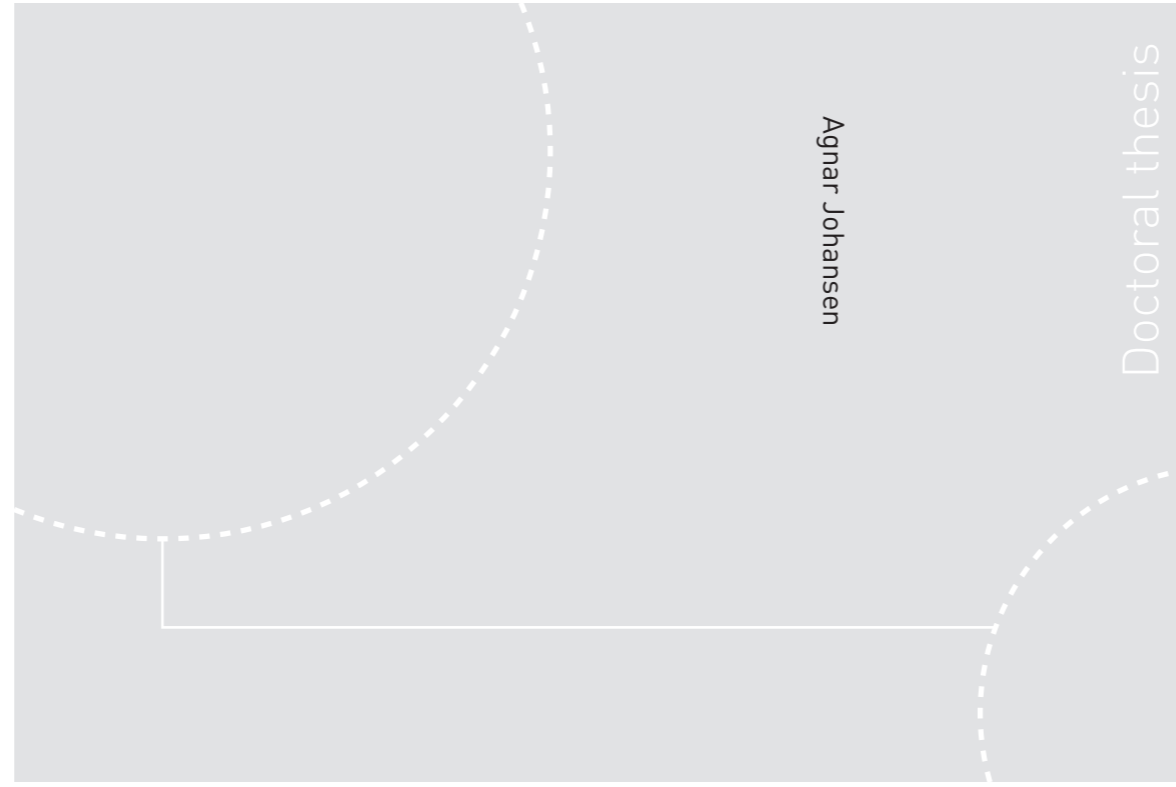


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Agnar Johansen

## Project Uncertainty Management: A New Approach – The ‘Lost Opportunities’

Practical uncertainty management seen from a project joint perspective

Agnar Johansen

# **Project Uncertainty Management: A New Approach – The ‘Lost Opportunities’**

Practical uncertainty management seen  
from a project joint perspective

Thesis for the Doctor Philosophiae Degree

Trondheim, June 2015

Norwegian University of Science and Technology  
Faculty of Engineering Science and Technology  
Department of Production and Quality Engineering



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## Preface

My starting point as a researcher was within the disciplines of production engineering and project management. I started my career as a junior researcher at SINTEF in 1995, and worked as project management consultant from 1999 to 2003. In the beginning, my research focused on standardization of project management practices and project start-up. Over the years, I have worked and published research on various project management topics, including as stakeholder analysis and management, cost estimation, time planning, public private partnership (PPP) contracts, uncertainty analysis, uncertainty management, and communication and learning in projects. My research on uncertainty analysis and on uncertainty management started in 2004, when I contributed to two research projects:

1. 'Uncertainty as a Learning Arena' (Usikkerhetsanalyser som læringsarena), a project initiated by the Norwegian Centre for Project Management (Norsk Senter for Prosjektledelse, NSP), in which we developed the first textbook on the Norwegian quality assurance system
2. 'Uncertainty analysis – Methodology' (Usikkerhetsanalyse – Metoder), a project associated with the Concept programme (Concept Report No. 12, co-authored by (Austeng, Midtbø, Jordanger, Magnussen, & Torp), in which I worked on a literature review of uncertainty management process and techniques.

At that time, I worked as a researcher manager for the Norwegian Centre for Project Management, and one of my responsibilities was for the annual research conference, at which new project ideas are discussed and developed. In the 2005 conference, two ideas were launched by our industry partners, and both had uncertainty as their focus area. It was decided that these ideas should be put together in one research proposal. In June 2006, the Norwegian Centre for Project Management together with the Research Council of Norway started a research and development project in cooperation with six companies and three academic partners. This project was titled 'Practical Uncertainty Management in a Project Owner Perspective' (Praktisk styring av usikkerhet i et eierperspektiv, abbreviated to PUS). I started as a senior researcher in the PUS project in 2006, and was appointed as the project manager in 2007. This position gave me the time and opportunity to work more or less full-time on the topic of uncertainty management, together with some of the Norway's leading companies, researchers, and consultants for a five-year period. The PUS project gave me the opportunity to focus my research on practical uncertainty management, and it shaped and formalized the direction of my research agenda. The PUS project also provided the practical cases as well as a community of practitioners and researchers that were interested in the same problem: How can we manage uncertainty in our projects in a practical way?

## **Acknowledgements**

I would like to thank the six companies, the Research Council of Norway, and the board of the Norwegian Centre for Project Management for their support and the courage shown when we proposed a four-and-a-half year research project on practical uncertainty management – the PUS project. I am deeply grateful for the support from the board and the contact persons from the seven companies that gave me access to their projects, managers, and the cases that have been important for the development of this thesis and for my understanding of the topic that I have been researching. In this regard, I sincerely thank the leader of the board Thor Inge Johansen (Statoil) and Mads Hembre (Statoil). I also thank Hilde Nordskogen, Jens Petter Lund, Asbjørn Hansen (Statsbygg and OPAK) and Ragnhild Aalstad (Statsbygg), Kittill Skogen (Telenor), Erik Guldhav and Erik Rønning (Norwegian Defence Logistics Organisation) Eirik Øvstedahl and Geir Enersen (Norwegian Public Roads Administration, NPRA), Runar Gravdal (Jernbaneverket, the Norwegian state railway administration), and Elisabeth Svendsen (Terramar) for their guidance and support during and after the PUS project.

I also wish to thank the Department of Production and Quality Engineering (NTNU) and SINTEF Technology and Society for support during 2012 and 2013, when most of the work for this thesis was carried out. Without their financial support, the thesis would not have been completed.

I sincerely thank all of my co-authors: Researcher Anandasivakumar Ekambaram (SINTEF), Researcher Andreas Økland (SINTEF), Associate Professor Olav Torp (NTNU), Researcher Linda Hald (SINTEF), Bettina Sandvin (Norwegian Public Roads Administration), Hans Petter Krane (NTNU and Rambøll), Petter Eik Andresen (Norwegian Defence Logistics Organisation), Researcher Siri Bøe Halvorsen (SINTEF), Researcher Trygve Steiro (NTNU and Safetec), Amin Haddadi (NTNU and Multiconsult), Senior Researcher Jan Alexander Langlo (SINTEF), Ragnhild Aalstad (Statsbygg), Researcher Ole Jermstad (SINTEF and Reinertsen), and Professor Asbjørn Rolstadås and Professor Nils Olsson (Department of Production and Quality Engineering, NTNU). All have all contributed to my research, and our discussions have made my research for this thesis more interesting and fun, and the results more interesting and more valid.

There are many colleagues that have given me comments and feedback on research ideas, early versions of papers, and early versions of this thesis, and I would like to mention five colleagues in particular: Researcher Anandasivakumar Ekambaram (SINTEF), Professor Bjørn Andersen (Department of Production and Quality Engineering, NTNU), Professor Nils Olsson (Department of Production and Quality Engineering, NTNU), Senior Researcher Jan Alexander Langlo (SINTEF), and Professor Asbjørn Rolstadås (Department of Production and Quality Engineering, NTNU). Without their support and feedback on the later versions of the thesis and their inspiring comments during the final phase of my work, this thesis would never have been accomplished. I am most grateful for all the time they invested.

I sincerely thank Professor Bjørn Andersen, who was my lineleader at SINTEF when I started working on this thesis. Without his support and willingness to let me focus on this work, the journey would never been started.

I have learned that I work in a rather unique place with colleagues that always will do their best to support a fellow colleague. I will endeavour to live up to the standards that they have set and

hopefully instil them in some of my other colleagues and future master's students and doctoral students.

Last, but not least, I thank my parents and family who taught me that with hard work anything is possible, and my wife Anne and my daughter Dina who have supported me in a busy period of our lives and let me 'play with research' for so many years.

Trondheim, February 2015

Agnar Johansen

## **Abstract**

The thesis examines uncertainty management in a single-project environment. In addition to the main chapters, Appendix I contains the published papers that this thesis is built upon, Appendix II contains the bibliography from the project 'Practical Uncertainty Management in a Norwegian Project Owner's Perspective' ('The PUS project'), and Appendix III lists the references.

In the early 2000s, uncertainty analysis became more or less mandatory for large projects in Norway. However, there was no clear evidence that the companies and projects subsequently used the results of the analyses when managing uncertainty. A lot of projects experienced that although they had done an uncertainty analysis they could not use the results in their uncertainty management process. Some of the relevant questions worth addressing are: Who should be involved in the uncertainty management process? What type of uncertainty or risks should be addressed in the process? Who should be responsible for following up the uncertainty on more strategic and tactical levels? Who 'owns' the process and who should be responsible for managing it? What types of practical tools are needed and how should the uncertainty management process be organized?

Projects have traditionally strived towards predictability and to keep all critical factors under control. However, for large and complex projects, such predictability does not exist in reality.

In the past, a project was about delivering a unique task, whereas today many projects are regarded as 'change agents' and they therefore have purpose: they should deliver the *objectives* and give *maximum benefit* for the *project owners*. This view creates new demands regarding how projects should be planned and executed.

In classical project management theories, project managers were supposed to 'stick to the plan', and deliver their projects according to specifications and within the cost and time frame established at the beginning of the project. However, in a shifting and changing environment with a lot of foreseen and unforeseen uncertainties, sticking to the plan is no longer an option for many projects. Instead, they need to *manage* uncertainty.

### **Most important findings and contributions to research presented in this thesis**

The empirical data in this thesis demonstrate that many projects still do not deal with threats and opportunities in a balanced way. The data from studies show more or less the same pattern – there are many more threats than opportunities in uncertainty registers. Also, opportunities that were identified in the execution phase were few and often not exploited at all. The case studies show that the private sector and public sector projects had more or less the same focus on threats. In addition, private projects were not better at exploiting opportunities than public projects. All of the studied projects seemed to be quite conservative about new ideas and change, and were not seeking new opportunities in their execution phase. Some opportunities were identified late in the project during uncertainty analysis workshops, yet the identification of new opportunities does not mean that projects will utilize such opportunities after the workshops are finished.

The empirical data show that managing risk is hard and exploiting opportunities is even more difficult, and is a different task than dealing with threats. The empirical data also show that exploiting opportunities often requires the project owner and the project management team to accept changes and have both the will and the power to change the solutions or deliverables described in the plans and in project management documentation. It is often a difficult task to motivate people to change;

an opportunity must be deemed significantly better than the planned solutions if it is to be considered worth taking, since implementing an opportunity means that the project must use money and time to change plans or, in the worst case, the whole concept.

In addition, the data show that many projects do not want to consider new opportunities. They may consider the list of opportunities that comes up in an uncertainty analysis as a gamble, because it means that they will need to change the process or concept, and it may be a gamble that the project management team will not be paid for or will not derive any benefit from. It is not possible to get an opportunity into a project without the project management team's willingness to change the existing plans. This means getting an opportunity into the project demands willingness and authority from the project sponsor and project management, since both must disregard something that they earlier in the process had agreed upon as the best solutions. This suggests that an opportunity has to be extremely interesting to be considered, because

- The project must be willing to change contracts, concepts, and plans to exploit a possible opportunity
- The project must abandon something it had earlier accepted as the best solution
- The project must use time and money on exploiting something that is uncertain – it cannot be certain that the effect will be positive or give benefits.

The six most important contributions in this thesis can be summarized as follows

1. The project uncertainty management maturity has increased as a result of the focused improvement efforts in Norway
2. The context matters and the focus of the analyses will differ if the project owners participate in the process
3. A new and improved uncertainty management process has been developed
4. A new tool for uncertainty management has been developed
5. Five characteristics of uncertainty and four characteristics of opportunities have been developed
6. Four characteristics of opportunities in projects have been developed

Research on organizations and projects has shifted from developing tools and techniques to focusing more on understanding human behaviour. This means that project management scholars acknowledge that both the context and the humans involved matter, and that there is a need to understand the organizational culture and the process in use in order to develop and change organizations.

If a company wants to develop skills in uncertainty management, it needs to understand its employees' behaviour, the culture in the company, the project owners' role, and how stakeholders interact with the uncertainty management process. If projects are to be efficient in dealing with uncertainty, they need to understand, interpret, and handle uncertainty both within and outside the project. Project manager must understand their circumstances and the impact of the efforts that they have initiated. If there is no focus on learning and knowledge creation as projects progress, then the process of managing uncertainty will not be efficient. This implies that the mother-organization, which is responsible for training and developing new methods, needs a strong focus on learning and knowledge sharing so that the new methods, tools, and techniques will be applied in 'all' projects.



Since 2005, a joint Norwegian effort on uncertainty management comprising the PUS project and several projects in the Concept research programme has clearly improved the level of maturity regarding uncertainty management in many companies in Norway. However, this is still no guarantee of success in all projects. Fewer cost overruns come at a price – there is a tendency to spend more money on each project, which means Norway gets fewer roads, railways, schools, and oil plants for the same money today as in the mid-2000s.

A high level of maturity regarding uncertainty management does not necessarily mean that all projects are efficient in their planning and execution. It is not known whether projects in Norway have become better at estimating uncertainty in time and cost, whether the estimates are more realistic now than in year 2000, whether the project managers and owners simply have been better at adding contingencies to their budgets, whether the contingencies or time buffers have been raised, or whether project managers and owners has been better at managing the uncertainty that exists in our changing world.

## **Sammendrag**

Denne avhandlingen fokuserer på styring av usikkerhet i enkeltprosjekter, og består av 9 kapitler og tre vedlegg.

Vedlegg I inneholder de 15 vitenskapelig paperene (alle publisert) som avhandlingen bygger på, vedlegg II inneholder en oversikt over artikler, bøker og rapportere som ble utviklet i forskningsprosjektet "Praktisk styring av usikkerhet i et eierperspektiv", vedlegg III oversikt over referanser.

Tidlig på 2000-tallet ble bruk av usikkerhetsanalyser mer eller mindre obligatorisk for store prosjekter i Norge. Men det var få spor av at firmaer og organisasjoner som benyttet seg av analysemetodikken brukte resultatene fra usikkerhetsanalysene aktivt i styring av usikkerhet i selve prosjektet. Mange prosjekter gjennomførte usikkerhetsanalyse og oppdaget at analysen var lite tilpasset den praktiske styringen av usikkerheten som det enkelte prosjektet måtte håndtere. Det var uklart hvem som burde være involvert i analyseprosessen og hvordan deltagelsen påvirket resultatet fra analysene. Det var uklart hvilke typer av usikkerhet som usikkerhetsanalysene burde vektlegge i de ulike fasene av prosjektet. Det var uklart hvilken del av usikkerhetsbildet som burde håndteres og styres av oppdragsgiver/eier (taktisk og strategisk usikkerhet) og hvilken del av usikkerhetsbildet som burde håndteres og styres av de ulike aktørene i prosjektet (operasjonell usikkerhet). Hvem 'eier' utviklingen av usikkerhetsstyringsprosessen? Hva slags praktiske verktøy og teknikker trenger man egentlig for å styre usikkerhet i prosjekter? Og hvordan bør usikkerhetsstyringsprosessen organiseres for å kunne håndtere stadig skiftende krav fra omgivelsene og prosjektets interessenter?

Prosjekter er designet for å levere endring for en oppdragsgiver/eier og er av natur usikre når de startes opp. For å kunne håndtere usikkerheten har prosjektfaget fra begynnelsen av jobbet med å utvikle metoder og systematikk som gjør prosjektledelsen i stand til å håndtere prosjektets kritiske faktorer. Men for store og komplekse prosjekter er forutsigbarhet nærmest en illusjon.

Tidligere var et prosjekt noe som leverte en unik leveranse, mens det i dag sees på som et middel for å skape endring som leverer maksimal nytte og effekt for oppdragsgiver og prosjekteierne. Denne måten å betrakte prosjekter på skaper nye krav til hvordan prosjekter skal ledes og styres, og det utløser et behov for vurdering av det eksisterende teorigrunnet i prosjektledelsesfaget.

I den tidlige prosjektledelsesteorien ble det sagt at prosjekter skulle holde seg til planene og levere det som ble bestilt i henhold til de tids- og kostnadsrammer som ble avtalt ved starten av prosjektet. Men når prosjektet strekker seg over flere år vil prosjektets interessenter og eier stadig utvikle ny forståelse for hva som skal leveres og det vil dermed kunne være uklart hva som egentlig bør være prosjektets leveranser. Prosjektledelsen opplever at usikkerhetsbildet (strategisk, taktisk og operasjonell) skifter, stiger og synker over hele prosjektforløpet, og det vil derfor i mange prosjekt være umulig å identifisere all usikkerheten i begynnelsene av prosjektet. Prosjektets eier og prosjektledelsen må håndtere og styre usikkerhet gjennom prosjektforløpet.

### **Oppsummering av avhandlingens viktigste funn og forskningsbidrag**

De empiriske dataene fra gjennomgang av 6 bedrifters systematikk og håndtering av usikkerhet i prosjekt indikerer at usikkerhetsstyring i mange prosjekter har langt større fokus på de negative aspektene (truslene eller risikoene) enn den positive delen av usikkerheten (mulighetene).

Mønsteret som ble avdekket i casestudiene viste at uavhengig av om man ser på prosjekter ledet av en privat eller offentlig aktør er det er langt flere trusler eller risikoer i usikkerhets-/riskregisteret enn det er muligheter. Videre viste gjennomgangen at de fleste prosjektene kun var opptatt av muligheter i planfasen, mens muligheter som ble identifisert på et sent stadiet i prosjektet (i gjennomføringsfasen) som regel ikke utforsket eller tatt.

Antagelsen om at private prosjektaktører vil ha større fokus på muligheter enn offentlige aktører ble i stor grad avkreftet. Resultatet fra to større casestudier viste at de offentlige og private hadde tilnærmet samme fokus på trusler/risiko, og at den private aktøren ikke var bedre enn den offentlige til å identifisere og håndtere muligheter som kom opp i løpet av prosjektforløpet.

Alle prosjektene som ble analysert i casestudiene vurderes å være relativt konservative i sin holdning til endringer og de fleste av dem jobbet ikke med å finne eller utforske muligheter i gjennomføringsfasen. Det ble i flere av de undersøkte prosjektene identifisert muligheter i gjennomføringsfasen vha. av usikkerhetsseminar (gjennomført i gjennomføringsfasen). Men det at de ble identifisert og nye muligheter avdekket var ikke ensbetydende med at prosjektet i etterkant av seminaret satt i gang arbeid med å utnytte disse mulighetene.

De empiriske dataene viser at styring av trusler eller risiko ofte er svært vanskelig, og at aktiv utnyttelse av muligheter ofte enda vanskeligere. Det vil derfor ofte kreve en annen tilnærming enn det som i dag praktiseres i de fleste norske prosjekt dersom eier ønsker at muligheter aktivt skal håndteres som en del av usikkerhetsstyringen som prosjektledelsen er satt til å håndtere.

Prosjekteier og prosjektledelsen må være villige til å akseptere endringer i planer og leveranser dersom muligheter skal utnyttes, og begge må ha vilje og evne til å håndtere endring av planer, løsninger og leveranser. Det er ofte en krevende øvelse å motivere prosjektledelsen til gjøre større endringer i et prosjekt i gjennomføringsfase, og motstand mot endring øker normalt etter hvert som prosjektet nærmer seg overlevering. En identifisert endring i gjennomføringsfasen må være langt bedre enn det som allerede er planlagt for at prosjektledelsen i det hele tatt skal vurdere den som interessant å gjennomføre, siden det betyr at man må bruke tid og penger på forandre det som alt anses som godkjent, og i verste fall må man reversere løsninger og forandre på deler eller hele prosjektleveransen.

De empiriske dataene viser at "nye" muligheter i liten grad er ønskelig eller interessante når man er kommet over i gjennomføringsfasen. Det å holde seg til planene vurderes av mange prosjektledere som den beste og mest fornuftig strategien. En mulighet som kommer opp på et sent stadium i prosjektforløpet blir ofte vurdert som svært usikker og en "gamble" i forhold til om den vil gi positiv nytte for prosjektet og for eier/oppdragsgiver. Og vurderes nytten som positiv for eier kan prosjektledelsen allikevel velge å avstå fra å ta muligheten fordi endring kan gi økte kostnader og mindre mulighet til å levere på avtalt tid. For å få inn en mulighet som representerer en endring av prosjektets planer og leveranser må prosjektledelsen ha fullmakter fra eier/oppdragsgiver og begge må være enige i at muligheten representerer en større nytte enn det som alt er avtalt og i noen tilfeller også levert. Noe som igjen antyder at en mulighet, hvis den kommer opp i gjennomføringsfasen, må være svært interessant eller ha høy nytte for at den i det hele tatt skal bli vurdert, fordi det vil bety at:

- Prosjektledelsen må være villig til å forandre planer og inngåtte kontrakter for å utnytte en mulighet
- Prosjektledelsen må forlate noe som de har investert tid og penger i å utvikle.
- Prosjektledelse må investere ressurser for å bekrefte eller avkrefte mulighetens potensial, og er de i det minste tvil om nytten vil de forholde seg til det som allerede er planlagt.

Denne avhandlingens seks viktigste bidrag vurderes å være:

1. Det er påvist at de seks deltagerbedriftene som deltok i PUS-prosjektet har økt sin kompetanse og modenhet i forhold til styring og håndtering av usikkerhet i prosjekt.
2. Prosjektets strategiske og taktiske omgivelser påvirker prosjektet, og hvem som deltar i identifisering og styring av usikkerhetene i de ulike fasene er avgjørende for hvilket fokus usikkerhetsstyringen får.
3. Det er utviklet og testet en ny 9 stegs modell for håndtering av usikkerhet over prosjektforløpet.
4. Det er utviklet og testet ulike praktiske verktøyer for styring av usikkerhet.
5. Fem karakteristika ved prosjekters forståelse og håndtering av usikkerhet er foreslått.
6. Fire karakteristika for hvordan prosjekter forstår og håndterer muligheter er foreslått.

Det er mye som tyder på at forskning på organisasjoner og prosjekter har skiftet fokus, fra tidligere å være mest fokusert på verktøy og metoder, til å bli mer fokusert på de ulike ledelsesprosessene og den menneskelige adferd i samspillet mellom aktørene i og rundt prosjektet. Dagens forskere innen prosjektledelsesfaget anerkjenner at metoder og verktøy har en naturlig plass i dette samspillet. De fleste anerkjenner også at to prosjekter ikke vil være "like" og at kontekst som prosjektene gjennomføres i og menneskene som er del av prosjektet betyr noe for løsningen som skapes og for de metodiske valgene som man som forsker observerer når man studerer prosjekter.

Hvis et firma eller en organisasjon ønsker å utvikle og forbedre evnen til å styre usikkerhet må man forstå de ansattes behov, forstå kulturen i firmaet, prosjekteierens rolle og hvordan indre og ytre interesser samspiller og påvirker usikkerhetene som prosjektledelsen og prosjekteier er satt til å håndtere. Skal et prosjekt bli effektivt i håndtering av usikkerhet, må prosjektledelsen være i stand til å identifisere og vurdere prosjektets reelle usikkerhet, forstå sitt mandat og være i stand til å forstå om de skal håndtere eiers strategiske og taktiske usikkerheter, eller konsentrerer seg om prosjektets operasjonelle usikkerhet.

En viktig del av håndtering av usikkerheten er refleksjon og læring underveis i prosjektforløpet. Prosjektledelsen må kontinuerlig vurdere hvordan valg og disponeringer påvirker fremdriften og de leveransene som man er satt til å utvikle. Effektiv styring av usikkerhet fordrer evne til å reflektere over hvordan beslutninger som løpende tas vil komme til å påvirke prosjektets slutt-resultat, og det krever evne til å vurdere hvordan gjenstående usikkerheten kan påvirke delleveranser, sluttresultatet og prosjektets effekt. Skal et firma eller organisasjon bli bedre til å håndtere usikkerhet i prosjekter, er det helt sentralt at moderorganisasjonen tilrettelegger for læring og refleksjon kan finne sted underveis og i etterkant at prosjekter er gjennomført.

Siden 2005 har det forgått to større parallelle forskningsinitiativ i Norge, Forskningsprosjektet "Praktisk styring av usikkerhet i et prosjekteier perspektiv" ("PUS prosjektet") og Concept

forskningsprogram ved NTNU. Dette har bidratt til økt kunnskap og modenhet hos mange av de store prosjektaktørene i Norge, men det er ingen garanti for at alle prosjekter vil oppnå suksess i fremtiden. Studier gjennomført av Concept antyder at offentlige prosjekter har færre kostnadsoverskridelser i dag enn tidligere. Men det er viktig at man er klar over at mindre kostnadsoverskridelser har sin pris. Mer penger til hvert prosjekt som gjennomføres vil bety at estimatet blir sikrere og budsjetter holdes oftere, men det er også en reell fare for at det settes av for mye penger i hvert prosjekt, og dermed får man færre veier, mindre jernbane, færre skoler og oljeinstallasjoner i dag enn vi fikk for de samme pengene tilbake på midten av 2000 tallet.

Økt modenhet på usikkerhetsstyring betyr ikke at alle prosjekter i Norge som har aktiv usikkerhetsstyring er effektiv i måten de planlegges og gjennomføres på. Det er ikke bevist eller bekreftet om prosjekter i Norge reelt sett har blitt bedre på estimering av usikkerhet, om estimatene er mer realistisk i dag enn ved år 2000 eller om prosjektledere og prosjekteiere har blitt bedre til å øke sine rammer og usikkerhetsbuffer, eller at prosjektledere og eier har blitt bedre til å styre den reelle usikkerheten som dagens prosjekt opplever i vår omskiftelige verden.

