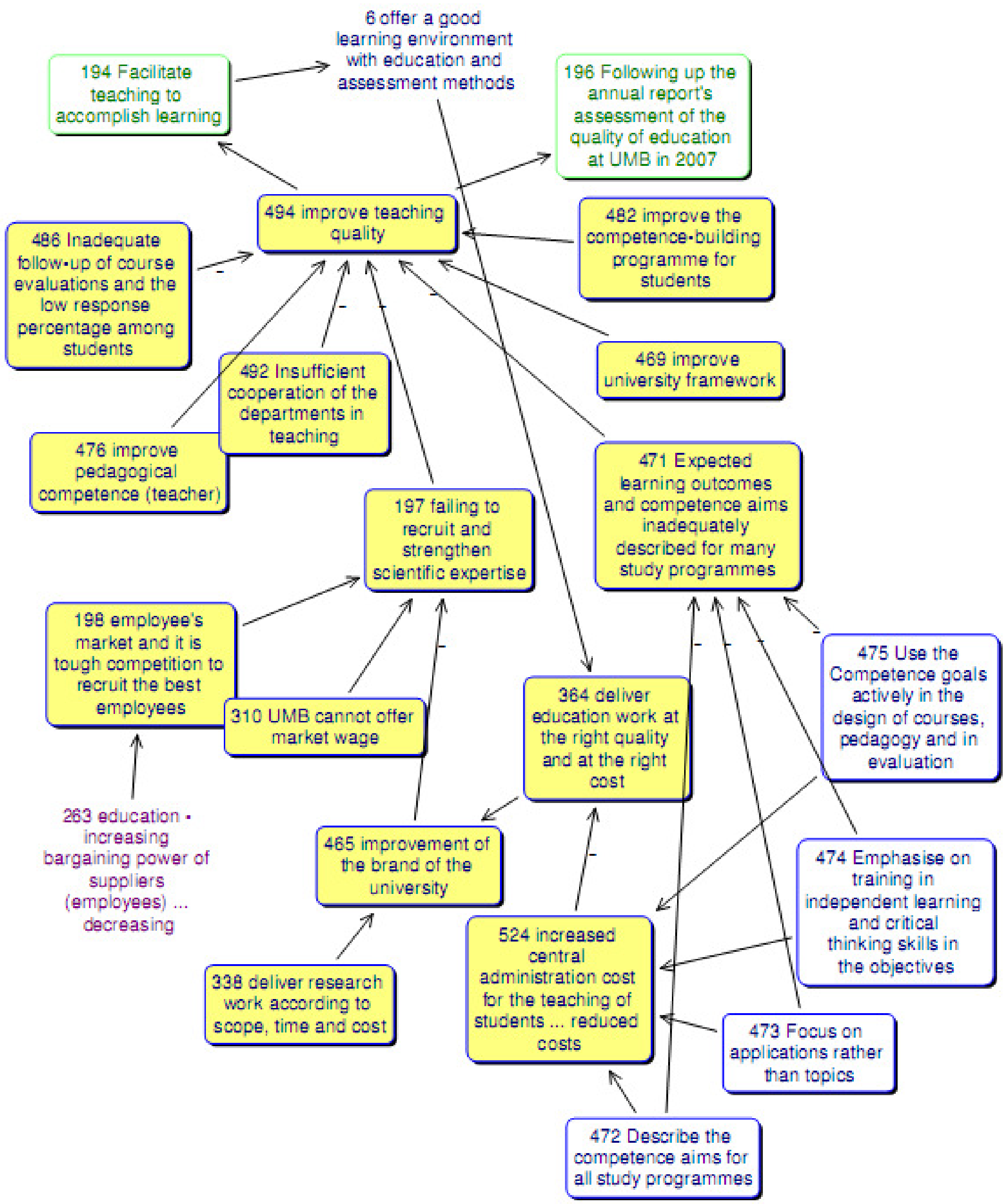


Figure 7.8 Risk treatment – proposed actions to improve expected learning outcomes and competence aims inadequately described for many study programmes

7.4.3 Risk treatment of "uncertainty related to the number of applicants for many of the educational programmes"

In UMB (2008b), there is many actions presented that will have a positive influence on "the uncertainty related to the number of applicants for many of the educational programmes". In this section, proposed actions that may influence on how UMB grasp the opportunity provided by globalisation and the proposed actions to influence the number of applicants to the 2-year master are examined.

The proposed risk treatment actions to improve the risk profile related to the number of applicants to English masters are visualised in Figure 7.9.

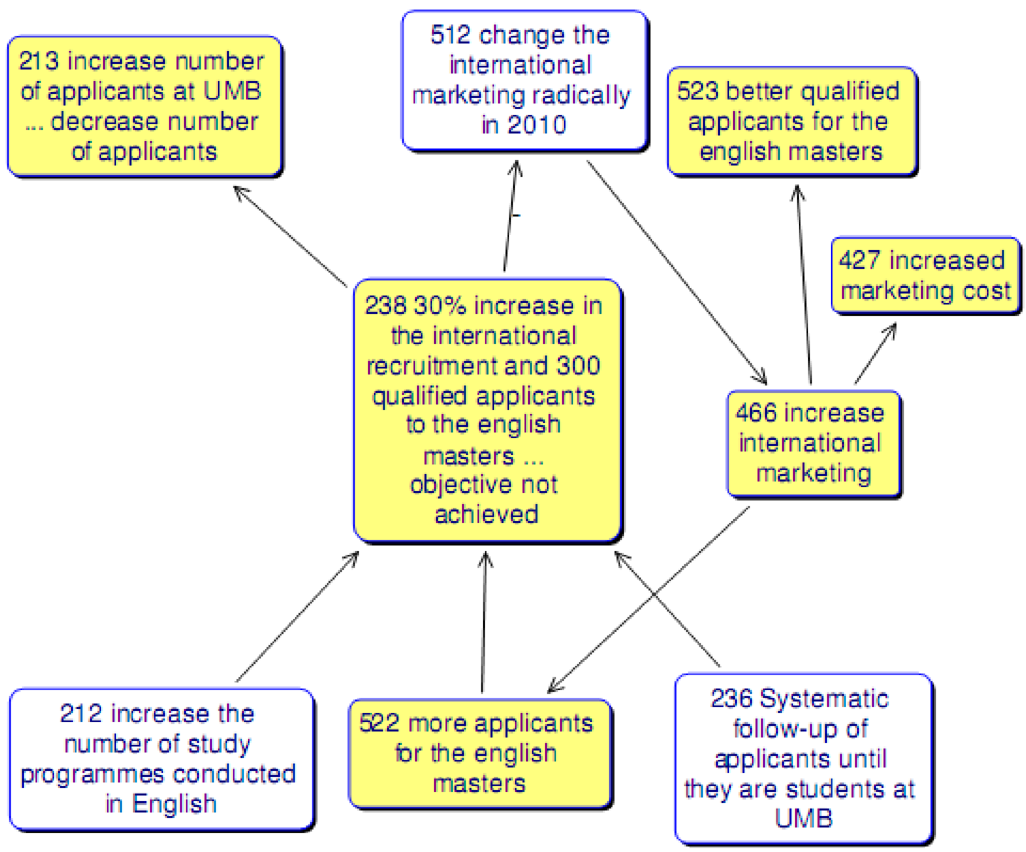


Figure 7.9 Risk treatment - focus on international recruitment

Figure 7.9 suggests two interesting points related to risk interdependency. First, node 466 increases the marketing costs for the university and thereby has a negative impact on the financial risk profile. Second, the figure has a negative feedback loop (node 238 – node 512 + node 466 + node 522 + node 238).

The proposed risk treatment actions to improve the risk profile related to number of applicants to the 2-year master are included in Figure 7.10.

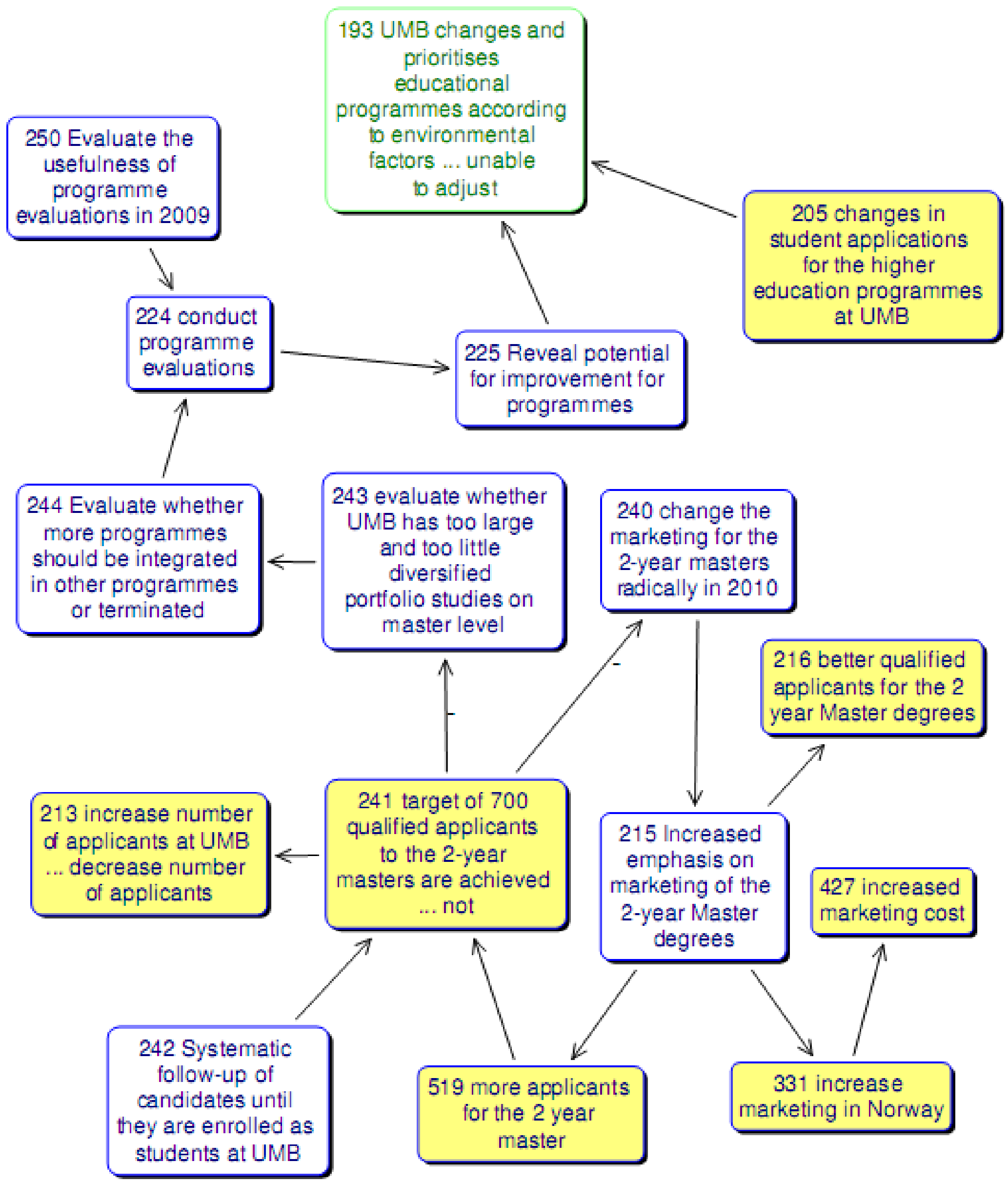


Figure 7.10 Risk treatment - focus on applicants to the 2-year master

Figure 7.10 suggests three interesting points related to risk interdependency. First, node 331 increases the marketing costs for the university and thereby has a negative impact on the financial risk profile. Second, the figure has a negative feedback loop (node 241 – node 240 + node 215 + node 519 + node 241). Finally, a failure to reach the target of 700 applicants to the two-year masters (node 241) leads to an evaluation of the portfolio of study programmes at master level, which again is linked to node 193 through a causal chain (node 193 is also a node in the causal chain presented in Figure 7.5).

The original name for the identified risk was "Risk for inadequate numbers of student applications for many of the educational programmes due to changes in the preferences of potential students". Roberts and MacLennan (2003) warn that "leaps of logic tend to mean that alternative choices are ignored". In this case, it is apparent that both the causal chain in Figure 7.5 and the causal chain in Figure 7.10 are needed to understand how the proposed action in node 243 influences on node 193, which again through a causal chain influences on node 213.

Figure 7.9 and Figure 7.10 suggest that the proposed marketing activities will increase the marketing costs for the university. This, once again, show how actions to improve the interface risk profile may result in the worsening of the financial risk profile.

Figure 7.9 and Figure 7.10 also suggest that the proposed actions will lead to negative feedback loops. In both cases these feedback loops were considered as appreciated effects, because the marketing effort could be increased or decreased according to the expected number of applicants. This form of control is aligned with Bryson et al. (2004):

> "When the loop contains an odd number of negative links, the loop is depicting self-control. That is, any perturbation in the state of the nodes in the loop will result in stabilizing dynamics to bring the activity into control."
> (Bryson et al., 2004: 322)

7.4.4 Conclusion

This section has demonstrated how a qualitative version of the ICRMM was used to predict the likely effect of proposed actions on the risk profile of the University of Life Sciences.

7.5 Reflection on the general findings of the first research cycle

The research question of this research cycle was:

- If the candidate designs a qualitative integrated causal risk management model, to what extent can the University of Life Sciences use this model to predict the likely effect of proposed actions on the risk profile?

To answer this research question, the candidate defined the following research objectives:

- To design a qualitative integrated causal risk management model that can be used to predict the likely effect of proposed actions on the risk profile
- To establish the risk profile facing the University of Life Sciences
- To use the qualitative integrated causal risk management model to predict the likely effect of proposed actions on the risk profile

The design of the qualitative ICRMM was based on ISO 31000. In the design, it was chosen to model the risk information gathered from the risk management process activities in qualitative causal maps. The design of the ICRMM was generic, and should therefore be just as useful for all organisations.

After the design was completed, the candidate used the ICRMM to establish a qualitative representation of the risk profile facing the University of Life Sciences. The qualitative risk profile showed causal relationships between uncertainties and issues affecting the achievement of the university's objectives.

The third research objective was about improving organisational risk management decision making by using the ICRMM to predict the likely effect of proposed actions. The candidate added risk treatment actions to the causal maps representing the risk profile of the university, and studied how these actions changed the risk profile of the university. The results indicated that the qualitative ICRMM could be used to predict the likely effect of proposed actions on the risk profile.

The candidate believes that the ICRMM designed for the university works very well together with the risk register already in use at the university. By assessing both the likelihood and impact of a risk in a risk register (or risk matrix) and by looking at how the same risk and its proposed risk treatment actions affect other risks in the risk profile, the university would get an improved framework for decision making related to risks and uncertainties in the candidate's opinion.

The qualitative ICRMM is very easy to work with and update with new information, so there is neither much cost associated with using the model. Based on the candidate's viewpoints, it would therefore be logical to expect that the University of Life Sciences would use the ICRMM to a great extent to improve risk management decision making at the university. However, nothing could be further from the truth.

The candidate's lack of optimism regarding future use of the ICRMM at the university comes from the fact that the managing director, which was the key owner and key stakeholder of the ICRMM, has left the university. The candidate has neither been successful in handing over the ICRMM for operation to the university. The candidate would, and should, add that at the final meeting between the financial director at the university and the candidate, the financial director said that he wanted the ICRMM for future use. However, since this meeting was held early in 2009, the candidate does no longer consider it likely that the ICRMM will be used as intended at the university. The candidate believes that the merger is partially to blame for the reduced interest from the university, but it should also be added that the Rector at the university never took or wanted any ownership of the working process related to the ICRMM. The candidate believes that this further reduces the likelihood of any future use of the model at the university.

The candidate is uncertain as to how to assess what practical value the University of Life Sciences actually has had from the candidate's research. The candidate and some of the key stakeholders at the university (in particular the former managing director) have had several good discussions on different aspects of the university's governance framework, strategy and risk management. The candidate is confident that these discussions have given insight to the key stakeholders as well as to the candidate.

The candidate originally planned to conduct the next research cycle at UMB, focusing on improving the ICRMM. However, already at the early stages of the merger the financial director and the managing director of UMB decided that a qualitative ICRMM was best suited for the university. The argument for this was that the qualitative version of the

ICRMM was easy to understand, that this model was easy to integrate with the current risk management system and, most likely, that with the upcoming merger it would difficult to support the candidate with information as originally planned. The decision to not design a semi-quantitative version of the ICRMM was also probably influenced by that the Office of Auditor General of Norway, the board, the rector and most of the management group were now happy with the current condition of the risk management system, even before the ICRMM had been introduced.

The candidate's supervisor for this research programme asked the candidate whether or not he agreed with UMB's decision to stop the design of the ICRMM before quantification. The candidate agrees that the conditions at the university would have made it difficult to motivate the rest of the management group to start working on quantifying the statements in the qualitative ICRMM. However, the real answer to the question is that the candidate believes that UMB should have organised their risk management initiative completely differently.

First, the risk management initiative should have been organised as a project according to normal project management standards such as PMI (2008). Second, the project should have been initiated with a much more precise project charter clearly dividing the project in separate phases with decision gates for each phase. Third, the university never developed a project statement that clearly described what deliverables could be expected from the risk management initiative nor what work was required to create these deliverables. Finally, the risk management initiative (project) needed a much more detailed project management plan with an outline of how the different project phases would be "planned, executed, monitored and controlled, and closed" (PMI, 2008). The first phases of the risk management initiative/project should have focused on aligning risk management at the university with ISO 31000 and relevant rules and regulations for the university. In this part of the risk management initiative/project the candidate believes that a purely qualitative ICRMM would have been most appropriate. When the risk management initiative/project had passed the decision gates for the first phases of the project, then the project would start working on the design of a semi-quantitative ICRMM.

The candidate was uncertain what to do at this stage. The candidate reflected on that an organisation interested in working on a semi-quantitative version of the ICRMM had to be a very risk mature organisation. The candidate, who was on an unpaid leave of absence from Terramar to work on the doctorate, suddenly realised that Terramar seemed to be a perfect sample organisation for the second research cycle. Luckily for the candidate, a key stakeholder at Terramar agreed.

Chapter 8 - Research methodology for the second research cycle

8.1 Introduction

The aim of this chapter is to describe the approach to data collection and processing used in the generation of the research data and results for the second research cycle. The research question for the second research cycle was:

- If the candidate designs a semi-quantitative integrated causal risk management model, to what extent can the Terramar telecommunication branch area manager use this model to predict the likely effect of proposed actions on the risk profile?

8.2 Research design

To answer the research question, the candidate used a case study research design inspired by Yin (2003), in a similar manner as for the first research cycle. Once again, the research design was based on Yin's five case study research design components.

The first component is the research question, which in this research cycle was:

- If the candidate designs a semi-quantitative integrated causal risk management model, to what extent can the Terramar telecommunication branch area manager use this model to predict the likely effect of proposed actions on the risk profile?

The study proportions of this research cycle were stated as the following research objectives:

- To design a semi-quantitative integrated causal risk management model that can be used to predict the likely effect of proposed actions on the risk profile
- To establish the telecommunication risk profile facing Terramar
- To use the semi-quantitative integrated causal risk management model to predict the likely effect of proposed actions on the risk profile

The third component, the unit of analysis, was the ICRMM in the context of the research objectives. The same unit of analysis was used in the UMB case study.

The fourth and fifth components, which are "the logic linking the data to the propositions" and "the criteria for interpreting the findings", were also the same as for the UMB case study. The candidate therefore once again decided that the most effective way of dealing with the fourth and fifth component was to study and evaluate each research objective in an "ISO 31000 Risk management - Principles and guidelines" (ISO, 2009b) context. The candidate decided that to meet the research objectives, a minimum was to comply with the listed principles in ISO 31000 that were relevant for this research. In addition:

- The first research objective was studied in the context of the ISO 31000 risk management framework.
- The second research objective was studied in the context of the ISO 31000 risk management process. The relevant risk management processes for this research objective was establishing the context and risk assessment.
- The third research objective was, as the second research objective, studied in the context of the ISO 31000 risk management process. However, the third research objective was studied in the context of the risk management process risk treatment.

8.3 Sources of data

8.3.1 Introduction to the sample: Terramar

The University of Life Sciences and Terramar AS agreed to participate in this study. These two organisations are not of similar size, one is a public organisation and one is a private company, and neither do the organisations have similar mission or purpose. The reason why it was possible to study the ICRMM at two so different organisations can be found in the ICRMM's generic character, which make the ICRMM just as useful for Terramar as it was for the university.

Terramar is a private and independent consultancy that was established in 1987. The company is fully owned by the employees. The original business idea was to transfer the skills that were developed in the Norwegian offshore industry in project governance and project management to other market areas within the public and private sectors. Terramar is currently one of the leading project management consultancies in Norway.

Terramar services customers in many different trades and has employed branch area managers (BAMs) for the following market segments:

- Building and property: The typical customers are large public and private clients. The New Opera house and Holmenkollen (ski jump) are two of the largest and most visible projects Terramar was working at the time the research was conducted.

- Industry and Technology: The Industry and Technology market consists of three segments: industry, technology and energy. Terramar focuses on technology based delivery projects and on improving the use of renewable energy (solar, water and wind). Typically, customers are large companies that operate nationally and internationally.

- Public Sector: The assignments within the public sector embrace the span from quality assurance of major government investment to the management of technological projects in the aviation sector. The customers include several ministries, agencies and publicly owned enterprises.

- Telecommunication: Telecommunication has not been a prioritised marketing segment for Terramar in recent years. However, in 2007 Terramar employed a new BAM responsible for the telecommunication market. This thesis will focus on the risk profile of this part of Terramar.

Until recently, the company had not formulated a public company purpose or a mission to be used for sale purposes or internally. Various visions/missions/top level objectives in the context of project management such as "Terramar's objective is to be a strong, visible and preferred project partner in the markets we choose to invest in and for the customers we are cooperating with" have been in use since the founding in 1987.

In Terramar's strategy document for the period 2009-2015, Terramar has sketched a strategic change in communication from focusing on the discipline of project management to focusing on realising strategies for customers through project management. Internally in Terramar this is not seen as a major strategic change, and basically the organisation will keep doing the same things as it has done the recent years. The new mission for Terramar is "bridging strategy and results" (Terramar, 2009).

Terramar has had positive operating results every year since it was founded in 1987. Costs for the development of methods and systems have been covered through the operation. Terramar's sales and profit in the last 5 years is presented in Table 8.1.

Year	Turnover (NOK 000,000s)	Profit (NOK 000,000s)
2004	28.0	1.0
2005	38.0	1.8
2006	40.9	1.9
2007	48.7	4.8
2008	55.6	3.3
2009	76.2	4.6

Table 8.1 Terramar's financial results

There is no fixed exchange rate between the Norwegian currencies (NOK) and the British Pound or Euro. Table 6.2 shows the exchange rate for two random days, which can give the reader an idea of the financial result of Terramar in GBP and Euro.

8.3.2 Market position

Status in the telecommunication market

Telenor is a dominant player in the Norwegian telecommunication market. Terramar has therefore focused on Telenor as the primary telecommunication customer. At the time of the research, the view of the Terramar's telecommunication BAM was that Terramar would build reputation as (project management) consultants in the telecommunication market by obtaining references on important assignments from Telenor.

The first step in getting more assignments from Telenor was achieved when Terramar signed a framework agreement with Telenor on 10/3 - 2008. This contract states the following purpose (Telenor is "The Purchaser" and Terramar is "The Supplier"):

> "The purpose of this contract is to secure The Purchaser access to necessary consultancy resources and to regulate the relevant commercial terms for such access. The Purchaser is therefore entering into this non-exclusive Framework Agreement, hereinafter referred to as The Contract, with the Supplier for the supply of consultants and related services.
>
> This contract is a Framework Agreement, and actual purchases of consultants and related services will be made as separate Purchase Orders subject to this Contract. The specific type and required qualifications of the, under this Contract engaged, consultant or consultants, and the specific task or tasks of the consultant(s) shall be separately specified for each specific Purchase Order.
>
> Prices stated in this Contract are maximum prices. Lower prices may be agreed for any individual Purchase Order. The Supplier is obliged upon request to offer a fixed price, target price or price mix...
>
> This Contract does not grant The Supplier any exclusivity as regards the provision of Services..."

Brand in quality assurance and assessments of risks and uncertainties

In Norway, Terramar has a strong brand related to quality assurance and assessments of risks and uncertainties of projects. One of the primary reasons for this is that Terramar, in partnership with Asplan Viak and Promis, has a framework agreement with the Norwegian Ministry of Finance for quality assurance of major public investments projects.