## Abbreviations

APM	Association for Project Management (UK)
ATOM	Active Threat and Opportunity Model
BPR	business process re-engineering
CII	Construction Industry Institute
CPM	critical path method
FLO	Forsvarets logistikkorganisasjon (Norwegian Armed Forces' logistic organization)
FMEA	failure modes and effects analysis
GERT	Graphical Evaluation and Review Technique
HES	health, environment, and safety
ICE	Institution of Civil Engineers
ICT	information and communications technology
IPMA	International Project Management Association (Europe)
KPI	Key Performance Indicator
NSP	Norwegian Centre for Project Management (Norsk Senter for Prosjektledelse 2000–2013; now Prosjekt Norge)
NPV	net present value
PERT	Programme Evaluation & Review Technique
PM	project management
PMI	Project Management Institute (USA)
PRAM	Project Risk Analysis and Management
PRINCE2	Projects in Controlled Environments, version 2 (UK)
PS2000	Research programme project, year 2000 (1994–2000 in Norway)
PUS/PUM	<i>Praktisk UsikkerhetsStyring</i> /practical uncertainty management
SHAMPU	Shape, Harness, and Manage Project Uncertainty
SIG	Special Interested Group

UA	uncertainty analysis
UMP	uncertainty management process
WBS	work breakdown structure

## Papers and declaration of authorship

No.	Paper title	Contribution/role in preparing the paper
1	Johansen A, Sandvind B, Torp O, Økland A Uncertainty analysis – 5 challenges with today's practice <i>Social and Behavioral Sciences</i> (2014), pp. 591–600 information Double blind review	First author Collecting the data, leading the discussions, and drawing up the conclusions from the work
2	Johansen A, Andresen PE, Ekambaram A Stakeholder benefit assessment – Project success through management of stakeholders <i>Procedia – Social and Behavioral Sciences</i> (2014), pp. 581–590 Double blind review	First author Collecting the data, leading the discussions, and drawing up the conclusions from the work together with my fellow researchers
3	Johansen A, Halvorsen SB, Haddadic A, Langlo, JA Uncertainty management – A methodological framework beyond 'the six Ws' <i>Procedia – Social and Behavioral Sciences</i> (2014), pp. 566–575 Double blind review	First author collecting the data, leading the discussions, and drawing up the conclusions from the work together with my fellow researchers
4	Krane H, Johansen A, Aalstad R Exploiting opportunities in the uncertainty management <i>Procedia – Social and Behavioral Sciences</i> (2014), pp. 615–624 Double blind review	Second author Responsible for data collection from five cases and the analyses, and for drawing up the conclusions from the work together with my fellow researchers
5	Johansen A, Langlo JA Effects of long-term improvement efforts within project uncertainty management Egos 2013 Conference proceedings Double blind review	First author collecting the data, leading the discussions, and drawing up the conclusions from the work together with my fellow researchers
6	Johansen A, Ekambaram A, Hald LC Opportunities in projects – What are they and do we really want them? IPMA, 2012 Conference proceedings Double blind review	First author collecting the data, leading the discussions, and drawing up the conclusions from the work together with my fellow researchers
7	Johansen A, Ekambaram A, Krane HP, Steiro T Uncertainty management – Myths and realities EURAM 2012 Conference proceedings Double blind review	First author Collecting the data, leading the discussions, and drawing up the conclusions from the work together with my fellow researchers
8	Johansen A, Ekambaram A, Hald LC Improving uncertainty management in projects by collaborating in an inter-organizational research project EURAM 2012 Conference proceedings Double blind review	First author Collecting the data, leading the discussions, and drawing up the conclusions from the work together with my fellow researchers



No.	Paper title	Contribution/role in preparing the paper
9	Johansen A, Ekambaram A, Krane HP, Steiro T Exploring uncertainty and flexibility in projects: Towards a more dynamic framework? Egos 2012 Conference proceedings Double blind review	First author Collecting the data, leading the discussions, and drawing up the conclusions from the work together with my fellow researchers
10	Johansen A, Ekambaram A, Hald LC Living uncertainty management – An approach to learning and improvement in project-based organizations ECKM 2012 Conference proceedings Double blind review Sonning Common, UK: Academic Publishing International	First author Collecting the data, leading the discussions, and drawing up the conclusions from the work together with my fellow researchers
11	Ekambaram A, Johansen A Uncertainty management in projects – A new perspective IPMA World Congress, 2011, Brisbane Conference proceedings Published in Project Perspectives 2013, pp. 68–73	Second author Development of the idea of the paper and leading the discussions together with my fellow researcher
12	Ekambaram A, Johansen A, Jermstad, O Opportunities in projects and the role of project owners IPMA World Congress, 2010 Conference proceedings	Second author Development of the idea of the paper, leading the discussions, and drawing up the conclusions from the work together with my fellow researchers
13	Ekambaram A, Johansen A, Økland A Opportunities in projects and innovative thinking ECIE, 2010 Conference proceedings Double blind review	Second author Development of the idea of the paper, leading the discussions, and drawing up the conclusions from the work together with my fellow researchers
14	Rolstadås A, Johansen A From protective to offensive project management PMI EMEA Congress, 2008 Conference proceedings	Second author Responsible for data collection from two cases and for the analyses, and drawing up the conclusions from the work together with my fellow researcher
15	Olsson, NOE, Johansen, A, Langlo, JA, Torp O Who owns a project? EURAM – 2007 (extended version) Double blind review Nordnett 2007 Reykjavik <i>Measuring Business Excellence</i> (2008) 12:1, 39–46	Second author I was part of the team that developed the idea, contributed with data, and I drew up the conclusions from the work together with my fellow researchers

## Table of contents

Preface.....	i
Abstract .....	iv
Sammendrag .....	vii
Abbreviations .....	xi
Papers and declaration of authorship.....	xiii
Table of contents.....	xv
1 Introduction: managing uncertainty – new project management theory? .....	1
1.1 Starting point of the thesis – the rationale behind the thesis .....	2
1.2 Uncertainty management dilemmas – Why do we need more research on uncertainty management? .....	5
1.3 Research question and focus in the thesis.....	6
1.4 Structure of the thesis.....	13
2 Research method and methodical approaches in PM research .....	16
2.1 Research methodology and theory .....	16
2.2 Research methods in social sciences.....	19
2.3 What is theory? Validity and reliability in project management research .....	27
2.4 Methods and research design of the thesis .....	30
2.5 AS-IS study from the PUS project.....	33
2.6 My contribution to the research published in the period 2005–2015.....	34
2.7 Critical assessment of research methods used in the thesis .....	46
3 ‘Practical Uncertainty Management in a Norwegian Project Owner’s Perspective’ – the PUS project .....	52
3.1 The PUS project – a successful collaborative research project.....	52
3.2 Theoretical contribution – humans, models, and techniques .....	55
3.3 Practical contribution – uncertainty management in public and private sectors.....	55
3.4 What is the status? Do project managers in Norway really manage uncertainty in their projects? .....	62
3.5 Project performance and maturity regarding uncertainty.....	64
3.6 Contribution to research .....	80
4 Projects – from delivering a unique task to a tool for delivering value for the project owners ...	82
4.1 What defines a project? .....	82
4.2 Project classification.....	87
4.3 Project actors and roles.....	88
4.4 The Norwegian evolution of development of project management .....	91

4.5	Development of uncertainty – risk management in Norway .....	91
4.6	The development of the risk management knowledge area .....	95
4.7	Uncertainty versus risk.....	97
4.8	Contribution to research .....	121
5	Uncertainty – analyses and management.....	122
5.1	Myths about uncertainty – assumptions and limitations .....	123
5.2	Planning – time and cost estimation .....	130
5.3	Uncertainty analyses in practice – the Norwegian approach .....	131
5.4	Five challenges that influence the results of the uncertainty analyses .....	135
5.5	The uncertainty management process.....	141
5.6	Results of uncertainty management in the energy sector and the public sector.....	143
5.7	Contribution to research .....	146
6	Uncertainty – the human aspect.....	147
6.1	Uncertainty – objective facts or subjective beliefs? .....	147
6.2	What has uncertainty management to do with learning? .....	149
6.3	Living uncertainty management – a tool for learning and knowledge creation .....	150
6.4	The role of the project owner .....	152
6.5	Stakeholder benefit assessment – project success through management of stakeholders.....	153
6.6	Stakeholder management and uncertainty .....	154
6.7	Contribution to research .....	155
7	Opportunity management.....	156
7.1	Opportunities in projects – what are they and do we really want them? .....	157
7.2	Stakeholder and opportunities.....	159
7.3	Opportunities and systems thinking .....	163
7.4	Cooperation between project managers and project owners.....	169
7.5	How good is the theory and how good are projects at identifying and managing uncertainty in practice? .....	170
7.6	Contribution to research .....	174
8	Practical uncertainty management – nine-step framework for identifying, analysing, and managing uncertainty .....	176
8.1	Nine-step framework for identifying, analysing, and managing uncertainty .....	176
8.2	Practical uncertainty management – step by step.....	178
8.3	How should the changes in the matrix be interpreted? .....	182
8.4	Discussion – from uncertainty analysis to uncertainty management.....	182

8.5	What are the steps if a company wants to implement 'living uncertainty management?' in their projects? .....	183
8.6	Contribution to research .....	184
9	Conclusion: project uncertainty management and the need for a new approach – the 'lost opportunities' .....	185
9.1	Most important findings relating to uncertainty management in practice .....	185
9.2	Most important findings and contribution – uncertainty management in practice.....	190
9.3	Further research – Where do we need to create new knowledge in uncertainty management? .....	194
9.4	Epilogue – 'having new eyes' .....	199

## List of Figures

FIGURE 1	SINGLE-PROJECT FOCUS – UNCERTAINTY MANAGEMENT AS A PART OF PROJECT MANAGEMENT	8
FIGURE 2	UNCERTAINTY FOCUS IN THE FRONT END .....	10
FIGURE 3	SINGLE PROJECTS – STRATEGIC UNCERTAINTY AND CONTEXTUAL UNCERTAINTY .....	11
FIGURE 4	LOGICAL FRAMEWORK FOR THE THESIS .....	15
FIGURE 5	ACTION RESEARCH – CYCLES IN ACTION .....	25
FIGURE 6	RESEARCH DESIGN – STEP-BY-STEP DEDUCTIVE AND INDUCTIVE APPROACH (INSPIRED BY TJORA 2012) .....	31
FIGURE 7	PROJECTS, PRODUCTION, AND DELIVERABLES .....	35
FIGURE 8	BUILDING BLOCKS FOR NEW THEORIES .....	46
FIGURE 9	MAJOR INDUSTRIAL PARTNERS IN THE PUS PROJECT.....	53
FIGURE 10	METHODOLOGICAL FRAMEWORK FOR THE PUS PROJECT .....	54
FIGURE 11	DEVELOPMENT PROJECTS AND INCREASES IN NUMBERS OF USERS OF RISK MANAGEMENT IN STATOIL .....	57
FIGURE 12	UNCERTAINTY MATRIX.....	61
FIGURE 13	THE FIVE LEVELS OF MATURITY (KERZNER, 2009).....	65
FIGURE 14	THE BASIS FOR EXECUTION OF UNCERTAINTY MANAGEMENT – RESPONSES FROM A SURVEY IN 2010. (A. JOHANSEN, LANGLO 2013).....	67
FIGURE 15	THE BASIS FOR EXECUTION OF UNCERTAINTY MANAGEMENT – DEVELOPMENTS FROM 2006 TO 2011 (A. JOHANSEN, LANGLO 2013).....	68
FIGURE 16	CHANGES IN ATTITUDE TOWARDS EXPRESSING UNCERTAINTY (A. JOHANSEN, LANGLO 2013) ...	68
FIGURE 17	COST DEVIATION RELATIVE TO P85 ESTIMATES (PRESENTED BY O.J. KLAKEGG AT THE CONCEPT SYMPOSIUM IN 2012).....	69
FIGURE 18	IMPORTANT FACTORS INFLUENCING THE PROJECT – ANTICIPATED VERSUS REAL (PRESENTED BY O.J. KLAKEGG AT THE CONCEPT SYMPOSIUM IN 2012) .....	72
FIGURE 19	NUMBER OF OPPORTUNITIES AND THREATS DURING PROJECT PLANNING AND EXECUTION PHASES (A. JOHANSEN, KRANE,EKAMBARAM,STEIRO, 2012) .....	73
FIGURE 20	FOCUS ON THREATS AND OPPORTUNITIES (A. JOHANSEN, KRANE,EKAMBARAM,STEIRO, 2012) .	74
FIGURE 21	IS UNCERTAINTY MANAGEMENT USED IN PROJECT IN YOUR COMPANY? (A. JOHANSEN, LANGLO 2013) .....	75
FIGURE 22	WHAT DOES UNCERTAINTY MANAGEMENT MEAN IN YOUR COMPANY? (A. JOHANSEN, LANGLO 2013) .....	76
FIGURE 23	WHAT IS THE UNCERTAINTY MANAGEMENT FOCUS IN THE PROJECT YOU ARE PART OF TODAY? (A. JOHANSEN, LANGLO 2013).....	77
FIGURE 24	DOES YOUR COMPANY HAVE A STANDARDIZED TOOL AND/OR SYSTEM THAT SHOULD BE USED IN ALL PROJECTS? (A. JOHANSEN, LANGLO 2013) .....	78
FIGURE 25	ARE THE TOOLS THAT THE COMPANY PROVIDES ADEQUATE FOR YOUR UNCERTAINTY MANAGEMENT WORK? (A. JOHANSEN, LANGLO 2013).....	78
FIGURE 26	THE PROJECT LIFE CYCLE (MORRIS, 2004).....	86
FIGURE 27	THE IRON TRIANGLE (ATKINSON, 1999).....	86
FIGURE 28	TYPICAL SEQUENCE OF PHASES IN A PROJECT LIFE CYCLE (PMBOK, 2013) .....	87
FIGURE 29	THE NORWEGIAN QUALITY ASSURANCE SCHEME .....	94
FIGURE 30	RISK MANAGEMENT PROCESS (SIMISTER, 2004) .....	97
FIGURE 31	THE THREE DIMENSIONS OF PROJECT RISK (ROLSTADÅS & JOHANSEN, 2008).....	103
FIGURE 32	RISK DEVELOPMENT DURING THE PROJECT LIFE CYCLE (ROLSTADÅS & JOHANSEN, 2008) .....	104
FIGURE 33	RELATIONSHIP BETWEEN UNCERTAINTY AND RISK (ROLSTADÅS, ET AL.) .....	106
FIGURE 34	UNCERTAINTY AND RISK (ROLSTADÅS, ET AL.).....	106
FIGURE 35	RISK – THE DEFINITION DEBATE (BASED ON (HILLSON, 2004) .....	107
FIGURE 36	UNCERTAINTY – OPPORTUNITIES AND THREATS .....	120

FIGURE 37	MYTH 1: UNCERTAINTY DURING THE COURSE OF PROJECTS (A. JOHANSEN, KRANE,EKAMBARAM,STEIRO, 2012) .....	123
FIGURE 38	UNCERTAINTY DURING THE COURSE OF PROJECTS – INTERNAL AND EXTERNAL UNCERTAINTY (A. JOHANSEN, KRANE,EKAMBARAM,STEIRO, 2012).....	125
FIGURE 39	MYTH 2: POSITIVE AND NEGATIVE UNCERTAINTY DECREASES DURING THE COURSE OF PROJECTS (A. JOHANSEN, KRANE,EKAMBARAM,STEIRO, 2012) .....	126
FIGURE 40	POSITIVE AND NEGATIVE UNCERTAINTY – IDEAL AND REAL (A. JOHANSEN, KRANE,EKAMBARAM,STEIRO, 2012) .....	127
FIGURE 41	FOCUS AREAS BASED ON BENEFITS TO THE PROJECT (A. JOHANSEN, KRANE,EKAMBARAM,STEIRO, 2012) .....	128
FIGURE 42	PROBABILITY DISTRIBUTION OF THE COST ESTIMATE FOR A PROJECT (A. JOHANSEN, SANDVIN, TORP, ØKLAND, 2014) .....	133
FIGURE 43	STAGE-GATE MODEL (A. JOHANSEN, SANDVIN, TORP, ØKLAND, 2014) .....	133
FIGURE 44	UNCERTAINTY DURING THE COURSE OF PROJECTS – INTERNAL AND EXTERNAL UNCERTAINTY (A. JOHANSEN, KRANE,EKAMBARAM,STEIRO, 2012).....	134
FIGURE 45	SEVEN UNCERTAINTY ANALYSES IN A PROJECT – 1–5 IN THE PLANNING PHASE, AND 6–7 IN THE EXECUTION PHASE (A. JOHANSEN, SANDVIN, TORP, ØKLAND, 2014).....	136
FIGURE 46	DECLINING UNCERTAINTY DURING THE PROJECT LIFE CYCLE (A. JOHANSEN, KRANE,EKAMBARAM,STEIRO, 2012) .....	138
FIGURE 47	PRACTICAL UNCERTAINTY MANAGEMENT PROCESS (WWW.PROSJEKTNORGE.NO/PUS/).....	142
FIGURE 48	UNCERTAINTY MATRIX USED IN UNCERTAINTY MANAGEMENT IN ORGANIZATIONS INVOLVED IN THE PUS PROJECT .....	142
FIGURE 49	RISK RESPONSE PLANNING (PINEY, 2002).....	158
FIGURE 50	FIRST, SECOND, AND THIRD ORDER CONSEQUENCES.....	164
FIGURE 51	THE NORWEGIAN APPROACH TO UNCERTAINTY ANALYSES AND MANAGEMENT OF UNCERTAINTY .....	170
FIGURE 52	WHAT IS THE VALUE AND WHO BENEFITS? .....	172
FIGURE 53	HOW MUCH BETTER MUST A NEW OPPORTUNITY BE?.....	173
FIGURE 54	UNCERTAINTY ANALYSES (UAS) DURING THE PROJECT LIFE CYCLE (A. JOHANSEN, HALVORSEN, ET AL., 2014).....	176
FIGURE 55	PRACTICAL UNCERTAINTY MANAGEMENT – 9 STEP FRAMEWORK (A.JOHANSEN, HALVORSEN ET AL.,2004).....	177
FIGURE 56	UNCERTAINTY MATRIX .....	180
FIGURE 57	REVISED UNCERTAINTY MATRIX – ONE MONTH LATER IN THE PROJECT .....	181
FIGURE 58	LIVING UNCERTAINTY MANAGEMENT (HALD, JOHANSEN ET AL., 2008).....	194

## List of Tables

TABLE 1	DIFFERENT TYPES OF RESEARCH.....	17
TABLE 2	FOUR STAGES IN GROUNDED THEORY APPROACH .....	26
TABLE 3	LEVELS OF THEORY – EXAMPLES .....	28
TABLE 4	PUBLISHED PAPERS AND MY CONTRIBUTION .....	36
TABLE 5	THE PAPERS: METHODOLOGICAL APPROACHES AND FOCUS .....	38
TABLE 6	WHICH PAPERS ARE USED IN WHICH CHAPTER IN THE THESIS:.....	45
TABLE 7	THE 2010 SURVEY IN THE PUS PROJECT (A. JOHANSEN, LANGLO 2013) .....	62
TABLE 8	SUBJECTIVE EVALUATION OF MATURITY LEVEL OF UNCERTAINTY MANAGEMENT IN 2006 AND IN 2010 (A. JOHANSEN, LANGLO 2013).....	65
TABLE 9	SOURCES OF ERGODIC AND NON-ERGODIC THEORY IN SCIENTIFIC DISCIPLINES (AALTOEN, 2012)...	99
TABLE 10	UNCERTAINTY MANAGEMENT ROLES AND TASKS ACCORDING TO TYPE OF UNCERTAINTY IN THE PROJECT.....	102
TABLE 11	DEFINITIONS OF UNCERTAINTY AND RISK.....	109
TABLE 12	THE UNCERTAINTY ANALYSES – STEP-BY-STEP APPROACH (A. JOHANSEN, SANDVIN, TORP, ØKLAND, 2014)) .....	132
TABLE 13	COST UNCERTAINTY AND STANDARD DEVIATION (A. JOHANSEN, SANDVIN, TORP, ØKLAND, 2014)	135
TABLE 14	PROJECT TYPES AND NUMBERS BY PROJECT PHASES (CONCEPT SCREENING ANALYSES; FEASIBILITY STUDIES AND PLANNING PHASE BUDGET, AUTHORIZATION, AND CONTROL; AND CHECK ESTIMATE BID/TENDER) (A. JOHANSEN, SANDVIN, TORP, ØKLAND, 2014) .....	138
TABLE 15	THEORETICAL AND EMPIRICAL LEVEL OF STANDARD DEVIATIONS IN FIVE PHASES (A. JOHANSEN, SANDVIN, TORP, ØKLAND, 2014) .....	139
TABLE 16	GENERIC UNCERTAINTY MANAGEMENT PROCESS (A. JOHANSEN, LANGLO 2013) .....	141
TABLE 17	DISTRIBUTION OF IDENTIFIED UNCERTAINTIES– THREAT/OPPORTUNITY CATEGORIES IN THE ENERGY SECTOR (KRANE, ET AL., 2014) .....	144
TABLE 18	THREATS AND OPPORTUNITIES IN THE PLANNING AND EXECUTION PHASE OF PUBLIC SECTOR PROJECTS (KRANE, ET AL., 2014) .....	145
TABLE 19	STRATEGIES FOR UNCERTAINTY MANAGEMENT RESPONSE – OPPORTUNITIES AND THREATS .....	159
TABLE 20	GOALS, CAUSES, UNCERTAINTIES (THREATS AND OPPORTUNITIES), AND POSSIBLE EFFECTS (A JOHANSEN, ET AL., 2012) .....	163
TABLE 21	WIDEMAN’S CLASSIFICATION OF RISK (WIDEMAN, 1992) .....	165
TABLE 22	FIRST ORDER CONSEQUENCES – OPPORTUNITIES IN THE EXECUTION OF THE PROJECT (A JOHANSEN, ET AL., 2012) .....	167
TABLE 23	SECOND AND THIRD ORDER CONSEQUENCES (A JOHANSEN, ET AL., 2012).....	168
TABLE 24	STRATEGIES FOR UNCERTAINTY MANAGEMENT RESPONSE – OPPORTUNITIES AND THREATS .....	180

## **1 Introduction: managing uncertainty – new project management theory?**

In the mid-1990s, I had my first introduction to uncertainty analyses when I took a continuing education course called 'Project planning under Uncertainty' at the Norwegian technical university (Norges tekniske høgskole, NTH) in Trondheim. It was a two-week course in how to do time and cost analyses under uncertainty (Austeng & Hugsted, 1993; Klakegg, 1993, 1994), and it gave me an introduction into the world of successive calculation of uncertainty (Lichtenberg, 1974). Later in the 1990s I started work as a project management consultant for a company, and we offered uncertainty analysis as a part of our services to public and private companies. Uncertainty analysis was a popular product, and those of us who had had the relevant training, had almost a full-time job doing uncertainty analyses all over Norway for several years. That meant that I had the privilege to be involved in more than 100 uncertainty analyses in the pre-planning, planning, and execution phases of many different types of projects. Most of the projects were in the public sector, and I typically worked with public buildings (e.g. schools and hospitals), road, and railway projects. However, information and communications technology (ICT) and research projects were also on my customer list. Working with these uncertainty analyses gave me the opportunity to discuss with different Norwegian project management teams and users how they understood the processes and the results of the processes. In addition, it gave me insight into how many project managers used uncertainty analysis as a tool – or, as I discovered, in most cases did not use it – in order to manage uncertainty in their projects.

I started to ask my customers quite systematically whether they used the output from the uncertainty analyses as a tool for managing uncertainty. The answers were very often quite vague. Some said that reports and output were used to establish the project budget and the uncertainty buffers, while others said that the processes and the workshops were very often quite useful, but on certain occasions, the output and/or reports were too general, so they could not use uncertainty analysis as a tool for uncertainty management. I also asked my customers how they perceived uncertainty management. To my surprise, it was almost impossible to obtain one clear answer to that question. Some customers said that uncertainty management was about doing two or three uncertainty analyses in the planning phase of the project, and when the budget was given, it was all about avoiding risk. Other said that all they did as a project manager was to deal with uncertainty. I then asked them whether uncertainty management equated with project management, and the answer was normally 'No'. Another trend that I observed was that when I asked the same group of customers what uncertainty analysis meant to them, their answers were much more consistent, and along the lines that uncertainty analysis is a tool used to find their project's expected value and the uncertainty in the cost estimation is expressed as a standard deviation in the percentage of expected value. Some also answered that uncertainty analyses could also be about finding the expected end data of the project. However, the majority of the answers connected uncertainty analyses to finding the expected end cost. I also asked about when my customers used uncertainty analyses in their projects and when they dealt with uncertainty in their projects, and the majority said that they did uncertainty analyses at the end of the planning phase, but they managed uncertainty from the project start-up until the project results were delivered. This led me to the question: If this was true, how did they analyse and manage uncertainty in the execution phase, given that they did not do any uncertainty analyses in that phase?



### 1.1 Starting point of the thesis – the rationale behind the thesis

In the early 1970s Steen Lichtenberg, together with researchers from Stanford University and MIT in the USA, Loughborough University in the UK, Chalmers University of Technology in Sweden, and the Technical University of Norway in Trondheim (NTH), developed a new approach for calculating the cost of big projects called the successive principle of cost estimation (Lichtenberg, 1974, 2000). Lichtenberg used the term uncertainty, and it was from the beginning a neutral concept and had a broader view than risk concept, which only dealt with the downsides of projects, such as unexpected delays and higher costs. For him, uncertainty just meant that something could go faster than expected, or the project could cost less than planned, or it could take longer, or cost more than planned. This concept was adapted by the Norwegian project management researchers from the Technical University of Norway, and, from the early 1990s uncertainty analysis was used in Norway as the concept to find the expected cost or expected time for projects and the variability of cost/time given by the standard deviation. The step-by-step approach (the Norwegian evolution from the successive principle) and stochastic estimation were introduced and subsequently spread together with the uncertainty analysis concept among consultants and practitioners (Austeng & Hugsted, 1993; Klakegg, 1993; 1994).

Today, the step by step approach and the term uncertainty analysis are established as the method to be used in Norway for uncertainty analyses of cost in projects. The method is used to calculate expected cost and find the uncertainty factors that could affect the project objectives in a positive (opportunities) or negative (threats) way. The Nordic tradition in uncertainty analysis is typically a group process lead by a facilitator who is an expert on uncertainty analysis, and a resource group of experts within the various sections of the project (Austeng & Hugsted, 1993); (Klakegg, 1993).

As pointed out by (Venkataraman & Pinto, 2008), the importance of estimating project costs arises as the estimates become the benchmarks by which future costs are compared and evaluated (A. Johansen, Sandvin, Torp, Økland, 2014). However, uncertainty analysis is also an important tool for management of the project in general, and uncertainty management is more than repeating the cost analysis two or three times in a project. Both the Project Risk Analysis and Management (PRAM) framework (C. Chapman, 1997; Simon, Hillson, & Newland, 1997) and the Shape, Harness, and Manage Project Uncertainty (SHAMPU) framework (C. B. Chapman & Ward, 1997) suggest that uncertainty analyses is an important task and it needs to be followed up during the execution of the project. In Norway, uncertainty analyses were established as a concept in the early 1990s. It could thus be assumed that uncertainty management soon became a well-defined concept. However, studies of different uncertainty management processes carried out as part of the Concept research programme revealed that the management part was relatively thin in most of the uncertainty management processes (Austeng, 2005; Drevland, Austeng, & Torp, 2005).

In the early 2000s, uncertainty analysis was becoming more or less mandatory for large projects in Norway, but there was no clear evidence that they subsequently used the results of the analyses when managing uncertainty. The uncertainty analyses were typically done by experts and/or consultants for the project management team in a two- or three-day group process or uncertainty workshop at the end of the planning phase. The experts were normally in charge of the process, and made the models and reports from the process. The project management team was involved in the process by giving the input to the model, but they had to rely on the experts' processes, models, and specialized advanced tools to secure the result from the process. For many projects, the result of the

process was a good discussion about the project's uncertainty, uncertainty models that they did not understand, and/or cost estimates that they could use in the upcoming budgeting process.

Representatives from Norwegian companies and Norwegian scholars had more or less the same experiences in the early 2000s, namely that the uncertainty analyses that were done in the early stages were in many cases not used in the uncertainty management in the later stages of the projects. As a consequence, a lot of projects experienced that although they had done an uncertainty analysis but they could not use the results in their project's uncertainty management process. They therefore had a clear understanding of what uncertainty management should include: identifying who should be involved in the process, what type of uncertainty or risks should be addressed in the process, who should be responsible for following up the uncertainty on strategic and tactical levels, who owns the process, who should be responsible for managing it, what types of practical tools are needed, and how the uncertainty management process should be organized. These questions were raised by Norwegian scholars and companies in several research workshops in the early 2000s. In spring 2005, the Norwegian Centre for Project Management (Norsk Senter for Prosjektledelse, NSP) decided that a project on practical uncertainty management was needed. I started as a research manager for NSP in 2004. It was then my job to make project proposals, secure financing for new research projects and motivate the partners' involved in the research projects. In 2005, the idea of a research project on practical uncertainty management was presented to the NSP board, and in 2006 an application for financing was submitted to the Research Council of Norway for a four-and-a-half year research project called 'Practical Uncertainty Management in a Project Owner's Perspective' ('Praktisk styring av usikkerhet i et eierperspektiv', abbreviated to PUS) and known as the 'PUS project'.

The main focus of the PUS project was to develop knowledge and insights into how uncertainty management should be executed throughout project execution in order to take advantage of opportunities and manage all the threats in an appropriate manner. The mantra in the project was to ensure that the project owner was actively involved in the uncertainty management process. My role in the PUS project was project manager and designated senior researcher. I was in charge of developing the research strategy and starting up the development project in the partner-companies. I led the 'AS-IS' study and was involved in the data collection, data analysis, and dissemination of knowledge in the project. The PUS project has been instrumental in my development and understanding of the topic, and I therefore give a short presentation of the project and its main results in Chapter 3.

Risk and uncertainty has long been a subject of interest for mankind (Bernstein & Bernstein Peter, 1996) (also see Table 11 and Section 4.6 for more details). The concept of dealing with uncertainty as a part of project management theory was first expressed when the Programme Evaluation & Review Technique (PERT) concept for estimating time in networks was presented in the mid-1950s (P. W. Morris, 2011; Rolstadås, 2011). Projects have traditionally strived towards predictability to keep all critical factors under control (G. Themistocleous & S. H. Wearne, 2000)b; (Rolstadås, 2011). However, for large and complex projects such predictability does not exist in reality (Rolstadås, Hetland, Jergeas, & Westney, 2011; Rolstadås & Johansen, 2008). Major uncertainties play a large role in important areas. Furthermore, especially under such conditions it may not be a good strategy to

strive for maximum predictability, but rather to choose a strategy of flexibility in the project, in order to be able to face changes in a better way. (N. Olsson, Johansen, Langlo, & Torp, 2007)

The first theory presented for what we today call projects was designed to gain control over a big complex and dynamic problem that had high uncertainty (internal and contextual uncertainty). (P. W. Morris, 2011; Rolstadås, 2008) More information on internal and contextual uncertainty is presented in Chapter 4.7. The first answer to the problem of coordinating many people in order to deliverer on time and cost was to standardize work breakdown, develop standard methods for time planning (e.g. the critical path method (CPM) and PERT), and to focus on optimization (Bredillet, 2008; P. W. Morris, 2011; Peter W. G. Morris, 2013; Rolstadås, 2008, 2011).

Over a 30–40 year period, project management research in general focused on developing a universal method that would fit much of the project most of the time (Bredillet, 2008; P. W. Morris, 2011; Packendorff, 1995; Söderlund, 2011a). This trend was strongly supported by the different project management associations started in the late 1960s, such as the International Project Management Association (IPMA) in 1965 and the Project Management Institute (PMI) in 1969.

However, during the 1990s, more and more scholars argued that it was not possible to have ‘one universal method’. The research community started to collaborate with other management traditions, and this led to the development of multiple theories for all types of projects (Bredillet, 2008; Peter W. G. Morris, 2013; Söderlund, 2011a). In the same time period, the theory of uncertainty planning and estimation was introduced (Austeng & Hugsted, 1993; Hillson & Murray-Webster, 2007; Klakegg, 1993, 1994; Lichtenberg, 1974). Initially, the focus was on the development of the techniques: how to make a time schedule that could handle uncertainty and how to make a cost estimation with the consideration of uncertainty (Austeng & Hugsted, 1993; Lichtenberg, 1974); (Klakegg, 1993, 1994), and the process of doing uncertainty analysis. The first Norwegian attempt to address the management of uncertainty came with the book *Usikkerhet som styringsparameter ved prosjektgjennomføring* (Uncertainty as a project follow up parameter) (Torp & Kilde, 1996). At the same time, Chapman and Ward developed their risk management frameworks, and in 1996 they published their book *Project Risk Management: Processes, Techniques and Insights* (C. Chapman & Ward, 1996). In 1997, Chapman presented the PRAM model in his paper ‘Project risk analysis and management—PRAM the generic process’ (C. Chapman, 1997). In the same year, *PRAM: Project Risk Analysis and Management Guide* was published (Simon, et al., 1997). At this stage, the debate started about risk versus uncertainty management and which of these was the correct term. Some scholars argued for uncertainty (Torp & Kilde, 1996); (C. Chapman & Ward, 1996), and others argued for risk (Hillson, 2002). This debate is still ongoing today (O. Perminova, Gustafsson, & Wikström, 2008); (Zhang, 2011).

Hillson’s paper ‘Extending the risk process to manage opportunities’ (Hillson, 2002) was one of the first papers that discussed managing opportunities. In 2004, he published a book titled *Effective Opportunity Management for Projects: Exploiting Positive Risk* (Hillson, 2004) one of few books focusing on opportunities in projects .

Many scholars have covered uncertainty management, and some have also tried to solve the puzzle of opportunities. However, projects still seem to fail to identify and exploit opportunities in practices. From the uncertainty analyses during the 1990s and developments after the Millennium in Norway it is apparent that there was much more focus on the downside of uncertainty (i.e. risks and threats)

than the upside (i.e. opportunities). Some have even suggested that projects are so optimistic that when they start only risks remain (De Meyer, Loch, & Pich, 2002).

## 1.2 Uncertainty management dilemmas – Why do we need more research on uncertainty management?

In 2006, those of us involved in the PUS project developed a list of six dilemmas of uncertainty management in projects, which served as the starting point of the project, (Langlo, Johansen, & Olsson, 2007). This list was based on preliminary literature studies and state-of-the-art analysis conducted in the PUS companies, and we found that there were some dilemmas in how uncertainties were managed (A. Johansen, Torp, Spjelkavik, & Hald, 2006):

1. Some uncertainties can be treated as a risk by a project organization, while the same uncertainties can be treated as opportunities by the project owner.
2. While a line organization often initiates a project to master a more complex environment or situation than normal, the project organization itself often uses a closeout strategy to minimize risk. This strategy often results in less potential for including improvements and managing changes during project execution than expected by line organization.
3. Tangible project uncertainty is prone to underestimation due to two conditions. First, contextual demands in complex and long-term projects usually develop considerably during project execution, leading to increased uncertainty. The project often finds itself in a situation where it cannot report this uncertainty without probably receiving a stop order. Second, this often leads to the project overrating the accuracy and quality of its available information and underrating the tangible uncertainty reported to line organization at decision gates.
4. In order to maximize chances of being perceived as successful, a project will in the early phases often actively work to widen its financial frames and to obscure its goals, thus hiding an increased total cost for the line organization.
5. In order to maximize benefit or return on investment in a life-cycle perspective, it is necessary to understand the project and its complexity in totality and in detail. Such an understanding requires continuous monitoring of its development, and the project owner is seldom in a position to follow the project on a daily basis.
6. When intervening or participating in project uncertainty management, there is a potential risk that a project owner will completely or partially take over the responsibilities and the role of the project manager. In turn, this will most likely result in increased internal project uncertainty.

Based on these dilemmas, we raised the question regarding which perspective should be used for analysing and describing uncertainty management in projects. In 2005, the dominating body of knowledge in project management used the task perspective (i.e. whereby uncertainty was identified and managed seen from the project management team's view) when describing the uncertainty management process, focusing on how the project should handle risks, and to some extent opportunities either in the best of the interests of the project organization or in the best interests of other stakeholders as defined by the project. Our research substantiated that using a broader project owner perspective and bringing the project owner closer into the uncertainty management process would benefit both the project owner and the project itself.

In a task perspective, the project would strive to access more resources, reduce its scope, increase its budget, and increase its time frame before undertaking its mission. After the mission commences, uncertainties are not communicated but kept under internal control. From a contextual viewpoint, it seems as though the project exists in an ideal world with fixed uncertainties.

The demand today is that projects need to be 'efficient and effective' and they need to follow up the early warnings signs and maximize the profit and the effect for the project owners (Peter W. G. Morris, 2013); (Klakegg, 2010). It is not good enough merely to deliver the objective within the 'iron triangle' (Atkinson, 1999). They also need to monitor, analyse, and take new actions on the shifting conditions of the projects. Uncertainty management must start on the very first day of the project and it must go on until the project has accomplished and/or delivered its objective and comes to its end.

### 1.3 Research question and focus in the thesis

When I was trained in uncertainty analyse in the mid-1990s, I was told that the uncertainty was a two-sided coin: activities and process could go better than planned or they could worsen. I was also told that uncertainty is neutral concept and is about the future outcome and the fact that we (i.e. project managers and all members of the management team) do not have all the information we need at the time when we need to make our decision (Austeng & Hugsted, 1993; Klakegg, 1993, 1994). Additionally, I was told that in an uncertainty analysis we should use just as much time identifying and analysing the opportunities as identifying and analysing the threats. However, my observations in the uncertainty analyses revealed another story; most of the time it was much easier for the project members to identify threats than opportunities in the workshops. Typically, eight to ten times more threats than opportunities were identified in the brainstorming process in the beginning of the analysis, and when we were discussing what to manage later in the analysis the process threats were dominant.

I started to wonder whether projects were really was interested in opportunities and whether project managers really meant that uncertainty was a two-sided coin (i.e. of opportunities and threats) or whether they meant that uncertainty management was the same as risk management and that the process should only be concern with the downside uncertainty and avoid and control the threats or risk. I also discovered that some of my customers had changed their name for the process and started to call it risk analyses and risk management. When I asked them what they meant by risk analysis, they explained that referred to cost analysis, and they used it as tool to find the expected value of the project. Moreover, they considered that risk analysis is about identifying risks and opportunities as well as measures for managing the risks. It therefore became clear to me that risk and uncertainty were used as separate terms by some of my customers and as synonymous terms by others.

I also started to wonder whether the use of the term 'risk' could have an effect on how good projects were at identifying and exploring opportunities. I started to wonder whether project managers and owners really spent time on identifying and exploring opportunities in all phases of the project or whether opportunities merely appeared as interesting in the early phase of the project? I also started to become more curious about how opportunities were dealt with in project management literature: Should project managers identify and exploit opportunities? Does the general project management theory or the uncertainty/risk management theory say anything specific on this subject?

Furthermore, I was curious to find out whether the uncertainty management process itself was dependent on the perspective it had (i.e. the owner's perspective versus project managers' perspective), and whether there would be more focus on both sides of the uncertainty in the process if the project owner and project management team were to identify and manage uncertainty together. Alternatively, should the process be carried out by the project manager and his or her staff, and just the results of the process during the execution of a project should be reported to the project owner? Who should be responsible for following up on opportunities that would give benefit after the project had delivered its result? Who should decide whether the project should exploit in the executing phase a possible opportunity that might give positive benefits for the owner but could jeopardize the time schedule or the budget for the project?

I found it hard to believe that projects that last for more than two years are able to identify and predict all opportunities and threats ahead of them. Based on my experience, I suggest that it is hard to estimate and plan fairly accurately for more than two to three months ahead. Most projects are executed in a continually shifting context with shifting governments, owners with new demands, a market that goes up and down, new projects are closed and started, new technology is developed, and some people are recruited while others leave the organization. All this means that stability is an illusion for most projects: projects are not islands, but rather open systems that continuously need to deal with uncertainty (Engwall, 2003; Peter W. G. Morris, 2013). Doing one or two uncertainty analyses in the early stage of the project will in most cases not be sufficient, and more focus on front end loading will not prevent a new demand from arising, a new technology becoming available, that a new competitor will bid on the job, or that the project objective will sometimes need to be changed.

In this thesis I argue that the current practice and the current project management literature do not fully and properly cover uncertainty management in general and opportunity management in particular, even though we acknowledge that opportunities are a part of the uncertainty, and that it could be important to exploit and harvest some of the opportunities. However, my empirical data show that project managers and project owners often ignore opportunities in the execution phase. I also argue that exploiting and harvesting opportunities is a more difficult and complex task than following up on threats. The challenges of dealing with opportunities in projects is not well covered in either the current project management literature or the uncertainty management literature, and this suggests that we need to develop new knowledge and theories within this area of the project management field. My experiences from my early years as consultant, together with the experience I gained in 2004 and 2005 when I contributed to three research projects – the NSP project 'Uncertainty as a learning arena' ('Usikkerhetsanalyse som læringsarena'), the Concept project 'Uncertainty analysis – Methodology' ('Usikkerhetsanalyse – Metoder') (Austen et al (2005) Report No. 12), and the NSP project 'Practical uncertainty management in a project owner perspective' (Praktisk styring av usikkerhet i et eier perspektiv) – have led to the following four research questions that I address in this thesis:

Q1 How do projects identify and manage uncertainty in practice?

Q2 How do the different roles of project owner and project manager affect or influence a project's capability to identify and deal with opportunities and threats?

Q3 Are today's project management and uncertainty management theories adequate in terms of dealing with opportunities and threats in projects?

Q4 Do project management and uncertainty management theories provide the right tools and concepts to enable projects to manage opportunities and threats in practice?

The four research questions indicate the focus of my research and this thesis, which is how projects perform in terms of delivering the desired effects, the respective roles of the project owner and the project management team as key stakeholders in identifying and dealing with the uncertainty regarding both e opportunities and threats.

Uncertainty management can be studied from many angles and views (e.g. from the owner's, project manager's or contractors' view). Uncertainty is part of the front end debate and the programme and portfolio management debate, and is included in the topic of governance and research on megaprojects, and is discussed in studies of success and failure and the typology of projects. Uncertainty management is one of many themes in project management. (see Figure1).

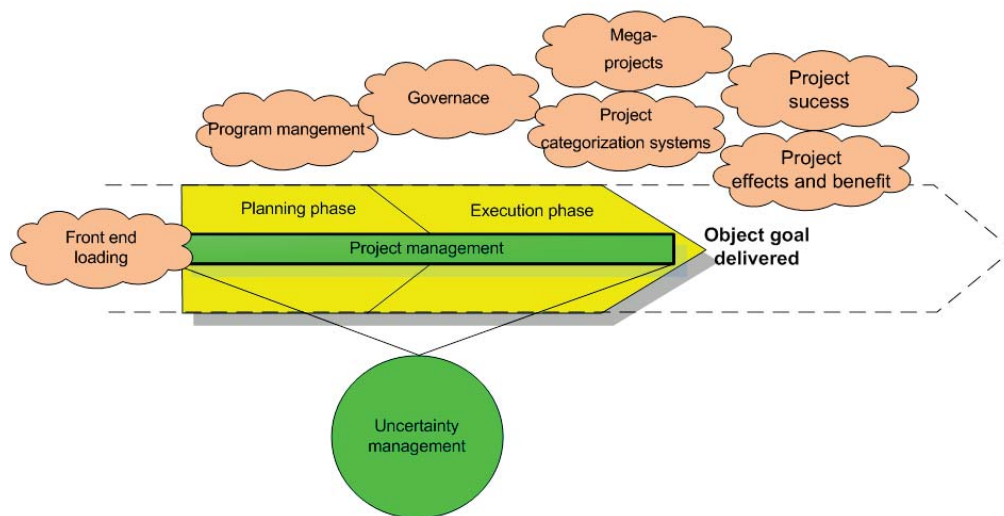


Figure 1 Single-project focus – uncertainty management as a part of project management

Furthermore, is not possible or desirable to isolate the effect of uncertainty management on project performance and project result goals. The true effect of a project and how well it has performed in terms of handling uncertainties can first be judged after the project is delivered (Christensen & Kreiner, 1991), which means that project uncertainty should also focus on results and effect, and should be considered from both the project management's and the project owner's perspectives.

It is not possible to develop a new theory in uncertainty management without acknowledging the position of uncertainty management in the project management theory. This means that the development of a new theory in uncertainty management needs to build on the project management body of knowledge as well as special uncertainty and risk literature and practice.

Uncertainty management as concept can be difficult to understand because the term 'uncertainty management' is used in different ways *dependent on time* (e.g. front end versus single project) and *position and roll in the organizational hierarchy* (e.g. top management owner's versus project managers' or contractors' perspective).

The term uncertainty is also used specifically in connection with some project management methods, such as cost estimation under uncertainty and time estimation under uncertainty in PERT and GERT network, and as part of the progress reporting see e.g. uncertainty matrix. Uncertainty is also used generically in single projects to describe how some of the elements in the project are unclear, have not been planned, or have some ambiguity in their description. There may be elements related to the process, the performance on the engineering and construction, milestones, or the objective, resources, technical solutions, and the work load. The elements also include uncertainty related to prices of materials and changes in the stakeholders' demands.

#### **Uncertainty in the front end**

The uncertainty debate in the front end of a project is different from the uncertainty debate that goes on in the project management team appointed to deliver a project within certain specification and within a certain time and budget. In addition, uncertainty management at project owner and top management level in the organization will often have a different focus than that of the project manager and his or her staff.

The focus in the front end of a project is typically on finding the best concept that satisfies the stakeholders' needs and that will give the best benefit to the owners and society; for example, when deciding on the best way to cross a fjord, it may be necessary to decide whether a bridge or a new tunnel should be constructed or whether ferry services should continue to run. In this phase the project management team typically is more concerned about the uncertainty related to the project objective on the different solutions and finding the best and preferred solution, see figure 2



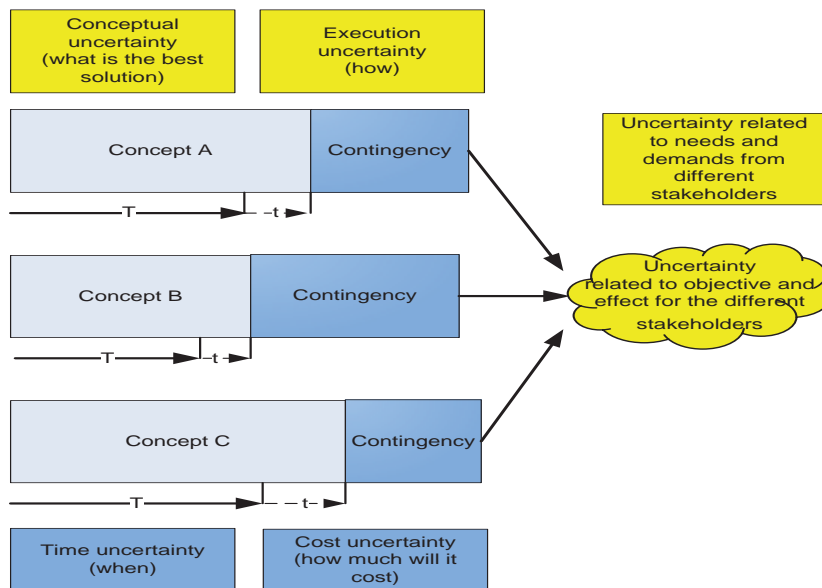


Figure 2 Uncertainty focus in the front end

In the front end, the focus is on finding the best concept that should be used in the next stage of process, based on limited knowledge about how the concept should be built or executed, and how easy or hard it would be to execute the different concepts in practice. The cost and time analyses are typically at aggregate level with high uncertainty, since the concept is not described or planned in detail at this stage in a project's life cycle. The mutual relations between different concepts and uncertainty on a more conceptual and more aggregate level are often more important than estimating the true expected value of the different concepts in the early stage of the process (A. Johansen, Sandvin, Torp, Økland, 2014).

#### Uncertainty as a part of project management

Uncertainty in single project can be related to the objective, the technical solution, the building process, the time needed to deliver activities and the objectives, the cost of the different components, and the different controllable and uncontrollable uncertainty factors that may play a part in the execution of the project. However, projects are also subject to strategic uncertainty and contextual uncertainty that happen because of changes in the mother organization and changes in the local and the global environment within which the project is executed (Figure 3).

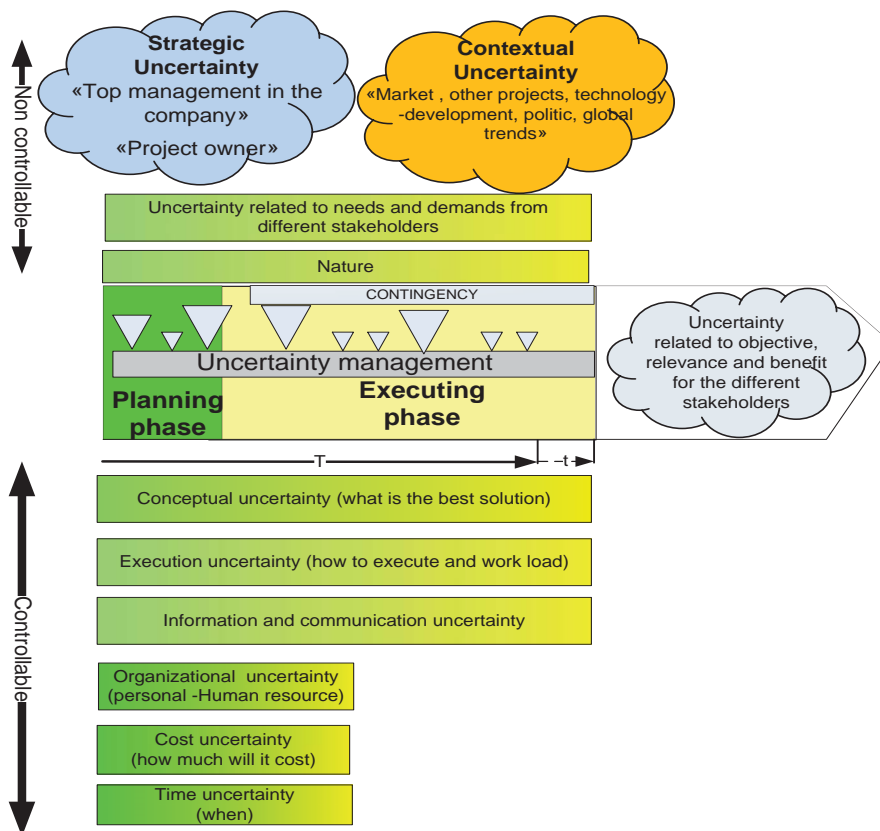


Figure 3 Single projects – strategic uncertainty and contextual uncertainty

Dealing with uncertainty in a single-project environment can be considered both simple and complex depending on the situation and the project. It can be considered as something quite simple if the objective is clear from the start, if the estimated budgets, time buffer, and the cost buffer or contingency is large 'enough', and if the project is able to 'stick to the plan' for as long as possible. By contrast, uncertainty in a single-project environment can be quite difficult if the objectives are unclear, the expectations are high, and the budgets are low. Managing uncertainty with small time and cost buffers as well as handling a lot of foreseen and unforeseen uncertainties in a complex environment with many different stakeholders with different expectations and demands is a difficult task and one that is of high importance for most companies that plan and execute projects.

The focus of my research was on managing uncertainty in single project rather than project programmes or portfolios. I focused on how the project managers and the project owners managed uncertainty, with particular focus on how they dealt with opportunities. I did not study how uncertainty or risk management is used at business or cooperate level or how it is used in finance and incurrence on a corporate level mainly concerned with monetary gain and losses.

I studied how Norwegian companies management uncertainly in practice and compared the findings with the project management, uncertainty, and risk management literature written in Scandinavian

languages (Norwegian, Swedish, and Danish) and English. My aim was to evaluate whether current theories in the field of uncertainty analyses and management are adequate. I therefore analysed and described the development and focus on uncertainty analyses and uncertainty management in Norway.

The concepts presented in this thesis have only been tested in practice in Norway, but all of the theoretical concepts have been presented internationally at conferences, in journals, and against the international state-of-the-art literature. The different concepts that have been developed have been tested against Nordic and English project management (PM) literature, project management standards, and the state-of-the-art research on uncertainty management during the work for this thesis.

Since my research was conducted and developed in collaboration with Norwegian companies, I focused on how they had developed their uncertainty management processes, and spent less time researching how international companies have been developed in terms of uncertainty management.

I had three main focus in my research, one was developing concepts and theories that make a difference to how projects in Norway are managed. Number two was developing and testing concepts, techniques, and theories that my partners in the research projects needed, and this may have had an impact on what types of concepts I developed in my research. And last I have focused on managing uncertainty as a part of project management theory in a single project.

As a result, I spent less time on debating how to manage uncertainty on a corporate level, less time on how to calculate uncertainty and what is the right distribution in an uncertainty analyses and whether Monte Carlo simulation should be used. Instead, I focused more on how project owners and project managers and their staff identify, analyse, and manage uncertainty during project execution in a single-project environment. There were two reasons for this choice of focus. First, in 2004 and 2005 the Concept research programme in Norway had a large project on the topic of uncertainty analysis, the coverage was comprehensive (see Concept Report No. 10 Context and foundation, No. 11 Modelling estimation and calculation, No. 12 Uncertainty analysis and Methodology, and No. 13 Uncertainty analysis- methodological errors in data and analyses) (see also (Klakegg, 1993, 1994; Lichtenberg, 1974). Since the Concept research programme had already done a lot of work on the uncertainty analyses methods area, the need for more theory on that topic was much more limited when I started my work for my thesis

Secondly, I suggest that the management of uncertainty is about identifying future events that may or may not happen, prioritizing them, developing strategies, executing measures, follow-up, and control if they have the expected effect.

Some of the work on how to do an uncertainty analysis is useful and important for managing uncertainty (i.e. the identification of threats and opportunities and the prioritizing part of the process). However, most projects do not have good, reliable statistics that can help them considerably in the prioritizing part, which means that project owners and managers often have to rely on gut feeling and common sense when discussing the probability of future events.

In this thesis I study practical uncertainty management, which concerns how projects deal with uncertainty management in their daily work, and I focus on the people that do the job, the type of process involved, and the types of tools and techniques used to manage uncertainty.

#### 1.4 Structure of the thesis

This thesis consists of five parts:

**Part I The theoretical background**

**Part II The key findings and summary of the publications**

Part III Appendix I – published papers

Part IV Appendix II – bibliography from the project ‘Practical Uncertainty Management in a Project Owner’s Perspective’ (the PUS project)

Part V Appendix III – References

The thesis consists of nine chapters. Chapter 1 (introduction), Chapter 2 (research method), Chapter 3 (the PUS project), and Chapter 4 (projects and uncertainty management theories) provide the theoretical background for the thesis and their purpose is to define the context my research focus.

Part 1 of the thesis covers uncertainty management in a single project, uncertainty management as a part of project management, and uncertainty management during the project life cycle.

Part II of the thesis consists of the remaining five chapters, in which I discuss uncertainty from different perspectives in a single-project environment. Chapter 5 focuses on myths and challenges relating to uncertainty, and uncertainty analyses as concept. Chapter 6 discusses how, in the uncertainty management literature, stakeholders and actors have been reported as influencing the focus and the results of the uncertainty management process. Chapter 7 focuses particularly on the challenges of including opportunities in the uncertainty management process. In Chapter 8 I present my propose method for practical uncertainty management, and in Chapter 9 I present my conclusions and recommendations for further research.