Klakegg et al. (2005) gives a good overview of what the Quality Assurance Scheme is, and thereby why this framework agreement is so important for Terramar's branding:

> "The Ministry of Finance established the Quality Assurance Scheme year 2000, and pre-qualified external consultants to perform quality assurance of the largest public investment projects (those exceeding EURO 60 millions). The goal is to ensure improved quality-at-entry, reduced cost and better use of the public funds…
>
> …include two separate analyses in sequence:
>
> 1. Quality assurance of the choice of concept (QA1)
> 2. Quality assurance of cost estimates and the basis for control and management, for the chosen project alternative (QA2)
>
> QA1 should help verify that the choice of concept is subject to a political process of fair and rational choice. Ultimately, of course, the choice of concept is a political process. The consultant's role is restricted to reviewing the professional quality of underlying documents constituting the basis for decision…
>
> QA2 aims to provide the Ministry with an independent analysis of the project before Parliamentary appropriation of funds. Focus is on the control aspect. This is partly a final control to make sure that the budget is realistic and reasonable. Partly it is a forward-looking exercise to identify the managerial challenges ahead. The analysis should help substantiate the final decision regarding the funding of the project, and be useful during implementation as a basis for control..." (Klakegg et al, 2005: 3)

8.3.3 Written sources of data

The strategic plan

Terramar (2006) lays the foundation of the company's strategy for 2007-2010. This strategy document has therefore logically had major implications on the strategic options for the telecommunications marked. Below are some of the highlights of the strategy document presented:

"Markets, customers and competitors: Implications for Strategy 2007 - 2010.

- We maintain the choice of the preferred sectors as all of these have either good or very good prospects for the coming strategic period.
- We will actively seek to form and develop relationships with preferred customers, as this is critical for our sale of services and our positioning to get key roles in large / visible projects.
- We will actively seek to establish framework agreements with preferred customers, as this gives us the necessary "hunting license" and facilitate the customers buying processes.

Service Strategy and role: Implications for Strategy 2007 - 2010.

- We maintain an approach of focusing on a preferred range of industries and customers to ensure adequate understanding of the client's business challenges and needs.
- Due to our limited size, we reduce rather than increase the number of industries and customers. Operationally, this is safeguarded by a critical assessment of the customers we offer to provide and the services offered.
- We need to turn our focus and awareness in relation to "create" projects. We shall therefore try to position Terramar as a business partner to preferred customers rather than being hired resources with tough price pressure.
- We will develop our strength, which is to combine business insight in the preferred industries / clients with expertise on projects and analysis.

Prerequisites for success: Implications for Strategy 2007 - 2010.

- We shall have a culture of continuous care of our customers. Our focus on relationship building must be strengthened through increased interaction with the customers during the sales processes and during the mission.
- The number of preferred markets / customers must be restricted to make it possible to acquire the necessary business understanding.
- Expertise in IT and telecommunication must be enhanced."
  (Terramar, 2006)

Terramar presented a new strategic plan to the employees in the spring 2009 (Terramar, 2009). The new strategic plan is built on Terramar (2006) and made it evident that Terramar is planning to follow the same strategic direction in the period 2009-2015.

8.4 Software programs used: Riscue

From the first research cycle, it can be seen that the University of Life Sciences chose a qualitative ICRMM. In this research cycle, the Terramar BAM chose a semi-quantitative ICRMM. The software program Decision Explorer was more or less used in the same manner for both the qualitative and the semi-quantitative ICRMM. In addition to Decision Explorer, the software program Riscue was used to establish and use a semi-quantitative ICRMM. If UMB had chosen a semi-quantitative ICRMM, then Riscue could have been used for the university as well.

This chapter does not repeat information about the software program Decision Explorer that was given as part of the methodology chapter of the first research cycle. This chapter only presents the software program Riscue.

Riscue has a homepage (http://www.riscue.org) and there the following introduction to the software is given:

> "Riscue is developed by Arne Bang Huseby and TerraMar, with support from Department of Mathematics at the University of Oslo. It is a result of more than 20 years of practical experience in risk management combined with state-of-the-art stochastic modelling methods.

Riscue is a software application for doing probabilistic risk analysis. Key application areas are:

- Cost and Schedule Risks
- Hazard analysis
- Reliability analysis
- Financial risks
- Insurance
- Total Value Chain Analysis
- Oil reservoir and production profile risk

The program offers powerful modelling capabilities, and is based on influence diagrams and Monte Carlo simulation. Even large, complex models integrating many different types of risks can be built and analyzed very fast."

Riscue supports numerous of distributions. In this research programme, it has only been used two simple and well behaved distributions, which are Triang3 and Uniform distributions. The practical difference between these two distributions can be seen by simulations presented in Section "3.5 Monte Carlo simulations" and by the definitions provided below:

- "TRIANG3: A continuous, unimodal distribution with a finite range. The probability of getting a value less than the mode value is equal to the ratio [(mode - minimum) / (maximum - minimum)]. The probability of getting a value greater than the mode value is equal to the ratio [(maximum - mode) / (maximum - minimum)]. The minimum and the maximum are determined so that the distribution gets the specified 10%- and 90%-percentiles (approximately).

- UNIFORM: A continuous distribution with a finite range. All values in the range are equally likely to occur." (Descriptions given in Riscue)

Riscue can be used in numerous ways. In this research programme, the following formulas have been used for statements and relationships between statements:

- "SUM: Returns the sum of a set of values. If the values are x1, x2, x3, x4, ..., the result is x1 + x2 + x3 + x4 + ... This function is similar to the INPUTSUM function except that the values are entered as formula arguments instead of formula inputs.

- INPUTSUM: Returns the sum of a set of values. If the values are x1, x2, x3, x4, ..., the result is x1 + x2 + x3 + x4 + ... This function is similar to the SUM function except that the values are entered as formula inputs instead of formula arguments.

- INPUTMINUS: Returns the sum of a set of values multiplied by (-1). If the values are x1, x2, x3, x4, ..., the result is -(x1 + x2 + x3 + x4 ..). This function is similar to the MINUS function except that the values are entered as formula inputs instead of formula arguments.

- DIFFERENCE: Returns the sum of differences of a set of values. If the values are x1, x2, x3, x4, ..., the result is (x1 - x2) + (x3 - x4) + ... or equivalently (x1 + x3 + ...)-(x2 + x4 + ...). If the number of values is odd, the first of these sums will contain one more term than the last sum. This function is similar to the INPUTDIFF function except that the values are entered as formula arguments instead of formula inputs.

- INPUTDIFF: Returns the sum of differences of a set of values. If the values are x1, x2, x3, x4, ..., the result is (x1 - x2) + (x3 - x4) + ... or equivalently (x1 + x3 + ...)-(x2 + x4 + ...). If the number of values is odd, the first of these sums will contain one more term than the last sum. This function is similar to the DIFFERENCE function except that the values are entered as formula inputs instead of formula arguments.

- PRODUCT: Returns the product of a set of values. If the values are x1, x2, x3, x4, ..., the result is x1 * x2 * x3 * x4 * ... This function is similar to the

INPUTPROD function except that the values are entered as formula arguments instead of formula inputs.

- INPUTPROD: Returns the product of a set of values. If the values are x1, x2, x3, x4, ..., the result is x1 * x2 * x3 * x4 * ... This function is similar to the PRODUCT function except that the values are entered as formula inputs instead of formula arguments.

- INPUTMIN: Returns the smallest value of a set of values. If the values are x1, x2, x3, x4, ..., the result is min(x1; x2; x3; x4; ...) This function is similar to the MIN function except that the values are entered as formula inputs instead of formula arguments.

- INPUTMAX: Returns the largest value of a set of values. If the values are x1, x2, x3, x4, ..., the result is max(x1; x2; x3; x4; ...) This function is similar to the MAX function except that the values are entered as formula inputs instead formula arguments." (Descriptions given in Riscue)

8.5 Data collection and processing from Terramar

This section will show that Terramar chose to establish a semi-quantitative ICRMM compared to the qualitative ICRMM chosen by UMB. This was a logical choice for Terramar since this organisation is a very risk mature organisation [please refer to Figure 2.4 Risk management maturity continuum (Abrams et al., 2007)].

The data collection and data processing related to Terramar must be divided in three. The first part of the process was not directly related to this research programme, but has most likely had some influence on the result. This first part of the process was the period when the candidate was an employee in Terramar, but yet had not decided to include Terramar as a sample in the research programme. This period lasted from august 2004 to the end of 2008. In this period the candidate did not consciously collect data for the research programme, but it would be naive to believe that this period has not had any effect on the ICRMM that was created.

The second part of the process was about collecting and processing data to establish the telecommunication risk profile facing Terramar, and to use the ICRMM to predict the likely effect of proposed actions on the risk profile. The data collection was conducted by using the interview technique cognitive mapping (Ackermann et al., 2004: Chapter 3; Bryson et al., 2004: Part II) on the telecommunication BAM in Terramar. The choice using cognitive mapping instead of using oval mapping (Ackermann et al., 2004: Chapter 4; Bryson et al. (2004, Part III) was taken by the telecommunication BAM. The reasoning for this was that the BAM wanted the ICRMM to reflect his views and not the views of the rest of the management group. The consequence of this choice was that the ICRMM would only be a valid representation of the views of the BAM, and not necessarily the views of the rest of the management group. The implications of this choice are further discussed in "Chapter 12 - Reliability, validity and generalisability".

Ackermann et al. (2004) includes a warning of a common problem for untrained researchers/consultants using the cognitive mapping technique:

> "When we have trained consultants in mapping we have found that often the consultant will construct a map that does not 'connect' with the interviewee. In these circumstances it is usual to find that the map does not reflect the views of the interviewee, but rather those of the consultant." (Ackermann et al., 2004: 38)

The candidate was aware of this danger and sought to avoid this by following advice and using process recommendations given in Ackermann et al. (2004: Chapter 3). For example, before the candidate had the first session with the BAM, the candidate trained on using the cognitive mapping technique by interviewing his wife on work issue and even had a training session using his mother-in-law as the interviewee on a private matter (not a choice for those who are risk averse). Before the candidate had his first interview with the BAM, the candidate had also already created the first drafts of the causal maps that would be used to create the ICRMM for UMB. For all these training sessions the software program Decision Explorer from Banxia Software was used.

Another recommendation in Ackermann et al. (2004: 42) was to conduct the mapping away from the interviewee's office. The candidate therefore scheduled the first cognitive mapping session to be conducted in the house of the candidate. The candidate also followed the advice to "arrange the chairs so that you are sitting at a 90-degree angle to the interviewee. This will not only help to build a degree of mutual confidence, it will also ensure that the interviewee will be able to see what you are writing and thereby enabling validation and joint exploration" (Ackermann et al., 2004: 41-42). The writing in this context was conducted by the use of the software Decision Explorer.

The candidate was also aware of advice given on "Closing the interview" and "After the interviews" in Ackermann et al. (2004: 45-46). The candidate closed the interviews with the BAM by summarising the map as the candidate understood it and by explaining what work still needed to be conducted to create the ICRMM. After the interviews the candidate always created files (printed pdf-files from Decision explorer) for the BAM as soon as possible to show "the structured representation of the BAM's thinking" (Ackermann et al., 2004: 46). The candidate agrees that this advice was an aid for the interview that followed, because it had given the BAM a chance to reflect on the map before the next interview session started.

The third part of the data collection and processing process was about quantifying the qualitative data in the qualitative cognitive map. As described in "Chapter 3 - Causal risk management models" there are numerous choices of different quantitative simulation techniques that could have been used. However, Terramar uses the Monte Carlo simulation program Riscue for project risk analysis, so the logical choice was to quantify the qualitative data in Riscue.

The choice of using Riscue and Monte Carlo simulations also had an important implication for the data collection and processing process, since the Monte Carlo simulations in Riscue cannot model feedback loops. The telecommunication BAM and the candidate were aware of this coding limitation and looked for alternative functional relationships between elements/nodes in the ICRMM when feedback loops were found. For example, by letting all the elements/nodes in a feedback loop be dependent of the same input node outside the feedback loop, you get the result that all the nodes in the feedback loop correlate. The actual cause –effect relationships in the feedback-loop are not coded [and thereby this solution does not fully comply with the structural models advocated by Miccolis and Shah (2001)], but correlation between the elements/nodes in the potential feedback loop is used as a substitute to get similar results. This way of coding is aligned with the coding principles Terramar uses for Monte Carlo simulations of projects (please refer to Section "3.5 Monte Carlo simulations" for further details).

The quantifying process was conducted by studying each statement and its related statements separately in the causal map. An example of such a causal map is given in Figure 8.1.

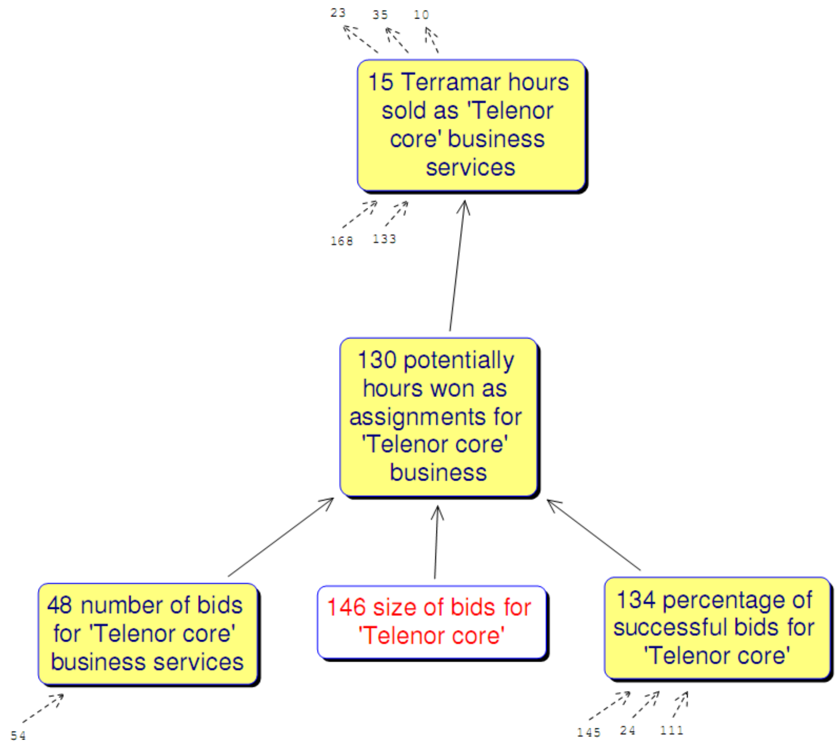


Figure 8.1 Risk assessment diagram for node 130 potentially hours won as assignments for 'Telenor core' business

The quantification process was about finding mathematical statements or functions to express the links as well as the nodes in the diagram. To conduct this work, the BAM sometimes needed to look at historical documents (such as contracts, budgets and strategic documents) and consult with other employees in Terramar. This part of the process also resulted in changes in the qualitative causal map, when the BAM and the candidate felt that relationships between statements had to be changed, new statements needed to be included or statements should be removed.

Figure 8.1 can be used to describe an example of the process of moving from a qualitative model to a semi-quantitative Monte Carlo simulation model. From the figure it can be seen that Node 130 "potentially hours won as assignments for 'Telenor core' business" has inputs from Node 48 "number of bids for 'Telenor core' business service", Node 146 "size of bids for 'Telenor core'" and Node 134 "percentage of successful bids for 'Telenor core'".

From “Appendix C: Manuscript Monte Carlo simulations for Terramar”, it can be seen that Node 130 is expressed with an Inputprod function, which in practise means that:

Node 130 = Node 48 * Node 146 * Node 134, which is the same as

Potentially hours won as assignments for ‘Telenor core’ business =
Number of bids for ‘Telenor core’ business service * Size of bids for ‘Telenor core’* percentage of successful bids for ‘Telenor core’

The only input to Node 48 “number of bids for ‘Telenor core’ business service” is node 54. From Appendix C, it can be seen that Node 54 is “potential assignments in pipeline (number of prospects”), that the link between node 54 and node 48 transfers the numerical value from the output of Node 54 to the input to Node 48 [written as 1:1 Links (output) on node 54], and that Node 48 is expressed as an “Inputsum” function. In practice this means that node 48 will end up with the same value as node 54.

Node 146 “size of bids for ‘Telenor core’” has no input from other nodes, and is expressed as a Triang3 [perc 10; mode; perc 90] distribution, where perc 10 is the 10 %-percentile of the distribution, mode is the most likely value of the distribution and perc 90 is the 90 % -percentile of the distribution. The choice of distribution and input to the distribution for the node were decided by the telecommunication BAM. His decision was based on historical data, the telecommunication BAM’s subjective judgement and subjective viewpoints from the candidate. The BAM chose to use perc 10 = 500 hours, mode = 1150 hours and perc 90 = 1800 hours.

From the figure it can be seen that Node 134 “percentage of successful bids for ‘Telenor core’” has inputs from three nodes (Node 145 expected percentage of bid success, Node 24 Reduce consultancy price for 'Telenor core' business services and Node 111 high quality bids). Node 134 is thereby expressed as a function of the three inputs.

By running a Monte Carlo simulation of the semi-quantitative ICRMM in Riscue, the results for all the nodes in the model can be studied. In Figure 8.2, the S-curve for the results for Node 130 is presented. The X-axis of the graph is “potentially hours won as assignments for Telenor core business”, while the Y-axis is percentage. The graph presents the likelihood of achieving a lower simulation results than the graphs x-value. Below the graph are the mean value, the standard deviation and the values for P10, P50 and P90 presented. By studying Figure 8.2, it can from both the graph and the stated P50 value be seen that there is 50 percent likelihood that each simulation will provide a value of 2,842.55 [potentially hours won as assignments for Telenor core business] or less.

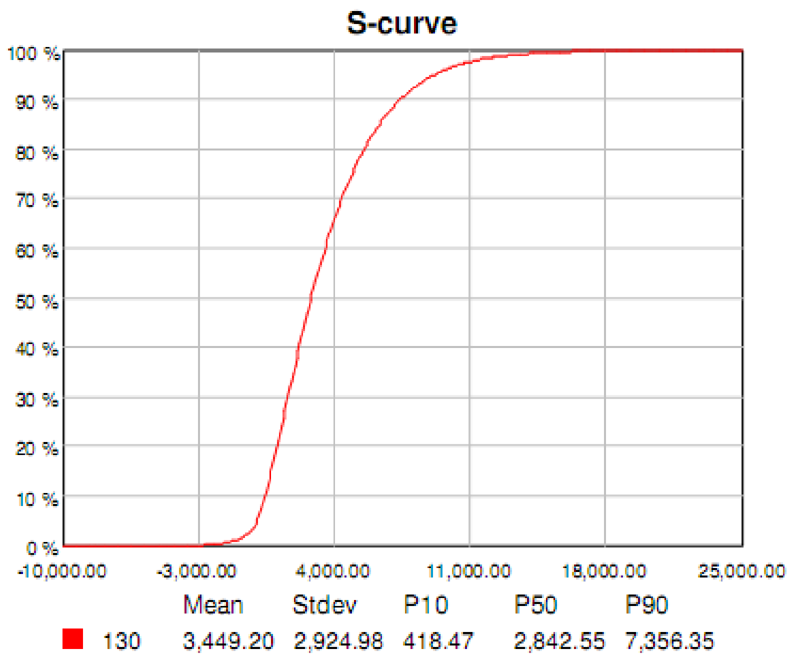


Figure 8.2 Riscue simulation of node 130

8.6 Conclusion

This chapter has presented the methodology of the second research cycle. The following chapter will examine the results and conclusions of this research cycle.

Chapter 9 - Results and reflections for the second research cycle

9.1 Introduction

The research question of this research cycle was:

- If the candidate designs a semi-quantitative integrated causal risk management model, to what extent can the Terramar telecommunication branch area manager use this model to predict the likely effect of proposed actions on the risk profile?

To answer this research question, the candidate defined the following research objectives:

- To design a semi-quantitative integrated causal risk management model that can be used to predict the likely effect of proposed actions on the risk profile
- To establish the telecommunication risk profile facing Terramar
- To use the semi-quantitative integrated causal risk management model to predict the likely effect of proposed actions on the risk profile

This chapter summarises the findings and results of the first Terramar case study. When reading the results and conclusions of this research cycle, the reader must be aware that the research results must be understood as indicative rather than definitive. The implications of the choice of research paradigm and research methodology are further discussed in "Chapter 12 - Reliability, validity and generalisability".

9.2 Results for the first objective of the second research cycle

9.2.1 Introduction

The first objective related to this case study was:

- To design a semi-quantitative integrated causal risk management model that can be used to predict the likely effect of proposed actions on the risk profile.

In Section "7.2 Results for the first objective of the first research cycle" the design of a qualitative ICRMM is examined. The material in that chapter applies for this chapter as well, and this information will not be repeated in this section. However, the design of a semi-quantitative ICRMM created some further design challenges, which will be covered in this section.

9.2.2 Establishing the context

Establishing the context of the risk management process – define risk assessment methodology

There are numerous simulations methods that can be used for conducting semi-quantitative risk assessments (please refer to Sections 3.4 and 3.5). Terramar uses Monte Carlo simulation as their main quantitative simulation technique for quantitative risk assessments, and the telecommunication BAM in Terramar therefore preferred the ICRMM to be designed with the use of the Monte Carlo simulation technique as the primary risk assessment methodology. The candidate had no objections to this request, as Monte Carlo simulation technique was also one of the options that were considered as part of the literature review.

The final manuscript for the Monte Carlo simulations for Terramar is presented in "Appendix C: Manuscript Monte Carlo simulations for Terramar". By studying this manuscript it can be seen that only simple and "well behaved" distributions have been used. Please refer to Section "8.4 Software programs used: Riscue" for further information about the distributions used in this research programme.

Developing risk criteria

The semi-quantitative ICRMM is designed with three risk criteria. The first risk criterion is related to the expected mean result for the top level objectives. The expected results for the top-level objectives are normalised by using the scores:

- -1 for the expected worst scenario result for the top-level objective
- 0 for the lowest acceptable result for the top-level objective
- 1 for the expected best scenario result for the top-level objective

The scale for the top level objectives is linear and therefore it is considered unnecessary to add any further categories for the objectives. This can be illustrated with an example:

The expected mean result for the financial top-level objective is set as:

- The expected worst scenario gives a financial result of NOK -1,300,000. In the ICRMM, a simulation result of NOK – 1,300,000 will be normalised to the score -1
- The lowest acceptable result for the financial top-level objective is set to NOK 1,300,000. In the ICRMM, a simulation result of NOK 1,300,000 will be normalised to the score 0
- The expected best scenario gives a financial result of NOK 3,900,000. In the ICRMM, a simulation result of NOK 3,900,000 will be normalised to the score 1

If a simulation gives a financial result of NOK 2,600,000, then the score for the top level objective will be calculated to the score:
(2,600,000 – 1,300,000) / 2,600,000 = 0.5.

The first risk criterion is designed to evaluate the mean simulation result for each of the top level objectives. The organisation defines the first risk criterion by setting acceptable levels for the mean scores for each of the top-level objectives (for example levels +/- 0.15 for the normalised objectives). Simulations, conducted as part of risk assessment, giving mean results for the top-level objectives outside the acceptable levels for mean scores indicate that the risk criterion has not been met.

The second risk criterion is related to the fact that the simulation outcome will form a distribution of outcomes for each node representing the uncertainty of the results for each node. In the semi-quantitative ICRMM the risk profile of each of the top-level objectives are visualised as an S-curve as in Figure 3.3. The S-curve presents the expected outcome for the objective, but more importantly it also presents the "effect of uncertainty on the objective".

The second risk criterion is designed to evaluate both a low level and a high level of confidence of simulation outcome for each of the top-level objectives. The organisation defines their second risk criterion by setting acceptable levels for both a low level and a high level of confidence of simulation outcome for each of the top-level objectives. In the ICRMM for Terramar, it was chosen to focus on the scores for the 10 % level of confidence (P10) and the 90 % level of confidence (P90) for each of the top-level objectives. Simulation results outside the defined acceptable levels for P10 or P90 indicate that the risk criterion has not been met.

The third risk criterion is related to the fact that the simulation results for the top-level objectives are not independent of the results of the other top-level objectives. Shah (2003) writes that correlation can be used as a measure for capturing this interdependency (or capture the portfolio effect as he calls it):

> "For companies implementing Enterprise Risk Management (ERM), risk assessment must also capture the portfolio effect. One of the biggest hurdles to implementing ERM is determining the correlation among risks." (Shah, 2003: 3)

The third risk criterion is designed to evaluate the correlation between the top-level objectives. The organisation defines their third risk criterion by establishing a degree of correlation table as shown in Table 9.1. If two top-level objectives have high correlation and the simulation results of the objectives are close to be outside the other risk criteria that have been set, then the organisation should consider whether treatment of the risk profile are needed due to the correlation factor.