#### **Background – structure and focus**

This thesis builds upon 15 papers that I have published over a period of six years. The papers were been developed from collected data and tested ideas and concepts in three different research projects. In Chapters 3, 4, 5, 6, 7, and 8, I summarize and present some of the main findings and contributions from the papers. The papers that these chapters build upon are listed in Tables 4 and Table 5 in Chapter 2, and can also be found in their original, unedited manuscript form in Appendix I. The elements presented in these chapters are based on my research efforts and reflections combined with those of other scholars, namely my co-authors. For most of the papers, a literature review was part of the writing process, which in turn was part of the deductive-inductive approach upon which this thesis is built. I have chosen to keep the plural form ‘we’ in these chapters, since the papers were produced together with two or three other researchers. Since Chapters 4–8 are based on published papers, I have kept as many of the original ideas and concepts in these chapters as possible. As a consequence, some of the chapters contain a mix of theory and empirical discussion. This choice was made so that it should be possible for readers to understand and read this section of the thesis as a narrative, although it also means that what is new and what are the various co-author’s contributions to the research in this part of the thesis may be less apparent.

The form of this thesis has an impact on how Chapter 2 is built up. A research paper has to follow the strict rules stipulated by the editors. Often, a paper should be a maximum of 10 pages, not more than 4000 words, contain one or a maximum of two ideas or contributions, and so forth. While these guidelines are made to ensure that published papers are focused, in my case they also mean that the research methodology aspects is quite limited and described quite generically in some of the papers. I have therefore chosen to go deeper into research methodology as a topic in Chapter 2, partly to overcome some of the shortcomings that are clearly evident in some of the papers, and partly to reflect and learn more about research methodology as part of my job as a researcher.

#### **The organization of the thesis (see figure 4)**

Chapter 1 presents the rationale for and background to the study. This chapter includes a short introduction on why this research was started, and presents the four research questions that have guided the development of this thesis.

Chapter 2 gives an overview of different methodological approaches to research in project management research and presents the approach used in this thesis. This thesis is a combination of a monographic narrative and many short papers developed in many projects over several years (see Table 4, Table 5, and Figure 7). Chapter 2 starts with a short introduction to the different research strategies in use in the social sciences in general and research on projects in particular. Then the research design and the research model for the thesis are presented, followed by a short introduction to the 15 papers and a summary of the methodological approaches in these papers. Chapter 2 ends with a discussion of the limitations of my research strategy.

Chapter 3 gives a short summary of the PUS project. The PUS project had a significant influence on my research agenda over a six-year period and a lot of my data and experiences in practical uncertainty management were acquired during the project. I have therefore chosen to highlight some of the theoretical and practical results of the PUS project, and I give short overview of the impact that research on uncertainty management has had on the participating organizations discussed in this chapter.

Chapter 4 provides an overview of the theoretical fundament that I consider relevant for this thesis. Uncertainty management has been a part of the PM development journey from the beginning.

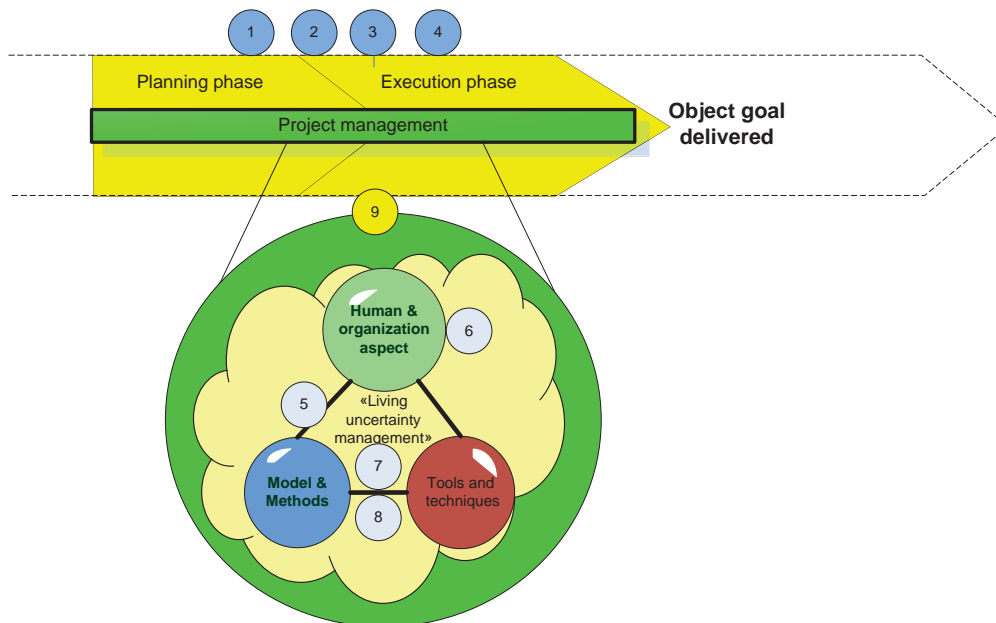


Figure 4 Logical framework for the thesis

Chapter 5 focuses on how uncertainty is understood and analysed in projects in Norway, and on some of the challenges in current uncertainty analyses and their missing link to daily uncertainty management in projects.

Chapter 6 deals with how the human and organizational aspect plays a part in the uncertainty management process. Is uncertainty objective or is it dependent on roles, attitudes, experiences, and how it may impact the different stakeholders during the project? The chapter focuses on how people's mindsets and roles in the project play a part in how uncertainty is managed, and it focuses mainly on the human and method aspect of the 'living uncertainty management' concept.

Chapter 7 focuses on the challenges faced when dealing with opportunity as a part of the traditional risk management process.

Chapter 8 focuses on how some of the challenges presented in Chapters 5, 6, and 7 can be addressed using a step-by-step process for practical uncertainty management: a nine-step framework for identifying, analysing, and managing uncertainty in practice.

Chapter 9 presents my conclusions. The four research questions are discussed, some of main contributions of the thesis highlighted, and suggestions for further research are discussed.

The full publications that Chapter 3–9 are built on are presented in Appendix I. Appendix II contains a complete bibliography of the papers and publications from the PUS project, to enable a more complete list of all paper that I have co-authored be reviewed. The thesis ends with a list of references in Appendix III.

## 2 Research method and methodical approaches in PM research

How can we make develop new theories on a topic that by definition 'is one of a kind'? How can we develop theories on uncertainty management as long as it is a part of project management and depends on the performance of the project management team, the contractor, the project owner, and decisions made by stakeholder outside the project? Is it possible to generate falsifications and acquire some type of objective new knowledge based on one or a few cases? Is it possible to make universal laws and develop theories for projects that are always dependent upon on the context in which they are planned and executed? Project management scholars have battled with these questions for decades. (Smyth & Morris, 2007) state:

A particular problem is the assumption that general patterns concerning the management of projects can be identified, which have explanatory power. Even if this were the case, we need to recognize that recommendations based on these insights cannot be applied mechanically with the expectation of automatic outcomes: applicability is contingent upon context. (Smyth & Morris, 2007)

In this chapter, I give a short introduction to the different research strategies in use in the social sciences in general and research on projects in particular. Then I present my research design and the research model for the thesis. At the end of the chapter, I give a short introduction to different papers that I have developed, summing up my contribution in developing new theory and discussing the limitations in my research strategy.

### 2.1 Research methodology and theory

When scholars start a research process, there are basically two questions or starting points:

- Someone has a problem that needs to be solved
- Someone has an idea and needs to find out how we can benefit from the idea.

The next questions for a researcher will typically be: Do theories relating to the topic exist and are they relevant and correct? The starting point is critical for the research process, which comprises the design of the inquiry, the data collection, the interpretation of the data, and ultimately the conclusions drawn and theory that can be built on the data.

A researcher's understanding of the idea or problem that guides him or her in the chosen research approach. If the idea or problem is not understood because, for example, it is new, complex, or foggy, it will not be a straightforward matter to select the right approach at the beginning of the project. Based on a more or less incomplete understanding of the idea or problem, the researcher must decide on the type and focus of their inquiry, whether it should be an exploratory approach (in cases where few or no previous studies exist), descriptive (to identify and classify elements or characteristics), analytical (to examine why or how something is happening), or predictive (to speculate on future possibilities based on close analysis of available evidence) (see Table 1) (Neville, 2005).

Table 1 Different types of research

Exploratory	Descriptive	Analytical	Predictive
<p>Exploratory research is undertaken when few or no previous studies exist. The aim is to look for patterns, hypotheses or ideas that can be tested and that will form the basis for further research. Typical research techniques: case studies, observations, and reviews of previous related studies and data.</p>	<p>Descriptive research can be used to identify and classify the elements or characteristics of the subject (e.g. number of days lost because of industrial action.</p> <p>Quantitative techniques are most often used to collect, analyse, and summarise data.</p>	<p>Analytical research often extends the descriptive approach to suggest or explain <i>why</i> or <i>how</i> something is happening (e.g. underlying causes of industrial action.</p> <p>An important feature of this type of research is in locating and identifying the different factors (or variables) involved.</p>	<p>The aim of predictive research is to speculate intelligently on future possibilities, based on close analysis of available evidence of cause and effect (e.g. predicting when and where future industrial action might take place.</p>

#### Quantitative versus qualitative research approach

When starting research, scholars need to reflect on their data gathering process and whether it should be quantitative or qualitative or a combined approach. What type of approach is appropriate also depends on the purpose of the study, the research questions, and the chosen strategy. (Marshall & Rossman, 1995) suggest four types of overall research strategies that are common in qualitative research: exploratory, explanatory, descriptive, and predictive studies. However, they also stress that these strategies are independent of the data collection method used in the research strategy. Furthermore, they give suggestions as to what research strategy best fits the different types of study:

1. Exploratory – investigate little understood phenomena, identify variables and generate hypotheses; research strategy – case studies and field studies.
2. Explanatory – explain phenomena, identify plausible causal networks and the shaping of phenomena; research strategy – multisite case studies, history studies, field studies, and ethnographic studies
3. Descriptive – document phenomena of interest; research strategy – field studies, case studies, and ethnographic studies
4. Predictive – predict the outcome of phenomena, and forecast events and the behaviour results of a phenomenon

#### Research strategy – experiment or quasi experiment

The qualitative research approach, which has its origin in sociological studies, has become popular among scholars that study projects (Smyth & Morris, 2007); (Denzin & Lincoln, 2005). However, some project management research studies have chosen a more quantitative approach or a combination of quantitative and qualitative approaches (Krane, Johansen, & Alstad, 2014; Krane, Rolstadås, & Olsson, 2010; G. Themistocleous & S. Wearne, 2000). Quantitative studies emphasize the measurement and analysis of causal relationships between variables, and are normally less interested in the process and context. The focus in quantitative research is on collecting and



analysing numerical data; it concentrates on measuring, for example, the scale, range, and frequency of phenomena. Quantitative studies are often considered as done from a value-free framework. This type of research, although harder to design initially, is usually highly detailed and structured, and the results can be easily collated and presented statistically (Neville, 2005).

The word 'qualitative' implies an emphasis on the qualities of entities and on process and meaning that are not experimentally examined or measured in terms of quantity, amount, intensity, or frequency. Quantitative researchers hold that reality is a social construction and that the close relations between the researcher, what is studied, and the situational context shape the inquiry. Qualitative research is more subjective in nature than quantitative research and involves examining and reflecting on the less tangible aspects of a research subject, such as the values, attitudes, and perceptions. Although this type of research can be easier to start, it can be often difficult to interpret and present the findings; also the findings can be challenged more easily.

(Tjora, 2012) suggests that there are three different starting points to research: the inductive, deductive, and abductive approaches. An inductive research approach means that theories are developed or models are based on observations of a particular situation, and based on the few observations new theories are developed. This type of approach suggests an explorative or empirically-driven research strategy, and hence a qualitative research approach is normally preferred. Inductive research moves from particular situations to make or infer broad general ideas/theories (Neville, 2005; Tjora, 2012).

A deductive research approach starts with the theory or with the models and uses it or them to analyse and understand a specific problem or idea. Consequently, a quantitative research approach is normally preferred. Deductive research moves from general ideas or theories to specific, particular situations: the particular is deduced from the general, such as broad theories (Neville, 2005; Tjora, 2012). By contrast, the abductive research approach has its starting point in the theory, but it acknowledges the importance of theory and perspective in the start-up of the inquiry and during the research process.

Tjora (2012) also suggests that qualitative research should alternate between an inductive and deductive approach. In qualitative research scholars should start with raw data and work from that data to develop new concepts and new theories in a step-by-step approach. The progression from data to concept and theory is inductive in nature, whereas the testing of the theory and concepts against empirical data is deductive in nature.

#### **Research position – positivistic versus phenomenological**

According to (Neville, 2005) surveys, experimental and longitudinal studies, and cross-sectional studies are the preferred methodical approach among researchers with a positivistic research position. A positivistic approach can also be referred to as quantitative, objectivist, scientific, experimentalist, or traditionalist. A positivistic approach is characterized by a detached approach to research and it seeks out the facts or causes of any social phenomena in a systematic way. Positivists hold that the study of human behaviour should be conducted according to the principles of natural sciences and seek to identify, measure, and evaluate any phenomenon and to provide a rational explanation for it. A positivist will attempt to establish causal links and relationships between the different elements that are studied and relate them to a particular theory or practice. Further, a positivist will argue that people respond to stimuli or forces and rules (norms) external to themselves

and that these can be discovered, identified, and described using rational, systematic, and deductive processes.

Neville (2005) further claims that case studies, action research, ethnography (participant observation), participative enquiry, feminist perspectives, and grounded theory are the preferred methodical approaches among researchers with a phenomenological research position. A phenomenological approach can also be referred to as a qualitative, subjectivist, humanistic, or interpretative approach.

However, phenomenological approaches to research have the perspective that human behaviour is not as easily measured as phenomena in the natural sciences. Human motivation is shaped by factors that are not always observable, such as inner thought processes, and therefore it can be hard to generalize on, for example, motivation from observations of behaviour alone. Furthermore, people place their own meanings on events, meanings that do not always coincide with the way others have interpreted them. This perspective assumes that people will often influence events and act in unpredictable ways that challenge any constructed rules or identifiable norms; they are often 'actors' on a human stage and shape their 'performances' according to a wide range of variables. Phenomenological approaches are particularly concerned with understanding behaviour from the study participants' own subjective frames of reference. Hence, research methods are chosen to try to describe, translate, explain, and interpret events from the perspectives of the subjects of the research.

## 2.2 Research methods in social sciences

Many research methods are used in social sciences and they have different weaknesses and strengths (Eisenhardt, 1989; Kvale, Brinkmann, Anderssen, & Rygge, 2009; Marshall & Rossman, 1995; Neville, 2005; Sismondo, 2004; Tjora, 2012; Yin, 2003). According to (Smyth & Morris, 2007), survey questionnaires, case studies, interviews, conceptual modelling, structured models, semi-structured interviews, and ethnographic studies are the most common methods in use in project management studies today.

When starting a research process, a scholar's knowledge of what exists in terms of theory will be more or less insufficient. It can be argued that there theories and concepts exist on almost every topic, and that most research is about reinventing the wheel over and over again. Moreover, when the research process is started it is impossible to have a complete picture of all theories that might be relevant for solving the problem or exploring the idea in question. I therefore recommend that a good, relevant literature study should be one of the first activities in most research projects.

### **Literature studies**

The word 'research' is a combination of two elements – 're' and 'search' – and one understanding of this word is thus 'look again'. Mankind has developed theories and concept to help us to understand the world around us since we were first able to communicate with each other. Today, students and scholars can discover and discuss theories developed by Socrates (b. 470 BC), Plato (b. 428 BC), and Aristotle (b. 384 BC) because they were recorded in writing and preserved for future generations.

The purpose of a literature study is either (1) to find out what has been published on the specific topic under investigation or (2) to identify any patterns in previously published literature. Most of the research done within project management during the last 100 year is available, and accessible via the

Internet. However, that does not mean that conducting a good and relevant literature study is a simple task, as the following considerations indicate:

- What are the right places to search?
  - all written texts that exist?
  - all journals and PM books in the local library?
  - all international PM journals or all management journals, or both places?
  - only internal journals on project management?
  - what types of databases should be used – the BIBSYS database (in Norwegian national libraries and/or international libraries)?
- What is the right time period?
  - the last 100 years?
  - the last two or three decades?
- What are the search terms for the inquiry?
  - ‘risk’ or ‘risk management’, ‘uncertainty’ or ‘uncertainty management’ (my search conducted via Google gave 253,000,000 results for ‘risk’, 95,000,000 results for ‘risk management’, 25,600,000 results for ‘uncertainty’, and 13,200,000 results for ‘uncertainty management’)
  - uncertainty or uncertainty management?
  - risk and opportunity?
  - threats and opportunity management?

Epistemology refers to the theory of knowledge and questions what knowledge is, how it can be acquired, and the extent to which knowledge that is pertinent to any given subject or entity can be acquired. Smyth and Morris (2007) discuss what types of research methodology have been dominant in project management research. In their paper ‘An epistemological evaluation of research into projects and their management: Methodological issues’ they review papers published in the International Journal of Project Management in 2005, in total 68 papers in 8 issues, including 1 special issue: the Sixth Biennial Conference of the International Research Network for Organising by Projects (IRNOP) (Smyth & Morris, 2007). They evaluate whether recent research had applied methodologies appropriately in terms of epistemology, the integrity of the methodologies, and the context in which they were applied in project management research.

Smyth and Morris (2007) found that positivist and empiricist traditions were the most common methodologies in PM research. Both methodologies explain events based on the human law of causality, and linear thinking is dominant. This creates a preference for closed cause–effect models in project management research. Smyth and Morris’s study also shows what types of methods were preferred by the scholars in the project management field in 2005; survey questionnaires, case studies, and interviews were common:

- Survey questionnaire (26)
- Case study (11)
- Case studies (10)
- Interviews (9)
- Conceptual modelling/model (5)
- Structured and/or semi-structured interviews (3)
- Ethnographic studies (2)

### **Positivism in project management research**

According to (Smyth & Morris, 2007) positivism has been dominant historically in research on projects: 'It underpins the PMBOK Guide. Positivism, in its various forms, pursues generalizations in order to establish principles or laws to govern its object. This might suggest it is the most appropriate methodology for a practitioner-oriented discipline like project management' (Smyth & Morris, 2007).

### **Empiricism in project management research**

(Smyth & Morris, 2007) argue that empiricism acknowledges that insufficient is known about a given topic to conceptualize or generalize, and therefore the facts have to be investigated to discover the truth. Empiricism takes a number of different forms. It places primacy upon observation and data, usually seeks to observe without theory, and uses evidence to induce generalizations and build theory. As with positivism, there is a strong instrumentalist current, endeavouring to identify practices and tools that may prove useful. Empiricism has been used in cases where researchers wanted to decouple themselves from existing belief systems, whether theist or paradigmatic. It has been used in cases where little or nothing is yet known, which is not the case concerning the management of projects (Smyth & Morris, 2007)

The study by (Smyth & Morris, 2007) illustrates a further point, namely that a large number of qualitative and quantitative research methods are used in the project management field today. Also, these methods have an impact on the types of results and conclusions that can be drawn from the research. Smyth and Morris conclude that very often there is a lack of evidence of understanding or of integrity in the methodological application in many of the papers they had examined. For example, they found that positivism was applied in six papers taking a case study approach and that several articles applied positivism using a single case, which methodologically is contradictory.

Several other scholars have gone through journals in the field of project management (Betts & Lansley, 1995; Crawford, Pollack, & England, 2006; P. W. Morris, 2011; Pollack & Adler, 2014; G. Themistocleous & S. Wearne, 2000; G. Themistocleous & S. H. Wearne, 2000) and tried to find pattern in themes and what has been in focus in PM research. Particularly good examples of this type of work are Crawford et al.'s paper 'Uncovering the trends in project management: Journal emphases over the last 10 years' (Crawford et al., 2006) and Pollack and Adler's paper 'Emergent trends and passing fads in project management research: A scientometric analysis of changes in the field' (Pollack & Adler, 2015). Scientometric techniques is a research method that has also been referred to as knowledge domain visualization or domain mapping, and can be considered a part of the more general field of information visualization. These types of studies are helpful when researchers are trying to find patterns and schools of thoughts, they also summarize what that has been on the research agenda in recent decades, and they are also helpful in the sense that they review and summarize what has been done and what has been cited, thereby making it easier for other researchers to find literature that could be interesting to read when a new study is planned and conducted.

### **Survey**

Surveys involve the selection of representative and unbiased samples of subjects drawn from the groups to be studied. The main methods involve asking questions face-to-face or by telephone, or sending a questionnaires by post or e-mail. The researcher will typically use structured interviews,

typically with multiple choice or semi-structures questionnaires, or they will use multiple choice or more open-ended questionnaires that allow respondents to state their own opinions, and they may record the data gathering process using an audio recorder (Kvale, et al., 2009; Marshall & Rossman, 1995). There are two main types of survey: descriptive and analytical (Kvale, et al., 2009; Marshall & Rossman, 1995). Descriptive surveys are concerned with identifying and counting the frequency of a particular response among the survey group, whereas analytical surveys are concerned with analysing the relationships between different elements (variables) in a sample group.

#### **Interviews: structured and semi-structured approach**

According to Kvale et al. (2009), interviews should be carried out in seven stages:

1. Deciding the purpose (Why is the research done?)
2. Plan the research (how, when, and who) – developing and testing the interview guide
3. Conducting the interviews
4. Summing up the interviews or transcriptions of the data
5. Analysing and coding the data (What can be learned or extracted?)
6. Verification – Is generalizing possible based on the method and findings?
7. Reporting – presenting use of methods and discoveries (findings)

When transcription is used at stage 4, all spoken words are written down just as they were said during the interview. The interviewer will typically use an audio recorder or a video camera in the process and then afterwards write down the questions, answers, remarks, and all other noises. A full transcription of an interview gives 'rich data' but it is a quiet time-consuming process to process the data afterwards. If the interview is conducted by two researcher, it is possible for one of the interviewers to write down keywords and short sentences during the interview and then supplement the records (summing up and filling in the gaps in the narratives) directly after the interviews have been completed. This will give less accurate data than a full transcription because there is a risk that the summing up may be biased by the interviewers' interpretations; instead of writing down what the respondent said, the interviewer may tend to write down what they believe was said or what they think was interesting, and therefore some parts that might not have seemed relevant would be left out. However, this process is less time consuming than a full transcription and the errors can at least partly be avoided by checking the recordings of the interviews or by letting the interviewees check the summarized version of the interviews. It is also possible to let respondents read through a summary and comment on the notes, to ensure that misunderstandings are minimized.

#### **Case study**

Case studies offer researchers an opportunity to study a particular subject, such as one organization, in depth, or to study a group of people, and usually involve gathering and analysing information that may be both qualitative and quantitative. According to (Eisenhardt, 1989), a case study is a research strategy that focuses on understanding the dynamics present within single settings. In case studies typically a combination of methods are used in the data collection such as archives, interviews, questionnaires, and observations, and the 'evidence' may be qualitative (e.g. words), quantitative (e.g. numbers), or both. Yin (2003) claims that case studies can involve either single or multiple cases and numerous levels of analysis or they can employ an embedded design (i.e. multiple levels of analysis within a single study, Case studies typically combine data collection methods such as archives, interviews, questionnaires, and observations. Lastly, case studies can be used to accomplish

various aims such as providing descriptions and testing, generating, and formulating theories. Thus, case studies can be:

- Descriptive (e.g. where current practice is described in detail)
- Illustrative (e.g. where the case studies illustrate new practices adopted by an organization)
- Experimental (e.g. where difficulties in adopting new practices or procedures are examined)
- Explanatory (e.g. where theories are used as a basis for understanding and explaining practices or procedures).

Some scholars; has according to (Flyvbjerg, 2006) been sceptical and critical of the use of case study as a research method in project management because of the problems of falsification and the fact that the summarizing and analysis of the data tends to be biased by the researcher's views in single-case studies. Abercromie et al. state:

The detailed examination of a single example of a class of phenomena, a case study cannot provide reliable information about the broader class, but it may be useful in the preliminary stages of an investigation since it provides hypotheses, which may be tested systematically with a larger number of cases (Abercrombie, Hill, & Turner, 1984).

Flyvbjerg (2006) claims there are five misunderstandings in use of case studies:

1. Theoretical knowledge is more valuable than practical knowledge
2. One cannot generalize from a single case, and therefore the single case study cannot contribute to scientific development
3. The case study is most useful for generating hypotheses, whereas other methods are more suitable for hypotheses testing and theory building
4. The case study contains a bias toward verification
5. It is often difficult to summarize specific case studies.

These five misunderstandings indicate that theory, reliability, and validity are problematic and hence the status of the case study as a scientific method. However, according to Flyvbjerg case studies take researchers closest to real-life situations, and are the best way to study the details and view how human behaviour plays a role in projects. Further, Flyvbjerg argues:

If researchers wish to develop their own skills to a high level, then concrete, context-dependent experience is just as central for them as to professionals learning any other specific skills. Concrete experiences can be achieved via continued proximity to the studied reality and via feedback from those under study. Great distance to the object of study and lack of feedback easily lead to a stultified learning process, which in research can lead to ritual academic blind alleys, where the effect and usefulness of research becomes unclear and untested. As a research method, the case study can be an effective remedy against this tendency. (Flyvbjerg, 2006, p. 6)

Case studies are in fact useful for both generating and testing of hypotheses but are not limited to these research activities alone (Flyvbjerg, 2006)

Flyvbjerg states that 'testing of theory' can be understood in both a hard and soft sense. In the hard sense, testing of theory is understood as something that comprises explanation and prediction,

whereas in the soft sense it comprises testing propositions or hypotheses. Further, Flyvbjerg argues that case studies are ideal for making generalizations when using the type of test that Karl Popper called 'falsification', which in social science forms part of critical reflexivity (Flyvbjerg, 2006, p. 11), as a case study 'contains no greater bias toward verification of the researcher's preconceived notions than other methods of inquiry. On the contrary, experience indicates that the case study contains a greater bias toward falsification of preconceived notions than toward verification' (Flyvbjerg, 2006, p. 21). A good case study will have rich data and be open to many interpretations, and therefore summarizing case studies is often difficult, especially regarding the processing of cases. It is less correct as regards case outcomes. However, the problems in summarizing case studies are more often due to the properties of the reality studied than to the case study as a research method. Furthermore, despite the difficulty or undesirability of summarizing case studies, in general the case study method can certainly contribute to the cumulative development of knowledge (Flyvbjerg 2006, p. 25). Flyvbjerg concludes that a scientific discipline without a large number of thoroughly executed case studies is a discipline without systematic production of exemplars, and that a discipline without exemplars is an ineffective discipline:

Good social science is problem-driven and not methodology-driven, in the sense that it employs those methods which for a given problematic best help answer the research questions at hand. More often than not, a combination of qualitative and quantitative methods will do the task best. (Flyvbjerg, 2006)

(Eisenhardt, 1989) shares some of the same ideas as Flyvbjerg, and claims that the strengths of building theory by case studies are that case studies give a likelihood of generating novel theory. Although one myth surrounding theory building from case studies is that the process is limited by the investigators' preconceptions, in fact the opposite is true. The constant juxtaposition of conflicting realities tends to 'unfreeze' thinking, and therefore the process has the potential to generate theory with less researcher bias than theory built from the results of incremental studies or 'armchair, axiomatic deduction'. The emergent theory is likely to be testable with constructs that can be readily measured and hypotheses that can be proven false. Measurable constructs are likely because they have already been measured during the theory-building process. The resulting hypotheses are likely to be verifiable for the same reason. The resultant theory is likely to be empirically valid. The likelihood of valid theory is high because the theory building process is so closely linked to the evidence that it is very likely that the resultant theory will be consistent with empirical observation. In well-executed theory building research, investigators answer to the data from the beginning of their research. This closeness can lead to a clear sense of things (i.e. 'how they feel, smell, seem'). This close interaction with actual evidence often produces theory that closely mirrors reality. However, Eisenhardt (1989) points to some weaknesses in theory building from cases. For example, the intensive use of empirical evidence can yield theory that is overly complex. A hallmark of good theory is parsimony, but given the typically enormous volume of rich data, there is a temptation to build theory intended to capture everything. The result can be theory that is very rich in detail, but lacks the simplicity of an overall perspective. There is also a risk that building theory from cases may result in narrow and idiosyncratic theory. Case-study theory building is typically a bottom-up approach, such that the specifics of the data produce the generalizations of theory. The risks are that the theory describes a very idiosyncratic phenomenon or that the theorist is unable to raise the level of generality of the theory (Eisenhardt, 1989).

### Action research

Action research is collective term for research methods where the data gathering and the research is done in connection with the research object. In action research, the intervention from the researcher will influence the situations that they monitor and evaluate, and the researcher will not just observe from distance but will be a part of the process that they are investigating. An action research approach allows the researcher to work with the client to identify a particular objective (e.g. ways of identifying opportunities and threats) as well as how to document it and follow it up in a risk matrix. The researcher enters the situation by, for example, introducing new techniques, and then monitors the results. This type of research requires active co-operation between researcher and client and a continual process of adjustment to the intervention in the light of new information and responses to it from respondents. According to (Dick, 2014), there are several types of approach under the common label of 'action research'. Action research is responsive and flexible, and is undertaken in cycles, whereby the content and choice of methodology in the later cycles are informed by the earlier cycles (Figure 5).

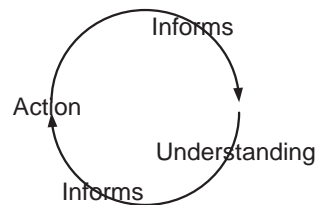


Figure 5 Action research – cycles in action

Method and data and interpretation and action develop simultaneously and from cycle to cycle together with the respondent. In action research, the inquiry and data gathering can be conducted in several ways, such as through interviews, situational observations, field notes, focus groups, and work colleague interviews, which indicate that it tends to be qualitative in its approach. The data collection is normally followed by data transcription data analyses and reflection. These steps can be repeated in several cycles before the process concludes in concepts and theory (Algeo, 2014). In action research, the distance between the researcher and the informant is often limited, and in the interests of building commitment to action, the researcher can play an active role in the process and can be a part of the process that will be analysed later. Action research tends to be participative, qualitative, action-oriented, and emergent (Dick, 2014).

### Ethnography (participant observation)

Ethnographic research evolved from anthropology, and the close study of societies is theoretically quite similar to action research in its approach. Ethnography is more usually described as participant observation, when the researcher becomes a working member of the group or situation under observation. The aim is to understand the situation from the inside, from the viewpoints of the studied people. The researcher shares the same experiences as the subjects, and this form of research can be particularly effective in the study of small groups and small firms. Participant observation can be overt (i.e. everyone knows it is happening) or covert (i.e. when the subjects are unaware that they are being observed).



### **Longitudinal studies**

Longitudinal studies are conducted over an extended period to observe the effect that time has on the situation under observation and to collect primary data (data collected at first hand) relating to the changes. Such studies are often conducted over several years, which makes them unsuitable for most relatively short, taught, post-graduate courses. However, it is possible to base short time-scale research on primary data collected in longitudinal studies by, for example, government agencies, and focusing the research on a close analysis of one or more aspects or elements of the data.

### **Autobiography**

Autobiography is a means of collecting information from small groups of respondents to identify patterns, underlying issues, and life concerns. This method can be used, for example, to trace the influences of variables, work experience, gender and educational experiences, certification of performance, career development and career progression, or lack of it, within an organization. However, it can be a time consuming process as it requires trust to be built between the researcher and the people concerned.

### **Grounded theory approach**

The grounded theory approach is used almost in the reverse order compared to traditional social science research. Rather than beginning with a hypothesis, the first step is data collection and the researcher should start with a clean sheet and an open mind. From the data collected, the key points are marked with a series of *codes*, which are extracted from the text. The codes are grouped into similar *concepts* in order to make the data more workable. From these concepts, *categories* are formed, which are the basis for the creation of a *theory* or a reverse engineered hypothesis.

Table 2 Four stages in grounded theory approach

<b>Stage</b>	<b>Purpose</b>
Codes	Identifying anchors that allow the key points of the data to be gathered
Concepts	Collections of <i>codes</i> of similar content that allows the data to be grouped
Categories	Broad groups of similar <i>concepts</i> that are used to generate a theory
Theory	A collection of categories that details the subject of the research

### 2.3 What is theory? Validity and reliability in project management research

In his article 'Objectivity, value judgment, and theory choice' (Kuhn, 1977) Kuhn states there are five characteristics of a good scientific theory, and that a good theory should:

1. Be accurate – consequences deductible from a theory should be in demonstrated agreement with the results of existing experiments and observation
2. Be consistent – not only internally or with itself but also with other currently accepted theories applicable to related aspects of nature
3. Have a broad scope – it should extend far beyond the particular observations, laws, or subtheories it was initially designed to explain
4. Be simple – it should bring order to phenomena that in its absence would be individually isolated and confused as a set
5. 'Be fruitful of new research findings' – it should disclose new phenomena or previously unnoted relationships among those already known.

(Tjora, 2012) suggests that new concepts and theories must be falsifiable, and it should at least be possible for other scholars to test and re-examine them. Some scholars argue that it is often quite difficult to falsify and re-examine theories derived from research in which a qualitative approach has been used. Universal theory cannot be made from some observation of a few respondents and based on a limited numbers of cases. However, others argue that case studies and action research are the best way to understand in depth what is going on and do not consider that new concepts and theories based on field studies, case studies, and an action research approach are problematic (Eisenhardt, 1989; Flyvbjerg, 2006; Tjora, 2012).

There are several difficulties relating to research on projects; by definition, they are one of kind – they are always influenced by the time and context in which they are executed and they are always dependent on the behaviour and performance of large numbers of different stakeholder that are directly involved in doing the project or more indirectly involved in the project process. The internal stakeholders can be divided into two groups: workers and managers. Both groups need know their job and deliver if a project is to perform well and succeed with the deliveries. However, most projects have also external stakeholders (e.g. sponsors, project owners, and asset owners) that play a vital role in how the project is carried out. The nature of project as a 'one-of-a-kind event' means that much PM theory is based on making sense of limited numbers of observations and that the development of PM theories and concepts will happen in the meeting between scholars and project actors in action. Concept and theory in PM are often built upon observations from cases that have more or less unique contexts and involved different actors. I therefore suggest that it should be accepted that much PM research and theory will be based on some type of qualitative research approach, and that true falsification of PM concepts and theories may be hard or even impossible in some cases, yet that does not mean that such theories have less value or are less valid than theory developed in more quantitative fields.

I suggest that the project management field and tradition have few 'laws or theorems' that are accepted as universal. Project management research is often positivistic in its strategy and it pursues generalizations or to establish principles or laws to govern its object (Smyth & Morris, 2007). However, it is also often qualitative and seeks to understand the world from the perspective of those in it (Merriam, 1995; Neuman, 1997). According to (Lewin, 1946), there are two types of research

objectives in social sciences research: ‘general laws’ and ‘groups of life and diagnostic of specific situation’. Laws deal with possible conditions and possible results, and they are expressed in terms of ‘if so’ propositions and serves as guidance to the achievement of certain objectives under certain conditions (Lewin, 1946). The ‘diagnostic’ has to do with specific character of the studied situation. Based on Lewin’s ideas, I suggest that project management theories mainly fall into what I class as Level 2 or Level 3 theories, as listed in Table 3.

Table 3 Levels of theory – examples

Level	Theory levels	Examples
1	Laws and theorems	Newton’s laws of motion First law: ‘An object either remains at rest or continues to move at a constant velocity, unless acted upon by an external force’ P.-S. Laplace – ‘The central limited theorem’
2	Recommended process components	PRINCE2 – ‘the eight management processes’ IPMA’s ‘competence eye’ PMI’s ‘ten management processes’ Project risk management: processes, techniques, and insights (C. Chapman & Ward, 1996) ‘Practical project management – from idea to profit’ (Rolstadås, 2014)
3	Theoretical texts or models that summarize data or give some kind of diagnostic of a specific situation	‘Who own a project?’ (N. Olsson, et al., 2007) ‘Exploiting opportunities in the uncertainty management’ (Krane, et al., 2014) ‘Opportunities in projects – what are they and do we really want them?’ (Johansen et al., 2012a) ‘Megaprojects – Challenges and lessons learned’ (Zidane, Johansen, Ekambaram, 2012) ‘Uncertainty management – Myths and realities’ (Johansen et al., 2012b) ‘The practical uncertainty management 9 step model’ (Johansen et al., 2013)

I consider textbooks and standards such as the PMBOK (PMBok, 2000), APM BoK (Dixon, 2000), PRINCE2 (Paul, 2003), IPMA competence Baseline (Association, 2006), ISO 21500(Norma; Zandhuis & Stellingwerf, 2013), that have been developed over decades as based on Level 2 theories. It may eventually be possible to falsify some part of this work and thereby consider it as based on Level 1 theories. I place from scholars’ and practitioners’ papers, models, and theoretical contributions in an early stage of development on Level 3. In addition, I consider much of the theoretical contribution of this thesis as Level 3. Hopefully, some of the concepts and theoretical contributions in this thesis also have high external validity and reliability, such that the concepts may change or influence recommended theoretical practice at Level 2.

#### **Validity and reliability in project management research**

The majority of the theoretical foundations of the project management field are theory and concepts developed from some type of observations of actions from projects when they are executed or some type of summarizing of data from projects after they had finished. The qualitative research approach

is often preferred in PM research (Smyth & Morris, 2007). The approach is ideal when operative variables cannot be identified ahead of time, and when the purpose of the study is to understand how the different actors in the project perceive their roles or tasks. The qualitative research approach is often the preferred strategy if the researcher is more interested in trying to build hypotheses rather than testing them (Merriam, 1995).

How the validity (true measured) and reliability (dependable measured) of the research conducted on project is judged is linked to the research strategy (i.e. quantitative versus qualitative approach). (Neuman, 1997) divides validity into internal and external validity, and argues that internal validity has to do with few or no errors in the internal design of the research project. High internal validity means that there are few errors in the design of the study and low internal validity means that internal errors are likely and may have affected the study. External validity is related to the ability to generalize findings from a specific setting, small samples, and a small or wider group of people. High external validity means that the results can be generalized to many groups and many projects, whereas low external validity means that the results apply only to a specific situation. According to (Neuman, 1997), reliability means dependability or consistency, and expresses how easy or hard it will be for other researchers to repeat a study and its conditions, and to what extent the findings will be repeated (Eisenhardt, 1989; Merriam, 1995; Neuman, 1997; Yin, 2003). The more often the findings of a study can be replicated, the more stable and the phenomenon will be considered (Merriam, 1995).

Project management is a part of the social science tradition and qualitative methods are often the preferred research method (Smyth & Morris, 2007), which means that high reliability is normal also problematic in project management research. Perfect reliability in the sense of whether another researcher can replicate a study and find the same results is impossible in most project management research because projects are of one kind. (Merriam, 1995) cites Lincoln and Guba (1985), who state that 'the real question of qualitative research is not whether the result of one study is the same as the results of a second or third study, but whether the results of a study are consistent with the data collected' (Merriam, 1995). Users of qualitative method in PM research are likely to assume that projects are constructed phenomena that are multidimensional and depend on the actors involved, the context in which they are executed, and researchers' capability to interpret the data and studied phenomena. Merriam states:

Qualitative researchers are not seeking to establish 'laws' in which reliability of observations and measurements are essential. Rather qualitative researchers seek to understand the world from the perspective of those in it. Since there are many perspectives, and many possible interpretations, there is no benchmark by which one can take repeated measures and establish reliability in the traditional sense. (Merriam, 1995)

Several strategies can be chosen to strengthen the internal and external validity and reliability in project management research (Eisenhardt, 1989; Merriam, 1995; Neuman, 1997; Yin, 2003):

Strategies for strengthening internal and external validity:

- Triangulation – use of multiple investigators, multiple sources of data, or multiple methods to confirm the findings
- Member checks – test and check the data collected on the people from whom they were derived; present the tentative interpretations of the data on some of the actors from the study
- Peer examination – test on colleagues the data and plausibility from the study
- Statement of researcher's experience and background, as well as statements of the starting point of the research, biases in literature, and the study cases or examples.
- Submersion or engagement in the research situation – collect data from enough projects or cases over a long enough period to ensure that in-depth understanding of the phenomenon is obtained.

Strategies for strengthening the reliability of a study:

- Clear conceptualization of the study – have a clear theoretical starting point and clear measures that indicate that only one concept is preferred, if possible
- Multiple levels of measurement – try to measure at the most precise and most specific level as possible
- Use multiple indicators of a variable – two indicators tend to be more stable than one
- Use pre-tests or pilot studies – by testing questions or doing a pilot study, 'bad questions' and errors in the study can be corrected before conducting the full-scale study.

High validity (internal and external) and reliability should always be the goal when research is conducted. However, in project management research it must be accepted that most of the research is conducted as a snapshot of a moving object, and that in most cases there are limited possibilities to control the context, the stakeholders, and all of the parameters that influence the study. It is therefore important that it is made clear how the study was conducted, what the limitations of the study are, and how far it is possible to generalize the results of the study.

#### 2.4 Methods and research design of the thesis

My starting point as a researcher was in production engineering and project management. I started my career as a junior researcher in 1995 and worked as a project management consultant from 1999 to 2003. At the beginning I focused on the standardization of PM practice and project start-up in my research. Over the years I have worked and published on various PM topics such as stakeholder analysis and management, cost estimation, time planning, PPP contracts, uncertain analyses, uncertainty management, and communication and learning in projects. Most of my research has had a social science approach and it has been executed in firm and PM organizations. Throughout, my focus has been on developing practical methods, tools, and PM management techniques for my clients. My research on uncertainty analysis and on uncertainty management started in 2004, when I contributed to two research projects: the NSP project 'Uncertainty as a learning arena', in which we developed the first textbook on the Norwegian Quality Assurance (QA) system; and the Concept

project ‘Uncertainty analysis – Methodology’ (Austeng, et al.), in which I worked on a literature review of uncertainty management process and techniques.

The experiences from my early years as consultant together with the experience I gained in the above-mentioned projects were important for the research design chosen for the third project in which I participated: ‘Practical uncertainty management in a project owner perspective’ (the PUS project). My ambition as the senior researcher and project manager for the PUS project was to develop something practical that project managers could use in their daily work with handling uncertainty. I also chose the research design developed in the PUS project for this thesis. It is a step-by-step deductive and inductive approach (Figure 6). It starts with the collection of empirical data that are checked against theory, and thereafter the data are processed, categorized, and again tested and checked against current theory. The process ends with the development of new concepts and a new theory that is checked against current theories. (Figure 6)

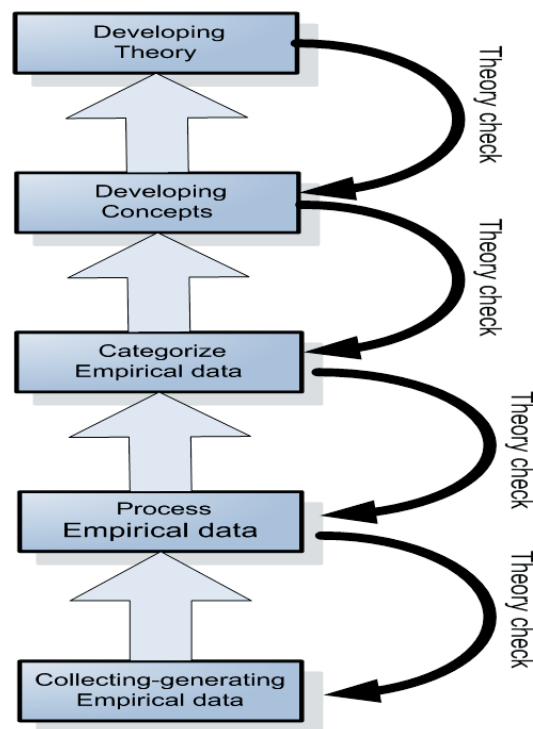


Figure 6 Research design – step-by-step deductive and inductive approach (inspired by Tjora 2012)

My research design builds upon literature reviews conducted as part of the development of the papers and literature reviews that were done as part of the three projects: the NSP project (‘Uncertainty as a learning arena’), the Concept project (‘Uncertainty analysis – Methodology’), and the NSP project (‘Practical uncertainty management in a project owner perspective’) (Torp, Karlsen, & Johansen, 2008). It builds upon two large surveys conducted in the PUS project, interviews conducted in six firms, discussions with experts in focus groups, and cases studies and action research conducted in six Norwegian companies over a period of six years. This implies that my

findings relate specifically to Norwegian project culture, which means that in some parts of my research results cannot necessarily be generalized globally (Dick, 2014; Neville, 2005; Tjora, 2012; Yin, 2003).

I use both quantitative and qualitative approaches in my papers. I tried to alternate between inductive and deductive approaches, as illustrated in Figure 6. This implies that in some of the studies on which the papers are based I started with raw data and worked from the data to develop new concepts and new theories, while in other cases I started with a theory and tested whether the recommendation or description in the theory fitted with what can be observed in practice. The moving upwards from data to concept and theory is inductive in nature, whereas the testing of a theory and concepts against empirical data is deductive in nature.

Risk and uncertainty have been a part of economic studies, psychology (decision theory), insurance, finance, and other engineering disciplines (including safety and reliability studies), to mention a few. My background and work experience as engineer working with large construction projects and with project management as topic influenced my starting point and the focus of my research. This does not mean that I did not look into other fields for inspiration, but rather that my work focuses on how to analyse and manage uncertainty in large infrastructure projects (e.g. hospitals, schools, roads, railways, power plants, oil and gas project, and public buildings) and in ICT and research projects. It also means that my ambition has been on developing project management theory and concepts that can be published in PM journals and that can be used in practice in projects.

Hence, reading and understanding what has been published about uncertainty management in the project management literature, textbooks, PM standards, company standards, research journals, and elsewhere was an important part of my journey to develop the concepts and theories presented in this thesis. Equally important for this thesis is the understanding of how projects identify, analyse, and deal with the uncertainty in practice. Accordingly, I aimed to collect empirical data that demonstrate how uncertainty is interpreted and dealt with in real projects. That process gave me in-depth insight into how the uncertainty analysis and management were conducted and who was involved in the process. I hoped to find out how the different stakeholder influenced the process, and how the empirical data from project practice fitted current theory in the PM literature.

Part of my empirical data collection also involved collecting material from companies that describes risk and uncertainty handling. I collected information on tools descriptions, process descriptions, company requirements, textbooks, and models in use in uncertainty and risk management in six different companies as a part of an AS-IS study conducted in the PUS project. As part of the preface to the PUS project 2005, we conducted a short literature review to try to establishing the theoretical front on uncertainty management as a part of establishing the need for doing the research on uncertainty management in Norway. Then, in 2007 and 2008, we did a more extensive literature study of uncertainty and uncertainty management.

The result was summarized in the Norwegian Centre for Project Management report titled *Theory and Knowledge Background in Uncertainty management (my translation)* (Teori, kunnskapsgrunnlag og rammeverk innen usikkerhetsstyring av prosjekter) (Torp O, 2008). The report describes current theories and methods within uncertainty and risk management from a literature point of view, and covers Norwegian and international PM literature published in the period 1998–2008. We used the Norwegian BIBSYS database, which has links to research databases, and used the search terms

'uncertainty', 'risk uncertainty management', and 'risk management'. We limited the research to what could be considered as PM-relevant journals (i.e. the International Journal of Project Management, Journal of Risk and Uncertainty, Building Research and Information, European Management Journal, and Risk Management); Norwegian and English PM textbooks; proceedings from the IPMA World Congress, Nordnet, and the PMI research conference; reports from the International Project Management Association (IPMA), Project Management Institute (PMI), and Association for Project Management (APM); reports of construction industry activities and cultural aspects of uncertainty management in project-driven organizations; and the Construction Industry Institute (CII) as well as Norwegian and international standards for risk and uncertainty management.

## 2.5 AS-IS study from the PUS project

A more extensive literature study of uncertainty and uncertainty management was conducted as part of the PUS project, and summarized in a report (Torp O, 2008). The AS-IS report describes current theories and methods within uncertainty and risk management from a literature point of view. Much of the literature within the field of risk and uncertainty management concerns uncertainty and risk analysis, and does not focus on the management aspects of risk and uncertainty management. Recent Norwegian research initiatives, such as PS 2000 and Concept, have focused on uncertainty and risk analysis. There is lack of a common and accepted terminology within uncertainty management (Torp O, 2008). This report describes different approaches to risk and uncertainty.

Uncertainty management is often described through a process model. A lot of such process models are described in the literature. I have tried to present processes with different approaches. In the report (Torp et al., 2008), we describe three internationally acknowledged processes: the PMI's Risk Management process, Chapman and Ward's SHAMPU framework, and the ISO 16085 Risk Management Process (ISO/IEC 16085, 2006). We also present the work done by the Norwegian Centre of Governmental Economics (Senter for Statlig Økonomistyring (SSØ)) on the risk management process. Based on the chosen processes and other literature identified, we established a generic framework for uncertainty management. The process consists of the following steps:

1. Uncertainty Management Planning
2. Uncertainty Analyses
3. Uncertainty Treatment
4. Uncertainty Monitoring
5. Evaluate the Uncertainty Management Process
6. Documentation

The report by Torp et al. (2008) describes findings from the literature within these steps. Based on these findings, we identify some areas that have been weakly covered by the literature and that should be focused on in future research in order to develop the project management theory further. The findings presented in the report were input into further research in the PUS project. The following questions are proposed as future research questions to be addressed in the PUS project:

- How should an organization plan and implement uncertainty management in their projects?
- How does the uncertainty profile of a project change during the project's life cycle?
- What management and leadership activities concern uncertainty?
- How could opportunity management be implemented (in addition to risk handling)?
- What is an efficient way of communicating uncertainty to project owner and other stakeholders?



- What cultural and organizational issues exist, and how should they be considered when implementing uncertainty management?

The main conclusion from the literature study in the PUS project is that there is much literature on uncertainty analysis, risk analysis, and risk management. Most of the PM literature focuses on risk analysis, and there seems to be lack of theories on uncertainty management.

## 2.6 My contribution to the research published in the period 2005–2015

Figure 7 shows the type of papers and books that I have published in the period 2005–2015. In my role as senior researcher in the PUS project I co-authored most of the paper produced in the PUS project. As project manager I was responsible for deciding what to research and for deciding the different research teams. Normally, my role in the team was to collect the data, lead the discussions, and draw the conclusions from the work. Additionally, as the project manager and senior researcher, I was responsible for the quality control of every paper that was produced based on data from the participating organizations in the PUS project.

Figure 7 shows some of the products and the main deliverables that I have produced together with my colleagues from NTNU and SINTEF in the three above-mentioned research projects. Tables 4 and 5 list the papers on which this thesis is built. Table 4 lists the published papers and my role as a co-author. The full versions of the papers are provided in Appendix I. Appendix II contains the bibliography from the PUS project and shows all papers that have been written in the PUS project and after it had finished (2011–2014). Table 5 provides a short overview of the research methodology and the purpose and focus of the papers, and Table 6 shows which papers are cited in which chapters in this thesis.

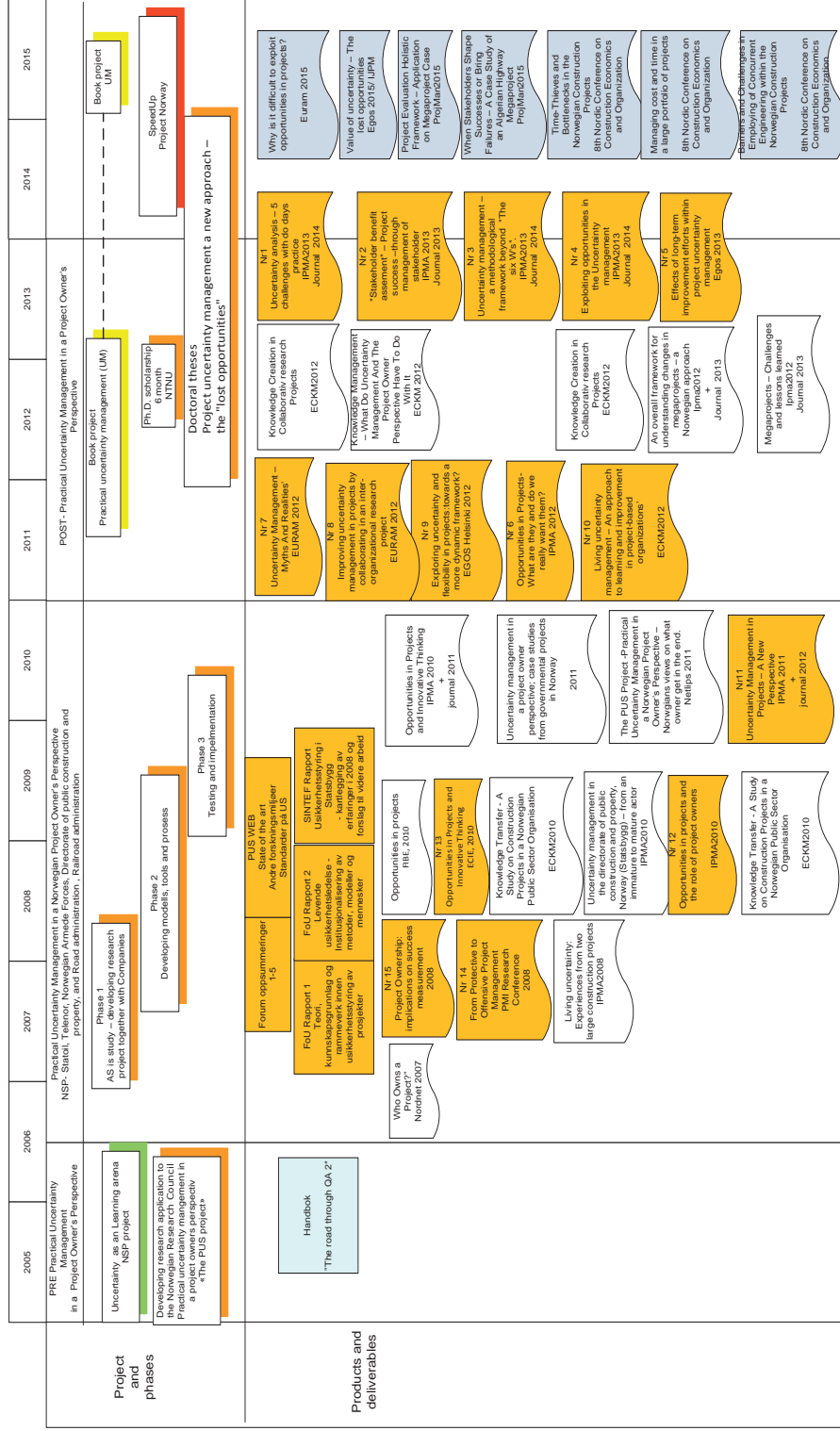


Figure 7 Projects, production, and deliverables

Table 4 Published papers and my contribution

No.	Paper title	Contribution/role in preparing the paper
1	Johansen A, Sandvind B, Torp O, Økland A Uncertainty analysis – 5 challenges with today’s practice <i>Social and Behavioral Sciences</i> (2014), pp. 591–600 information Double blind review	First author Collecting the data, leading the discussions, and drawing up the conclusions from the work
2	Johansen A, Andresen P E, Ekambaram A Stakeholder benefit assessment – Project success through management of stakeholders <i>Procedia – Social and Behavioral Sciences</i> (2014), pp. 581–590 Double blind review	First author Collecting the data, leading the discussions, and drawing up the conclusions from the work together with my fellow researchers
3	Johansen A, Halvorsen SB, Haddadic A, Langlo JA Uncertainty management – A methodological framework beyond ‘the six Ws’ <i>Procedia – Social and Behavioral Sciences</i> (2014), pp. 566–575 Double blind review	First author collecting the data, leading the discussions, and drawing up the conclusions from the work together with my fellow researchers
4	Krane H, Johansen A, Aalstad R Exploiting opportunities in the uncertainty management <i>Procedia – Social and Behavioral Sciences</i> (2014), pp. 615–624 Double blind review	Second author Responsible for data collection from five cases and the analyses, and for drawing up the conclusions from the work together with my fellow researchers
5	Johansen A, Langlo JA Effects of long-term improvement efforts within project uncertainty management Egos 2013 Conference proceedings Double blind review	First author collecting the data, leading the discussions, and drawing up the conclusions from the work together with my fellow researchers
6	Johansen A, Ekambaram A, Hald LC Opportunities in projects – what are they and do we really want them? IPMA, 2012 Conference proceedings Double blind review	First author collecting the data, leading the discussions, and drawing up the conclusions from the work together with my fellow researchers
7	Johansen A, Ekambaram A, Krane HP, Steiro T Uncertainty management – Myths and realities EURAM 2012 Conference proceedings Double blind review	First author Collecting the data, leading the discussions, and drawing up the conclusions from the work together with my fellow researchers
8	Johansen A, Ekambaram A, Hald LC Improving uncertainty management in projects by collaborating in an inter-organizational research project EURAM 2012 Conference proceedings Double blind review	First author Collecting the data, leading the discussions, and drawing up the conclusions from the work together with my fellow researchers