Degree of correlation	Negative	Positive
Small	-0.1 to 0.0	0.0 to 0.1
Medium	-0.4 to -0.1	0.1 to 0.4
High	-0.4 to -1.0	0.4 to 1.0

Table 9.1 Degree of correlation table

Organisations can also set risk criteria for other important nodes than the top-level objectives in the ICRMM. For example, this can be conducted for project or operational objectives considered as important for the organisation, but still not categorised as top-level objectives of the organisation.

There is no optimal degree of correlation between the risk profiles of the different objectives for an organisation. However, the correlation can be used to predict likely future effects for an organisation. For example, if an organisation is failing in achieving an objective and the risk profile of this objective is highly correlated with risk profiles for other objectives of the organisation, then the correlation in the ICRMM provides an early warning signal for the organisation that the objectives with correlated risk profiles are likely to be affected of the failure of the first objective.

9.2.3 Risk assessment

The S-curve

The ICRMM is designed to give an S-curve as an output of the semi-quantitative risk assessments (an example can be seen in Figure 9.1). The S-curve must be understood correctly. The graph represents the likelihood of not achieving an objective. For example, the P10 scores represent the values where it is 10 % likelihood of not achieving an objective (and thereby 90 % likelihood of achieving the objective).

The S-curve also includes values for mean, which is the same as expected value, and standard deviation. To describe how these values are calculated the candidate has used Dougherty (1990: 109-110, 118) as underlying material.

If X is a discrete random variable with probability mass function f(x), then the expected value is found by summing all products of the form xf(x), where x is the codomain of X.

Calculation of the expected value/mean value of a discrete random variable X possessing the discrete density f(x) is given by:

$$Mean_X = \mu_x = E[X] = \sum_{f(x)>0} xf(x)$$

The notion "σ" is often used for standard deviation, and the standard deviation is the square root of the variance of a random variable. Calculation of the variance of a discrete random variable X possessing the discrete density f(x) is given by:

$$Var\,[X] = \sigma_x^2 = E\left[\left(X-\mu_x\right)^2\right] = \sum_{f(x)>0} \left(x-\mu_x\right)^2 f(x) = E(X^2) - E(X)^2$$

The standard deviation of a variable is therefore:

$$\sigma = \sqrt{\sigma_x^2} = \sqrt{E(X^2) - E(X)^2}$$

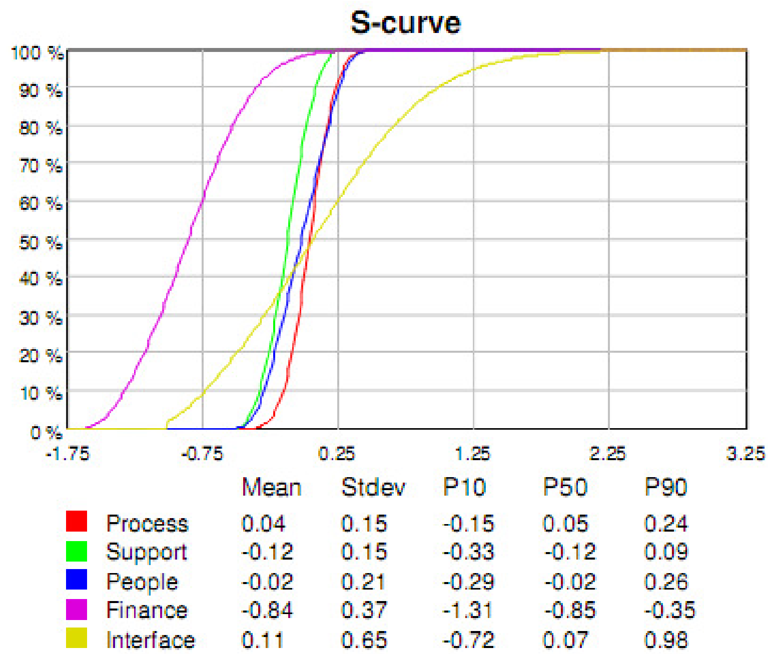


Figure 9.1 Example S-curves for top objectives in the ICRMM

The correlation table

The ICRMM is designed to give the correlation table as output of the semi-quantitative risk assessments (an example can be seen in Table 9.2).

The correlation, which is closely related to covariance, is calculated in the following manner:

> "The covariance provides a measure of the linear relationship between random variables; however, the deviations X - μ_X and Y - μ_Y, from which the covariance is derived, are dependent upon the units in which X and Y are measured. The correlation coefficient provides a normalized measure."
> (Dougherty, 1990: 241-242)

The correlation coefficient of the random variables X and Y is defined by

$$\rho_{xy} = \frac{COV\,[X,Y]}{\sigma_x \sigma_y} = \frac{E[XY] - E[X]E[Y]}{\left[\sqrt{E(X^2) - E(X)^2}\right]\left[\sqrt{E(Y^2) - E(Y)^2}\right]}$$

The correlation table represents values where the calculated risk profiles for the top level objectives of the organisation, for example process, support, people, finance and interface, have been used as X and Y in different combinations in the formula for the correlation coefficient.

Name	Process	Support	People	Finance	Interface
Process	1.000	0.218	0.496	0.606	0.392
Support	0.218	1.000	-0.012	0.209	0.150
People	0.496	-0.012	1.000	0.432	0.227
Finance	0.606	0.209	0.432	1.000	0.888
Interface	0.392	0.150	0.227	0.888	1.000

Table 9.2 Example correlation table for the top objectives in the ICRMM

Risk assessment of unforeseeable risks using scenarios

The semi-quantitative ICRMM is designed to separate between foreseeable risks and unforeseeable risks by the use of scenarios. The reasoning for this is two-fold. First, it is difficult to adequate weigh high consequence and low likelihood risks compared to the other risks in the profile. Second, by running unforeseeable risks in separate simulations, it is much easier to stress test what impact the unforeseeable risks will have on the total risk profile.

The sub-prime mortgage crisis has led to an increased focus on unforeseeable risks and stress testing of the risk profile of an organisation. To illustrate what is meant with ‘stress testing’ the risk profile an example can be used. An important input node in the risk profile for Terramar is to “receive bids from Telenor through frame agreement”. In the normal case, the representation for this node was chosen to vary between 5-25 bids. To simulate a scenario where Terramar had lost this frame agreement, the value on this node was set to zero before a new simulations for this scenario was run. By comparing the two simulation results, it was possible to assess what impact this unforeseeable risk had on Terramar’s risk profile.

9.2.4 Risk treatment

The semi-quantitative ICRMM is designed to include proposed actions as nodes in the model. By running separate risk treatment simulations, it can be seen how proposed actions changes the S-curves for the top-level objectives and the results in the correlation table compared to simulations without these actions. By comparing the simulation results from the simulations run with and without the proposed actions, the ICRMM can be used to predict the likely effect of proposed actions on the risk profile.

9.2.5 Conclusion

The first research objective of this research cycle was:

- To design a semi-quantitative integrated causal risk management model that can be used to predict the likely effect of proposed actions on the risk profile.

This section describes that the candidate aligned the design of the ICRMM with the ISO 31000 risk management process. This section also describes how to establish the context, how to conduct risk assessment and how to conduct risk treatment. Finally, this section has shown that the ICRMM presents the risk profile of an organisation with S-curves and a correlation table.

9.3 Results for the second objective of the second research cycle

9.3.1 Introduction

The second objective of this case study was:

- To establish the telecommunication risk profile facing Terramar.

This section will describe that the candidate used the ICRMM to conduct the risk management processes "establishing the context" and "risk assessment".

9.3.2 Establishing the context for Terramar

The organisation of the data (statements/concepts/nodes) context causal map for Terramar can be seen in Appendix B. The context causal map, including all risks and proposed actions, consisted of 161 concepts and 209 links. This gave a ratio of links to nodes of 1.30.

In the semi-quantitative ICRMM for Terramar, the top-level Terramar telecommunication objectives were normalised by using the scale:

- -1 for a worst scenario result for the top-level objective
- 0 for the lowest acceptable result for the top-level objective
- 1 for a best scenario result for the top-level objective

The Terramar telecommunication BAM did not define any explicit risk criteria scores for each of the objectives (please refer to Subsection "9.2.2 Establishing the context"). There was neither any explicit levels defined for acceptable standard deviation nor created levels to classify the degree of correlation (an example of such a table can be seen in Table 9.1).

There was one top level objective developed for process, people, finance, support and interface, which is the same categories of objectives as used in the RIF-model described in Roberts et al. (2003c: Chapter 8). This choice was taken by the telecommunication BAM, and the choice was most likely influenced by the fact that the BAM was familiar with the RIF-model.

The scores for each of these top level objectives were the results of a combination of qualitative and quantitative assessments:

Vertical function	Terramar telecommunication objective	Comment on how result was calculated
Process	Node 6 "to ensure that our assignments are executed with the proper balance between governance, management, business understanding and content understanding"	Qualitative criteria
People	Node 37 "to have the correct mix of internal human resources as employees"	Qualitative criteria
Finance	Node 7 "to have NOK 1,300,000 in profit (2009)"	The scale used was Result of NOK -1,300,000 = -1 Result of NOK 1,300,000 = 0 Result of NOK 3,900,000 = 1
Support	Node 26 "to have proper support services for consultants"	Qualitative criteria
Interface	Node 23 "to win 3 600 Terramar hours of consultancy assignments in core business at Telenor (in 2009)"	The scale used was 0 hours sold to Telenor core = -1 3 600 hours sold to Telenor core = 0 7 200 hours sold to Telenor core= 1

Table 9.3 Terramar's telecommunication objectives

9.3.3 Risk assessment of Terramar

The risk identification process and the qualitative risk analysis process basically followed the same procedure as for UMB. A slight difference was that in the case of feedback loops, where alternative ways of representing these relationships in the map were examined. The reason for this was that the semi-quantitative analysis were conducted as Monte Carlo simulations and that this simulation method does not support feedback loops (please refer to Section "8.5 Data collection and processing from Terramar" for further discussion on how feedback loops were dealt with).

The qualitative causal map, which had been developed during the earlier risk management activities, were coded into a semi-quantitative map, where the concepts/statements/nodes and links were expressed as mathematical functions or numbers. To code the qualitative map into mathematical expressions proved to be a challenging task. Often it was experienced that even though the causal map seemed logical, it was needed to change the causal map slightly to establish suitable expressions and relationships in the Monte Carlo simulation model.

This part of the research had a high degree of reactance between the BAM and the candidate. To find the mathematically best possible expressions the BAM often wanted the views of the candidate, and the candidate then offered his views. The end result was that some parts of the semi-quantitative ICRMM were developed by using direct inputs from the BAM, while other parts of the ICRMM were developed as a joint effort between the BAM and the candidate.

The qualitative representation of some concepts and links from the earlier analyses were in some cases replaced by a single "input node". The reasoning for this was to reduce the complexity of the coding of the Riscue model.

Another limitation of the Riscue model was that it was coded to simulate only one year ahead. In practice, this meant that the risk profile found represented the risk profile for the forthcoming year. However, as will be seen in the discussions of the results, the simulated risk profile also gave some indication of how the risk profile was likely to develop in the long term as well. The candidate would like to add that the one-year timescale was chosen by the telecommunication BAM. The ICRMM could easily have been coded to simulate a longer time scale if this had been the preferred choice of the BAM.

In "Appendix C: Manuscript Monte Carlo simulations for Terramar" the final manuscript for the coding of Riscue for this research programme can be found.

The various Riscue analysis that were conducted were run as 100,000 simulations. This number of simulations ensured that the same simulation result would occur if the same analysis was run several times. To make sure the simulation results were reliable, the candidate tested that the same result occurred when the same analysis was conducted several times with 100,000 simulations. The candidate is a bit embarrassed to admit that the choice of using exactly 100,000 simulations was not a sophisticated choice taken after considerable consideration. The candidate reasoning was similar to what is referred to as "the law of large numbers". The candidate reasoned that since the model only uses "well-behaved" distributions and since the model deals with unforeseeable risks in separate simulations, then the aggregated results of the simulations would be reliable if the same aggregated results applied when the analysis/simulations were replicated several times. This would have been the case for a much lower number of simulations than 100,000 as well, but since the time needed for running 100,000 simulations was acceptable the candidate chose this number of simulations.

The semi-quantitative ICRMM was used to simulate scenarios as part of the risk analysis. The different risk analysis scenarios were developed by changing the input nodes in the Riscue model.

The results of the simulations were presented in an S-curve with a table presenting the scores for mean, standard deviation, P10, P50 and P90 and in a correlation table.

The first risk analysis scenario represented the normal case and thereby what the Terramar BAM believed the telecommunication risk profile actually was. Risk analysis scenario 2-3 represented scenarios where unforeseeable risks occurred, and these scenarios gave indications on how Terramar would be affected by such types of risks. Risk analysis scenario 4 represented a scenario where Terramar was more focused on creating projects for the key customer than what was currently the case and simulated in the first risk analysis scenario.

Risk analysis scenario 1 – nothing unusual happens

This risk analysis scenario represented the normal case and the simulation results thereby represented the telecommunication risk profile that the BAM believed Terramar had in February/March 2009.

This scenario was conducted without any manipulation of the input nodes (all the nodes were represented as in Appendix C). The simulation results are presented in Figure 9.2 and Table 9.4.

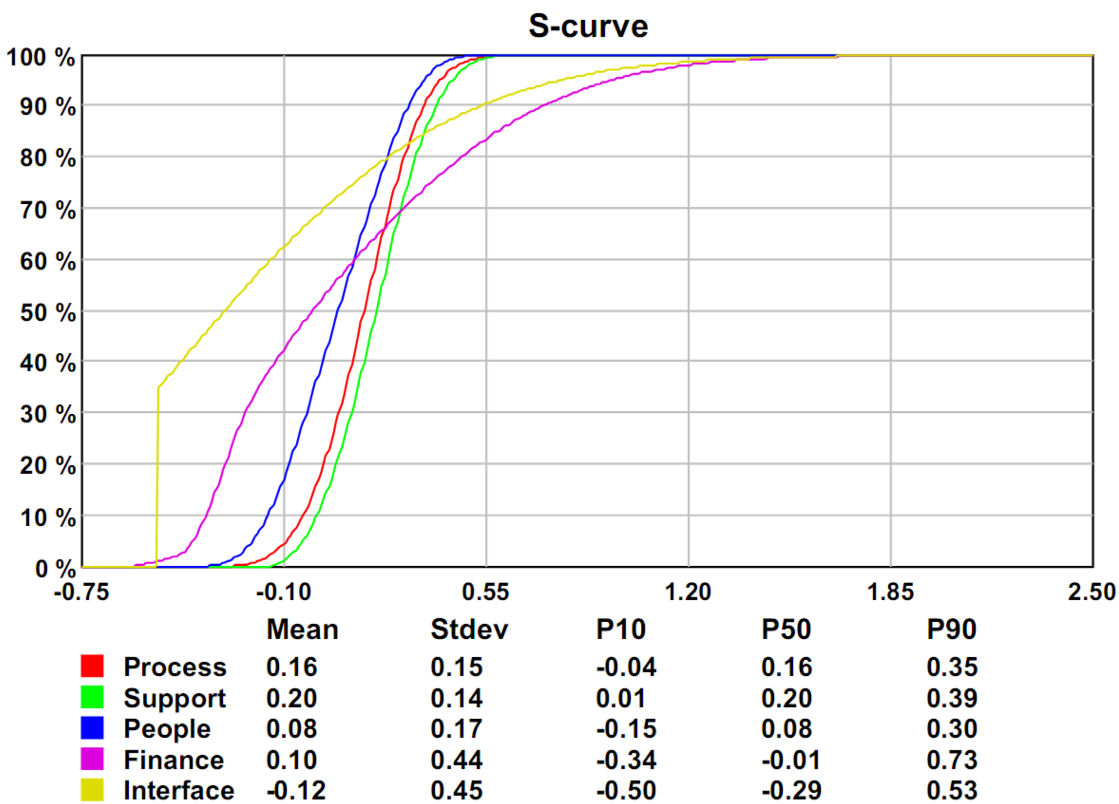


Figure 9.2 S-curve for the scenario of nothing unusual happens

Name	Process	Support	People	Finance	Interface
Process	1.000	0.227	0.494	0.596	0.379
Support	0.227	1.000	-3.880E-4	0.222	0.159
People	0.494	-3.880E-4	1.000	0.414	0.208
Finance	0.596	0.222	0.414	1.000	0.888
Interface	0.379	0.159	0.208	0.888	1.000

Table 9.4 Correlation table for the scenario of nothing unusual happens

The simulation result could easily have been interpreted as Terramar having a satisfactorily telecommunication risk profile, since only the interface telecommunication objective has a negative mean score. However, further studies of the simulation results provide some additional insights.

First, the S-curve for the interface objective starts with a horizontal line that reaches to the value -0.50. From the x-value -0.5, the S-curve follows a vertical line to approximately 35 %. This layout of the S-curve suggests that in approximately 35 % of the simulations, Terramar will not get additional assignments to the already signed contracts for the simulated year. The interface mean score is not very negative (-0.12), but the P50 score is as low as -0.29. The reason for this difference is that the previously signed contracts act as boundaries towards extreme negative scores and therefore the simulations cannot give worse results than -0.50. These results thereby suggests that in most of the simulations Terramar will be far from achieving the interface objective, but that in a few (lucky) cases the simulations provide excellent results for the interface objective.

Second, the standard deviations of both the finance and the interface objective are very high. This suggests that the results for these objectives are very uncertain. The combination of the negative interface objective score and the high deviation for the interface objective suggests that Terramar lacks control of the result for the interface objective, and that the objective most likely won't be achieved. This again suggests that the risk profile for the interface objective is not particularly good.

Finally, the correlation table suggests that there is a high correlation between the finance and the interface objectives. At present, the finance objective is partially protected on the downside by the previously signed contracts. However, the correlation between the finance and interface objective suggests that there is a powerful linkage (high degree of risk interdependency) between the finance and interface risk profile. This again suggests that if the score for the interface objective deteriorates, then it is likely that the same will happen to the score for the finance objective in the long term.

Risk analysis scenario 2 – loss of core competence in project governance and project management

Risk analysis scenario 2 represented a scenario where an unforeseeable risk had occurred. The scenario was designed to examine how Terramar's risk profile would be affected by such a risk.

Terramar's core competence has historically been in project governance and in project management. This was still the case when these simulations were conducted, but in recent years Terramar has started to focus more on business competence and domain competence as well. A potential downside risk by broadening the competence profile is that Terramar's core competence in project governance and project management may be reduced or lost.

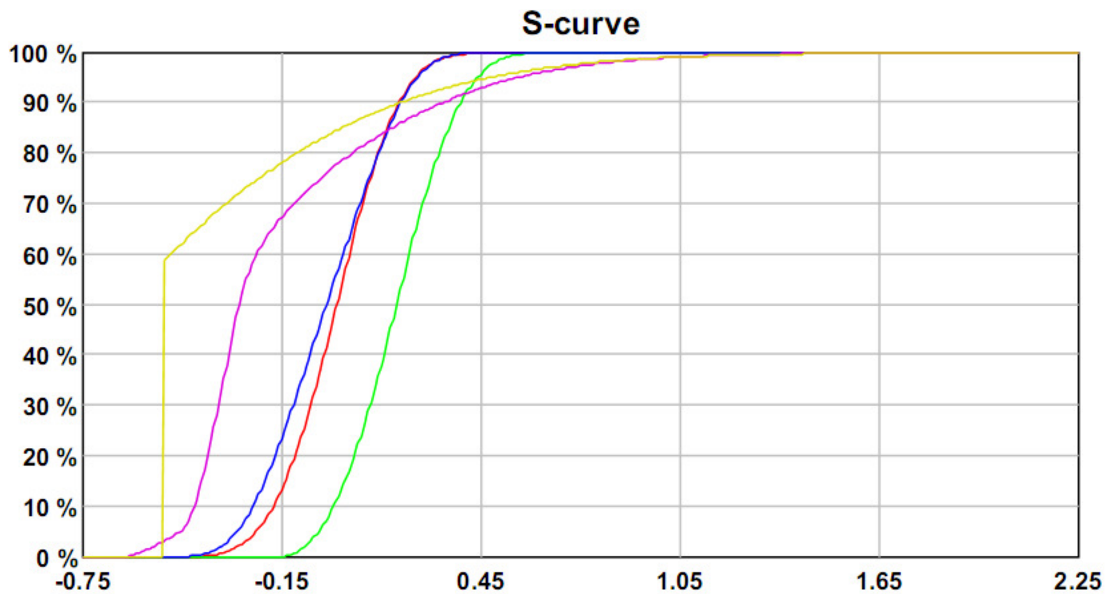
The scenario below represented a case where Terramar no longer had a competitive advantage in project governance and project management compared to their competitors for telecommunication assignments. In the scenario it was simulated that Terramar had approximately the same project governance and management competence as their competitors. The scenario was created to analyse what effect the loss of Terramar's main competitive advantage would have on the telecommunication risk profile.

To create this scenario the following input nodes were changed:

Input node	Original representation	Scenario representation	Comment
Node 122 current ability to deliver appropriate project governance knowledge and competence in assignments	Uniform(0; 1)	UNIFORM (-0.25; 0.25)	A score of 0 represent what is believed to be the typical competence by the telecommunication consultancies. The new representation of node 122 gives a mean value of 0 and a standard deviation of 0.14, compared to the original representation with a mean value of 0.5 and a standard deviation of 0.29
Node 128 current ability to deliver appropriate project management knowledge and competence in assignments	Uniform(0.4; 1)	UNIFORM (-0.25; 0.25)	A score of 0 represent what is believed to be the typical competence by the telecommunication consultancies. The new representation of node 128 gives a mean value of 0 and a standard deviation of 0.14, compared to the original representation with a mean value of 0.7 and a standard deviation of 0.17

Table 9.5 Scenario input for loss of core competence in project governance and project management

The simulation results are presented in Figure 9.3 and Table 9.6.



	Mean	Stdev	P10	P50	P90
Process	0.02	0.15	-0.17	0.02	0.20
Support	0.20	0.14	0.01	0.20	0.39
People	-0.01	0.17	-0.23	-0.01	0.21
Finance	-0.15	0.33	-0.41	-0.27	0.34
Interface	-0.30	0.35	-0.50	-0.50	0.20

Figure 9.3 S-curve for the scenario loss of core competence in project governance and project management

Name	Process	Support	People	Finance	Interface
Process	1.000	0.231	0.478	0.580	0.435
Support	0.231	1.000	-0.005	0.216	0.186
People	0.478	-0.005	1.000	0.428	0.231
Finance	0.580	0.216	0.428	1.000	0.926
Interface	0.435	0.186	0.231	0.926	1.000

Table 9.6 Correlation table for the scenario loss of core competence in project governance and project management

In the short term, this scenario was not considered very realistic. However, in the longer term a continuous focus to broaden the competence profile of the company is likely to increase the likelihood of this risk analysis scenario. The simulation results of the scenario gave some very interesting insights as to how an unforeseeable risk could affect Terramar’s telecommunication risk profile.

The simulation results show that loss of competence in project governance and project management do negatively affect all the telecommunication objectives except the support objective. This can be explained by the high degree of risk interdependency in the risk profile, which can be seen from the correlation table (Table 9.6).

Compared with risk analysis scenario 1, the scenario result is a bit surprising. Logically, the loss of project governance and project management competence should worsen the risk profile of the process objective the most, but the simulation results indicates that it is in fact the risk profile of the finance and interface objectives that deteriorate the most. According to the telecommunication BAM, the reason for this can be divided in two. First, the BAM argued that Terramar's strongest marketing/selling aid was the branding in project management. Without this branding, the BAM believed it would be difficult to get access to potential key customers in Telenor. Secondly, the BAM argued that Terramar was not in a position to compete for many of the project management roles for major projects. Instead, Terramar was mostly competing for smaller assignments where significant competence in project management was not needed. Based on these two arguments, the BAM considered the simulation results to be similar to what he had expected.

The candidate would like to add that if Terramar succeeds in becoming one of Telenor's important business partners, the simulation results for this risk analysis scenario is likely to change considerably. In this case, Terramar would compete for project management roles in bigger and more complex projects, and Terramar would in this scenario have difficulties in delivering consultants who were capable of filling the roles where significant project governance and project management competence were needed. This would worsen the risk profile of the process and people objective considerably. On the other hand, as an important business partner of Telenor, Terramar would be in a better position to compete for and win important project management roles than what was simulated in risk analysis scenario 1, even though the consultants would be less suited for filling such roles.

Risk analysis scenario 3 – the framework agreement with Telenor lost

Risk analysis scenario 3 represented a scenario where an unforeseeable risk had occurred. The scenario was designed to examine how Terramar's risk profile would be affected by such a risk.