No.	Paper title	Contribution/role in preparing the paper
9	Johansen A, Ekambaram A, Krane HP, Steiro T Exploring uncertainty and flexibility in projects: Towards a more dynamic framework? Egos 2012 Conference proceedings Double blind review	First author Collecting the data, leading the discussions, and drawing up the conclusions from the work together with my fellow researchers
10	Johansen A, Ekambaram A, Hald LC Living uncertainty management – An approach to learning and improvement in project-based organizations ECKM 2012 Conference proceedings Double blind review Sonning Common, UK: Academic Publishing International	First author Collecting the data, leading the discussions, and drawing up the conclusions from the work together with my fellow researchers
11	Ekambaram A, Johansen A Uncertainty management in projects – A new perspective IPMA World Congress, 2011, Brisbane Conference proceedings Published in Project Perspectives 2013, pp. 68–73	Second author Development of the idea of the paper and leading the discussions together with my fellow researcher
12	Ekambaram A, Johansen A, Jermstad, O Opportunities in projects and the role of project owners IPMA World Congress, 2010 Conference proceedings	Second author Development of the idea of the paper, leading the discussions, and drawing up the conclusions from the work together with my fellow researchers
13	Ekambaram A, Johansen A, Økland A  Opportunities in projects and innovative thinking  ECIE, 2010 Conference proceedings Double blind review	Second author Development of the idea of the paper, leading the discussions, and drawing up the conclusions from the work together with my fellow researchers
14	Rolstadås A, Johansen A From protective to offensive project management PMI EMEA Congress, 2008 Conference proceedings	Second author Responsible for data collection from two cases and for the analyses, and drawing up the conclusions from the work together with my fellow researcher
15	Olsson, NOE, Johansen, A, Langlo, JA, Torp O Who owns a project? EURAM – 2007 (extended version) Double blind review Nordnett 2007 Reykjavik <i>Measuring Business Excellence</i> (2008) 12:1, 39–46	Second author I was part of the team that developed the idea, contributed with data, and I drew up the conclusions from the work together with my fellow researchers

Table 5 The papers: methodological approaches and focus

No.	Paper title	Main methodological approach	Main focus of the paper
1	Uncertainty analysis – 5 challenges with today's practice	This paper is a product of collective reflection, experience, and the knowledge of the authors. It is of a qualitative nature as we do not present any quantitative or statistical evidence or methods in our approach. It build upon the literature review conducted in the PUS project and the two surveys (see Paper 5 for more details). Semi structured interviews, in-depth interviews, and discussions with experts form six different companies that participated in the PUS project.	We present five challenges in connection with the way uncertainty analyses of cost estimates are done today in Norway, and present findings that indicate a need to rethink the uncertainty analyses of the projects that have a high degree of uncertainty.
2	Stakeholder benefit assessment – Project success through management of stakeholders	This paper is a product of collective reflection of our experience and knowledge. It is qualitative in the sense that we do not use any quantitative or statistical evidence or methods in our approach. It build upon the literature review conducted in the PUS project and the two surveys, semi structured interviews, in-depth interviews and discussions with experts form 6 different companies that participated in the PUS project).	This paper focuses on the relationship between the stakeholders and opportunities. It discusses how a project should deal with its internal and external stakeholders who are associated with determining the project's objectives and uncertainty issues.

No.	Paper title	Main methodological approach	Main focus of the paper
3	Uncertainty management – A methodological framework beyond 'the six Ws'	<p>The framework and methods outlined in this paper were developed as a part of a Norwegian research project with special focus on uncertainty analysis and uncertainty management 'Practical uncertainty management in the project owner perspective' ((Praktisk styring av usikkerhet i et eierperspektiv, abbreviated to the PUS project) (2005–2010).</p> <p>Data were collected relating to literature reviews, surveys, semi-structured interviews, in-depth interviews, and discussions with experts, and action research in case studies. Some of the case studies were longitudinal and qualitative in nature.</p>	<p>We suggest a framework for uncertainty management consisting of two steps for preparing the process, a five-step group process for identifying, analysing and developing measures for exploiting or controlling the uncertainty, and two steps for following up the uncertainty during the project life cycle.</p> <p>The framework that we present corresponds to a certain extent to the ATOM framework developed by Hillson and Simon (2012) in the UK.</p>
4	Exploiting opportunities in the uncertainty management	<p>In the studies we use combined qualitative and/or quantitative methods with interviews and analyses of the projects' risk registers as two of the main elements.</p> <p>We also build upon the literature review conducted in the PUS project, and discussions and semi-structured interviews with experts from six different companies that participated in the PUS project.</p>	<p>Uncertainty management should include both possible threats and opportunities This is claimed to be the common view among both practitioners and academics. However, it is questioned whether uncertainty analyses and uncertainty management is still focus mainly on threats, and too few seek to exploit opportunities. If this is the case, then the projects will only to a small extent achieve the benefits they could potentially achieve from those opportunities. In this paper we analyses how projects actually exploit opportunities.</p>

No.	Paper title	Main methodological approach	Main focus of the paper
5	Effects of long-term improvement efforts within project uncertainty management	<p>This paper uses a longitudinal approach and it combines results from two research projects in Norway: The Concept research programme and the PUS project.</p> <p>The Concept programme has carried out trailing research on the management and governance of, in principle, all larger Norwegian public sector projects (i.e. with total costs of more than EUR 70 million) since 2002. This means that it has examined and evaluated approximately 130 large public projects, and holds records of those projects in its database.</p> <p>Our results are based on a multitude of techniques and methodologies. There have been literature studies of the different areas of relevance (e.g. (Torp, 2002) and (Torp, et al., 2008), there have been several surveys, action research has been done in a number of projects and trailing research in others, and in-depth interviews and discussions with experts.</p> <p>The results presented are also based on a number of case studies of projects. Some of the case studies were of a longitudinal and qualitative nature, in which the authors were involved as researchers and process contributors, repeatedly in all the cases.</p> <p>Two surveys regarding the uncertainty management of the projects were conducted in a number of the projects studied in the PUS research project. Questionnaires were distributed to a representative selection of participants related to the projects. Electronic and paper-based</p>	<p>The research findings show that cost estimates normally increase over time. However, the increase from sanction to delivery is modest and normally within acceptable risk contingencies. The findings also confirm that organizational maturity in the uncertainty management area and individual maturity evolved between 2006 and 2011.</p>

No.	Paper title	Main methodological approach	Main focus of the paper
		<p>questionnaires were distributed to 2701 persons, and overall there was a response rate of 29.7%. In both instances, the questionnaires use of longitudinal surveys were not identical. This means that the results from the first survey had to be manually processed in order to be compared.</p> <p>Some of the quantitative studies done in the PUS research project were based on data extracted from the risk registers of seven large projects in the energy sector and five projects in the public sector.</p> <p>Also, longitudinal quantitative economic analyses have been done in the Concept programme.</p>	
6	Opportunities in projects – what are they and do we really want them?	<p>The study builds upon different research results from the PUS project.</p> <p>Data were collected relating to a literature review, surveys, semi-structured interviews, in-depth interviews and discussions with experts, and action research in case studies. Some of the case studies were of a longitudinal and qualitative nature.</p>	<p>This paper discusses what opportunities are, and how to explore and exploit opportunities actively during the project.</p> <p>It also presents strategies to deal with opportunities and threats. In addition, this paper briefly describes the roles of project owner and project manager with respect to dealing with opportunities and threats.</p>
7	Uncertainty management – Myths and realities	<p>The study related to this paper is based on literature studies of the different areas of relevance, several surveys. Action research has been done in a number of projects and also in-depth interviews and discussions with experts.</p>	<p>The aim of this paper is to discuss a set of often-claimed viewpoints on project uncertainty. We organize the ideas into what we denote as ‘three myths about project uncertainty’. We describe relevant theories as a background and a framework for describing the three myths.</p>



No.	Paper title	Main methodological approach	Main focus of the paper
8	Improving uncertainty management in projects by collaborating in an inter-organizational research project	This paper uses a longitudinal study approach. It builds upon two surveys (see Paper 5) and semi-structured interviews, in-depth interviews, and discussions with experts from six different companies that participated in the PUS project.	This paper presents how a collaborative research project on uncertainty management (the PUS project) contributed to produce positive results, on both the theoretical and practical fronts. In this regard, this paper describes instances and achievements that demonstrate how the participating organizations developed their competence in managing uncertainty in projects.
9	Exploring uncertainty and flexibility in projects: Towards a more dynamic framework?	The same approach as in Paper 6. The paper builds upon different research results from the PUS project. Data were collected relating to a literature review, surveys, semi-structured interviews, in-depth interviews, and discussions with experts and action research in case studies. Some of the case studies were of a longitudinal and qualitative nature.	In this paper we question some of what we believe are the basic assumptions regarding uncertainty and flexibility in projects. We address and/or discuss three basic assumptions that have strong impact on how projects are planned and executed in what some authors refer to as the task perspective (e.g. Andersen, 2008).
10	Living uncertainty management – An approach to learning and improvement in project-based organizations	This paper builds upon semi-structured interviews, in-depth interviews and discussions with experts from six different companies that participated in the PUS project.	<p>This paper discusses learning and improvement in project-based organizations. It paper looks at uncertainty management in projects and focuses on learning in organizations:</p> <ul style="list-style-type: none"> <li>• Managing and/or dealing with uncertainty are connected to learning and knowledge sharing</li> <li>• Reflecting and making sense of the situation individually and/or collectively</li> <li>• Utilizing existing knowledge or seeking new knowledge to manage uncertainty</li> <li>• Gaining new knowledge and competence by managing uncertainty effectively</li> </ul> <p>These four aspects can go in a spiral to facilitate improvement in managing uncertainty, and contribute to developing learning organizations.</p>

No.	Paper title	Main methodological approach	Main focus of the paper
11	Uncertainty management in projects – A new perspective	<p>This paper uses a longitudinal study approach. During the PUS project, two focus seminars per year were conducted with the intention of anchoring plans, developing new models, procedures, routines, and transferring experiences between project managers and project owners in the involved organizations. The results were summarized in internal forum reports.</p> <p>This study is primarily descriptive. However, it also incorporates explorative characteristics, at least certain extent. The manner data were obtained and looked was and is qualitative nature. The research instruments and methods that we used were semi-structured interviews and action research: Semi-structured interviews in workshops over an approximately six-month period. Twelve persons participated in the workshops in that period. Discussions at the workshops were carried out with the help of sets of questions. Action research: several sessions of uncertainty analysis were carried out in various projects. One of the authors of this paper participated actively in and led or facilitated the sessions. Experience from these analyses were reflected upon in connection with the topic of opportunities in projects and used in this paper.</p>	<p>This paper presents examples from industry to highlight some of the benefits that the involved organizations obtained in collaboration with the PUS project</p>
12	Opportunities in projects and the role of project owners	<p>This study is primarily descriptive. However, it also incorporates explorative characteristics, at least certain extent. The manner data were obtained and looked was and is qualitative nature. The research instruments and methods that we used were semi-structured interviews and action research: Semi-structured interviews in workshops over an approximately six-month period. Twelve persons participated in the workshops in that period. Discussions at the workshops were carried out with the help of sets of questions. Action research: several sessions of uncertainty analysis were carried out in various projects. One of the authors of this paper participated actively in and led or facilitated the sessions. Experience from these analyses were reflected upon in connection with the topic of opportunities in projects and used in this paper.</p>	<p>This paper looks at opportunities, and how to identify and create opportunities in projects. Exploring potential opportunities in a project and utilizing them requires among other things a broad understanding of the project as well as of its effect.</p>
13	Opportunities in projects and innovative thinking	<p>The same approach is used as in Paper 12.</p>	<p>This paper looks at the positive side of uncertainty (i.e. opportunities). In this regard, the paper attempts to characterize opportunities in projects – in general as well as with respect to different types of objectives associated with projects. This paper also suggests ways of finding and/or creating opportunities.</p>

No.	Paper title	Main methodological approach	Main focus of the paper
14	From protective to offensive project management	The research is based on case study approach combined with a literature review.	The project risk management focuses on risk analysis at the front end loading. This paper suggests that this is a protective strategy. Seven challenges are proposed, that enable a project to shift from a protective to an offensive strategy. The strategies are developed and discussed in relation to two cases.
15	Who owns a project?	The research is based on a case study of owner structures in 11 projects from both the private and public sectors.	The purpose of this paper is to discuss ownership in a project perspective, and to illustrate different aspects of ownership in a set of selected cases. Owners are defined as stakeholders who have both control and responsibility for cost and income related to a project. The study results indicate that owner responsibilities are not always concentrated in an individual stakeholder in a project. While a traditional owner can be identified for some projects, it is a more complex picture in many other projects. In particular, this is the case for governmental projects.

Table 6 Which papers are used in which chapter in the thesis:

Chapter in thesis		Paper			
1	Introduction – managing uncertainty new project management theory?	Starting point and the rationality for the thesis			
2	Research method and methodical approaches in PM research	Research methodology and theory Methods and research design for the thesis My contribution to the research			
3	Practical uncertainty management in a Norwegian project owner’s perspective – the PUS project	Paper nr 5	Paper nr 8	Paper nr 9	
4	Projects – from delivering a unique task to a tool for delivering value for project owners	Paper nr 5	Paper nr 14	Paper nr 15	
5	Uncertainty – analyses and management	Paper nr 1	Paper nr 5	Paper nr 7	Paper nr 8
		Paper nr 9			
6	Uncertainty – the human aspect	Paper nr 4	Paper nr 5	Paper nr 6	Paper nr 8
		Paper nr 9	Paper nr 13		
7	Opportunity management	Paper nr 2	Paper nr 4	Paper nr 6	Paper nr 7
		Paper nr 11	Paper nr 12	Paper nr 13	
8	Practical uncertainty management – nine-step framework for identifying, analysing, and managing uncertainty	Paper nr 1	Paper nr 2	Paper nr 3	Paper nr 8
9	Conclusion: Project uncertainty management: the need for a new approach – the ‘lost opportunities’				

## 2.7 Critical assessment of research methods used in the thesis

The starting point for a thesis can be *inductive* (i.e. based on observations or new theories), it can be *deductive* (i.e. based on theories developed and studied, and ending with a new or adjusted theory), or it can have a *grounded theory* approach if no theories or observations on the subject exist. In all cases, the thesis should start with a need to develop new theory, normally visualized in research questions that the study aims to answer. In an ideal world, the research questions should be developed at the beginning of the study and there should be a close link between the research questions, the research method, the data collection, the analysis, the presentation of the findings, and the development of concepts and theory. From the beginning the development of this thesis has been less structured than the above-described ideal. The story that led to this thesis started at the end of the 1990s. The research for this thesis was not done in a single project, but is based on several large research projects that had separate purposes and research agendas. The data and theory development have been ongoing over a 10-year period, as shown in Figure 7. This thesis is built on four different building blocks:

1. The experience I have gained from different projects in which I have had a uncertainty management role in the period 2000–2015
2. The uncertainty analyses that I have been part of in the period 2000–2015
3. The literature I have reviewed
4. The research projects in which I have participated in the period 2005–2015

Figure 8 shows the building blocks in the development of new theories.

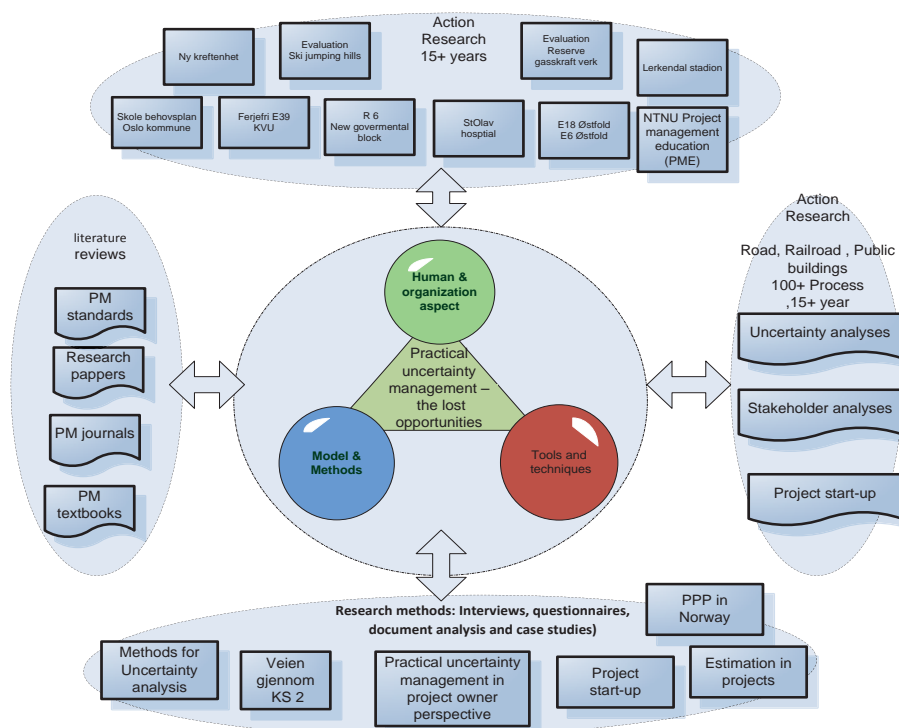


Figure 8 Building blocks for new theories

The research question for this thesis was developed and formalized as a part of my work as project manager and senior researcher in the PUS project that started in 2006. The PUS project gave me the opportunity to focus my research on practical uncertainty management, and it formalized the direction of my research agenda. The project provided the research agenda, the practical cases, and a community of practitioners and researchers interested in the same question: How can uncertainty in Norwegian projects be managed in a practical way? The project also gave me the opportunity to develop and conduct research on the four areas covered by my research questions (see Section 1.3). My research questions were therefore more or less deduced from the PUS agenda rather than developed as a starting point of my thesis. That means that the papers (listed in Table 5) upon which this thesis is built fit the research questions quite well in some areas and quite poorly in others. All of the papers presented as part of this thesis have practical uncertainty management as their focus, but not all of them were written with the four research questions as their explicit starting point.

#### **How valid and how reliable are the results of the research for this thesis?**

I started this chapter with four questions. Doing research on a topic that by definition 'is one of a kind' and that is dependent on the context and the stakeholders involved makes falsification of theory and laws difficult in project management research.

I consider projects as open systems that are influenced by company strategies, other projects, the market, and the changing society in which they are executed. Consequently, it is impossible to isolate the performance of a project to one role or one person, when discussing project owners, project managers, project management teams, or how well projects perform in uncertainty management. This means that it is always some degree of subjectivity involved, and in most cases some type of social construction that we try to analyse and from which we try to develop new theories. It will therefore always be possible to *question the reliability* of the data and the conclusions that we draw from data in PM research.

My research was conducted on Norwegian companies and Norwegian projects, which means that my insights and my conclusions are drawn based on cases with Norwegian personnel and a Norwegian project management culture. Hence, my findings may have some limitations in terms of external validation, since the culture of a country is known to affect the management culture in its projects (Hofstede, 1980). To strengthen the external validation and reliability of the thesis, triangulation of methods in terms of multiple investigators, multiple sources of data, or multiple methods to confirm the findings, and member checks were used extensively during the research process.

Part of the conclusions drawn in this thesis build upon two case studies with a longitudinal design and case studies with an action research approach (A. Johansen, Eik-Andresen, & Ekambaram, 2014a; A. Johansen, Ekambaram, & Hald, 2012a; A. Johansen, Krane, Ekambaram, Steiro, 2012b; A. Johansen & Langlo, 2013; A. Johansen, Sandvin, Torp, Økland, 2014c). In the two case studies with a longitudinal design (collecting and following up opportunities and threats), we followed up threats or risks as well as opportunities identified from the risk registers of seven large projects in the energy sector and five large projects from the public sector. The studies were conducted in teams of two researchers and the conclusions drawn from the findings were discussed with the participating companies. The cases with an action research approach involved developing and testing an uncertainty matrix as a tool for managing uncertainty, and developing and testing a nine-step method for uncertainty management.

When it came to conducting interviews, interview guides prepared by the researchers were semi-structured to enable and encourage the respondents to engage actively and in a relaxed manner during the interviews. Both individual and group interviews were held. The representatives of the organizations that took part in the interviews came from both the private sector and the public sector, including oil and gas, telecommunications, construction, public buildings, and defence.

In the PUS project, we conducted two large surveys regarding the uncertainty management of the projects in the six companies, at the beginning and end of the projects. Questionnaires were distributed to a representative selection of participants related to the projects. Using both electronic and paper-based formats, the questionnaires were distributed to a total of 2701 persons, and overall there was a response rate of 29.7%. In the first study, the questions were pre-tested and a pilot study conducted, and many of the questions from the first survey were repeated in the second survey. My research builds both upon structured literature reviews conducted as part of the development of the papers and upon structured reviews of literature done in the PUS projects (Torp, et al., 2008), the NSP project ('Uncertainty as a learning arena'), and the Concept project ('Uncertainty analysis – Methodology'). All literature reviews have limitations in terms of time, choice of language, and choice of journals and books, and these limitations can always be criticized and challenged by other scholars.

Some might argue that uncertainty management is a fairly limited topic and just a small part of the project management field. While this may be true, it does not necessarily mean that the amount of work and hence the amount of literature on the subject is limited. After six years of work, I reached the conclusion that it is an impossible task to read all available literature and therefore some limitations have to be imposed. I therefore concentrated my focus on literature written in Scandinavian languages (Norwegian, Swedish, and Danish) and English. I have read PM literature, but also textbooks on risk analysis from all over the world. I concentrated my reading on books and articles published in the 1970s or later. However, in my journey to seek an understanding of the root of risk and uncertainty, I searched back as far as AD 1600 (Bernstein & Bernstein Peter, 1996) and found different types of sources (textbooks, research articles, and PM standards) that have provided definitions of risk and uncertainty during a 300-year period (Table 11). Since uncertainty management is an integrated part of the project management field, it is covered in the following:

- Standard PM textbooks (Arto K., 2011; Rolstadås, 2011)
- Books with a single focus on uncertainty or uncertainty as a part of the project management discipline (Austeng, et al.; C. Chapman, 1997; C. Chapman & Ward, 2007; Christensen & Kreiner, 1991; Cooper, Grey, Raymond, & Walker, 2005; Hillson & Murray-Webster, 2007; Hillson & Simon, 2012; Lichtenberg, 1974; Loch, DeMeyer, & Pich, 2006; Rolstadås, Hetland, Jergeas, & Westney)
- PM bodies of knowledge (i.e. IPMA, PMI, PRINCE2, and ISO 21500)
- Different risk standards (Raz & Hillson, 2005)
- Different PM journals (e.g. International Journal of Project Management, Project Management Journal, Project Perspectives, Risk Management and Insurance Review, Risk Management International Journal, Building Research and Information)
- Papers submitted to PM conferences (e.g. IPMA, PMI, IRNOP, EGOS, EURAM, EKCEM, ProjMan).

Most PM conferences have a risk or and uncertainty management theme, and new articles, books, and special issues of journals are currently under planning or in production. I have tried to find and cover as many works and sources as possible, but my list is far from complete. Most of the journal articles were found through resources available via the NTNU database, such as SCOPUS (Elsevier) and Thomson Reuters' Web of Science. I have typically searched and read papers, as well as relevant papers presented at PMI, IPMA, EGOS, EURAM, and EKCEM conferences in the period 2005–2014.

Most researchers have limited time and resources, and therefore it is not possible to find or read all literature that could be relevant for a topic in a research project. The best that can be achieved as a researcher is to recognize the limitations, ensure that the choices are as good as possible, and that the most relevant literature and theories are found, given the limitations of the research scope. Hopefully, the limitations will not jeopardized the inquiry, and hopefully important theories and relevant studies are identified in order for researchers to build on previous scholars' work or even develop new insights and theories that have not yet been published by other scholars.

Both quantitative and qualitative approaches are used the papers that form part of this thesis, and I have tried to alternate between inductive and deductive approach in my research. In some parts of the research I started with raw data collected in the companies and work from the data, and for some papers both I and my co-authors started with a theory and tested how well the current theory matched practices in the industry. In both cases, there has been an attempt to develop new concepts and to develop new theory using a step-by-step approach.

The compound research basis means that results presented in this thesis do not refer to just one dataset as the basis for our results and conclusions. I suggest that using teams in the research process and in the development of the concepts and theories has contributed to making the conclusion from the studies more valid and reliable. However, as I have stated in Section 2.3 true falsification of theory and laws that have been developed for projects is difficult and not normally the aim of most project management research.

I have tested the concepts and theories in two ways; I have tested them by letting practitioners use them in their daily work and if they did not fit or make sense the practitioners either abandoned them or tell me what needed to be changed; and I have tested theories through papers presented at PM conferences and published in PM journals. The theory building of the concept of uncertainty analysis and management has to a large extent been tested in practice and can be considered as done using an action researcher approach. I have participated actively in and led and/or facilitated uncertainty analysis sessions for almost 20 years. Experiences gained from analyses have been further reflected upon in connection with the development of some of the papers listed in Tables 4 and 5. Developing and testing of the methods presented in Chapter 8 was done together with participants from the PUS project and the research approach was an action research approach. The researchers took an active role in the development and testing of the methods, tools, and techniques that had been developed. The models in Figure 47 and Figure 48 are therefore a product of collective reflection on our experiences and knowledge. The testing of the methods presented in Chapter 8 was qualitative in the sense that we did not use any quantitative or statistical evidence or methods in our approach when testing the model.



Since the 15 papers included in this thesis are co-authored, collective reflection has been an important part of my research strategy. As a result, the ideas and concepts that this thesis builds upon have been developed and tested jointly with other researchers. Table 5 shows my research contribution in the different papers and the Table was shown to and discussed with my co-authors before it was included in this thesis. I contributed in collecting data, analyses, and literature reviews, and to developing concepts and drawing conclusions in all 15 papers. However, it is hard to isolate which part of a give paper is solely 'invented by me' or presents 'my idea', or how discussions with my co- authors influenced the content and direction of the papers. I consider that all of the papers have benefitted and been impacted by the discussions with my co-authors. Without those discussion and contributions, the results would most likely have been different and probably less interesting.

Developing interesting new ideas, concepts, and research papers without having the opportunity to discuss them in a process with colleagues and other co-others is very hard and also less interesting than doing the work together with other scholars. I give credit to all co-authors that have contributed and played an important part in developing the ideas in the papers, been part of the data collection, been part of the developing the research strategy, or who have played a role in the discussion of the conclusions presented in the papers. Not all of the co-authors have written parts or sections in the papers presented in Tables 4 and 5, but they have all contributed with ideas, feedback, and direction to my work and by challenging my suggestions and solutions when the papers were in an early stage of development.

The results presented in the 15 papers are dependent on how well the action research, interviews, surveys, case studies, and literature reviews were conducted by me and my fellow researchers. However, I believe that collecting data, analysing, and developing new solutions together with partners from the companies and together with fellow researchers have increased the reliability of my research.

Since the research was done in three collaborative research projects, my conclusions and solutions dependent on the quality and relevance of the data obtained from the cases and the companies. Additionally, they depend on how good the interpretation of the different types of data has been in the research process.

My theoretical foundations and concepts have been developed from observations of projects in action, from tests of methods and concepts in projects when they are executed, and from summarizations of the data from projects after the projects had finished. These types of observations will always be snapshots of what is going on in the project, and therefore in most cases it is impossible to truly test for falsification of project management theory. As I have already mentioned (in the section 'Case study' in Chapter 2), some scholars are sceptical towards concepts and theories developed from a small numbers of cases and action research that is conducted in close connection with respondents from projects. However, historically, the development of project management as an academic discipline has to a large extent developed theories and concepts based on this type of research strategy, and I suggest that that this will be the case in the future too.

In general, research projects deal with innovation in varying degrees of innovation. Innovation often requires risk-taking and the ability to change course mid-stream in order to take advantage of emerging new ideas and trends or to acknowledge the failure of specific lines of enquiry. Publically funded research projects such as the PUS project often initially respond to emerging trends and are

frequently rigid and inflexible due to the need to control project outcomes and meet the requirements of funding agencies regarding agreed aims and objectives. Conflict can exist between the need for agility to respond to changes and the rigidity of the project work plan. Hence, management and decision-making related to research projects are not only a question of rational logic and optimizing technological and economic solutions, but are also about power and negotiation, and networks and alliances.

Projects usually face complex issues. When it comes to inter-organizational research projects, there is an extra dimension to complexity, due to distances, differences in organizational culture, and the fact that several autonomous organizations are involved. That means that the actors involved need to be aligned to the project with the research policy or needs of their respective organizations. Academics might have a stronger focus on long-term research and publishing opportunities, while participating industrial organizations might search for short-term solutions in order to improve their organizations. Collaborations between diverse organizations are difficult to manage and the cultural differences between academia and industry present particular difficulties (Wong, Unsal, Taylor, & Levitt, 2010)

Research projects play an increasingly important role in innovation processes at national and global levels. This requires close partnerships between researchers and other stakeholders. The idea is to engage enterprises in the research process to ensure sustainable research results. Research projects aim at creating new knowledge or finding applicable knowledge. When a research project is started, few know what the outcome of the project will be. This means that a research project can be rated as highly successful even though the results of the project differ from those originally planned. In many cases, collaborative research projects are initiated by a university partner, sometimes in cooperation with an industrial partner, who together may seek to identify other partners to fund and participate in the project. Researchers are typically concerned with interesting scientific phenomena and fundamental technology breakthroughs, whereas the intended development must satisfy the demands of business units and impatient costumers.

Project management of collaborative research projects needs to involve the support of dynamic processes, and flexible approaches to goals and project objectives. This means not only supporting the scientific methodology of the researchers, but also the nature of the work carried out by different stakeholders in the project. The processes and approaches include the primary research work such as conducting experiments, and gathering and analysing data, as well as supporting activities such as producing proposals, conducting quality reviews, and managing projects and all of their stakeholders.

### **3 ‘Practical Uncertainty Management in a Norwegian Project Owner’s Perspective’ – the PUS project**

In 2006, the Norwegian Centre for Project Management funded and started a research for a development project in cooperation with six companies and three academic partners. The work was co-funded by the Research Council of Norway. The project was called ‘Practical Uncertainty Management in a Project Owner’s Perspective’ (‘Praktisk styring av usikkerhet i et eierperspektiv’, abbreviated to PUS). The PUS project lasted approximately five years and involved six major Norwegian public and private ‘project-intensive’ companies and organizations. Together, the six organizations have a total yearly project portfolio of approximately EUR 10 billion. At the time, the PUS project, with a total budget of more than EUR 4 million, was one of the largest research projects on project management in Europe .

This chapter is based on the following papers:

- Paper 5 – ‘Effects of long-term improvement efforts within project uncertainty management’
- Paper 8 – ‘Improving uncertainty management in projects by collaborating in an inter-organizational research project’
- Paper 9 – ‘Exploring uncertainty and flexibility in projects: Towards a more dynamic framework?’

In this chapter I summarize some of the experiences from the PUS project. At the end of the PUS project, participants from the board and project managers from the participating companies were interviewed. In addition, two surveys of the uncertainty management in the PUS projects were conducted: one at the start of the PUS project and one at the end. The questionnaires were distributed to a representative selection of participants related to the projects. Both electronic and paper-based questionnaires were distributed to 2701 persons, and overall there was a response rate of 29.7%.

#### **3.1 The PUS project – a successful collaborative research project**

Prior to the PUS project, a lot of work had done on the issue of uncertainty analysis both in Norway and abroad, and much of this work has carried out in the early phase (‘front end loading’) of the projects. However, less research had been done on the issue of how to manage opportunities and threats in a project’s life cycle in a practical manner. Furthermore, not much research had been done on the project owner role with respect to the management of uncertainty from the start of the project to the phase where the intended benefits of the project are realized.

Uncertainty management must not only be established at the project level. Rather, it is important that uncertainty management becomes a vital part of the organization’s management philosophy. Although current uncertainty management is to a large extent developed and implemented from the project’s perspective, many organizations normally discuss the possibility of viewing uncertainty management from the project owner’s and senior executive’s perspective. Practical uncertainty management in a project owner perspective concerns practical uncertainty management techniques and tools for managing uncertainty from the project owner’s perspective. In addition, it emphasizes giving adequate focus to managing uncertainties (threats and opportunities) in projects, and on contributing to create a positive culture that promotes effective and efficient uncertainty management in project organizations.

The main industrial partners of the PUS project were:

- Statoil (an international energy company with operations in 34 countries, headquartered in Norway)
- Norwegian Directorate of Public Construction and Property Management (Statsbygg)
- Telenor (one of the world's largest mobile operators, with 33,200 employees worldwide in 2008, headquartered in Norway)
- Norwegian Defence Logistics Organisation (Forsvarets logistikkorganisasjon)
- Norwegian Public Roads Administration (Statens vegvesen)
- Norwegian government agency for railway services (Jernbaneverket)



Figure 9 Major industrial partners in the PUS project

The PUS research project aimed to explore uncertainty management in projects in a broad and empirical perspective. In this regard, the project chose to focus on the project owner's perspective. The way a project owner looks at his or her project is not limited to the 'iron triangle' of time, cost, and quality, on which a project manager normally focuses. A project owner focuses also on the effects or benefits of his or her project. In addition to the PUS project's consideration of project managers, its project owner's perspective led to the development of a broader understanding of projects – a broader understanding of objectives, uncertainties (both opportunities and threats), and the consequences associated with projects.

A project owner has rights to and is responsible for the project. He or she is also responsible for the risks connected to the project's cost and its future (P. T. Eikeland, 1999). Olsson, Johansen, Langlo, and Torp (2007, p. 7) state:

The beauty behind the concept of a project owner lies in the fact that a project owner has incentives for weighing costs against benefits for a project. Project owners are therefore expected to strive for project governance aimed at maximizing the value from the project.

To gain a complete picture of how to manage uncertainty from an owner's perspective, the PUS project was divided into two equal main parts:

- uncertainty management – theoretical view/contribution
- uncertainty management – the practical view/contribution

To examine and understand a phenomenon (in this case uncertainty management) in a complex (or seemingly complex) environment with many factors that affect the outcome is a demanding task. In the PUS project, we tried to integrate researchers' ambitions to deliver excellent and breakthrough results in various development projects initiated by the participating organizations. Figure 10 shows the research frame work for the PUS project.

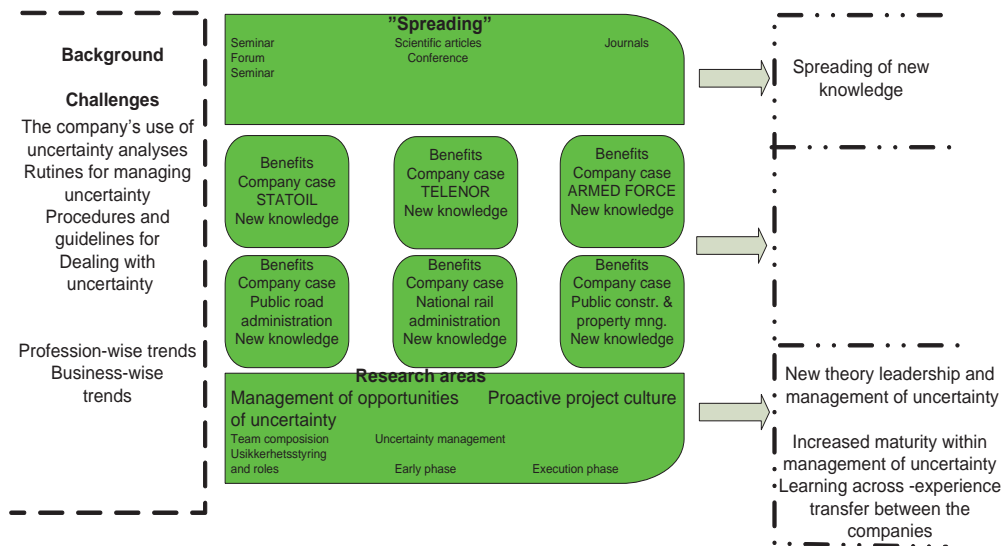


Figure 10 Methodological framework for the PUS project

The PUS project aimed to focus on leadership and the culture connected to the practical management of uncertainty in major public and private projects, and had five objectives from the beginning:

1. To develop a theory/knowledge base within uncertainty management leadership
2. To develop project-specific means for identifying and managing uncertainty in collaboration with the organizations participating in the project
3. To test the theoretical foundation and project-specific means in case projects from the project participants (participating companies)
4. To gather experience-based knowledge across companies
5. To develop a maturity model with concrete Key Performance Indicators (KPIs) for managing uncertainty.

The PUS project had an additional aim to shed light on the project owner's role related to uncertainty management throughout the project life cycle. Uncertainty analysis was already well established as concept, but there was less research on the issue of how to manage opportunities and threats in a project's life cycle in a practical manner. Furthermore, there was not much research on how and what the project owner's role should be with respect to management of uncertainty from the very start of the project to the phase when the intended benefits of the projects are realized. The PUS project had a keen interest in finding out how large organizations' thinking patterns and actions

associated with the identification and management of uncertainty in projects was developed and managed.

Uncertainty management must not only be established at the project level; it is also important that uncertainty management becomes a vital part of the organization's management philosophy. Although current uncertainty management is to a large extent developed and implemented from the project's perspective, many organizations discuss the possibility of viewing uncertainty management from the project owner's and senior executive's perspective. In addition to looking at uncertainty management from the project owner perspective, the PUS project placed emphasis on giving adequate attention to opportunities in managing uncertainties in projects, and contributing to create a positive culture that would promote effective and efficient uncertainty management in project organizations.

### 3.2 Theoretical contribution – humans, models, and techniques

The PUS project adopted an approach named 'living uncertainty management', which is a sustained, active approach developed by the project to enable organizations to deal with uncertainties continuously, and make timely and effective responses to challenges emerging from dynamic environments. The aim of the approach is to discuss how to integrate uncertainty as a part of project management. Living uncertainty management is described by three elements and their interaction with each other:

- **Humans and organization aspects:** This aspect deals with what types of people gather in a project team, their abilities, their impacts, and who has what role and position in the project. These issues will influence the identification of uncertainty elements and management of uncertainty.
- **Models and methods:** This aspect is about what activities or steps are to be implemented in order to archive uncertainty in projects.
- **Tools and techniques:** This aspect concerns which identifying-techniques and analytical and visualizations methods are used in projects.

The three elements formed the basis for the development of the theories that were studied in connection with practice in the participating organizations. The practical contribution of the PUS project (i.e. how the involved organizations improved their uncertainty management through collaborating in the project) reflects the theoretical views as well as theoretical contributions of the project.

### 3.3 Practical contribution – uncertainty management in public and private sectors

In this section, I summarize the practical view (effect) of the PUS project by describing what the involved organizations (i.e. the six industrial partners) accomplished through the collaboration in the PUS project.

#### **International energy company – Statoil**

Risk management in Statoil is an important process in connection with project development. Statoil was involved in the PUS project with the intention of implementing improvements in risk management, and researching selected topics in risk management. The following description is of Statoil's efforts to develop and improve risk management in its projects, in which the PUS project played a notable role. This presentation does not specify the exact contribution of the PUS project in

detail, since the collaborative work was integrated with the improvement efforts that Statoil took in connection with risk management.

Over many years, Statoil has worked with the topic of risk in its projects. In the mid-1990s, Statoil developed its own risk registers for the Lotus Notes platform, and developed procedures for managing risks in its projects. Today, Statoil has a well-defined methodology with its own governing documents and its own tools for managing risk in projects. Statoil can therefore be called a 'mature' organization in the field of risk management. Statoil has organized its work on risk management in a separate group that has resources to develop procedures and tools, and provide assistance in conducting seminars and support implementation (e.g. of tools and procedures) in projects in the organization. The group has its own website on Statoil's intranet, where the 'governing documents' in the area of risk management are gathered and made available to the users. There is also a possibility to obtain assistance from the central support unit. In addition, Statoil's website also contains links to tools, presentations, and detailed descriptions of the latest developments. Furthermore, the website publishes announcements on internal seminars, which are held two or three times per year, at various locations in Norway.

In 2001, Statoil introduced the first version of a web-based risk management system, called PIMS Web. The tool contains a risk matrix that handles all types of risks (e.g. health, safety, environment, and cost and time) in projects. PIMS Web was (and still is) fully integrated with the group's e-mail system, which enabled the group to assign actions to deal with the risk factors that had been identified in meetings. The tool also has its own report generator, so that a list of the most highly prioritized opportunities and threats (i.e. the top 10 risks) at the project level and subproject level can easily be made.

After Statoil merged with parts of Hydro in January 2008, it was necessary to review and revise work instructions and procedures for risk management. Hence, a new working procedure for risk management in projects and a risk management module were developed. In addition, templates and tools were modified in order to reflect the two organizations' methodologies in this area of risk management. Statoil's 'new' methodology was launched in autumn 2008. The methodology is closely connected to the ISO 31000 risk management standard, and Statoil participated actively in the development of the standard.

In 2009, Statoil launched Risk Lite, a simplified version of PIMS Web, and a corresponding training module. The Risk Lite module included all the key features of PIMS Web on one screen or display, and thus simplified the user interface between projects and subprojects.

In 2010, PIMS Version 3 (R3) of the risk management system was launched. R3 has an improved risk management module. It provides the possibility to monitor risks conditions over time. It also has a built-in module for transferring experience, and it provides information to Statoil's suppliers, so that the suppliers can use the same tool as used by Statoil.

Statoil continuously measures how many active users utilize the various tools offered by the organization in the area of risk management. Figure 11 shows a rising curve (graph line) in connection with the number of risk management tools. The labels in the Figure (x-axis) specify the timeline of some of the most important measures taken in information technology (IT) support for uncertainty management in Statoil. The three boxes below the curve show three generations of

Statoil's basic support tools for risk management in projects, while the boxes above the curve highlight 11 key internal development projects (within risk management in projects in Statoil) during the time period.

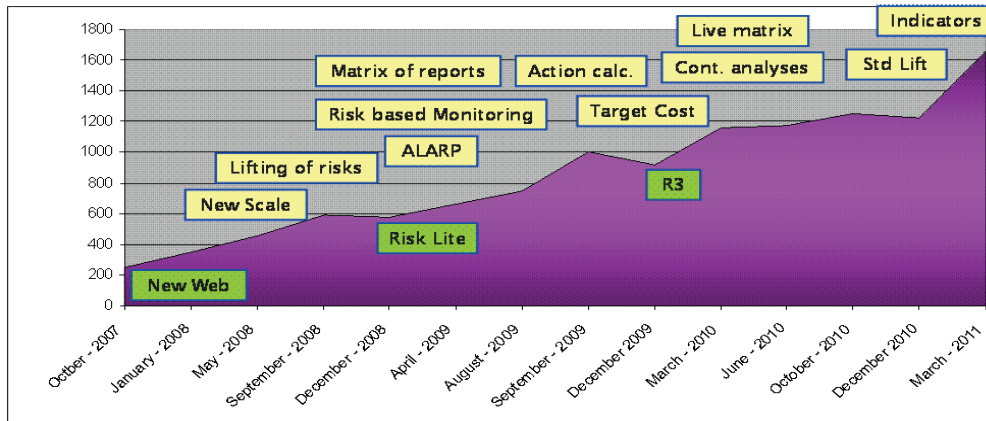


Figure 11 Development projects and increases in numbers of users of risk management in Statoil

In common with many large organizations, Statoil is in constant state of change. In 2011, the units Quality and Risk were integrated into a common group within the project unit in Statoil. This group now has the responsibility for improving the governing documents and business processes. Risk management in Statoil is under continuous development, due to new user requirements or new demands from external stakeholders. Feedback from project participants is collected continuously and new features and functions are tested continuously. Giving quick response to user requirements and providing adequate support to the above-mentioned projects (see Figure 11) were two key success factors in the introduction of 'living risk management' in Statoil's projects.

#### Mobile operator – Telenor

Telenor, through its participation in Norwegian Centre for Project Management (NSP), was one of the initiators of the PUS project. Telenor made commitments to support the project with NOK 100,000 per year from 2007 to 2010, in addition to its own efforts worth NOK 1.8 million in own man-hours. Telenor's collaboration with the PUS project created two positive results for Telenor: (1) getting help from academia and the participating companies to obtain quality assurance on its existing methodology and process for risk management; and (2) obtaining suggestions for improvements and suggestions for how to 'spread' a positive culture for better risk management in the whole organization in an effective manner.

According to Telenor, the purpose of the collaboration was to implement a culture in which risk management would be an equally integral part of the project culture in addition to the focus on time, cost, and quality. This applied to the project steering committee, making investment decisions and priorities, and following up benefits. On this basis, a mandate for Telenor's participation in the PUS project was prepared. According to Telenor, risk management means to maximize the likelihood of the consequences of positive events and minimize the likelihood of the consequences of negative events. In Telenor, work on risk management was organized as a cross-organizational subproject.



This subproject followed up uncertainty related activities throughout the organization and sought to create and enhance synergies of these activities in order to achieve the purpose of the collaboration. The deliveries with respect to methodology and tools during the collaboration are summarized below:

1. Establish 'as-is' and/or status in the organization at the start of the PUS project
2. Practical early warning concept – Health Check. Health Check was developed in collaboration with the PUS project and will make a practical contribution for projects wanting to identify risks. Using the software 'Quest Back', core team members can anonymously register their experiences in eight topics as responses to twenty questions. This registration of experiences (i.e. the health check of the project) is done every four weeks, and the results are sent in a report to the project manager or risk manager. The report shows individual results separately and over time. The purpose of Health Check is to provide more and/or better information that can be used to sharpen risk assessment and identification work.
3. Specific and detailed requirements for managing risk in strategic (large) projects were tested in large projects in 2008, and the requirements were due to be implemented in 2009. The PUS project followed this pilot project.
4. The reason for and background to Telenor's participation in the PUS project was due to the project's focus on the project owner's perspective. Telenor wanted risk management to receive attention beyond the project group and project period. There was a strong collaboration between Telenor and the PUS project in order to prepare and formulate a new concept for owner management of projects in Telenor.
5. Quality assurance of Telenor's training on risk and owner management
6. Usage of the portfolio management tool 'Artemis A7' in a follow-up of risk in project portfolios.

One of challenges that the organization had was to see all six elements as a whole and make them understandable as natural concepts for the entire organization. The PUS project ended in the summer of 2010, and according to Telenor the project had helped Telenor to focus on risk-related issues. Work on these issues was scheduled to continue and for this purpose Telenor planned to establish a risk forum.

#### **Norwegian Directorate of Public Construction and Property Management (Statsbygg)**

In 2010, Statsbygg had 830 employees. It organizes plans and executes c.160 projects (large and small) at all times, and 20–30 large projects are completed every year.

Two master's degree theses at the Norwegian University of Science and Technology (NTNU), Trondheim, Norway were carried out at the start of the PUS project (Løken et al., 2006; Lund, 2007). Both theses focus on describing how uncertainty management in Statsbygg was actually carried out, and the authors conclude that Statsbygg had an unstructured approach to uncertainty management, and that there was lack of methodology and supportive culture connected to uncertainty management in Statsbygg.

Statsbygg, in collaboration with the PUS project, started its own development project called 'Uncertainty Management in Statsbygg' ('Styring av Usikkerhet i Statsbygg', abbreviated to the SUS project). Statsbygg (including its SUS project) worked closely with the researchers connected to the

PUS project. Through the collaboration with the PUS project, Statsbygg introduced developments to deal with uncertainty both effectively and efficiently.

**The three phases of the SUS project.** The uncertainty management process was developed and tested in eight case projects: the Lapp Science Center, Norwegian Central Bank, Domus Media (part of the University of Oslo), R6 (government buildings), National Theatre, Halden prison, Vestfold University College, and the Department of Computer Science II (IFI2, University of Oslo). Various methods and tools were tested in this phase, including a matrix for visualizing situations of uncertainty, a risk register for monitoring uncertainty, and monthly reporting of uncertainty in the case projects. Other activities associated with this phase included work related to establishing training courses, the development of project management culture in accordance with the focus of the SUS project, and the preparation of experience reports from four of the case projects.

With regard to the development of the systems, Statsbygg developed methods and tools on the basis of experiences from the case projects. New governing documents were created, and a new role called 'uncertainty coordinator' was established. By October 2010, the tools were used by c.20 projects. Procedures, guidelines, templates, and training programmes were also in use. Statsbygg offers internal taught courses and training for their employees. The courses are conducted according to Statsbygg's own direction and guidelines. Uncertainty analyses and uncertainty workshops are conducted, and uncertainty analyses are seen as a basis for uncertainty management. Uncertainty analyses focus mainly on quantitative aspects, while uncertainty workshops focus more on qualitative aspects. Uncertainty workshops are conducted every other month. Between five and eight people participate in the workshops. People linked to other projects can participate in the workshops as observers, and such participation can be viewed as a means to transfer knowledge and experience.

At the beginning of 2011, the SUS project won Statsbygg's innovation prize. The prize was accompanied by a description highlighting the fact that the project had provided documentation of both threats and opportunities over time in projects, including effects and efforts related to the projects. The overview of uncertainty provided by the documentation gives both project managers and project owners more confidence in executing their roles in managing uncertainty in projects.

#### **Norwegian Armed Forces (Defence)**

Both the Norwegian Armed Forces and the Ministry of Defence investment process owners and project owners, have a strong focus on uncertainty management in projects. The purpose of dealing with uncertainty is to identify systematically any potential and real uncertainty elements, and then handle these elements by taking measures to increase the likelihood of fulfilling projects' objectives, including result objectives (i.e. performance, time, and cost). Defence projects vary in size, scope, and value, but common to all is that there is a requirement to manage uncertainty. Investment staff of the Norwegian Armed Forces' logistic organization (Forsvarets logistikkorganisasjon, FLO) represented the armed forces in the PUS project.

The Norwegian Armed Forces wanted to take an active part in the PUS project because the collaboration could provide them a good indicator of the possibilities and limitations they might face. The armed forces participated in various seminars and workshops and offered various contributions and suggestions. They presented the following two effect objectives with respect to the PUS project:

- To create greater awareness of the fact that projects are inherently uncertain and that the projects must relate to upside uncertainties (opportunities) and downside uncertainties (risks) in order to ensure value creation
- To generate results that can affect the culture and maturity of the Armed Forces in relation to the management of risk in complex projects.

By 30 November 2010, the Norwegian armed forces considered that there had been a limited impact from the PUS project on how the armed forces handled risk management. The limited impact was seen, at least to a certain extent, in connection with internal restructuring efforts in the armed forces, which had been undergoing a restructuring process during the PUS project period, and yet another restructuring was planned for 2011. The restructuring efforts partly influenced the focus on risk management in the Norwegian armed forces, and could have had significant effect on the investment staff of the logistic organization (FLO) and its various FLO divisions. The restructuring efforts could have taken the required attention and focus away from dealing specifically with risk management in this collaboration. The Norwegian armed forces recognized that it had to be more proactive in creating an environment in which risk management is more focused and monitored or followed up at all levels with respect to the project manager, project locations, and the project and process owner, the Ministry of Defence.

#### **Norwegian Public Roads Administration (Statens vegvesen)**

According to the Norwegian Public Roads Administration, its participation and collaboration with the PUS project had the following result objectives:

- To establish tools and processes for uncertainty management so that uncertainty could be identified and managed in a simple and uniform manner in all investment projects
- To make small improvements in uncertainty management in several areas to provide significant gains
- To extract practical uncertainty management as an independent part of project management in order to increase focus and improve uncertainty management significantly.

In summary, the concrete result objectives were to:

- Develop and implement new analytical tools for dealing with uncertainty in different phases
- Develop procedures for uncertainty management in investment projects
- Ensure that risks would be identified, processed, and followed up.

The Norwegian Public Road Administration currently uses an IT tool called Anslag 4.0 to calculate cost in road projects. The tool is newly developed and one of the changes with respect to the earlier version is greater focus on uncertainties and events. In addition, a spreadsheet for registering uncertainty has been developed. The spreadsheet manages both risks (threats) and opportunities in projects. As a result of this development, a new module was included in the project management system adopted by the Norwegian Public Roads Administration. The module is called 'G-Prog project economics', and it follows up the uncertainties. The matrix presented in Figure 12 shows that risks and opportunities can be assessed using the same matrix.

Uncertainty - matrix	Consequence							
	Opportunity				Threat			
	Extra large >10 mill	Large 2 - 10 mill	Medium 0,5 - 2 mill	Small < 0,5 mill	Small < 0,5 mill	Serious 0,5 - 5 mill	Critical 5 - 20 mill	Catastrophic 20 mill +
Almost certain >50 %	A					4	1, 3	
Likely 25-50%		B				6	2	
Possible 5-25%		C	D			7		
Unlikely 1-5%						8		
Rare <1%								

Figure 12 Uncertainty matrix

A template and a guide for how uncertainty management should be dealt with were made by the Norwegian Public Roads Administration. The guide consists of three parts: (1) a description of uncertainty management in the organization, (2) a user manual for the template used in the uncertainty analysis plan, and (3) descriptions of various special topics.

The tools used by the Norwegian Public Road Administration will ensure that uncertainty is monitored throughout the project life cycle from 'Anslag 4.0' via 'G-Prog project economics' to 'Cost Bank'.

**Norwegian government agency for railway services (Jernbaneverket)**

National rail administration had the following rationale for its involvement in the PUS project. The administration wanted to ensure the quality of their framework by updating the tools and techniques they used and their general knowledge of risk management. Also, they wanted to be able to utilize best practices in this field of knowledge at any time. Furthermore, the organization wanted to document the required or relevant knowledge and share the knowledge with their workforce.

The status of the work situation in the rail administration with respect to the rationale for its participation in the PUS project was reported as follows:

- Estimating guide with estimating manual had been prepared and put into the railway administration's management
- Established new structure that supports detailed estimation and experience gathering
- Established new programmes for training of process management and improved general education in risk management together with the Norwegian University of Science and Technology (NTNU).
- Gathered other countries' experiences and analysed their contexts, and compared them with their own experiences and contexts
- Apply systematic quality assurance of projects using qualitative and quantitative uncertainty analyses

- National rail administration added quality to the decision portals in the project model. In this connection, the administration invited external contractors and consultants to participate in the framework agreements to secure resources for this quality assurance
- Establish and implement new tools for estimation.