Telenor was Terramar's preferred customer for the telecommunication market when the simulations were conducted. Terramar also had a framework agreement for consultancy work with Telenor, which provided a "hunting license" and facilitated Telenor's buying processes (Terramar, 2006). This scenario represented the unforeseeable risk where the framework agreement was lost.

To create this scenario the following input node was changed:

Input node	Original representation	Scenario representation
Node 57 receive bids from Telenor through frame agreement	Uniform (5; 25)	0

Table 9.7 Scenario input for the framework agreement with Telenor lost

The simulation results are presented in Figure 9.4 and Table 9.8.

The scenario results show how important the framework agreement is for the score of the finance and the interface objective. This scenario results thereby indicate that the framework agreement is essential for the achievement of the finance and the interfaced objectives, but not for the other telecommunication objectives. The scenario results also demonstrate how vulnerable Terramar's position in the telecommunication market actually was when the simulations were conducted.

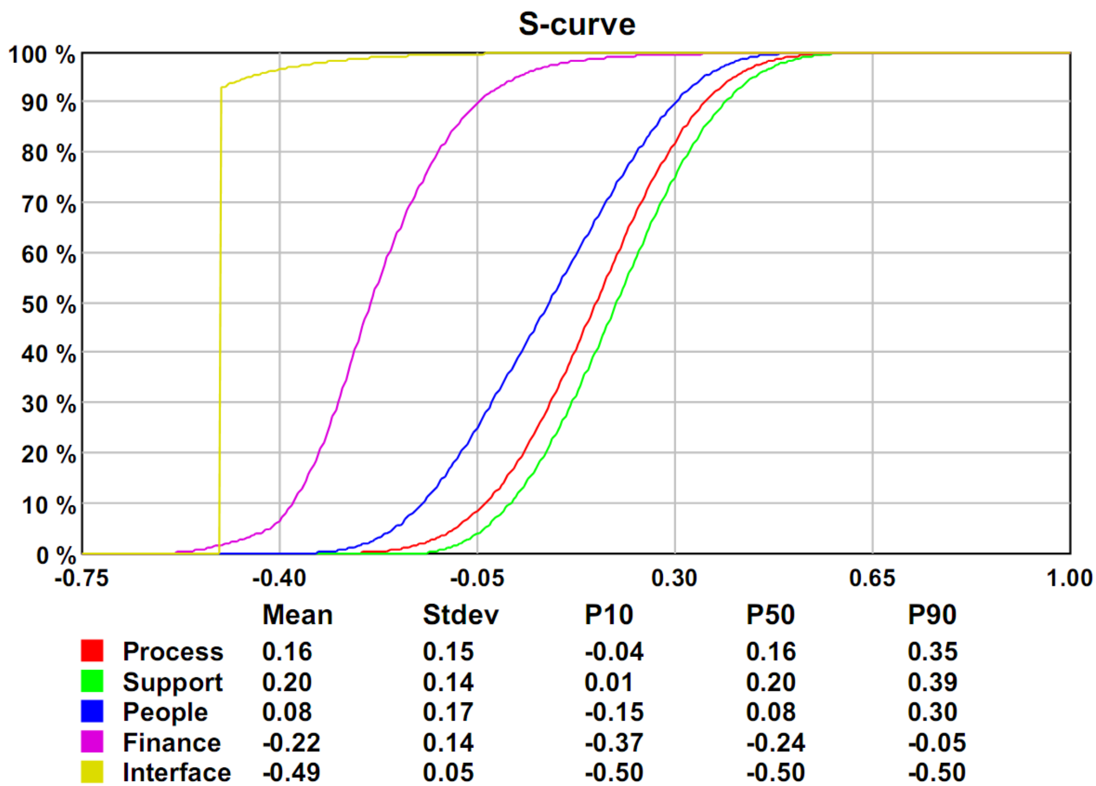


Figure 9.4 S-curve for the scenario the framework agreement with Telenor lost

Name	Process	Support	People	Finance	Interface
Process	1.000	0.226	0.489	0.615	0.219
Support	0.226	1.000	0.001	0.177	0.094
People	0.489	0.001	1.000	0.620	0.120
Finance	0.615	0.177	0.620	1.000	0.413
Interface	0.219	0.094	0.120	0.413	1.000

Table 9.8 Correlation table for the scenario the framework agreement with Telenor lost

Risk analysis scenario 4 – improved bid success due to better success in creating projects

Risk analysis scenario 4 represented a scenario where Terramar was more focused on creating projects for the key customer than what was currently the case and simulated in the first risk analysis scenario. This scenario was aligned with Terramar's strategic plan:

> "We need to turn our focus and awareness in relation to "create" projects. We shall therefore try to position Terramar as a business partner to preferred customers rather than being hired resources with tough price pressure." (Terramar, 2006)

The normal scenario indicated that Terramar was a long way from creating projects at Telenor. The argument for this is based on that "expected percentage of bid success" was estimated as low as "UNIFORM (0; 0.2)", which gave a mean value of 0.1 (10 % bid success). In the simulation results for the normal scenario, the problem of the low degree of bid success was partly cancelled out by the high number of bids received from Telenor through the framework agreement [number of bids simulated as UNIFORM (5; 25), which gave a mean value of 15].

This scenario represented the case where Terramar was much more successful in creating projects and thereby improved the bid success. The downside in this scenario was that the number of bids through the framework agreement was reduced due to a much stronger focus in what bids to aim for.

To create this scenario the following input nodes were changed:

Input node	Original representation	Scenario representation
Node 145 expected percentage of bid success	UNIFORM(0; 0.2)	UNIFORM(0.25; 0.35)
Node 57 receive bids from Telenor through frame agreement	UNIFORM(5; 25)	UNIFORM(5; 10)

Table 9.9 Scenario inputs for improved bid success due to better success in creating projects

The simulation results are presented in Figure 9.5 and Table 9.10.

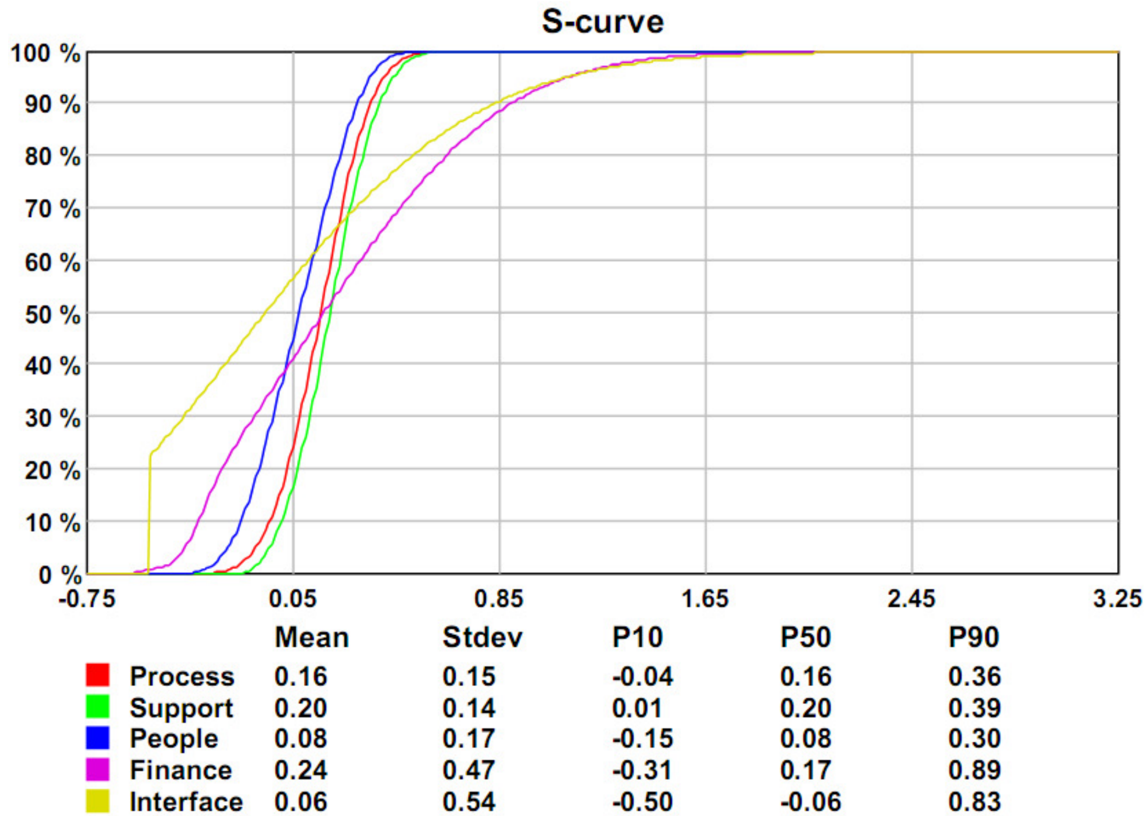


Figure 9.5 S-curve for the scenario improved bid success due to better success in creating projects

Name	Process	Support	People	Finance	Interface
Process	1.000	0.228	0.492	0.490	0.242
Support	0.228	1.000	-5.853E-4	0.181	0.099
People	0.492	-5.853E-4	1.000	0.350	0.132
Finance	0.490	0.181	0.350	1.000	0.896
Interface	0.242	0.099	0.132	0.896	1.000

Table 9.10 Correlation table for the scenario improved bid success due to better success in creating projects

The candidate balanced this scenario by reducing the number of potential assignments (the downside of this strategy), but still the simulations give significantly improved mean score and P50 score for both the finance and the interface objectives compared with the normal scenario. The simulation result of this scenario clearly indicate that Terramar should increase the focus of finding actions to become a business partner of Telenor and thereby achieve a position where Terramar could create projects to improve the percentage of bid success. The simulation results of this risk analysis scenario thereby clearly support the strategic direction outlined in the strategic plan for 2009-2015 (Terramar, 2009).

Risk evaluation

> "The purpose of risk evaluation is to assist in making decisions, based on the outcomes of risk analysis, about which risks need treatment and the priority for treatment implementation." (ISO, 2009b: 18)

The risk analysis of the first "normal" risk analysis scenario indicated that Terramar had an acceptable risk profile related to process, support and people objectives. The finance objective had acceptable mean score and P50 score, but the standard deviation (which represented uncertainty) was high. The interface objective had both poor score for P50 and a high standard deviation. The correlation table indicated that there was significant correlation between the result for the finance and the interface objectives. Based on this, the conclusion of the risk evaluation process was that actions to improve the risk profile related to the interface objective should be prioritised.

The second scenario introduced the unforeseeable risk that the competitive advantage in project governance and management was lost. The risk analysis of this scenario indicated that this unforeseeable risk would result in a significant deterioration of the overall risk profile. Based on this, the conclusion of the risk evaluation process was that uncertainties or factors affecting the competitive advantage should be continuously monitored, but that no risk treatment action was necessary at this stage due to the fact that the scenario was considered as very unlikely in the short term.

The third scenario introduced a situation where the unforeseeable risk that Terramar's framework agreement with Telenor was lost. The risk analysis of this scenario indicated that the framework agreement was essential for the achievement of the finance and interface objectives at the time the simulations were conducted. Based on this and that the scenario was found to be reasonably realistic, the conclusion of the risk evaluation process was that actions to reduce the dependency of the Telenor framework agreement should be prioritised.

The fourth scenario represented the case where Terramar was much more successful in creating projects and thereby improved the bid success. The risk analysis of this scenario indicated that at the time the simulations were conducted, Terramar's risk profile would be significantly improved if Terramar became better position to create projects at Telenor. Based on this and that this scenario was found to be reasonably realistic, the conclusion of the risk evaluation process was that actions to become a business partner of Telenor, and thereby come in a position where Terramar could create projects to improve the percentage of bid success, should be prioritised.

9.3.4 Conclusion

This section has demonstrated how a semi-quantitative representation of Terramar's risk profile was established. The semi-quantitative risk profile included both risks and their interdependencies. By the use of different scenarios it was also looked at how unforeseeable risks affected the achievement of objectives and thereby how unforeseeable risks were important elements in the risk profile. The risk profile established was referred to as semi-quantitative due to the fact that the methods used combined quantitative and qualitative information.

9.4 Results for the third objective of the second research cycle

9.4.1 Introduction

The third objective of this case study was:

- To use the semi-quantitative integrated causal risk management model to predict the likely effect of proposed actions on the risk profile.

To achieve the third research objective various actions proposed by the telecommunication BAM were simulated in the semi-quantitative ICRMM. To improve the telecommunication risk profile the BAM suggested the following actions:

- Reduce consultancy price for 'Telenor core' business services
- Create policies for knowledge transfer between employees
- Have cooperation agreements (or access to) the right pool of external human resources
- Keep telecom people at office to be used on strategic assignments…sell consultants when possible
- Arrange internal content (IT and telecom) training
- Arrange seminar which is developed and directed towards Telenor
- Employ star telecommunication consultants
- Terramar prioritise to serve project owners ... prioritise to serve project suppliers
- Spend more time on networking
- Choose and focus on fewer business units as potential customers
- Arrange internal telecom related business training

The risk evaluation suggested that the risk profile related to the interface objective needed to be prioritised. The simulations in this section examine three of the proposed actions that could improve the risk profile for the interface objective.

9.4.2 Simulation of proposed action: reduce consultancy price for 'Telenor core' business services

To improve the risk profile for the interface objective, the BAM considered reducing the consultancy price for Telenor core assignments. The simulation elaborated below used a reduction of the hourly rate by NOK 200,-.

To include this action in the ICRMM the following change was made:

Input node	Original representation	Scenario representation
24 Reduce consultancy price for 'Telenor core' business services	0 (no discount for 'Telenor core' assignments)	200 (comment: NOK 200 in discount to win more 'Telenor core' assignments)

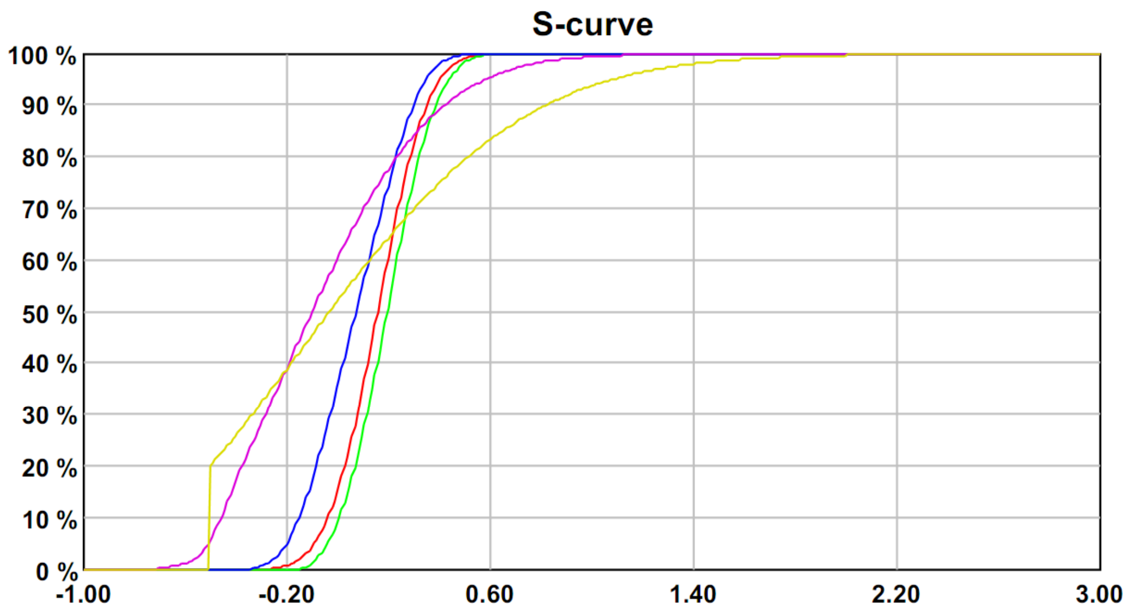
Table 9.11 Risk treatment – reduce consultancy price for Telenor 'core' assignments

The simulation results are presented in Figure 9.6 and Table 9.12.

The S-curves suggest that the risk profile for the interface objective has improved compared with the normal scenario, but a more worrying point is that the risk profile for the finance objective has significantly deteriorated. The risk profile for the rest of the objectives are unaffected by the action.

Due to the reduction in the consultancy price for the key customer ('Telenor core' services), the correlation between the finance and the interface objective has decreased compared to the scenario where no action was taken. However, the correlation between these two objectives is still considerable.

The simulation results indicate that this risk treatment action should not be conducted under normal circumstances due to the major negative impact on the financial risk profile.



	Mean	Stdev	P10	P50	P90
Process	0.16	0.15	-0.03	0.16	0.36
Support	0.20	0.14	0.01	0.20	0.39
People	0.08	0.17	-0.15	0.08	0.30
Finance	-0.05	0.34	-0.46	-0.09	0.42
Interface	0.07	0.53	-0.50	-0.03	0.82

Figure 9.6 Risk treatment - S-curve for reducing consultancy price

Name	Process	Support	People	Finance	Interface
Process	1.000	0.230	0.489	0.586	0.270
Support	0.230	1.000	0.005	0.215	0.113
People	0.489	0.005	1.000	0.432	0.146
Finance	0.586	0.215	0.432	1.000	0.794
Interface	0.270	0.113	0.146	0.794	1.000

Table 9.12 Risk treatment – correlation table for reducing consultancy price

9.4.3 Simulation of proposed action: do not sell the telecom consultants to customers of low strategic value

To improve the risk profile for the interface objective, the BAM considered proposing that consultants with telecommunication competence should be used more strategically than what was currently the case. This could be conducted by keeping the telecommunication consultants at the office until telecommunication assignments were available. The simulation presented in this section was a balanced scenario, where it was sought to find the correct balance between short-term financial result and strategic use of the telecommunication consultants.

To include this action in the ICRMM the following change was made:

Input node	Original representation	Scenario representation
53 keep telecom people at office to be used on strategic assignments ... sell consultants when possible	1 (comment: prioritise the short term financial result and thereby do not keep consultants at office to improve the likelihood of winning 'Telenor core' assignments)	0.5 (comment: seek a balance between the strategic use of the telecommunication consultants and financial result in the short term)

Table 9.13 Risk treatment – prioritise the use of telecommunication resources to 'Telenor core' assignments

The simulation results are presented in Figure 9.7 and Table 9.14.

The S-curves suggest that the risk profile for the interface objective has improved compared to the normal scenario, but also that the risk profile for the finance objective has become dreadful due to the action. The risk profiles for the rest of the objectives are unaffected by the action.

The correlation table suggests that the correlation between the finance and interface objectives has been reduced due to the action. However, also in this simulation the correlation is considerable.

The simulation results indicate that this risk treatment action should not be conducted under normal circumstances due to the major negative impact on the financial risk profile.

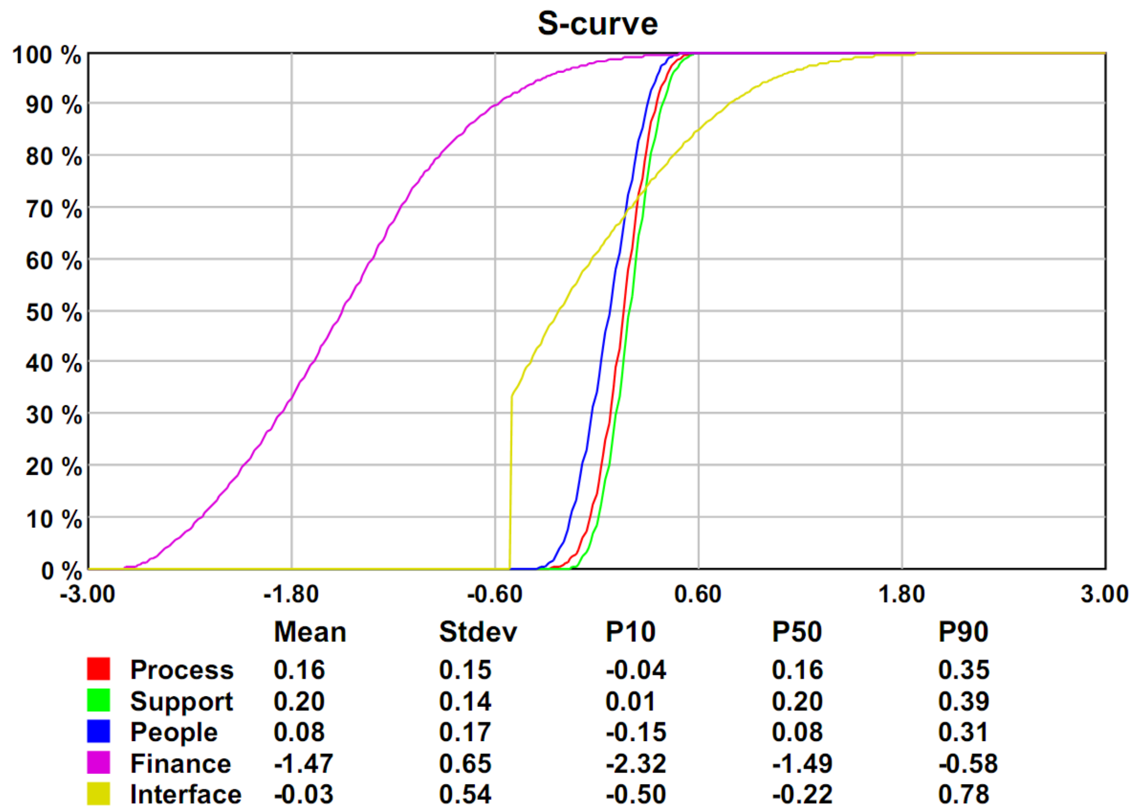


Figure 9.7 Risk treatment – S-curve of prioritising the use of telecommunication resources to 'Telenor core' assignments

Name	Process	Support	People	Finance	Interface
Process	1.000	0.228	0.491	0.410	0.467
Support	0.228	1.000	-3.949E-4	0.157	0.194
People	0.491	-3.949E-4	1.000	0.283	0.253
Finance	0.410	0.157	0.283	1.000	0.686
Interface	0.467	0.194	0.253	0.686	1.000

Table 9.14 Risk treatment – correlation table of prioritizing the use of telecommunication resources to 'Telenor core' assignments

9.4.4 Simulation of proposed action: employ a star telecommunication consultant to create assignments in Telenor

To improve the risk profile for the interface objective, the BAM considered proposing to employ a star telecommunication consultant. The idea behind this action was that the star telecommunication consultant would not only get consultant work for herself/himself, but also create further assignments for other Terramar consultants.

To include this action in the ICRMM the following change was made:

Input node	Original representation	Scenario representation
77 employ "star" telecom consultants	0 (do not employ star telecommunication consultants)	1 (employ one star telecommunication consultant with the objective of creating assignments in Telenor)

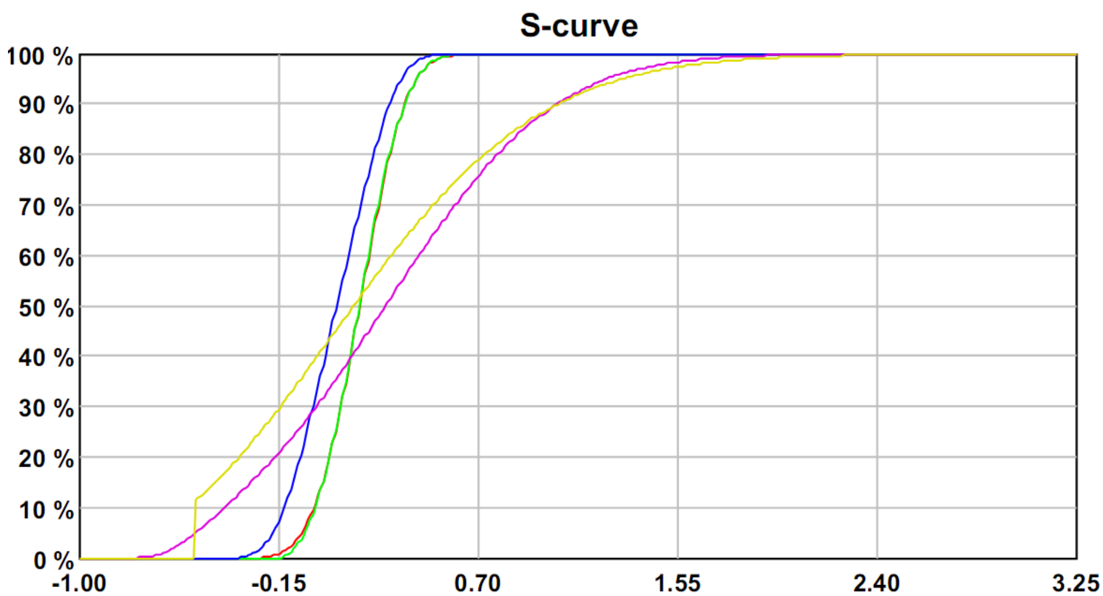
Table 9.15 Risk treatment – employ a star telecommunication consultant with the objective of creating assignments in Telenor core

The simulation results are presented in Figure 9.8, Figure 9.9 and Table 9.16.

The S-curves for this simulation suggest that both the risk profiles for the finance and interface objectives have significantly improved compared to the normal scenario. The risk profiles for the process and people objectives have also slightly improved, while the risk profile for the support objective is unaffected.

The simulation results clearly suggest that employing a star telecommunication consultant would improve the telecommunication risk profile. However, the simulation results also suggest that there is a potential downside in this scenario as well. The downside for this action that can be seen from the simulation results is that the employment of a star telecommunication consultant might lead to wage drift and thereby increased operational running cost for Terramar. This is presented in Figure 9.9. The reason for the potential wage drift is that at the time the simulations were conducted, the BAM considered that a star telecommunication consultant would usually have a much higher remuneration than what was custom for the consultants in Terramar.

The simulation results suggest that the employment of a star consultant would improve the overall telecommunication risk profile, but also that there is a risk that the action could result in wage drift and increased operational running cost (P50 equals a wage drift of approximately NOK 350,000,- in total for all the consultants). The increased operational running cost could again negatively affect the financial risk profiles for the other marketing segments in addition to the telecommunication segment.



	Mean	Stdev	P10	P50	P90
Process	0.20	0.15	0.01	0.20	0.39
Support	0.20	0.14	0.01	0.20	0.39
People	0.10	0.17	-0.12	0.10	0.33
Finance	0.33	0.53	-0.37	0.31	1.03
Interface	0.24	0.58	-0.50	0.17	1.03

Figure 9.8 Risk treatment – S-curve for employing a star telecommunication consultant

Name	Process	Support	People	Finance	Interface
Process	1.000	0.229	0.488	0.480	0.205
Support	0.229	1.000	-0.004	0.178	0.086
People	0.488	-0.004	1.000	0.331	0.110
Finance	0.480	0.178	0.331	1.000	0.820
Interface	0.205	0.086	0.110	0.820	1.000

Table 9.16 Risk treatment – correlation table for employing a star telecommunication consultant

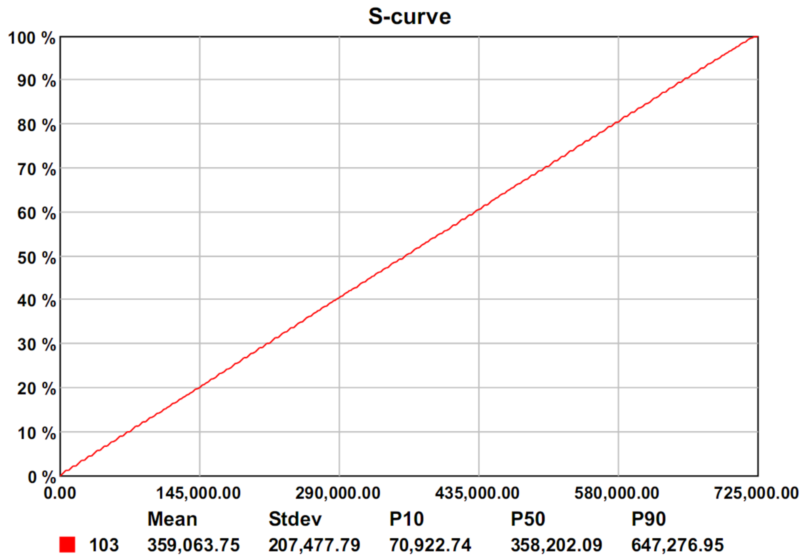


Figure 9.9 Risk treatment - potential wage drift due to employment of a star telecommunication consultant

9.4.5 Conclusion

This chapter has demonstrated how the semi-quantitative ICRMM can be used to predict the likely effect of proposed actions on the risk profile.

9.5 Reflection on the general findings of the second research cycle

The research question of this research cycle was:

- If the candidate designs a semi-quantitative integrated causal risk management model, to what extent can the Terramar telecommunication branch area manager use this model to predict the likely effect of proposed actions on the risk profile?

Regarding the case study, the risk profile of the telecommunication market segment of Terramar was mostly developed from oral information from the telecommunication BAM. The reality of the ICRMM should therefore not be considered as an objective truth, but rather to how the former BAM made sense of the different issues affecting the telecommunication risk profile of Terramar at the time the research was conducted. The candidate believes that the reality of the ICRMM was good based on two arguments. First, the BAM expressed that the ICRMM gave results according to his expectations and also that the ICRMM made it possible for him to predict the likely effect of his proposed actions on the risk profile. Second, the BAM proposed the same actions as recommended by the model in the management group to improve the telecommunication risk profile.

It should be added that this first version of a semi-quantitative ICRMM is far from exact when it comes to input and output values. This semi-quantitative ICRMM was designed and implemented to give indications of the likely effect of proposed actions on the risk profile and not to be a precise quantitative decision support model. However, it was intended to improve the precision of the ICRMM in an iterative manner by learning through experience. For example, experience could indicate that concepts should be added or removed, links between concepts should be changed, and that figures, formulas or distributions used for representation of concepts and links should be changed.

Unfortunately for this research programme, the telecommunication BAM at Terramar left the company shortly after the research on the ICRMM was finalised. Also, since the new BAM was neither involved in the working process of designing the ICRMM nor in collecting and analysing data, the candidate felt it would be wrong to advise her to use the ICRMM in its current version. The reason for this was that the reality of the current ICRMM was related to the previous BAM and not to an objective truth.

The candidate was very disappointed at this stage of the research programme. In both research cycles the ICRMM seemed to work as intended, but in neither of the research cycles the ICRMM were integrated with the client system infrastructure and used in a real environment. In the beginning, the candidate blamed it all on bad luck, but as time went by the candidate started wondering if something could have been conducted differently. In October 2009, the candidate became certain that elements of the research should have been conducted very differently.

The insight that struck the candidate was that his hopes and ambitions for the research were to change the sample organisation's risk management framework in a manner that made the system better in predicting the likely effect of proposed actions on the risk profile. This of course would necessarily be a major change for the organisations participating in the research programme. However, during the research the candidate had neither considered who was responsible for managing this change nor how this change was managed in practice. What suddenly struck the candidate was that in neither the first nor the second research cycle anyone had really thought of the ICRMM as a project that had to be managed. This made the candidate realise that he had been too focused on his own research objectives and not focused enough on helping the sample organisations in managing the change of their risk management framework.

The candidate expected that his research was finished at this stage, and he had even started to write up the thesis. However, a meeting between the managing director of Terramar and the candidate resulted in a new short research cycle, where the candidate could use his new insight.

Chapter 10 - Research methodology for the third research cycle

10.1 Introduction

The aim of this chapter is to describe the approach to data collection and processing used in the generation of the research data and results for the third research cycle.

The candidate did not want to repeat the mistakes from the two previous research cycles, where he had lost focus on what the participating organisations could gain from the research. This time the candidate wanted the research objectives to be clearly aligned with the needs and wants of the participating organisation. The candidate therefore concluded that the focus in this research cycle had to be on how Terramar managed the design and implementation of the ICRMM.

The research question for the third research cycle was:

- How will Terramar forming an integrated risk management framework project affect the design and implementation of the integrated causal risk management model?

10.2 Research design

To answer the research question, the candidate used a case study research design inspired by Yin (2003) as for the two previous research cycles. The first component is the research question, which in this research cycle was:

- How will Terramar forming an integrated risk management framework project affect the design and implementation of the integrated causal risk management model?

The study proportions of this research cycle were stated as the following research objectives:

- To describe how the project sponsor affected the design and implementation of the integrated causal risk management model
- To describe how the senior user affected the design and implementation of the integrated causal risk management model
- To describe how the risk management experts at Terramar affected the design and implementation of the integrated causal risk management model

An observant reader might here miss a research objective related to the project manager. However, since the candidate was the project manager of the project, it was chosen to look at this as part of a reflection section, which follows after the description of the results of the research objectives.

The third component, the unit of analysis, was the ICRMM in the context of the research objectives. The unit of analysis is thereby the same as for the previous two research cycles, but the context has been changed.

The candidate decided not to use Yin's fourth and fifth research design components. This definitely could have been done, but the candidate wanted instead to try to make sense to the data found as part of this research cycle, and then describes the findings in an exploratory manner.

10.3 Sources of data

The sample organisation Terramar has previously been described in Section "8.3 Sources of data" as part of the description of the research methodology for the second research cycle. In this third research cycle there were in particular three key people that were used as data sources. The candidate would like to add that he considers these three people highly competent, and below is a short description of who these three people are.

Managing director Pierre Henrik Bastviken

Mr. Bastviken graduated from the Norwegian Naval Academy in 1980 and holds a Master of Science degree having studied in the Faculty of Science, Technology and Management at Cranfield Institute of Technology in 1989.

He has broad management experience from various positions in civilian industry and the military, in both national and international organisations. He has operational experience as Senior Staff Officer in a NATO Operational Headquarter, as Commanding Officer of Navy ships, as the Market manager for a Norwegian based multinational company.

Mr. Bastviken has project management experience having been responsible for more than 100 different projects. He has international project management experience, among other from the $5 billion co-operative NATO Alliance Ground Surveillance acquisition program; developing the program, deriving requirements, developing concept of operation and cost sharing models.

He has held the position advising the Chief of the Navy on the future structure of the RNoN CCIS environment.

Chief of staff May Kristin Lysvik

Ms. Lysvik is a business and leadership graduate from BI in Norway.

Ms. Lysvik has been the chief of staff in Terramar since 16.10.1989. Her areas of responsibility in Terramar includes all internal support processes such as processes related to accounting, financial forecasts, HR and IT.

Ms. Lysvik is hands-on in all reports to the board, to the management group and to the employees.

Head of the analysis division Jan Rune Baugstø

Mr. Baugstø holds a Master of Science degree in Civil Engineering from the Norwegian Institute of Technology in Trondheim and a Masters Degree in Finance from the Norwegian School of Management in Oslo. He has additionally studied Economic History at the University of Oslo.

Mr. Baugstø has work experience from large programs in the Norwegian offshore sector, both technical disciplines and within the project management area, including 5 years from the Troll A project, the world's largest oil platform. He has also worked with product development and analysis in the insurance sector.

Mr. Baugstø is an expert in decision support and risk analysis for large, complex investment programs. Through the last 10 years he has supported numerous of programs in public and private sector for national and international enterprises. He has supported in all phases of a program; early phase investigations and alternative concept evaluations, development of Business Plans, project risk and profitability analyses, portfolio analyses, real option analyses and market forecasting models.

In Terramar Mr. Baugstø is head of the analysis division and responsible for the overall quality of all Terramar analysis deliveries. Mr. Baugstø is hands on – and has participated in most of Terramars Quality Assurances of Major Investment Projects for the Royal Norwegian Ministry of Finance.

Mr. Baugstø frequently speaks in conferences and publishes articles and papers within his area of expertise.

10.4 Data collecting and processing

The data collecting and processing phase lasted from the beginning of December 2009 to the end of March 2010. This period includes the earliest phases of the integrated risk management project of Terramar.

The candidate has, in this period, reflected on how the key stakeholders in the project have affected the design and implementation of the ICRMM. The working process was that the candidate reflected on project documents that have been written, project meetings and informal conversations with the key stakeholders as the project progressed. The material in this section was thereby written in an iterative manner as the project materialised.

In the period end of March to the beginning of April the candidate arranged three separate meetings with the key stakeholders to present his writings to them. These meetings were held to increase the reliability and validity of the study.

In the first meeting, the candidate presented his writing on the first research objective to the managing director. This meeting was held 26.3.2010. The managing director had only minor comments to the candidate's writing, and the material on the first objective of the third research cycle was updated during the meeting.

In the second meeting, the candidate presented his writing on the third research objective to the head of analysis division. This meeting was held 26.3.2010. The head of analysis had only minor comments, and the material on the third objective of the third research cycle was updated during the meeting.

In the third meeting the candidate presented his writing on the second research objective to the Chief of staff. This meeting was held 9.4.2010. The chief of staff had only minor comments, and the material on the second objective of the third research cycle was updated during the meeting.

The three meetings indicated that the three key stakeholders and the candidate had a common understanding on how these key stakeholders affected the design and implementation of the ICRMM. These meetings have thereby increased the reliability and validity of the findings in this research cycle.

10.5 Conclusion

This chapter has presented the methodology of the third research cycle. Next, the results and conclusions of this research cycle will be examined.

Chapter 11 - Results and reflections for the third research cycle

11.1 Introduction

After the second research cycle was finalised, there has been some small interesting changes in Terramar. First, in June 2009 the market area telecommunication was changed to telecommunication and the Norwegian armed forces (focusing on the information and communication technology departments in the Norwegian Defence Logistics Organisation). This change is expected to make the market segment more robust than what was considered to currently be the case. Second, the new telecommunication BAM is currently (March 2010) working on assignment in Telenor. Third, Terramar has increased the emphasis on recruiting highly qualified consultants with appropriate telecommunication backgrounds, and currently (March 2010) four new experienced telecommunication consultants have joined the company.

Interestingly, the changes in the company are aligned with the results from the previous research cycle. The candidate firmly believes that the alignment of the results of the second research cycle and the changes in the company is one of the key reasons for why Terramar decided to authorise an integrated risk management project with the candidate as the project manager. The earliest phases of the integrated risk management project were the centre of attention for the third research cycle.

The research question for the third research cycle was:

- How will Terramar forming an integrated risk management framework project affect the design and implementation of the integrated causal risk management model?

To answer this research question, the candidate defined the following research objectives:

- To describe how the project sponsor affected the design and implementation of the integrated causal risk management model
- To describe how the senior user affected the design and implementation of the integrated causal risk management model
- To describe how the risk management experts at Terramar affected the design and implementation of the integrated causal risk management model

This chapter summarises the findings and results of the second Terramar case study. When reading the results and conclusions of this research cycle, the reader must be aware that the research results must be understood as indicative rather than definitive. The implications of the choice of research paradigm and research methodology are further discussed in “Chapter 12 - Reliability, validity and generalisability”.

11.2 Results for the first objective of the third research cycle

The first objective of the third research cycle was:

- To describe how the project sponsor affected the design and implementation of the integrated causal risk management model.

Terramar’s project management methodology is based on Project Management Institute’s Project management body of knowledge, fourth edition (PMI, 2008). In Terramar’s methodology, a project is authorised by the use of a project charter:

> “The project charter documents the business needs, current understanding of the customer’s needs, and the new product, service, or result that it is intended to satisfy, such as:
>
> - Project purpose or justification,
> - Measurable project objectives and related success criteria,
> - High-level requirements,
> - High-level project description,
> - High-level risks,
> - Summary milestone schedule,
> - Summary budget
> - Project approval requirements (what constitutes project success, who decides the project is successful, and who signs off on the project),
> - Assigned project manager, responsibility, and authority level, and
> - Name and authority of the sponsor or other person(s) authorizing the project charter.” (PMI, 2008: 77-78)

The authorising process of the integrated risk management project started with a meeting held on 27.11.2009 between the managing director of Terramar and the candidate. In this meeting it was discussed how Terramar could design and implement an integrated risk management framework. The result of this meeting was a decision to organise a task force to look further at what was needed to succeed with this initiative. This meeting can be considered as the first step of authorising the integrated risk management project at Terramar.

In the period from 27.11.2009 to 5.3.2010 the candidate arranged meetings with a selected group of risk management specialists in Terramar, the chief of staff and the managing director to discuss details of how to approach an internal integrated risk management project. This period lasted longer than what was expected mainly due to that the risk management specialists and the candidate being fully occupied on assignments for external clients. Another element that delayed the authorising of the project was that no one was formally assigned as project manager until the middle of February, when the candidate formally accepted and took on the role.

In the meetings with the managing director, chief of staff and risk management specialists it became evident that each of the stakeholders (the meeting participants) had different expectations to the effects, objectives and deliveries from the project. To get common expectations for the project, the candidate prepared a draft project charter based on the information gathered from the stakeholders in the previous meetings and conversations. The draft project charter was then presented to and discussed with all the key stakeholders in working meetings, and in these meetings the draft project charter was refined. In this manner the project charter was refined in an iterative process until it became a formal document 8.3.2010, when the managing director formally authorised the project by signing the project charter.

The project charter defined the managing director as the project sponsor of the integrated risk management project.

> "A sponsor is the person or group that provides the financial resources, in cash or in kind, for the project. When a project is first conceived, the sponsor champions the project. This includes serving as spokesperson to higher levels of management to gather support throughout the organization and promote the benefits that the

project will bring. The sponsor leads the project through the engagement or selection process until formally authorized, and plays a significant role in the development of the initial scope and charter.

For issues that are beyond the control of the project manager, the sponsor serves as an escalation path. The sponsor may also be involved in other important issues such as authorizing changes in scope, phase-end reviews, and go/no-go decisions when risks are particularly high." (PMI, 2008: 25)

In the authorisation process of the project, the managing director particularly focused on the effects of the project. The listed effects in the project charter were:

- "Terramar uses integrated risk management as part of our total management framework
- The integrated risk management framework should improve management oversight and decision making related to uncertainty without increasing the amount of administration work for the administration
- Terramar obtains practical management experience for integrated risk management projects
- Terramar is emerging as a more attractive supplier of integrated risk management services in that we "take our own medicine"
- The project will contribute to that Terramar is emerging as a leading provider of risk management and uncertainty management" (Terramar, 2010a: 4)

To achieve these effects, the following project objectives were agreed in the project charter:

- "To design and implement an integrated risk management framework in Terramar that is aligned with ISO 31000 Risk management – Principles and guidelines
- To develop integrated risk management tools and techniques that also can be used by Terramar's customers" (Terramar, 2010a: 4)

The managing director played an important role in scoping the project. The scoping process started with defining requirements for the integrated risk management framework. In this process, it soon became apparent that a prioritisation of the various requirements was needed. The managing director decided that he wanted a first version of the risk management framework operational by the first of October. The first version of the integrated risk management framework was required to be highly integrated with Terramar's strategic plan. In particular, the managing director wanted the integrated risk management framework to provide information about whether or not Terramar experiences strategic drift compared with the existing strategic plan.

The managing director was also focused on how much human resources the project needed to deliver a first version of the integrated risk management framework. The candidate, in the role as project manager, estimated approximately 350 internal Terramar supplier hours in the period from middle of February to the first of October to get a first basic version of the integrated risk management framework up and running. The managing director found this estimate acceptable, and it was also stated in the project charter that an expansion of the project will be discussed after the milestone "a first version up and running" had been achieved.

The integrated causal risk management model will be a part of Terramar's integrated risk management framework. The managing director, in the role as the project sponsor, has affected the design of the model by his emphasis on the requirement that the risk management framework must be aligned with the strategic plan. The managing director expects the project to present the chosen design, and his level of satisfaction by these presentations will decide in what degree he will involve himself in design choices taken by the project.

The managing director has affected the implementation of the integrated causal risk management model through the use of the project charter and project management plan. These two documents can be understood as a contract between the project sponsor (the managing director) and the project manager (the candidate) describing how the managing director wants the project implemented. The project has chosen a non formalistic approach for handling changes, but major changes will lead to that the project charter or/and the project management plan must be updated.

11.3 Results for the second objective of the third research cycle

The second objective of the third research cycle was:

- To describe how the senior user affected the design and implementation of the integrated causal risk management model.

The project will deliver the end product of the project to the chief of staff, and she will be the main user of the integrated risk management framework. The role senior user is not defined in Terramar's project management methodology. However, the candidate is positive towards using the role senior user in the project management board, and in the first draft to the project charter the candidate proposed the chief of staff in this role. All the stakeholders supported this proposal, and the chief of staff happily accepted the role. In the project management methodology PRINCE2, the senior user is always part of the project management board with the following responsibility:

> "The Senior Users(s) is responsible for specifying the needs of those who will use the project's products, for user liaison with the project management team, and for monitoring that the solution will meet those needs within the constraints of the Business Case in terms of quality, functionality and ease of use.
>
> The role represents the interests of all those who will use the project's products (including operations and maintenance), those for whom the products will achieve an objective or those who will use the products to deliver benefits. The Senior User commits user resources and monitors products against requirements. This role may require more than one person to cover all user interests. For the sake of effectiveness the role should not be split between too many people..."
> (Office of Government Commerce, 2009: 270)

In the early design stages of the project, the project examined the working processes, methods, tools and techniques the chief of staff currently uses in her work for developing budgets, staffing plans, financial forecasts, etc. The chief of staff, on the other hand, wanted the project to integrate risk management into her current working processes, so she was positive towards supporting the project.

In the candidate's opinion, the chief of staff was the most important stakeholder in the process of defining and prioritising requirements. The reason for this was that she had the overview of the current internal working processes and also on which working processes that could be improved by integrating risk management in the processes. Related to the design of the integrated causal risk management model, the chief of staff focus on the following particularly affected the design:

- Short term forecasts for assignments for each consultant (typically four to six months ahead). The chief of staff wanted to use these forecasts to develop the best possible financial forecasts for the organisation.
- Short term financial forecasts (typically four to six months ahead). The financial forecasts are currently deterministic, but the chief of staff wanted to have the option to present the forecast in a similar manner as the S-curve used for projects. The chief of staff also required that the first version of the integrated risk management framework replaces her current "Excel sheets" used for short term financial forecasts.
- The integrated risk management framework must be non-bureaucratic and easy to use.
- The integrated risk management must be usable as a basis for decision making in managing the long term risk profile of Terramar. Particularly important is it that the framework is usable for assessing trade-off decisions, such as considering low paid but high strategic value assignments (achieve legitimacy, high visibility or high learning potential) towards highly paid assignments without any additional value excluding the short term profit.
- The integrated risk management framework must be usable for developing and analysing scenarios. For example, a scenario can be based on possible bad publicity for a high profiled project for an important customer, various risk treatment actions for modifying this risk, and finally an assessment on the impact of Terramar's risk profile.
- The integrated risk management framework must include and assess existing organisational processes that are already in use in Terramar, such as the existing control process illustrated in Figure 11.1.

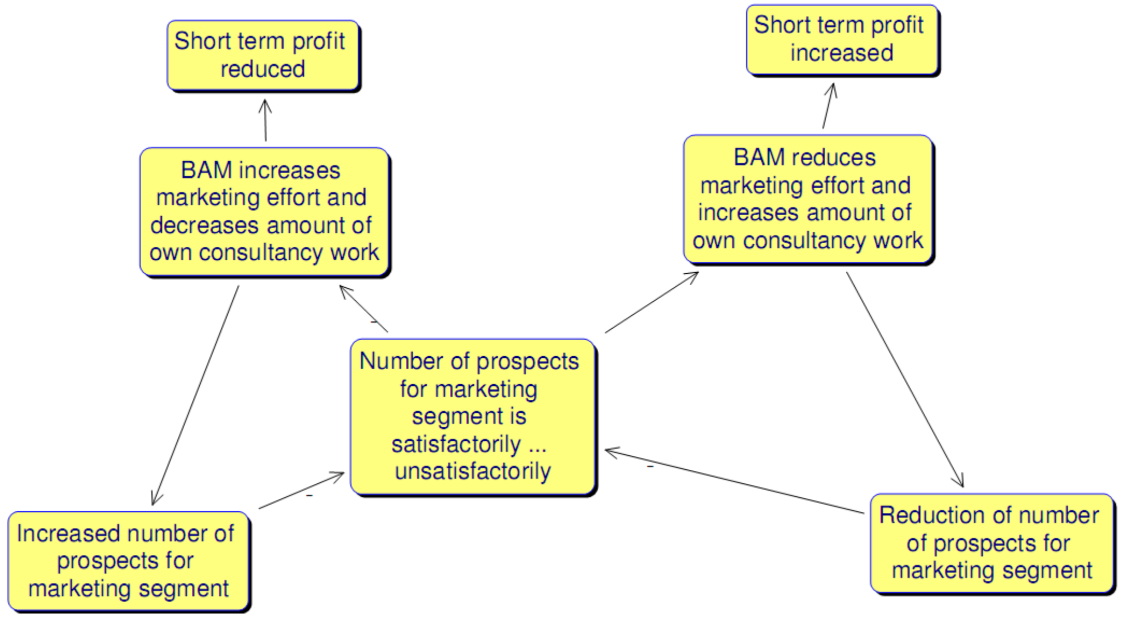


Figure 11.1 Terramar BAM process

The integrated risk management framework project is currently (March 2010) in its early phases, but the candidate expects the chief of staff to have a major affect on both design and implementation of the integrated causal risk management model due to the planned project approach. The chief of staff and the project has agreed a working method with a lot of short design meetings, where the project presents the latest version of the tools and models to be used in the framework. The chief of staff will in these meetings give direct feedback on the current and planned design, and this will lead to the design of the integrated risk management framework being developed in an iterative manner.

The chief of staff has already in the early stages of the project (end of March 2010) affected the design of the integrated causal risk management model. Her requirement for short term financial forecast combined with her and the managing director's need for tools to manage the long term risk profile has resulted in that the project had to change the design of the integrated causal risk management model. The project had in the earliest phases started designing a model having a fifteen months horizon, and it was not expected that the model (or the framework) had to replace current tools for short term financial forecasts.

11.4 Results for the third objective of the third research cycle

The third objective of the third research cycle was:

- To describe how the risk management experts at Terramar affected the design and implementation of the integrated causal risk management model.

The role senior supplier is not defined in Terramar's project management methodology. However, the candidate advocated for establishing the project board with a senior supplier together with the project sponsor and senior user, which was supported by the rest of the main stakeholders of the project. In the project management methodology PRINCE2 the senior supplier is always part of the project management board with the following responsibility:

> "The Senior Supplier represents the interests of those designing, developing, facilitating, procuring and implementing the project's products. This role is accountable for the quality of products delivered by the supplier(s) and is responsible for the technical integrity of the project..."
> (Office of Government Commerce, 2009: 271)

The senior supplier role was given to and accepted by the head of the analysis division in Terramar. The head of analysis was in the early design phase of the project particularly focused on that the design of the framework must be aligned with the needs and wants of the managing director and the chief of staff. He also focused on that the integrated risk management framework had to be integrated with Terramar's existing governance framework to be successful.

The head of analysis and the candidate shared the view that causality has an important place in risk management. The risk concept mapping technique presented in Bartlett (2002), where qualitative cause - effect relations between risk drivers, risks, assumptions, risk situations and impacts are drawn in causal maps, is one of the sources that have inspired the head of analysis to focus on qualitative risk mapping. In addition to describe a variant of qualitative risk mapping, Bartlett (2002) describes how qualitative risk mapping and risk registers can be used together:

"...individual risks may be added to the map and attached to the risk situations and impacts. This is usually more conveniently done after an initial working session, once risks have been fully articulated and added to a risk register."
(Bartlett, 2002: 2)

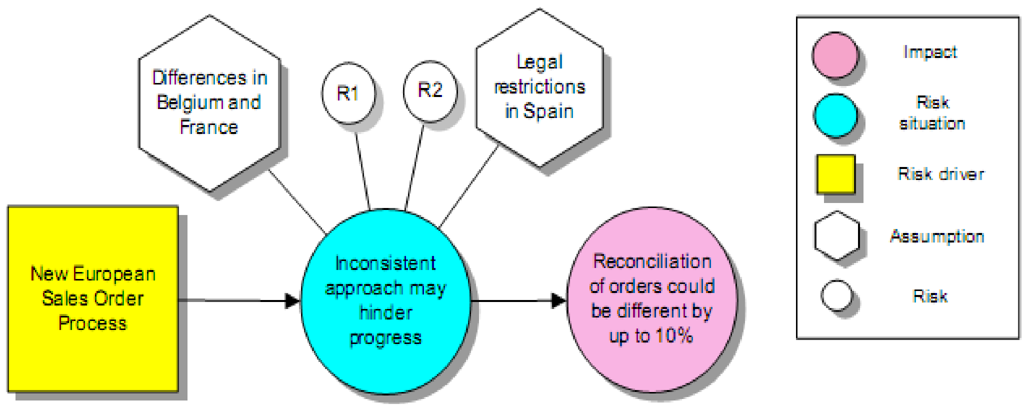


Figure 11.2 Example of concept risk map (Bartlett, 2002)

The head of analysis was enthusiastic about the idea of developing a tool/software to make the process of moving from causal risk maps to quantitative representations of the maps smoothest possible. The head of analysis considered this kind of tool/software to be just as useful for conducting risk assessments of major projects as for the integrated risk management framework. However, the head of analysis considered the development of this tool/software as a major task, which was clearly outside the scope for the first version of Terramar's integrated risk management framework. The head of analysis aimed at having a pilot model/tool ready at the end of 2010.

For the first version of the integrated risk management framework, the head of analysis and the two other risk management specialists supported the candidate's view that the first version of Terramar's integrated risk management framework should be based on three tools that must be used together. The first tool was Decision Explorer, which should be used to establish qualitative integrated causal risk maps. The second tool was Terramar's risk registers. Compared with how the risk register is mostly used in projects, the risk register should have less emphasis on describing risks and increased emphasis on describing risk treatment actions and what conditions that trigger the various risk treatment actions.

According to the current design (March 2010), the risk treatment actions in the risk register will be included in the causal risk map. The causal risk maps together with the information in the risk registers will form the ICRMM. In the first version of the framework, the ICRMM will thereby be a qualitative model. However, the head of analysis, the risk management specialists and the candidate want to develop the model to a semi-quantitative or possibly a quantitative model in later versions of the integrated risk management framework.

The third tool of the framework was the short term financial forecast tool wanted by the chief of staff. For the first version of the integrated risk management framework, the forecast tool should be a standalone tool with manual subjective inputs from the user. The head of analysis and the two other risk management experts were all clear on that they would have preferred the three components to be better integrated. However, they also supported the candidate's view that with the time and resource constraint put on the project for the first version of the framework, it was the right decision to down prioritise the integration and rather focus on establishing the three tools.

The responsibility for the development of the three tools in Terramar's integrated risk management framework has been divided. At the time of writing (March 2010), the candidate is responsible for the design and first drafts of the causal risk maps, the responsibility for further development of the risk register is handed to the risk management specialist, which previously has been responsible for developing the project risk register, and, finally, the responsibility for the design and development of the short term financial forecast tool is handed to the second risk management specialist. As previously stated, the head of analysis has the role as the senior supplier in the project management board.

11.5 Reflection on the general findings of the third research cycle

The research question for the third research cycle was:

- How will Terramar forming an integrated risk management framework project affect the design and implementation of the integrated causal risk management model?

The results of the first research cycle indicated that a qualitative ICRMM can be used to improve organisational risk management decision making by predicting the likely effect of proposed actions on the risk profile. However, the candidate does not believe that the university will use the model in the future since there is currently no one at the university that feels any ownership of the ICRMM. As part of the reflections of the research cycle, the candidate writes that he believes the ICRMM at UMB would have been more successful if UMB's integrated risk management initiative had been authorised and managed as a project.

The results of the second research cycle indicated that a semi-quantitative ICRMM can be used to improve organisational risk management decision making by predicting the likely effect of proposed actions on the risk profile. In the second research cycle, the candidate worked closely with Terramar's telecommunication BAM in the design and implementation of the ICRMM. A major difference from the first research cycle was that in this research cycle there was a stakeholder with ownership of the ICRMM. However, when the telecommunication BAM left the organisation, it also became evident that the ICRMM was not an element of Terramar's governance framework, and once again the candidate experienced that it became unlikely that the ICRMM would be used in the future.

The third research cycle is different from the previous two. In this research cycle, the candidate started the research by looking at the needs and wants of the most important stakeholders in Terramar related to the managing director's integrated risk management initiative. Based on these findings, the candidate aided the managing director in organising and authorising an integrated risk management project. The design of the ICRMM, which will be an important component of Terramar's integrated risk management framework, was based on the needs and wants of the key stakeholders, which again is expected to increase ownership of the ICRMM in the organisation.

Finally, the increased ownership is expected to increase the likelihood for the ICRMM becoming an integrated component in Terramar's governance framework.

As part of the candidate's reflections, the candidate has realised that the first and the third research cycle had a very similar starting point. In both cases, the managing director of the organisation wanted to organise an integrated risk management initiative for their organisation. The candidate must reluctantly admit that in the first case he could have done a much better job in aiding the managing director, if the candidate had been more focused on the needs and wants of the organisation and less focused on his own research. In retrospect, the candidate also believes that both UMB and the candidate would have received more value out of the research programme, if the candidate had chosen an approach more similar to the approach used for the third research cycle.

The third research cycle showed that the managing director, the chief of staff and the risk management specialists in Terramar all consider the ICRMM to be an important component of the integrated risk management framework. The findings in this research cycle indicated that using a project management methodology is effective in organising, authorising and managing an integrated risk management initiative in an organisation. By using project management methodologies, it is ensured that the various stakeholders together can cooperate on the design and implementation of the integrated risk management framework, including the ICRMM.

On a personal note, the candidate believes that he has improved as an "action researcher" during the research programme. Particularly, in the first research cycle the candidate believes he was too detached from the actual problem experienced by the organisation than what is considered optimal in action research. In the second and particularly in the third research cycle, the candidate believes the research became better aligned with the aim for action research than for the first research cycle:

> "Action research aims to contribute both to the practical concerns of people in an immediate problematic situation and to the goals of social science by joint collaboration within a mutually acceptable ethical framework."
> (Rapoport, 1970: 499)

Chapter 12 - Reliability, validity and generalisability

12.1 Introduction

Though issues related to reliability, validity and generalisability have been discussed as part of the reflections of each research cycle, the candidate finds it useful to summarise some of the main issues in a common chapter. In this chapter the focus is on how the choice of adopting the phenomenological paradigm and an action research methodology influence on how the research results should be interpreted. This will now be looked at in terms of reliability, validity and generalisability.

12.2 Reliability

> "Reliability is a measure of the extent to which a set of results can be regarded as being dependable. In the context of research, reliability is usually measured in terms of the extent to which the same results will be generated on successive occasions using the same methodology." (Roberts et al., 2003a: 5/33)

The results of this research programme must be considered as indicative and not definitive. This research programme is impossible to replicate in the sense that exactly the same conditions at either UMB or Terramar would never occur again. Regarding reliability another worrying point is that even if the candidate could travel back in time and conduct the research once more under exactly the same conditions the results would be different than for the existing research. The difference in the research results would be due to the fact that the candidate's subjective interpretation of the information gathered would not be identical in both cases, and in addition that cognitive maps are never totally accurate:

> "A cognitive map will never be totally accurate – a person's thinking is continually changing (in part because of the interview and mapping process), and people are never completely open to an interviewer. Nevertheless, mapping usually manages to capture significant aspects of the way a person thinks." (Ackermann et al., 2004: 29-30)

The candidate is not the only doctoral student who has struggled with the issue of reliability. Vaagaasar (2006), who conducted a longitudinal study inspired by ethnography in her PhD, writes the following about reliability in her thesis:

> "In the kind of research I conducted, reliability might have more to do with credibility than with repetition of research (Guba and Lincoln, 1985)." (Vaagaasar, 2006: 69)

A list of typical issues that may result in unreliable data is presented in Roberts et al. (2003a). This list can be used to look at how the candidate has coped with the most typical issues to increase the credibility of the research.

Methodological error:

The research methods used in this research programme are well known in the research environment. The candidate has also sought to describe when and how the different methods were used to improve the trust that reliable methods have been used.

Processing/analytical error:

The software programs that have been used are well tested in research and it is highly unlikely that these programs introduced any significant errors. The manual input of data in the software is a much more likely cause of error due to the different models developed is large and complex. However, the candidate finds it unlikely that any errors in the input of data into the system have affected either the research objectives or the answer to the research cycle questions.

Errors due to subject misdirection or subject bias:

In the case of UMB the ICRMM was based on published written information. That parts of the written data have been produced with other intentions than to present an objective truth cannot be dismissed. Regarding Terramar, most of the data in the ICRMM has come as inputs from the telecommunication BAM, and these views are definitely subjective and should therefore be treated as such. However, both the ICRMM produced at UMB and at Terramar were supposed to represent the subjective data put into the model, and not an objective truth (even though the candidate hopes and believes that the subjective views and the objective truth are similar). Based on this, errors due to subject misdirection or subject bias were not considered as a problem in this research programme.

Presentation error:

Presentation error may be tested through replication by conducting new simulations of the models originally used. The candidate has repeated the different quantitative simulations to ensure that the likelihood of presentation errors is minimal.

Researcher error and researcher bias:

By training and experience researchers will improve their skills and commit fewer mistakes. This research programme is conducted as part of the candidate's research education and this research programme is also the first major research programme conducted by the candidate. Based on this, errors related to the capabilities of the candidate are very likely. For the candidate this became very apparent when he worked with the ICRMMs. In the beginning of the research programme the candidate found it difficult to establish the correct causal relationship between concepts/statements/nodes, but this became more intuitive in the later part of the research work. Regarding possible research errors, the candidate believes that it is likely that there are several researcher errors in the ICRMMs caused by the candidate's lack of researcher experience. However, in the case of UMB it was focused on establishing the correct causal relationships of those concepts/statements/nodes that were directly related to the achievement of the research objectives. In the case of Terramar, all the causal relationships in the ICRMM were assessed at least twice. First this was conducted to establish a qualitative causal map as part of "establishing the context". Then each concept/statement/node and each relationship was assessed again as part of the quantifying process. Based on this, the candidate believes that the research results were reliable enough to ensure that the correct conclusions for the research objectives were drawn. The candidate has to the best of his abilities sought to document the research methodology and how the different results were achieved. This should assist the reader in making up her/his mind about whether or not researcher errors and researcher bias have influenced on the final research results.

In terms of reliability it is also necessary to be aware of the criticism of phenomenology raised by positivist researchers:

> "A common criticism of phenomenology is that it is too passive and interpretative. Critics argue that the paradigm lacks the rigour and discipline of positivism, and it passively allows the researcher too much freedom of action. Positivists find it unacceptable that the researcher can actually join the sample and become embedded within it. They argue that there must be a degree of reactance after such involvement and interference on the part of the researcher.
>
> Positivists also argue that phenomenological results are open to interpretation because of the high levels of subjective assessment used. The researcher interprets observations and results on the basis of his or her knowledge and experience. In some cases these interpretations form the basis of real-time modifications to the design of the research so that emerging points of particular potential and promise can be investigated. Positivists argue that this lack of structure leads to a semi-chaotic structure." (Roberts et al., 2003a: 3/20)

The candidate believes that the criticism from positivist researchers about reactance and subjective assessments are highly relevant, and the candidate also agrees that these two issues reduce the reliability of the research result. The candidate supports the view that in general does the use of the positivist paradigm provide research results with better reliability than research based in the phenomenological paradigm. The candidate would like to stress that this must not be interpreted as that the candidate supports a view that the positivist paradigm is a superior research paradigm to phenomenology or that the candidate is in any kind apologetic of using action research. As stated in Section "5.2 Study philosophy", the candidate is aligned with Susman and Evered (1978: 594) in that the criticism from the positivist researchers must be interpreted from the fact that there exist contrasting conceptions of science with different foundations for the philosophical viewpoints between positivist science and action research. The candidate chose to use the phenomenological paradigm and an action research methodology for this research programme, because the candidate thought the advantages of this choice outweighed the disadvantages compared to the alternatives. The candidate still believes this was a correct assumption.

12.3 Validity

> "Validity is a measure of how well the results can be justified and considered to be a true and accurate reflection of reality...Reality could be defined in terms of a theory defining a state that cannot actually be verified. This reality is real enough because it holds for all conditions as far as we know and it has never been falsified." (Roberts et al., 2003a: 5/35)

The question of reality is particular important for the first case study conducted at Terramar. In this case study the main input to the ICRMM came from the telecommunication BAM. One of the research methods used was cognitive mapping. Ackermann et al. (2004) provide some important insight on how this affects validity:

> "Cognitive mapping is a technique designed to capture the person's values and embedded wisdom in a diagrammatic format...It seeks to map out how each person 'make sense of their organizational world'." (Ackermann et al., 2004: 28)

The reality of the Terramar ICRMM is thereby not related to an objective truth, but rather to how the BAM made sense of his organisational world at the time the research was conducted. To increase the validity of this part of the research the candidate used recommendations about how to apply the cognitive mapping technique provided in Ackermann et al. (2004: Chapter 3). Please refer to Section "8.5 Data collection and processing from Terramar" for further details about this.

The reality of the ICRMM that was studied at UMB is also interesting. The ICRMM that was created was based on the information the candidate gathered as part of the first, second and third data collection and processing periods (please refer to Section "6.5 Data collection and processing from the University of Life Sciences"). The information from each of these data sources could have been mapped in numerous individual maps, but the candidate decided to develop an aggregated model constructed by combining the information provided by the different sources. This idea was inspired by Eden (1988):

> "An aggregated model constructed by combining each of the individual cognitive maps produces a "team map" that is no longer a representation of the cognition/thinking of anyone and does not belong to anyone. The team map is a facilitative device where each team member will recognise concepts that belong to

> them but will not necessarily recognise the meaning attributed to them because the concepts that explain and the concepts that are consequential will belong to others in the group as well as the individual viewing the team map." (Eden, 1988: 7)

The candidate believes that the objective truth and the information provided by the data sources are aligned. However, the reader should understand that the reality of the ICRMM for UMB is not related to the objective truth, but rather to whether or not it gives a valid representation of the information provided by the data sources.

The validity of the research can have been reduced due to the same type of errors as described in Section "12.2 Reliability". The reader should therefore look at how the candidate has sought to reduce the likelihood of these errors.

Regarding the third research cycle, the candidate arranged three separate meetings with the key stakeholders of the ICRMM to present his writings to increase the reliability and validity of the research cycle. The three meetings indicated that the three key stakeholders and the candidate had a common understanding on how these key stakeholders affected the design and implementation of the ICRMM. These meetings thereby increased the reliability and validity of the findings in this research cycle.

The candidate believes that both the ICRMM in research cycle one and two give valid representations of the information provided by the data sources. The candidate also believes that the material on the third research cycle provides valid information on how the key stakeholders affected the design and implementation of the ICRMM. Based on this, the candidate believes that the validity of the research programme is high.

12.4 Generalisability

> "Generalisability is a measure of how well the conclusions of the research can be applied to the population as a whole. Generalisability is sometimes referred to as external validity. It is an important concept, especially in EBS DBA research, where candidates are encouraged to produce applied research that is of direct use and relevance to the sample company and to wider business and management sectors in general." (Roberts et al. 2003a: 5/38)

The candidate has sought to design the research methodologies of the second and third research cycle in a manner that made it possible to triangulate the results with the previous research cycles. This approach was used to increase generalisability of the research results. However, once again, the reader should be aware of that these research results are indicative and not definitive, and also that the use of two samples and three research cycles are not enough to conclude that generalisability is high.

Chapter 13 - Conclusions and suggestions for further research

13.1 Introduction

This chapter outlines conclusions from the research, and the knowledge gained as part of the research is used for suggestions for further research.

13.2 ISO 31000 provides a good framework for managing risks

Subsection "6.3.2 The integrated risk management initiative" concludes that the University of Life Sciences needs to establish the risk profile facing the university. The risk profile can be understood as the description of a set of risks that relate to one or more of the aims and/or objectives of the university. The risk profile includes all the individual risks facing the university and the risk interdependency between all the different individual risks.

A problematic area for the university is the confusion as to what risk actually is. The Committee of Sponsoring Organizations of the Treadway Commission (2004a) [COSO (2004a)] presents risk as:

> "An event is an incident or occurrence from internal or external sources that affects achievement of objectives. Events can have negative impact, positive impact, or both. Events with negative impact represent risks. Accordingly, risk is defined as follows:
>
> Risk is the possibility that an event will occur and adversely affect the achievement of objectives." (COSO, 2004a: 16).

In COSO (2004a) it is argued that "Enterprise risk management deals with risks and opportunities to create or preserve value". However, in the risk management framework for the Norwegian public sector developed by The Norwegian Government Agency for Financial Management (2005) [SSØ (2005)], which is based on COSO's "Enterprise Risk Management – Integrated Framework" (COSO, 2004a, 2004b), risk management is limited to dealing with risks only. In other words, the parts related to opportunity have not been incorporated into the Norwegian risk management framework for the public sector.

Difficult trade off decisions are challenging because there is uncertainty related to the outcome of the possible options available. If possible positive effects are taken out of the equation many decisions will become less complicated, but then again it is less likely that the organisation will choose the optimal option for the organisation. Unfortunately, SSØ (2005) is not a framework for management of risks, but rather a framework for dealing with the possibility that an event will occur and adversely affect the achievement of objectives. The consequence is that risk management, as advocated in the SSØ (2005) framework, becomes an obstacle for dealing with uncertainty for the public organisations choosing to follow this framework. This finding is aligned with Samad-Khan (2005:1) on COSO's "ERM – Integrated Framework".

The qualitative ICRMM for UMB establishes causal maps of both the positive and negative effects that the various issues/variables and actions may have on the university's objectives. This makes it possible to adhere to the ISO (2009b) principle that "risk management is an integral part of all organizational processes" and use the ICRMM for all decisions that involve uncertainty. If the ICRMM had only looked at the downside of uncertainty in accordance with SSØ (2005), then the ICRMM could not have been used to aid decision-making where the outcome includes possible uncertain favourable outcomes. This is highly problematic since risk management is about making optimal decisions in the face of uncertainty (Knight, 2008: slide 24).

13.3 To design an effective purely quantitative integrated causal risk management model is almost an impossible task

In Subsection "4.2.1 Effective integrated causal risk management models can be designed" it was argued that the literature provides no clear answer to the degree which an effective quantitative integrated causal risk management model (ICRMM) can be designed.

This research programme indicates that it is possible to design a qualitative ICRMM and a semi-quantitative ICRMM. Regarding the semi-quantitative ICRMM, it was categorised as such due to that it used a combination of qualitative and quantitative information. The intention of the semi-quantitative ICRMM was not to provide an exact numerical representation of the risk profile, but rather to provide quantitative information that was accurate enough to improve decision-making in the organisation.

To design the semi-quantitative ICRMM, subjective judgements and filtering/reduction of the contents of the qualitative ICRMM, representing the organisation's environment and processes, were needed. If the ICRMM of the second research cycle had been designed to represent the total risk profile of the consultancy, compared to just one small market area, then even further filtering/reducing of content of the organisation's environment and processes would have been needed. Though the design of an ICRMM covering the total risk profile would have been complex, the candidate has not identified any real barriers for the design of such a semi-quantitative ICRMM.

The literature provides evidence that quantitative models are used to develop the risk profile related to financial objectives (Froot et al., 1994), project objectives (Williams 2004; Concept 2005b) and operational objectives (Acharyya, 2007). Regarding the operational objectives, it should be noted that Acharyya (2007: 17) advocates for "a suitable balance between qualitative and quantitative approaches towards measuring and managing operational risk and integrating operational risk with financial risk".

In terms of designing a quantitative ICRMM representing the total risk profile of an organisation the candidate would advise against such a design. The argument for this can be found in the following ISO (2009b) risk management principle:

> **"Risk management is an integral part of all organizational processes**
> Risk management is not a stand-alone activity that is separate from the main activities and processes of the organization. Risk management is part of the responsibilities of management and an integral part of all organizational processes, including strategic planning and all project and change management processes." (ISO, 2009b: 7)

Organisations do not have reliable quantitative models representing all organisational processes and all the interdependencies between these processes. It will therefore be an impossible task to try to design a reliable quantitative model that is integrated with all these processes, that expresses the uncertainty related to each organisational process and that also express the (causal) interdependencies between all processes and uncertainties.

The candidate agrees with the literature that it will be possible to develop quantitative models representing different silo objectives of the organisation. Different silo quantitative models can also be used as inputs to a semi-quantitative ICRMM representing the total risk profile of the organisation. This kind of use of reliable silo quantitative models will also increase the reliability of the semi-quantitative ICRMM representing the total risk profile of the organisation.

13.4 Use project management methodologies

In retrospect, the candidate believes that the working process of designing the ICRMM and establishing the risk profile in the ICRMM is just as valuable as the final version of the ICRMM itself. The working process demands considerations of how organisational processes actually works, understanding of how the different processes are related to each other, assessments of what uncertainties may influence on the achievements of the objectives and how the various uncertainties are best treated. During the early simulations of a semi-quantitative ICRMM each node is studied in detail, which again leads to further reflection as to whether or not the ICRMM is a true and accurate representation of reality. Based on the importance of the working process, the candidate believes the success of an ICRMM in an organisation is dependent on the key stakeholders' involvement and participation in the working process.

The importance of the working process also leads to the conclusion that the working process of designing and implementing a risk management framework in an organisation must be initiated, planned, executed, monitored and closed with the most suitable approach. In the candidate's view, the most suitable approach is to manage the design and implementation of the risk management framework as a project, and to manage the project by using established project management frameworks and methodologies. The findings in the three research cycles of this research programme also indicate that organisations should use a project management methodology to manage their integrated risk management initiatives.

13.5 The ICRMM can be used to improve risk management decision making

The essence of the ICRMM is captured in the following ISO principle for managing risk:

> **"Risk management is part of decision making.**
> Risk management helps decision makers make informed choices, prioritize actions and distinguish among alternative courses of action." (ISO, 2009b: 7)

The ICRMM fully complies with this principle. In the first research cycle it was demonstrated how a qualitative version of the ICRMM can be used to improve decision making for the University of Life Sciences. The use of the qualitative version of the ICRMM showed that to assess risks, and in particular to assess the likely effect of proposed actions on the organisation's risk profile, it is needed to assess how numerous deterministic and uncertain factors interrelate. Without using decision support models, such as the ICRMM, it becomes more or less impossible for decision makers to make fully informed choices.

In the second research cycle it was demonstrated how a semi-quantitative version of the ICRMM can be used to improve decision making for Terramar. In this research cycle, the ICRMM presented the organisation's risk profile by combining S-curves for each top level objective and a correlation table. The semi-quantitative ICRMM was not designed to give precise numbers, but was designed to be accurate enough to improve decision making by predicting the likely effect of proposed actions on the risk profile. The results of the research cycle indicate that the ICRMM worked as intended, since the BAM was satisfied with the simulation results of the ICRMM and Terramar chose to implement the same actions as proposed by the ICRMM.

In the third research cycle, how the risk mature organisation Terramar chooses to implement an integrated risk management framework is examined. In this research cycle it can be seen that Terramar chose to start with a qualitative design for the ICRMM. However, in this research cycle it can also be seen that the head of analysis (Terramar's most experienced risk management expert) wants to move from a qualitative ICRMM to a quantitative version in the near future. This research cycle thereby indicates that risk mature organisations, such as Terramar, support the idea that the ICRMM can be used to improve decision making in the organisation.

13.6 Practical contribution

In recent years, the literature, academics and practitioners all agree that the risk profile of an organisation is affected by risk interdependency, and that an organisation should use an integrated approach to manage its risk profile. However, there is a lack of applied research giving clear advice on a best practice methodology for conducting integrated risk management and how to deal with risk interdependency in practice. The candidate has with this applied research programme aimed at contributing towards this knowledge gap by designing, implementing and using ICRMMs in real business environments through three research cycles.

Chapter 6 and Chapter 7 show that the candidate answered the research question and achieved the three research objectives for the first research cycle. Chapter 7 demonstrates the potential contribution to risk management decision making for UMB by the use of a qualitative ICRMM.

Chapter 8 and Chapter 9 show that the candidate answered the research question and achieved the three research objectives for the second research cycle. Chapter 9 demonstrates how the Terramar telecommunication BAM used a semi-quantitative ICRMM in a real business environment to improve his risk management decision making.

Chapter 10 and Chapter 11 show that the candidate answered the research question and achieved the three research objectives for the third research cycle. Chapter 11 describes how Terramar organised an integrated risk management framework project to improve the organisation's risk management capability. In Terramar's integrated risk management framework the ICRMM is used to manage risk interdependency and to improve risk management decision making.

Through the three research cycles, the candidate has answered the research question of this programme, which was "how can an integrated causal risk management model be designed, implemented and used to predict the likely effect of proposed actions on the risk profile?"

13.7 Suggestions for further research

Further research related to the integrated causal risk management model

This research programme gives only indicative results. This suggests that further studies or research programmes related to the same research topic are needed for definitive results. Studies or research programmes can be designed to replicate the candidate's studies with other sample organisations, or they can use similar research objectives but be designed completely differently to offer a form of methodology triangulation of the results. Particularly useful would be a research programme triangulating the results by using the positivist paradigm.

Research related to the Strategic Focus Wheel

The research field of this research programme is integrated/strategic risk management, which is one of the four elements in the Strategic Focus Wheel governance framework (the four elements are Strategic Planning, Making Strategies Work, Project Management and Strategic Risk Management). The Strategic Focus Wheel (SFW) is based on the concept that the four elements are closely integrated (Roberts and MacLennan, 2003: 10-12). The candidate's research clearly supports this view, but does not provide answers as to how the elements in the SFW governance framework interrelate. A possible research area could look at how the various elements in the SFW interrelate in practice or how to design the SFW governance framework in a real business environment.

Research related to ISO 31000

ISO 31000 is the new international standard for risk management. This research programme has also used ISO 31000 as an important part of the knowledge base. Possible research programmes could look at the practical value of the new ISO 31000 standard, for example, by focusing on its principles, on its framework, on its processes or by comparing ISO 31000 with other respected risk management frameworks such as the enterprise risk management framework provided by COSO.

Research related to structural simulation models

The candidate used causal mapping and Monte Carlo simulations in the design of the ICRMM. There are other viable simulation techniques available such as system dynamics, fuzzy logic and Bayesian belief networks that could have been used instead. Research programmes could be designed to evaluate the advantage of using these various simulation techniques in the design of the ICRMM.

Further research on issues related to the integrated causal risk management model of the candidate

The candidate's research indicates that an integrated causal risk management model can be used to improve risk management decision making in organisations by aiding them in predicting the likely effect of proposed actions on the risk profile. Further research related to designing and implementing similar risk management models may discover weaknesses in the design choices taken in this research programme. Related to the causal maps, it can be looked at other coding techniques or it may be looked other ways of assessing the information gathered in the map. Related to the semi-quantitative ICRMM it can be looked at the use of other distributions, other ways of structuring the data or other ways of assessing the data gathered and structured in the ICRMM. Further research on the semi-quantitative ICRMM could also examine coding principles for various types of feedback loops, which is a challenging task in the coding of causal models.

Research on the use of project management to design and implement risk management frameworks

The candidate believes that further studying of the use of project management tools and techniques for designing and implementing a risk management framework would be very interesting. In the candidate's view, the ICRMM designed for the University of Life Sciences would have been much more successful if the design and implementation of the ICRMM had been run as a project according to accepted project management standards and methodologies such as PMI or PRINCE2. This would, for example, have ensured that the project had been initiated, planned, executed, monitored and closed according to standard project management tools and techniques. In project management, it is also required that the handing over process from the project to normal operations is planned for, which requires that the line organisation is prepared for taking the responsibility of running and using the ICRMM.

Chapter 14 - References

Abrams, C., von Känel, J., Müller, S., Pfitzmann, B. and Ruschka-Taylor, S. (2007) 'Optimized Enterprise Risk Management', *IBM Systems Journal*, 46(2), 219 – 234.

The Accident Investigation Board/Norway (2005) *Safety in Norwegian aviation during the process of change*, report.

Acharyya, M. (2007) 'The fundamentals of designing an integrated model of financial risk and operational risk within an Enterprise Risk Management framework: Findings of an empirical study', paper presented at the *Enterprise Risk Management Symposium Society of Actuaries,* 28-30 March, Chicago. Available from http://www.soa.org/library/monographs/other-monographs/2007/august/m-as07-1-07.pdf

Ackermann, F., Cropper, S. and Eden, C. (1992) 'Getting Started with cognitive Mapping', paper published as a tutorial paper at the *7th Young OR Conference* (p 65-82), 13-15 April, University of Warwick. Birmingham. Available from http://www.banxia.com/dexplore/pdf/GettingStartedWithCogMapping.pdf

Ackermann, F. and Eden, C. with Brown I (2004) *The Practice of Making Strategy: A Step-by-Step Guide*, London, Sage Publications.

Ackermann, F., Eden, C. and Williams, T. (1997) 'Modeling for litigation: mixing qualitative and quantitative approaches', *Interfaces*, 27(2), 48–65.

Ackermann, F., Eden, C., Williams, T. and Howick, S. (2006) 'Systemic Risk Assessment: a case study', *Journal of the Operational Research Society,* 58 (1), 39-51.

Ackoff, R. L. (1971) 'Towards a system of system concepts', *Management Science* 17(11), 661-671.

Andersen, H., Berge, T. O., Bernhardsen, E., Lindquist, K. G. and Vatne, B. H. (2008) 'A suite-of-models approach to stress-testing financial stability', publication in the series Staff memo published by the central bank of Norway. Available from http://www.norges-bank.no/upload/68187/staff_memo_0208.pdf

Banathy, B. (2000) 'A taste of systemics', paper presented at the *1st International Electronic Seminar on Wholeness*, 1-31 December (online) (cited 25 April 2008). Available from http://www.newciv.org/ISSS_Primer/asem04bb.html

Bartlett, J. (2002) 'Using Risk Concepts Maps in a Project or Programme', paper presented at the *Fifth European Project Management Conference, PMI Europe 2002*, 19-20 June Cannes France.

Bastviken, P. H. (2009) 'Integrert usikkerhetsstyring', a first draft to a Terramar internal integrated risk management project where the managing director was the project owner.

Broadlef Capitol International PTY LTD (2009) 'A Simple Guide to Risk and Its Management', (online) (cited 28 April 2009). Available from http://www.broadleaf.com.au/pdfs/trng_tuts/Tut_Simple_Guide_to_Risk_v10.pdf

Bryson, J., Ackermann, F., Eden, C. and Finn, C. (2004) *Visible Thinking: Unlocking Causal Mapping for Practical Business Results*, Chichester, John Wiley & Sons Ltd.

Butcher, J., Turner, N. and Drenth, G. (2006) 'Navigating in the Midst of More Uncertainty and Risk', *Journal of applied corporate finance',* 18(4), 76-80.

Causality Actuarial Society Enterprise Risk Management Committee (2003) 'Overview of Enterprise Risk Management', (online) (cited 13 September 2007). Available from http://www.casact.org/research/erm/overview.pdf

The Committee of Sponsoring Organizations of the Treadway Commission (2004a) *Enterprise Risk Management — Integrated Framework: Executive Summary and Framework*, Jersey City, AICPA.

The Committee of Sponsoring Organizations of the Treadway Commission (2004b) *Enterprise Risk Management — Integrated Framework: Application Techniques*, Jersey City, AICPA.

Concept 10 (2005a) *Report 10 Uncertainty analysis - Context and foundations*, the report is published by the Concept program. Norwegian version available from http://www.concept.ntnu.no/Publikasjoner/Rapportserie/Concept%2010%20Usikkerhetsanalyse%20-%20Kontekst%20og%20grunnlag.pdf.
English summary version available from http://www.concept.ntnu.no/Publikasjoner/Rapportserie/Concept%2010%20UncertaintyContext%20Summary.pdf

Concept (2005b) *Report 12 Uncertainty analysis – Methods,* the report is published by the Concept program. Norwegian version available from http://www.concept.ntnu.no/Publikasjoner/Rapportserie/Concept%2012%20Usikkerhetsanalyse%20-%20Metoder.pdf
English summary version available from http://www.concept.ntnu.no/Publikasjoner/Rapportserie/Concept%2012%20UncertaintyMethods%20Summary.pdf

Creswell, J.W. (2007) *Qualitative inquiry and research design: Choosing among five approaches* (2nd edn.) Thousand Oaks, Sage.

D'Arcy, S. D. (2001) 'Enterprise Risk Management', *Journal of Risk Management of Korea* 12(1), 207-228.

Deloitte research (2005) *Disarming the value killers*, study published by Deloitte research.

Denzin, N. K. and Lincoln, Y. S. (2005) *The Sage handbook of qualitative research* (3rd edn.), Thousand Oaks, Sage.

Diffenbach, J. (1982) 'Influence diagrams for complex strategic issues', *Strategic Management Journal,* 3(2), 133-146.

Dougherty, E.R. (1990) *Probability and statistics for the engineering, computing and physical sciences,* United States of America, Prentice-Hall Inc, pp 109-110, 118, 241-242.

Dugstad, N. (2008) Unpublished letter: Letter of support from UMB, the letter of support was an attachment to the candidate's research proposal.

Eden, C. (1988) 'Cognitive mapping: a review', *European Journal of Operational Research,* 36, 1–13.

Eden, C. and Ackermann, F. (2004) 'Cognitive mapping expert views for policy analysis in the public sector', *European Journal of Operational Research*, 152, 615–630.

Eden, C., Williams, H., and Smithin, T (1986) 'Synthetic Wisdom: the design of a mixed mode modelling system for organisational decision making', *Journal of the Operational Research Society,* 37(3), 233-241.

Eden, C., Williams, T., Ackermann, F. and Howick, S. (2000) 'The role of feedback dynamics in disruption and delay on the nature of disruption and delay (D&D) in major projects', *Journal of the Operational Research Society,* 51(3), 291-300.

Eden, C., Ackermann, F. and Williams, T. (2005) 'The amoebic growth of project costs', *Project Management Journal,* 36(2), 15–27.

Forrester, J. W. (1994) 'Learning through System Dynamics as Preparation for the 21st Century' Keynote Address for Systems Thinking and Dynamic Modeling Conference for K-12 Education, June 27-29, 1994 at Concord Academy USA.

Forrester J. W. (1998) 'Designing the future', this paper is the English version of the paper presented at the University of Seville on December 15th, 1998.

Fraser, J. R. S. and Simkins, B. J. (2007), 'Ten Common Misconceptions about Enterprise Risk Management', *Journal of Applied Corporate Finance*, 19(4), 75-81.

Froot, K. A., Scharfstein, D. S. and Stein, J.C. (1994) 'A Framework for Risk Management' *Harvard Business Review,* 72, 91-102.

Holton, G. A. (2004) 'Defining risk', *Financial Analysts Journal*, 60(6), 19-25.

Howick, S., Eden, C., Ackermann, F. and Williams T. (2008) 'Building confidence in models for multiple audiences: The modelling cascade', *European Journal of Operational Research*, 186, 1068–1083.

IEC (2009) *Risk Management – Risk Assessment Techniques*, reference number IEC/FDIS 31010:2009 (E).

ISO (2009a) *ISO Guide 73 Risk management – Vocabulary*, Switzerland, ISO.

ISO (2009b) *ISO 31000 Risk management - Principles and guidelines*, Switzerland, ISO.

Jen, R. (2009) Visual Ishikawa Risk Technique (VIRT) - An Approach to Risk Management, article published in PMI Virtual Library.

Kaplan R. S. and Norton D. P. (1992) 'The Balanced Scorecard - Measures that Drive Performance', *Harvard Business Review*, 70(1), 71-79.

Kelly, G.A. (1955) *The Psychology of Personal Constructs*, New York, Norton.

Klakegg, O.J., Samset, K., Magnussen, O. M. (2005) Improving Success in Public Investment Projects. Lessons from a Government Initiative in Norway to Improve Quality at Entry, (online) (cited 6 July 2010). Available from http://www.concept.ntnu.no/attachments/058_2005_klakegg_improving_success_in_public_investproj.pdf

Knight, F. H. (1921) *Risk, Uncertainty, and Profit* Boston, MA: Hart, Schaffner & Marx; Houghton Mifflin Company.

Knight, K. W. (2008) 'Out with AS4360 - In with ISO 31000', presentation held at *RMIA – Knowledge* 16th July. (online) (cited 24 July). Available from http://rmia.mediavisionz.com.au/080716-RMIAP2/# (the candidate did not use the presentation mode, but looked at the slides individually by typing in the slide numbers in the following manner http://rmia.mediavisionz.com.au/080716-RMIAP2/Slide24_1.jpg).

Lam, J. (2000) 'Enterprise-Wide Risk Management and the Role of the Chief Risk Officer', *eRisk,* 25th March. Available from http://www.erisk.com/Learning/Research/011_lamriskoff.pdf

Layton, M. and Garitte, J. (2008) 'Chief Audit Executives and Risk Management Silos', *IRMI online.* Available from http://www.irmi.com/Expert/Articles/2008/Deloitte03.aspx

Lofquist, E. A. (2008) *Measuring the Effects of Strategic Change on Safety in a High Reliability Organization*, PhD thesis at the Norwegian School of Economics and Business Administration.

Markowitz, H. M. (1952) 'Portfolio Selection', *Journal of Finance*, 7(1), 77-91.

Markowitz, H. M. (1959) *Portfolio Selection: Efficient Diversification of investments*, New York, John Wiley & Sons.

Markowitz, H. M. (1999) 'The Early History of Portfolio Theory: 1600-1960', *Financial Analysts Journal*, 55(4), 5-16.

Marriam, S. B. (1998). *Qualitative research and case study applications in education*. San Francisco, Jossey-Bass Publishers.

Meulbroek, L. (2001) 'A Better way to manage risk', *Harvard Business Review*, 79(2), 22-23.

Meulbroek, L. (2002a) 'Integrated Risk Management for the Firm: A Senior Manager's Guide', *Harvard Business School's Division of Research Working Papers*. Available from http://www.hbs.edu/research/facpubs/workingpapers/papers2/0102/02-046.pdf

Meulbroek, L. (2002b) 'The promise and challenge of integrated risk management' *Risk Management and Insurance Review*, 5(1), 55-66.

Miccolis, J. and Shah, S. (2001) Modeling the Reality of Risk: The Cornerstone of Enterprise Risk Management, *IRMI Online* (online) (cited 22 May 2010). Available from http://www.irmi.com/expert/articles/2001/shah07.aspx

The Ministry of Education and Research (2007) Statsbudsjettet for 2008 kap. 271 - Tildelingsbrev for Universitetet for miljø og biovitenskap.

The Norwegian Government Agency for Financial Management (2005) *Risikostyring i staten: Håndtering av risiko i mål- og resultatstyringen.* Available from http://www.sfso.no/upload/forvaltning_og_analyse/risikostyring/Metodedokument%20nettversjon_jan08.pdf

The Norwegian University of Life Sciences (2006) *Strategic plan 2005-2008*. Available from http://www.umb.no/download.php?filnavn=strategiskplan05-08.pdf

Office of Auditor General (2007) Riksrevisjonens rapport om den årlige revisjon og kontroll for budsjettåret 2006. Available from http://www.stortinget.no/Global/pdf/Dokumentserien/2007-2008/Dok_1_2007_2008.pdf

Office of Government Commerce (2009) *Managing Successful Projects with PRINCE2* (Fifth edition), London, TSO.

Project Management Institute (2008) *A guide to the Project Management Body of Knowledge: PMBOK guide* (fourth edition), USA, Project Management Institute.

Project Management Institute (2009) *Practice standard for project risk management*, USA, Project Management Institute.

Rapoport, R. N. (1970) 'Three dilemmas of action research', *Human Relations*, 23, 499-513.

Reason, J. (2000) 'Human error: models and management', *BMJ,* 320, 768-770.

Reason, P. and Torbert, W. (2001) 'The action turn: Toward a transformational social Science', Concepts and Transformation, 6(1), 1-37.

The Research Council of Norway (2007) *Report on Science & Technology Indicators for Norway*. English version available from http://www.forskningsradet.no/servlet/Satellite?blobcol=urldata&blobheader=application%2Fpdf&blobheadername1=Content-Disposition%3A&blobheadervalue1=+attachment%3B+filename%3DIndikatorrapportEngelsk2007.pdf&blobkey=id&blobtable=MungoBlobs&blobwhere=1224693986225&ssbinary=true

Riel, M. (2007) Understanding Action Research, Center For Collaborative Action Research. Pepperdine Univerity, (online) (cited 30 January 2010). Available from http://cadres.pepperdine.edu/ccar/define.html

Roberts, A. and MacLennan, A. (2003) *Making Strategies Work* (Release MW-A2-engb 1/2005 (1028)), Great Britain, Pearson Education.

Roberts, A., Wallace, W. and O'Farrell, P. (2003a) *Introduction to Business Research 1* (Release IR-A3-engb 1/2006 (1017)), Great Britain, Pearson Education.

Roberts, A., Wallace, W. and Pfab, F. A. (2003b) *Introduction to Business Research 3* (Release LS-A3-engb 1/2006 (1025)), Great Britain, Pearson Education.

Roberts, A., Wallace, W. and Mclure, N. (2003c) *Strategic Risk Management* (Release RK-A2-engb 1/2005 (1024)), Great Britain, Pearson Education.

Samad-Khan, A., (2005) 'Why Coso is flawed?' *Operational Risk*, 6(1), 24-28.

Scott, A. (2003) *Strategic Planning* (Release SP-A3 1/2007), Great Britain, Pearson Education.

Shah, S. (2002) 'Measuring and Managing Operational Risks', *IRMI Online* (online) (cited 22 May 2010). Available from http://www.irmi.com/Expert/Articles/2002/Shah04.aspx

Shah, S. (2003) 'Measuring Operational Risk Using Fuzzy Logic Modeling', *IRMI Online* (online) (cited 22 May 2010). Available from http://www.irmi.com/Expert/Articles/2003/Shah09.aspx

Sharpe, W. F. (1964), 'Capital Asset Prices: A Theory of Market Equilibrium under Conditions of Risk', *Journal of Finance*, 19(3), 425-442.

Stake, R.E. (2005) 'Quantative case studies' in Denzin N. K. and Lincoln Y. S. (eds.), *The Sage handbook of qualitative research* (3rd edn.) (pp. 443-466). Thousand Oaks, Sage.

Susman, G. I. and Evered, R. D. (1978) 'An Assessment of the Scientific Merits of Action Research', *Administrative Science Quarterly*, 23(4), 582-603.

Terramar (2006) *Terramar's strategic direction 2007-2010*. Document in Norwegian published on Terramar's Intranet.

Terramar (2009) *Terramar's strategy for the period 2009-2015*. Document in Norwegian published on Terramar's Intranet.

Terramar (2010a) Prosjektmandat for Integrert usikkerhetsstyring i Terramar (Project charter for Integrated risk management in Terramar). Document in Norwegian published on Terramar's Intranet.

Terramar (2010b) Prosjektplan for Integrert usikkerhetsstyring i Terramar (Project managment plan for Integrated risk management in Terramar). Document in Norwegian published on Terramar's Intranet.

UMB (2008a) *The Annual Report on the Quality of Education 2007*. Available from http://www.umb.no/statisk/studietilbud/studiekvalitet/arsrapport07.pdf (report is in Norwegian, but summary is also translated to English).

UMB (2008b) Unpublished letter: US-SAK NR: 177/2008 Årsplan 2009 – 1. gangs behandling.

Vaagaasar, A. L. (2006) From Tool to Actor: How a project came to orchestrate its own life and that of others, PhD thesis at BI Norwegian School of Management.

Wadsworth, Y. (1998) 'What is Participatory Action Research?' *Action Research International,* Paper 2 (online) (cited 24 May 2010). Available from http://www.scu.edu.au/schools/gcm/ar/ari/p-ywadsworth98.html

Ward, S. and Chapman, C. (2003) 'Transforming project risk management into project uncertainty management', *International Journal of Project Management,* 21, 97–105.

Whitehead, J. (2009) 'Justifying the use of a living theory methodology in the creation of your living educational theory. Responding to Cresswell', (online) (cited 23. May 2010). Available from
http://www.actionresearch.net/writings/arsup/Cresswellqualitativemethods.pdf

Williams, T. M., Ackermann, F. and Eden, C. (1997) *Project risk: systemicity, cause mapping and a scenario approach*. In: Kahkonen K and Artto KA (eds). Managing Risks in Projects. E&FN Spon, London, 343–352.

Williams, T., Ackermann, F. and Eden, C. (2003) 'Structuring a delay and disruption claim: An application of cause-mapping and system dynamics', *European Journal of Operational Research,* 148, 192–204.

Williams, T.M. (2004) Why Monte-Carlo simulations of project networks can mislead. *Project Management Journal* 35(3), 53-61.

Yin, R. K. (2003,) *Case study research: design and methods*, 3rd edition, Thousand Oaks, California, Sage Publication.

Appendix A: Organisation of the causal maps for the University of Life Sciences

For UMB the data (statements/concepts/nodes) were organised in the following manner:

- Sector aims, university objectives and result objectives were placed on the top of the map (the sector aims were written with the font Black, Arial, Bold and Size 12, the university objectives were written with the font Navy, Arial, Regular and Size 12, and the result objectives were written in the font Black, Arial, Regular, Size 12).
- Environmental threats and opportunities were placed at the bottom left of the map (with the font Purple, Arial, Regular and Size 12).
- Internal strengths and weaknesses were placed at the bottom right of the map (with the font Olive, Arial, Regular and Size 12).
- Critical success factors were placed in the middle of the map (with the font Green, Arial, Regular and Size 12 and with border Rounded Rect and back color white).
- Risks were placed in the middle of the maps and renamed to issues [the risks often needed to be split in more than one statement to be coded according to Ackermann et al. (1992)]. The issues were written in the font Navy, Arial, Regular and Size 12 and with border Rounded Rect and back color yellow).
- Proposed actions were placed in the middle of the map (with the font Navy, Arial, Regular and Size 12 and with border Rounded Rectangles and back color white).
- Different views (maps) were established for the four sector aims stated by the Ministry of Education and Research.

Appendix B: Organisation of the causal maps for Terramar

For Terramar the data (statements/concepts/nodes) were organised in the following manner:

- Terramar objectives were placed at the top of the map (were written with the font Black, Arial, Bold and Size 12)
- There was one Terramar telecommunication objective developed for each of the vertical functions used in the RIF-model described in Roberts et a. (2003, c, Chapter 8). The Terramar telecommunication objectives were linked placed on the top of the map (written with the font Navy, Arial, Regular and Size 12).
- Environmental threats and opportunities were placed at the bottom left of the map (with the font Purple, Arial, Regular and Size 12).
- Internal strengths and weaknesses were placed at the bottom right of the map (with the font Olive, Arial, Regular and Size 12).
- Issues were placed in the middle of the map written with the font Navy, Arial, Regular and Size 12 and with border Rounded Rect and back color yellow).
- Proposed actions were placed in the middle of the map (with the font Navy, Arial, Regular and Size 12 and with border Rounded Rectangles and back color white).
- Different views (maps) were established for the vertical functions: process, support, people, finance and interface.

Appendix C: Manuscript Monte Carlo simulations for Terramar

ID	Function	Links (output)	Output node	Commentary
1 Process (Telecom)	INPUTSUM()	None	None	Process (Telecom) is a result of node 6
2 Support (Telecom)	INPUTSUM()	None	None	Support (Telecom) equals node 26
3 People (Telecom)	INPUTSUM()	None	None	People (Telecom) equals node 37
4 Finance (Telecom)	INPUTSUM()	None	None	Finance (Telecom) equals 7/KR
5 Interface (Telecom)	INPUTSUM()	None	None	Interface (Telecom) equals 23
6 to ensure that our assignments are executed with the proper balance between governance, management, business understanding and content understanding	INPUTSUM()			Input weight: 20 % from 28 and 80 % from 30
6		1:1	1	
6		Weight 0.4	47	Most important input for 47
7 to have NOK 1 300' in profit (2009)	INPUTSUM()			Normal input from 8 9 11
7		Formula (Node 7 – 1 300 000)/2	4	Scale Result -1 300’ = -1 1 300’ = 0 3 900’ = 1
8 Income of NOK 5,2 000' from Telenor (2009)	INPUTSUM()			Normal input from 10, 12
8		1:1	7	
9 expenses of NOK 4,4 000' related to Telecom (2009)	INPUTSUM()			Normal input from 21, 22
9		Node 9 * (-1)	7	
10 Income related to Telenor core business	INPUTPROD()			Normal input from 14, 15
10		1:1	8	
11 Income of NOK 500' from unstrategic Telecom customers	INPUTSUM()			Normal input 13
11		1:1	7	
12 Income related to Telenor but not core	INPUTPROD()			Normal input from 16, 17
12		1:1	8	
13 Income related to unstrategic Telecom customers	INPUTPROD()			Normal input from 18, 19
13		1:1	11	
14 Consultancy price for 'Telenor core' business services	Node 136 – Node 24			Normal input 136, 24
14		1:1	10	
15 Terramar hours sold as 'Telenor core' business services	MAX(MIN(Node 130; Node 133); Node 168)			Normal input 130, 133, 168
15		1:1	10	
15		1:1	23	
15		1:1	35	
16 consultancy price for	INPUTSUM()			Normal input 136

ID	Function	Links (output)	Output node	Commentary
'Telenor uncore' services				
16		1:1	12	
17 hours sold as 'Telenor uncore' services	MAX(MIN(Node 137; Node 138); Node 170)			Normal input 137, 138, 170
17		1:1	12	
17		1:1	35	
17		Node 17 * (-1)	131	
18 consultancy price for unstrategic customers	INPUTSUM()			Normal input 136
18		1:1	13	
19 hours sold to unstratetegic Telecom customers	MAX(MIN(Node 141; Node 142); Node 169)			Normal Input 141, 142, 169
19		1:1	35	
19		1:1	13	
19		Node 19 * (-1)	131	
20 hours spent related to telecom, but without income	INPUTSUM()			Normal input Node 53, Node 92, Node 143
20		1:1	35	
21 Variable costs related to telecom	INPUTSUM()			Normal input Node 29*500.000,- Node 71* 25.000,- Node 75 Node 102 Node 110
21		1:1	9	
22 fixed costs related to telecom	INPUTSUM()			Normal input Node 101
22		1:1	9	
23 to win 3600 Terramar hours of consultancy assignments in core business at Telenor (in 2009)	INPUTSUM()			Normal input Node 15
23		Formula (Node 23 – 3600)/3600	5	Scale Result 0 = -1 5400 = 0 10 800 = 1
24 Reduce consultancy price for 'Telenor core' business services	Action node			Used for scenarios: Reduce node in NOK
24		Node 24 * (-1)	14	
24		Uniform (0; Node 24 / 1000)	134	Uncertain outcome of action on Node 134 Reason for mean value: 100 NOK discount results in 5 % better hit ratio (success)
25				Has been deleted
26 to have proper support services for consultants	INPUTSUM()			Weighted priority of 27 (0,1) 28 (0,4) 31 (0,1) 46 (0,4)
26		1:1	2	
27 proper legal support	INPUTMIN()			Normal Input 113, 114
27		Node 27*0.1	26	Weighted priority on link (see also node 26)
28 proper governance	INPUTMIN()			Normal Input

ID	Function	Links (output)	Output node	Commentary
support (company template etc)				117, 118
28		Node 27*0.4	26	Weighted priority on link (see also node 26)
28		Node 28*0,2	6	Weighted priority, see node 6
29 create policies for knowledge transfer between employees	Action Node			Used for scenarios Not used value = 0 Alt 1 (0.1): Alt 2 (0.2):
29		UNIFORM(0; Node 29)	126	Uncertain outcome on 126
29		UNIFORM(0; Node 29)	127	Uncertain outcome on 127
30 to have the correct mix of knowledge and competence available to be used in projects and assignments	INPUTSUM()			Weighted priority of 38 (0,2) 39 (0,2) 40 (0,2) 41 (0,3) 150 (0,1)
30		Node 30*0,8	6	Weighted priority, see node 6
30		Node 30 * 0.5	37	Weighted priority, see node 37
30		Node 30 * 0.5	111	Weighted priority, see node 111
31 proper administrative support	INPUTMIN()			Normal Input 115, 116
31		Node 31*0.1	26	Weighted priority on link (see also node 26)
32 costs pr hour for proper support services	INPUTSUM()			Normal Input 147
32		1:1	34	
33 labour costs pr hour (average salaries of consultants)	INPUTPROD()			Node152 *(1 + Node 78)
33		1:1	34	
33		1:1	153	
34 cost pr hour	INPUTSUM()			Normal Input 32, 33
34		1:1	102	
35 hours used related to telecom	INPUTSUM()			Normal Input 15, 17, 19, 20
35		1:1	102	
36 have cooperation agreements (or access to) the right pool of external human resources	Action node			Used for scenarios Not used value = 0 Alt 1 (0.1) Alt 2 (0.3)
36		UNIFORM(0; INPUT())	126	Uncertain outcome of action on Node 126
36		UNIFORM(0; INPUT())	127	Uncertain outcome of action on Node 127
37 to have the correct mix of internal human resources as employees	INPUTSUM()			Weighted input Node 30 *0.5 Node 112 * 0.5 Comment: Current situation gives weighted input. May change in the future.
37		1:1	3	
37		Node 37 * 0.1 * 14.400	143	See node 143
38 have available proper governance knowledge and competence to ensure successful	INPUTMIN()			Normal input 121, 122

ID	Function	Links (output)	Output node	Commentary
execution of consultancy asignments/ projects				
38		Node 38 * 0.2	30	See Node 30
39 have available proper management knowledge and competence to ensure successful execution of consultancy assignments/ projects	INPUTMIN()			Normal input 125, 128
39		Node 39 * 0.2	30	See Node 30
40 have available proper business knowledge and competence to ensure successful execution of consultancy assignments/ projects	INPUTMIN()			Normal input 123, 126
40		Node 40 * 0.2	30	See Node 30
41 have available proper IT and telecom content knowledge and competence to ensure successful execution of consultancy assignments/ projects	INPUTMIN()			Normal input 124, 127
41		Node 41 * 0.3	30	See Node 30
42				Deleted
43				Deleted
44				Deleted
45				Deleted
46 proper bid support	INPUTMIN()			Normal Input 119, 120
46		Node 46 * 0.2	111	See Node 111
46		Node 46 * 0.4	26	See node 26
47 relevant references and know-how from previous assignments	INPUTSUM()			Weighted Input 6 (0.7) 129(0.3) Argument: Newest successful completed assignments considered most important for references
47		Node 47 * 0.3	111	See node 111
48 number of bids for 'Telenor core' business services	INPUTSUM()			Normal Input 54
48		1:1	130	
49 numbers of bids to unstrategic telecom customers	INPUTSUM()			Normal input 96.
49		1:1	141	
50 number of bids to 'Telenor uncore' services	Inputsum()			Focus on Telenor core customers reduces number of bids to Telenor uncore (0.3 * Node 57) + Node 96
50		1:1	137	
51				Deleted
52 hours used by telecom resources related to other business segments	Inputsum()			Strategic prioritizing of telecom resources will reduce the use of telecom resources for other

ID	Function	Links (output)	Output node	Commentary
				segments
52		Node 52 * (-1)	131	
53 keep telecom people at office to be used on strategic assignments ... sell consultants when possible	Action node			8 * 1800 available hours Used for scenarios Not used value = 1 Alt 1 (0.75): Alt 2 (0.5): Alt 3 (0):
53		PRODUCT (14400;DIFFERENCE(1; INPUT());UNIFORM(0.5; 1.5))	20	If 100 % strategic priority of resources, then expected 720 hours wasted.
53		1:1	161	
53		1:1	164	
53		1:1	166	
54 potential assignments in pipeline (number of prospects)	INPUTSUM()			Input Node 57 * 0.7 Node 56
54		1:1	48	
55 get and keep in touch with key people in Telenor	INPUTSUM()			
55		1:1	56	
56 receive bids through strenghtening the prospect dialog with Telenor (outside frameagreement)	INPUTSUM()			Input from Node 55
56		1:1	54	
57 receive bids from Telenor through frame agreement	Input node()			Uniform (5; 25)
57		Node 57*0.3	50	
57		Node 57 * 0.7	54	Number of frame agreement bids to core (link works as factor)
58 ETOP - Telecom				Analysis node (not included in RIF)
59 Political factors				Analysis node (not included in RIF)
60 Economical factors				Analysis node (not included in RIF)
61 Social factors				Analysis node (not included in RIF)
62 Technological factors				Analysis node (not included in RIF)
63 Macro environment				Analysis node (not included in RIF)
64 Porter's five forces				Analysis node (not included in RIF)
65 increasing intensity of rivalry				Analysis node (not included in RIF)
66 Buyers power				Analysis node (not included in RIF)
67 Supplier power				Analysis node (not included in RIF)
68 threat of new entrants				Analysis node (not included in RIF)
69 threat of substitutes				Analysis node (not included in RIF)

ID	Function	Links (output)	Output node	Commentary
70 increasing buyer (telenor) power				Analysis node (not included in RIF)
71 arrange internal content (IT and telecom) training	Action node			Scale from 0 to 0.2
71		Node 71 *500.000	21	Increase knowledge by 10 %. Estimated cost 50.000
71		Node 71* TRIANG3[0,5 ; 1; 1,5]	127	Uncertain outcome on 127
72 Internal factors				Analysis node (not included in RIF)
73 have established contact with some key people at Telenor				Analysis node (not included in RIF)
74 have frameagreement with Telenor mobile				Analysis node (not included in RIF)
75 arrange seminar which is developed and directed towards Telenor	ACTIONNODE = QUOTIENT(PRODUCT(2; TRIANG3(0.5; 1; 1.5); SUM(1; 0)); 2)			[(Number of seminars per year:2) * (Received bid factor = Triang3 (0.5; 1; 1,5) * (quality factor = 0 if just standard seminar)]/2
75		Node 75*25.000,-	21	Each seminar estimated to cost Kr 25.000.
75		1:1	55	How many potential bids for each seminar?
76 use the frame agrement between Telenor and Terramar as a tool to keep in touch with key people	INPUTNODE () = 2			Choose number of prospects from marketing the frame agreement
76		Node 76* TRIANG3[0,5; 1; 1,5]	55	
77 employ "star" telecom consultants	Action node			Number of star telecom consultants employed. Not likely to be more than 2 per year (fill inn number of star telecom consultants employed, no action = 0)
77		Node 77* Uniform(0; 0,02)	78	See node 78 PRODUCT (UNIFORM(0; 0.02); INPUT())
77		Node 77* Uniform (0,05; 0,15)	126	PRODUCT(UNIFORM(0.05; 0.15); INPUT())
77		77* Uniform(0,05; 0,15)	127	PRODUCT(UNIFORM(0.05; 0.15); INPUT())
77		Node 77 * 0.5	129	
77		Node 77 * 1800	131	
77		Node 77 * 600.000	21	
77		Node 77 * 0,1 * 1800	143	90 % expected invoicing factor Product(1800;0,1;INPUT())
78 salaries of "star" consultants interpreted as a potential for increased salaries for existing employees	Inputsum()			
78		1:1	33	
79 relatively low salaries in Terramar compared to				Analysis node (not included in RIF)

ID	Function	Links (output)	Output node	Commentary
competence profile of the Terramar consultants				
80 high employee power for" star" consultants (due to that star consultans are attractive for employers)				Analysis node (not included in RIF)
81 Terramar has a good reference list related to project management and project governance for other markets				Analysis node (not included in RIF)
82 Terramar lacks references in telecom services	Inputnode()			Normal = -0.1
82		1:1	47	
83 recession in the Norwegian economy				Analysis node (not included in RIF)
84 Public stimuli to strenghten the Norwegian economy				Analysis node (not included in RIF)
85 pressure to improve public services				Analysis node (not included in RIF)
86 increased globalization				Analysis node (not included in RIF)
87 need for more mobile consultants	INPUTNODE()			Triang3 (0; 0.15; 0.3) Uncertain estimate
87		1:1	150	
88 many important customers in Oslo region (including Telenor) are expected to seek growth from foreign business				Analysis node (not included in RIF)
89 Terramar prioritize to serve project owners ... prioritize to serve project suppliers	Actionnode			Action node but does not have an significant effect in 2009 and the node is therefore treated as Input node Input = 0.25
89		Node 89 * 0.1	121	
89		Node 89 * 0.0	123	
89		Node 89 * -0.2	124	
89		Node 89 * 0.1	125	
90 priorize to improve content competence				Not included in Riscue
91				Deleted
92 spend more time on networking	Action Node			Normal input 0 Max input = 50 (93, 94, 95 not included in Riscue)
92		1:1	20	
92		Uniform(0; 0.06] * Node 92	55	
93 write articles				Not included in Riscue
94 develop and send marketing material to customers				Not included in Riscue
95 arrange meetings				Not included in Riscue
96 choose and focus on fewer business units as potential customers	Action Node			Focus degree. Scale: 0 to 1 Normal Input = 1
96		4 * Node 96	49	

ID	Function	Links (output)	Output node	Commentary
96		4 * Node 96	50	
97				Deleted
98 segment the telecom services and focus on the services relevant for relevant business units in Telenor				Not included in Riscue
99 establish a narrow but focused area of of content competence in IT and telecom				Not included in Riscue
100 have visible and significant implementation roles in a variety of telecom projects and processes				Not included in Riscue
101 costs for Key Account Manager	INPUTNODE()			600.000
101		1:1	22	
102 cost pr hour * hours used related to telecom	PRODUCTNODE()			Normal Input Node 34 * Node 35
102		1:1	21	
103 changes in the Terramar cost profile (due to telecom)	INPUTSUM			Normal Input Node 155
104 proper ICT support may improve efficency of consultants considerable				Not included in Riscue
105 reduced employee power for normal consultants				Not included in Riscue
106 expected reduction of assignments (total market)				Not included in Riscue
107 board and administration are commited to win market shares in the telecom consultancy market				Not included in Riscue
108 renumeration system favours consultants working on external assignments				Not included in Riscue
109 most of the current consultans that can be used in telecom assignments can also be used in other markets				Not included in Riscue
110 arrange internal telecom related "business" training	Actionnode			Not relevant for 2009 Might be relevant 2010 and 2011 Therefore only used as a dummy variable in Riscue For 2009: Node 110 = 0, but the link to Node 40 is not included in Riscue
111 high quality bids	INPUTSUM()			Weighted input: 47(0.3) 30(0.5) 46(0.2)
111		1:1	134	

ID	Function	Links (output)	Output node	Commentary
111		1:1	139	
111		1:1	156	
112 the ability to recruit and keep the correct employees	INPUTNODE():			We are not attractive enough for the correct people, but currently not loosing resources. However, this variable is uncertain Input = Uniform(- 0.25; 0.25)
112		1:1	37	
113 the need for legal support	INPUTNODE()			Need for legal support is low: Uniform(0; 0.2)
113		1:1	27	
114 the ability to deliver legal support	INPUTNODE()			Normal Input = 0.4
114		1:1	27	
115 the need for administrative support	INPUTNODE()			Need for admin support is low: Uniform[0; 0.2]
115		1:1	31	
116 the ability to deliver administrative support	INPUTNODE()			Normal Input = 0.5
		1:1	31	
117 the need for governance support (company templates etc)	INPUTNODE()			Need for governance support varies from low to high, dependent on assignment: Uniform(0; 1)
117		1:1	28	
118 the ability to deliver governance support (company templates etc)	INPUTNODE()			Varies: Uniform(-0.25; 0.75)
118		1:1	28	
119 the need for bid support	INPUTNODE()			Need for bid support is high: Uniform(0.3; 1)
119		1:1	45	
120 the ability to deliver bid support	INPUTNODE()			Uniform(-0.2; 0.8)
120		1:1	45	
121 the need for proper governance knowledge and competence in assignments	INPUTNODE =			Sum(Uniform(0; 1); INPUT())
121		1:1	38	
122 current ability to deliver appropriate governance knowledge and competence in assignments	INPUTNODE()			Uniform(0; 1)
122		1:1	38	
123 the need for proper telecom business knowledge and competence in assignments	INPUTNODE()			SUM(UNIFORM(0; 1); INPUT())
123		1:1	40	
124 the need for proper IT and telecom content knowledge and competence in assignment	INPUITNODE ()			SUM(UNIFORM(0; 1); INPUT())
124		1:1	41	

ID	Function	Links (output)	Output node	Commentary
125 the need for proper (project)management knowledge and competence in assignment	INPUITNODE ()			SUM(UNIFORM(0.2; 1); INPUT())
125		1:1	39	
126 current ability to deliver appropriate telecom business knowledge and competence in assignments	INPUTSUM()			Normal input Node 148, Node29, Node 3 Node 77
126		1:1	40	
127 current ability to deliver appropriate IT and telecom knowledge and competence in assignments	INPUTSUM()			Normal input Node 36, Node 71, Node 77, Node 29, Node 149
127		1:1	41	
128 current ability to deliver appropriate (project)management knowledge and competence in assignments				Uniform(0.4; 1)
128		1:1	39	
129 use previous references from star consultants as references	INPUTSUM()			Normal Input Node 77
129		1:1	47	
130 potentially hours won as assignments for 'Telenor core' business	INPUTPROD()			Normal input Node 48, Node 146, Node 134
130		1:1	15	
131 number of theoretical hours available for conducting 'Telenor core' services	14.400 – Node 19 – Node 17 – Node 52 + (1800 * Node 77)			
131		1:1	133	
132 available factor core (available at the right time)	INPUTNODE()			Uniform(0.5; 1)
132		1:1	133	
133 available internal resources to conduct 'Telenor core' services	INPUTPROD()			Normal input Node 131 Node 132
133		1:1	15	
134 percentage of successful bids for 'Telenor core'	INPUTSUM()			Normal input Node 24, Node 145, Node 111
134		1:1	130	
135				Deleted
136 Standard hour price	INPUTNODE()			Standard hour price = 1100
136		1:1	14	
136		1:1	18	
136		1:1	16	
137 potentially hours won as assignments for 'Telenor uncore' business	INPUTPROD()			Normal input Node 50, Node 157, Node 139
137		1:1	17	
138 available resources to	INPUTMIN()			

ID	Function	Links (output)	Output node	Commentary
conduct 'Telenor uncore' services				
138		1:1	17	
139 attractiveness of bids for 'Telenor uncore'	INPUTSUM()			Normal Input Node 111
139		MAX(INPUT(); 0)	137	
140 actual available resources for unstrategic telecom customers	INPUTSUM()			Normal Input Node 164
140		1:1	164	
141 potentially hours won as assignments for unstrategic customers	INPUTPROD()			Normal input Node 49, Node 156, Node 158
141		1:1	19	
142 available resources to conduct assignments for unstrategic telecom customers	INPUTMIN()			
142		1:1	19	
143 hours wasted	Node 143 = (1 - Node 144) * 14.400 – (Node 37 * 0.1 * 14.400)			
143		1:1	20	
144 Expected percentage of time invoicing by telecom consultants	Node 144 = 0.9			
144		PRODUCT(DIFFERENCE(1; INPUT()); 14400)	143	
145 expected percentage of bid success	INPUTNODE()			Node 145 = Uniform(0; 0.2)
145		1:1	134	
146 size of bids for 'Telenor core'	INPUTNODE()			Triang3 [500; 1150; 1800]
146		1:1	130	
147 extra internal cost pr hour pr consultant hour for support services	INPUTNODE()			Node 147 = 5 / 40 * 600
147		1:1	32	
148 input current ability to deliver approproate telecom business knowledge and competence in assignments	INPUTNODE()			Triang3(-0.4; -0.2; 0)
148		1:1	126	
149 input current ability to deliver approproate IT and telecom knowledge and competence in assignments	INPUTNODE()			Triang3(-1; -0.4; 0.2)
149		1:1	127	
150 have available mobile consultants to ensure successful execution of consultancy assignments / projects	INPUTMIN()			Node 87, Node 151
150		1:1	30	
151 current ability to deliver mobile consultants in assignments	INPUTNODE()			Triang3(0.2; 0.3; 0.4)

ID	Function	Links (output)	Output node	Commentary
151		1:1	150	
152 current labour cost pr hour (average salaries of consultants)	INPUTNODE()			Node 152 = 500
152		1:1	153	
152		1:1	33	
153 difference in cost pr hour due to changes in salaries				Node 153 = Node 33 – Node 152
153		1:1	155	
154 number of Terramar hours	INPUTNODE()			Node 154 = 1800 *40 = 72 000
154		1:1	155	
155 changes in cost pr hour * number of Terramar hours	INPUTPROD()			Node 153 Node 154
155		1:1	103	
156 attractiveness of bids for unstrategic customers	INPUTSUM()			Node 111
156		MAX(INPUT(); 0)	141	
157 size of bids Telenor uncore	INPUTNODE()			Triang3(500; 1150; 1800)
157		1:1	137	
158 size of bids unstrategic customers	INPUTNODE()			Triang3(500; 1150; 1800)
158		1:1	141	
159 exprected available resources for 'Telenor uncore'	INPUTNODE()			Triang3(3600; 5400; 7200)
159		1:1	162	
159		1:1	138	
160 expected available resources to other business segments	INPUTNODE()			Triang3(0; 3600; 7200)
160		1:1	165	
160		1:1	167	
161 available resources for Telenor uncore, included priority of startegic assignments	INPUTPROD()			Input Node 162 Node 53
161			138	
162 actual available resources for Telenor uncore	INPUTSUM()			Normal Input Node 159
162			161	
163 expected available resources for unstrategic telecom customers	INPUTNODE()			Triang3(0; 900; 1800)
163		1:1	140	
163		1:1	142	
164 available resources for unstrategic customers, included priority of startegic assignments	INPUTPROD()			Normal Input Node 140, Node 53
164		1:1	142	
165 actual available resources for other business segments	INPUTSUM()			Normal input Node 160
165		1:1	166	

ID	Function	Links (output)	Output node	Commentary
166 available resources for other business segments, included priority of startegic assignments	INPUTPROD()			Normal Input Node 165, Node 53
166		1:1	167	
167 available resources to conduct other business segments services	INPUTMIN()			Normal Input
167		1:1	52	
168 current assignments for Telenor core	Inputnode()			February 2009: Telenor Norge (Signed contract): 1400 hours Telenor Nordic (Signed contract): 400 hours: Total = 1800
168		1:1	15	
169 Current assignments to unstrategic Telecom customers	Inputnode()			February 2009: No signed contracts: =0
169		1:1	19	
170 current assignments for Telenor uncore services	Inputnode()			February 2009: Telenor eiendom (Signed contract) : 960 hours Expected new contract: 900 hours = Sum(960;BINARY(0.9; 0; 900))
170		1:1	17	