### 3.4 What is the status? Do project managers in Norway really manage uncertainty in their projects?

The PUS project conducted two surveys that aimed to map how the different participating companies understood the different terms related to uncertainty management, one at the beginning and one at the end of the PUS project. Electronic and paper-based questionnaires were distributed to a representative selection of participants related to the projects, in total 2701 persons. The overall response rate was 29.7%.

Table 7 The 2010 survey in the PUS project (A. Johansen, Langlo 2013)

Number of respondents, 2010	Size of sample 2010	Answers (%)
71	235	30%
364	1174	31%
23	77	30%
41	103	40%
25	102	25%
21	101	21%
<b>545</b>	<b>1792</b>	<b>30%</b>

The questionnaires used in the two longitudinal surveys were not identical and therefore the results from the first survey had to be manually processed in order to be compared to the results of the second survey. Furthermore, the results presented here also based on a number of case studies of projects conducted over six-year period in the PUS project. Some of the case studies were longitudinal and qualitative in nature, and the authors were involved as researchers and process contributors repeatedly in all cases.

In addition to the survey, two different longitudinal studies were executed as a part of the PUS project. Krane and colleagues studied risk registers of seven large projects in the energy sector (Krane, Rolstadas, & Olsson, 2011; Krane, et al., 2010). In spring 2013 the second longitudinal study was conducted on five cases from the public sector (Krane, et al., 2014). The results from the first study were updated, analysed further, and compared with the results from the public sector projects.

At the same period as the PUS project was conducted, the Concept research programme did trailing research on the management and governance of, in principle, all large Norwegian public sector projects (i.e. with total costs of more than EUR 70 million) since 2002. It examined and evaluated approximately 130 large public projects, and holds records of those projects in its database conducted a longitudinal study of 35 projects that had been completed and presented the study's findings during the 2013 Concept symposium. Their study findings were later compared and combined with the findings from the PUS survey, in the conference paper 'Effects of long-term improvement efforts within project uncertainty management' (A. Johansen, Langlo 2013).

The main findings from the two studies can be summarized in the following 11 points:

1. The project maturity had increased in all six organizations. Supporting evidence was found in the form of new systems, and development of support and training in concept of uncertainty analysis and management. In addition, there was better performance on how the organizations analysed and managed uncertainty in the cases that was investigated in the PUS project and the Concept research programme study.
2. There was an increased ability to meet cost targets. Projects that had been analysed as part of the QA regime had become better at hitting their cost target, and there were fewer cost overruns than before the regime was introduced.
3. There was increased active involvement by project owner in uncertainty management. In the mid-2000s the project owner role was not very common and not well defined in most of the companies in the PUS project; the situation has since clearly changed. All companies had a project owner role in place and most of them had established a new role in the project management organization – an uncertainty manager, responsible for the management of uncertainty in their project.
4. There were some potential negative impacts of the QA system. It was easier for projects to meet a budget if the cost was overestimated. In the first years of the QA regime there was an increase in the budgets, and almost all of the external reviews resulted in increases in budget, both in the base estimate, but more frequently in the uncertainty allowances.
5. There was overestimate and underestimation of potential influence. There was still room for improvement in the analyses. The projects had clearly overestimated the potential influence on the project from some factors, while the influence of other factors was underestimated.
6. The research has revealed that many projects lacked ability to identify and utilize opportunities. They had ‘the blind spot’; they did not spend time or effort on identifying and analysing opportunities when they entered the execution phase.
7. The project literature was inconsistent in use of the terms ‘uncertainty’ and ‘uncertainty management’.
8. Norwegian companies were not consistent how they use the term ‘uncertainty’.
9. Uncertainty management in the companies mainly focused on opportunities and threats or risks in the planning phase and threats or risks in the execution phase of their projects.
10. Tools and methods for handling of uncertainty were available – but finding and exploiting or utilizing opportunities was still a problem in many projects.
11. Project owners and project managers may have different views on what are considered threats and opportunities. (Rolstadås & Johansen, 2008) conclude that there was major incompleteness in the way risk was managed. The typical strategy was protective – to try to develop a robust plan and minimize risk exposure and sensitivity at the front end.

The focus on uncertainty management had improved the maturity in uncertainty management in the companies but this was still not a guarantee of successful projects or that every project would be efficient in its planning and execution phase.

The findings from the PUS project and the Concept studies are discussed more in detail in the next section.

### 3.5 Project performance and maturity regarding uncertainty

#### **Finding 1: Increased maturity in project uncertainty management**

The research findings relating to the studies discussed in Section 3.5 revealed that almost all organizations involved in the research had increased the maturity level of their organizational project uncertainty management. In order to see whether the long-term efforts had had any impact, we needed to be able to measure whether there had been any changes or developments over the time period to which our research results related. We had close contact with six major organizations in Norway through the PUS project, which provided us with a vast amount of data. To help us narrow down the scope, we used the following four elements in our analyses of the organizations' maturity level:

- The use of the term 'uncertainty' should include both opportunities and threats on equal terms, and both aspects should be exploited and visible in the projects and in the management of the projects from the organization's view.
- There should be a clearly structured process; in other words, the organizations should have established what to do, when it should be done, and who would be responsible.
- There should be a clear recommendation of tools and techniques that projects should apply in their daily management.
- There should be a clear structure for support, training, and further development of the uncertainty management process in the projects and in the line organization.

We anticipated that all four aspects would be covered if they were considered as indicative of mature organization in uncertainty management. In addition, we anticipated that an organization with high maturity on uncertainty would have a clear process that included opportunities and threats, and that both aspects would be exploited and visible in the management of the projects from the organization.

We also wanted to elaborate more on how the organizations involved in the PUS project developed and how they matured within project uncertainty management during the time they were involved in the PUS project. Kerzner (2009) has described a maturity model in connection with project management (see Figure 13). This model can be used to look at the levels at which an organization learns and develops.

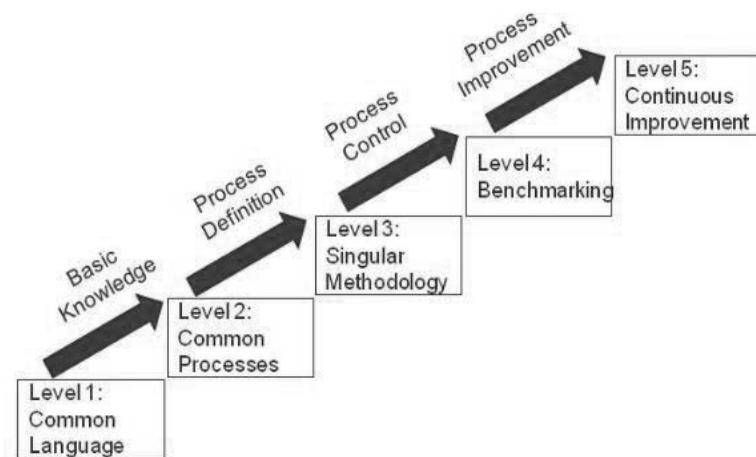


Figure 13 The five levels of maturity (Kerzner, 2009)

Based on Kerzner’s maturity model, we tried to make a subjective evaluation of the maturity levels in the organizations involved in the PUS project. We followed these organizations closely for four years, and felt confident when trying to illustrate their maturity level in the same manner. Table 8 shows the maturity level of the involved organizations regarding managing uncertainty in projects at the beginning of the PUS project in 2006 (denoted by a small ‘x’), and the maturity level of the organizations regarding managing uncertainty in projects at the end of the project in 2010 (denoted by a large ‘X’).

Table 8 Subjective evaluation of maturity level of uncertainty management in 2006 and in 2010 (A. Johansen, Langlo 2013)

Company	Level of maturity*				
	1	2	3	4	5
Statoil (private)					xX
Telenor (private)			x	X	
Norwegian Directorate of Public Construction and Property Management (Statsbygg)		x		X	
Norwegian Armed Forces (Forsvaret)			xX		
Norwegian Public Roads Administration (Statens vegvesen)			x	X	
Norwegian government agency for railway services (Jernbaneverket)		x		X	

Note: \*The five levels of maturity as derived from Kerzner’s maturity model (Kerzner, 2009); x =2006 ; X =2010



From Table 8, it is clear that Statoil was considered a matured organization in terms of dealing with uncertainty management from the beginning of the PUS project. They had a clear understanding of the importance of uncertainty management in their projects. Statoil had made systematic efforts to develop their workforce (humans), models, and techniques, where developed. They were (and still are) at a level where they performed 'living uncertainty management'; they were constantly working to improve their knowledge, skills, attitudes, processes, and tools in order to enhance their uncertainty management process.

When it comes to the Norwegian Armed Forces, the PUS project did not have any noticeable impact. This may have been due to the recurring restructuring processes that would have taken away or reduced the needed attention and energy to work with managing uncertainty in projects.

The Norwegian Directorate of Public Construction and Property Management improved its ability to manage uncertainty in its projects through its participation in the PUS project. The organization established new roles (such as uncertainty coordinators), conducted courses for its employees to improve their knowledge and competence, developed its model for dealing with uncertainty management, and started to apply systematic techniques to improve uncertainty management. In addition, the organization's participation in the PUS project and the good results were recognized in a high profile manner when a prize for innovation was awarded to its representatives in 2011.

Norwegian Public Road Administration made developments in managing uncertainty. Conducting and arranging courses for its employees, developing and applying models and techniques (e.g. tools for analysis) were prominent focal points that the organization started to adopt in order to manage uncertainty effectively. This description also points to the role of 'living uncertainty management' in the organizational setting.

The improvement that Telenor and Norwegian rail administration experienced can also be considered with respect to the 'living uncertainty management'. The focus on humans, models, and techniques, and the interplay between these three elements may have contributed to create a positive culture that promotes effective management of uncertainty. The wishes and intentions to create a positive culture for uncertainty management was mentioned by the representatives of organizations that participated in the PUS project (e.g. by Telenor).

In the longitudinal study carried out in the PUS project, the respondents were asked to explain what they based their execution of uncertainty management on.

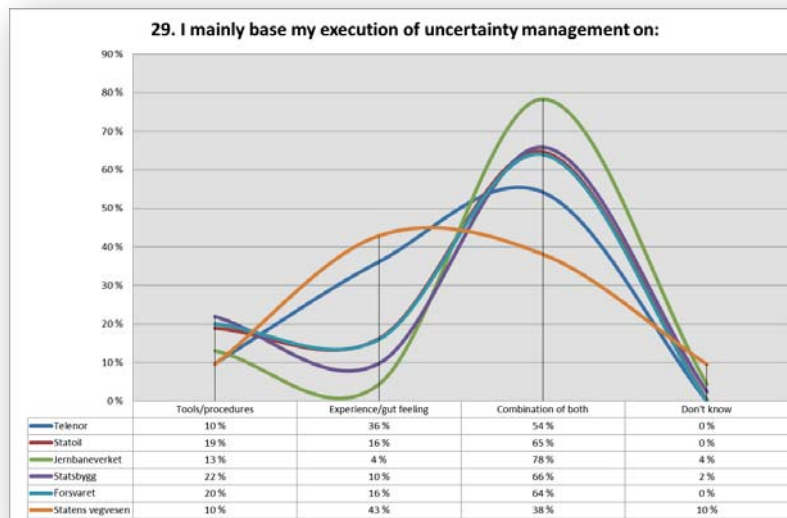


Figure 14 The basis for execution of uncertainty management – responses from a survey in 2010. (A. Johansen, Langlo 2013)

Figure 14 is based on a survey of all the partners in the PUS project. The Figure shows that projects utilized gut feeling in combination with tools and routines. This is a good indication of maturity with reference to the fact that both tools and gut feeling are used as equal early warning signs in projects. (Klakegg, Williams, Walker, Andersen, & Magnussen, 2010). Two of the investigated organizations scored slightly differently compared to the others, which was natural as all of the projects had different maturity levels. The fact that some of the organizations had inconclusive results regarding which of the three alternatives they used is also an indication of lower maturity. Potential reasons for this were lack of training, no common tools for uncertainty management, wanting the involvement of the project owner, and lack of procedures for uncertainty management, just to mention a few. Figure 14 shows a snapshot in time, and that there were clear differences between the evaluated organizations, but it does not provide any clues as to how this situation evolved from 2006 to 2011, which is illustrated in Figure 15.

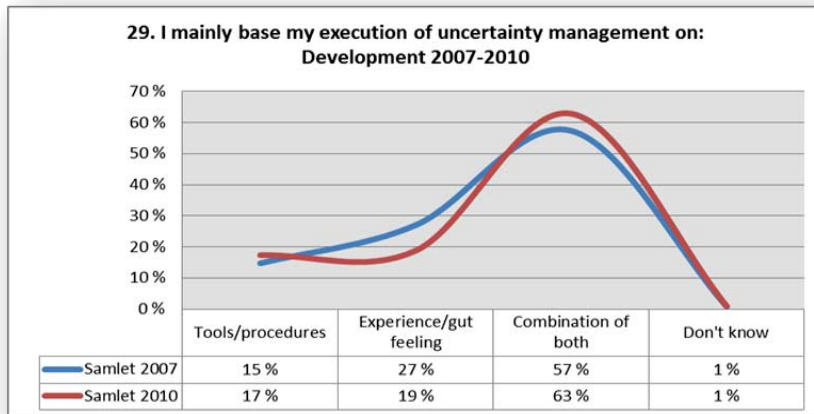


Figure 15 The basis for execution of uncertainty management – developments from 2006 to 2011 (A. Johansen, Langlo 2013)

Figure 15 shows how the score for the same question had changed between 2006 and 2011. This is was the average score for all organizations. From the Figure it is apparent that the single use of gut feeling had decreased and that there was an increase in the combined use of tools and gut feeling. This is an indication that the average project uncertainty management maturity had increased from 2006 to 2011. Figure 14 does not show the development for each organization, but from our detailed results it was clear that all organizations had improved; some had improved more than the others, but all had improved. In order to investigate the maturity further, we asked the respondents whether it was acceptable in their organization to express their concerns regarding uncertainty. Figure 16 shows how their attitudes had changed between the period 2006–2007 and the period 2010–2011.

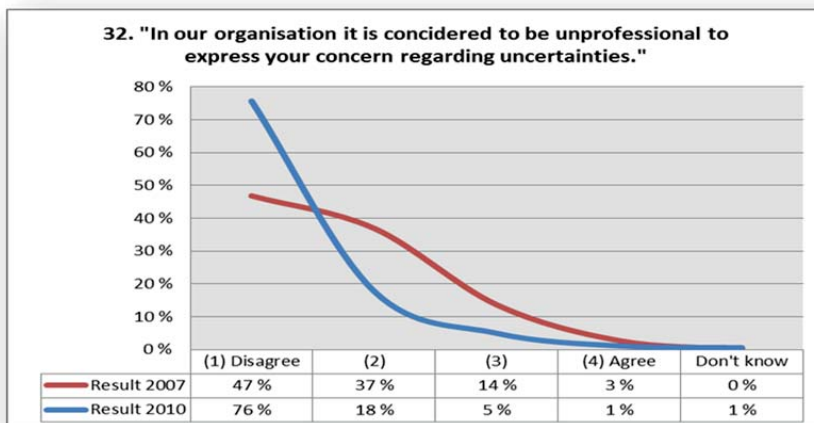


Figure 16 Changes in attitude towards expressing uncertainty (A. Johansen, Langlo 2013)

Figure 16 illustrates that all organizations largely accepted and endorsed project team members' opportunities to express their concerns. The change between the two periods as significant, as the score for (2) had reduced from 37% to 18%, while the score for (1) had increased from 47% to 76%. This indicates that uncertainty management maturity had increased in all organizations. However, there was still room for further improvement. In this case too, the results are the combined results for all the organizations, and the detailed results showed that some organizations had more improvement than others. Still, there was some degree of improvement in all organizations.

**Finding 2: Increased ability to meet cost targets**

A further main finding related to the studies discussed in Section 3.5 was documented through an evaluation done by the Norwegian Ministry of Finance in 2012. The results of the evaluation indicate that to a large extent recent Norwegian public projects have been able to meet their cost and time targets. Furthermore, since the estimates had some variance, the Ministry of Finance was interested in measuring how much variation they could find in the final cost compared to the control estimate. Figure 17 was produced in 2012 by the Ministry and shows the cost deviation for 35 of the then most recent investment projects.

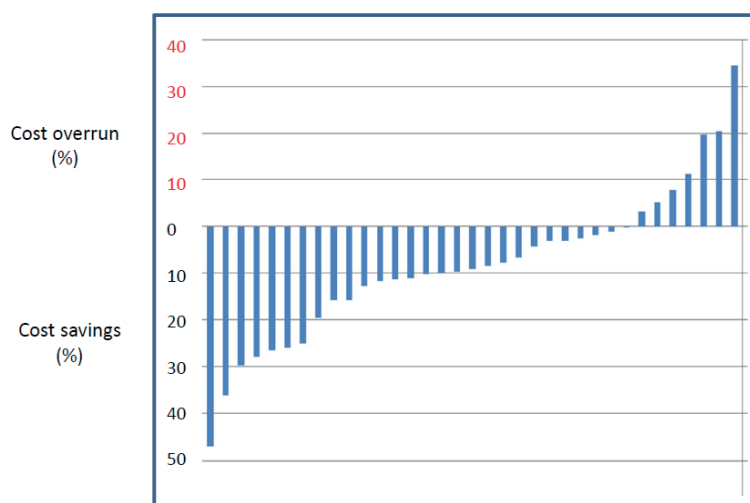


Figure 17 Cost deviation relative to P85 estimates (presented by O.J. Klakegg at the Concept Symposium in 2012)

It is interesting to observe that the distribution of the 35 projects that Klakegg analysed in the Concepts study in 2010 presented almost identical shape as to a P85 distribution. The standard in Norwegian public projects is to use P85 estimates as the total budget, and Figure 17 shows approximately 85% of the projects were spending less than their budget. We found the same situation when we compared the results with the P50 estimates: approximately 50% of the projects were spending less than their budget. This indicates that public projects in Norway had succeeded in their estimation and project control, and that their uncertainty management processes had been successful. We also found that most of the projects were returning 5–30% or more of their budget. This could indicate that they had overestimated, but it could also indicate that they were looking for opportunities and actively exploiting them, thus returning money to the government. Public projects

do not have any natural incentives to reduce cost, as the project does not benefit from this itself. The results presented by the Ministry of Finance are therefore a strong indication that there has been a shift in the mindset of public projects, and that uncertainty management is placed higher on the agenda. It is also an indication that the public agencies are taking a clearer lead in the improvement efforts and that they are succeeding in completing projects within budget and within time.

**Finding 3: Increased active involvement of the project owner in uncertainty management**

The research results of the studies discussed in Section 3.5 documented that project owners had become more actively involved in managing the uncertainty in their projects. This aspect is important to ensure that the project can utilize the opportunities discovered in course of project execution. We found that also the project owners involved in the PUS project had improved their processes, procedures, and tools for project uncertainty management (Ekambaram A, 2013b; A. Ekambaram, Johansen, Aalstad, & Hansen; A. Johansen, Halvorsen, Haddadic, & Langlo, 2014; Langlo, et al., 2007; N. O. Olsson, Johansen, Langlo, & Torp, 2008). Some of the project owners had actively developed and offered internal training in uncertainty management, both formal (together with academic institutions) and informal (in-house). We also registered that there was more communication between the project and the project owner than before, and that the project owner was taking more part in following up the project.

However, it is important that the project owner is 'hands on' and not 'hands in'. There is a balance to be maintained, and if the project owner is too involved in the project, he or she will undermine the position of the project manager. Nevertheless, the project owner has to be involved and have close relations with the project manager and the project if opportunities are to be exploited and when measures on major threats are to be developed and implemented. Both cases normally mean that the scope has to be changed, that funds have to be redistributed, or that the cost will increase. All these changes require acceptance from the project owner, and project owner involvement will ensure project success. It is therefore with great enthusiasm we registered that in recent years project owners had taken a more active part in the projects and were 'playing' their role better than before.

**Finding 4: Potential negative impacts**

The research results of the studies discussed in Section 3.5 also unveiled some unintended and potential negative impacts of the improvement efforts, which may have resulted in more expensive projects and less innovation.

As mentioned previously, it is easier to meet a budget if the cost is overestimated. In the first years of the quality assurance regime, we detected a certain increase in the budget, and almost all of the external reviews resulted in increases in budget, both in the base estimate, but more frequently in the uncertainty allowances. This could have been a result of previous underestimations of the cost of uncertainty, but it is also likely that all parties benefited from increasing their budgets: the project, because it would be easier to ensure success; the politicians, since they would not have to answer for cost overruns to the opposition; and the external reviewers, since they would not like to be blamed for cost overruns, and so forth. It became apparent though, that this development could have two major disadvantages: (1) the tax payers would have to pay more for the services provided by the public as the projects became more expensive, and (2) the large allocation of funds to meet potential

threats from all the projects combined could actually reduce the total number of projects to be sanctioned in a given time period.

There are at least three possible explanations for why projects in Norway, at least on paper, have fewer cost overruns compared to what seems to be the average elsewhere in the Western world.

First, they may have been some 'hidden reserves' in the estimates that project manager team did not know about – the base estimate should be without any contingency according to the textbooks. However, it is almost impossible to check whether some of the participants in the process had added some contingency into the different estimates as a part of the preparation of the cost statement that served as input to the uncertainty analysis workshop.

Second, the 'good' project managers chose the contractor that had bid that was 20–25% lower than what the project manager anticipated would be the end result of the contract. If the project anticipates that the highest a contract could end on is 120, the project manager must secure a bid on 100 so that the contingency will still remain intact and can be used on uncertainties that will occur in the execution phase of the project.

Third, in reality the budget may have been higher than a P50 estimate when the project started the execution phase. If contracts increase by 15% to 20% on average, as companies in Norway experience, is it not possible to manage the uncertainty with an 8–10% contingency allowance on project management level. Hence, if they do not choose a bid that is lower than the expected end value or if they have hidden reserves in the estimate they will need to raise the total budget to a higher level than P50. That means that instead of a P50 estimate the project will in fact have the P60 or P65 estimate as their budget, but this is not expressed or communicated to the project owners.

Despite the positive indications, we considered that these potential negative impacts still have to be watched closely the coming years, and it should always be a part of the project owner's responsibility to make sure that the funds are appropriate for the project objectives.

#### **Finding 5: Overestimation and underestimation of potential influence**

The study done by Klakegg et al. shows that there is still room for improvement (Klakegg et al., 2010). Figure 18 illustrates the score of important factors at the time of cost estimation (to the left in blue) and the real score at project completion (to the right in orange). Klakegg et al.'s study suggests that the project's management team overestimates the potential influence on the project from some factors, whereas the influence from other factors is underestimated.



Figure 18 Important factors influencing the project – anticipated versus real (presented by O.J. Klakegg at the Concept Symposium in 2012)

It is known that over the years organizations and the market situation will always become the top priority at the time of quality assurance before project sanction. It was therefore interesting to find that they still came out on top, but at a much lower impact than anticipated (Figure 18). It seems that the actual most influential factors are overrated, and that the factors coming out as less important at the time of quality assurance are underrated. In other words, there is clearly room for improvement. This indicates that the uncertainty analysis systematically delivers results that take too much headroom for the most frequent factors, and too little headroom for the apparently less frequent factors. This finding is supported by the line of thinking related to the concept of ‘black swans’. These findings will certainly foster more research on uncertainty management.

The results of the study conducted by Klakegg et al. (2010), evaluating 23 capital projects in Norway, indicate that the approximately 85% of the projects are spending less than their budget. When compared with the P50 estimates, the authors found the same situation: approximately 50% of the projects were spending less than their budget. The projects’ cost control was so good that most of them returned 5–30% (or more) of their budget. Klakegg et al.’s study indicates that public projects in Norway are succeeding in their estimations and becoming better at cost control, and that their uncertainty management processes are successful. However, this could also indicate that they are projects that overestimated in the early phase, or looked for opportunities and actively exploited them, thus returning money to the government. A public project does not have any natural incentives to reduce cost, as it will not benefit from cost or time reduction itself. The results presented by the Ministry of Finance are therefore a strong indication that there has been a shift in the mindset of public projects, and that uncertainty management is placed higher on the agenda. It is also an indication that the public agencies are taking a clearer lead in the improvement efforts and that they are succeeding in completing projects within budget and within time.

**Finding 6: The ‘blind spot’ of uncertainty management**

The research done by the PUS project has revealed something that could be called the ‘blind spot’ of uncertainty management. In short, the blind spot is the lack of ability to unveil and utilize the opportunities in a project. Figure 19 illustrates the development in number of opportunities and threats during project planning and execution phases. In the left-hand part of the Figure, the

development regarding opportunities and threats is symmetrical, but with an overall, though uneven, dropping trend towards delivery. In the right-hand part of the Figure, the set of lost (i.e. unexploited) opportunities due to a low opportunity focus is marked as 'blind spot'.

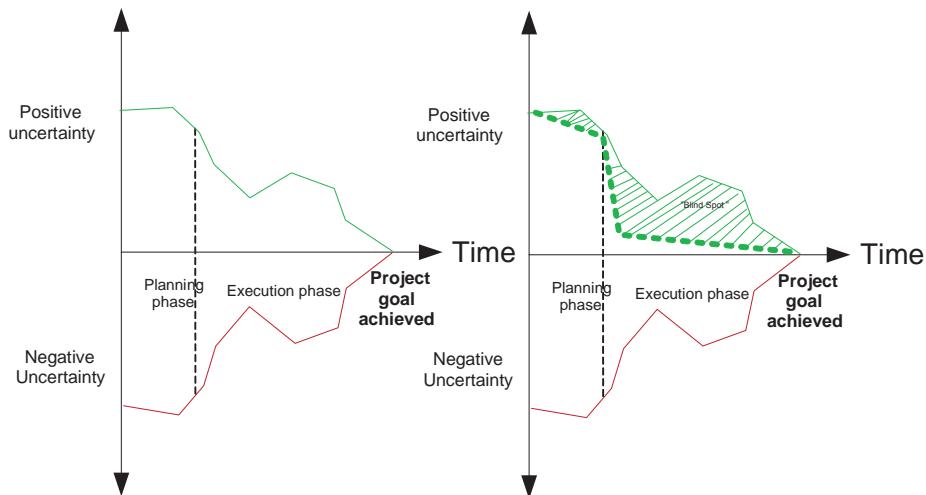


Figure 19 Number of opportunities and threats during project planning and execution phases (A. Johansen, Krane, Ekambaram, Steiro, 2012)

Figure 19 may give the impression that most project managers and project owners have realized that there is an opportunity side to uncertainty, and that those opportunities are pursued and utilized in most projects today. However, most project managers are preoccupied with the threats, and therefore lose sight of the opportunities.

The matrix in Figure 20 is another way of illustrating the blind spot in uncertainty management. The Figure is intended to serve as a principle illustration of how the project owner (PO) and project manager (PM) has either a high or low focus on threats and opportunities, and how this is typically developing through the project. At the start of the project, the main focus of both actors is on opportunities, typically the opportunities that the project will or can bring. At later stages –already when the project is detail planned and organized – most project managers will normally change focus from 'high on opportunities and low on threats' to a 'high focus on threats and low focus on opportunities'. The project owner, being responsible for achieving benefits from the project, will still be highly focused on project opportunities, but at later project stages will usually also have a higher focus on threats.



High focus on opportunities		"Blind spot"
Low focus on opportunities		
	Low focus on threats	High focus on threats

Figure 20 Focus on threats and opportunities (A. Johansen, Krane, Ekambaram, Steiro, 2012)

However, we observed that some project owners assumed that their project manager had a high focus on uncertainty but their attitude toward uncertainty meant that they had a high focus on threats and a low focus on opportunities. The gap regarding opportunity focus between the two types of roles illustrated here represents a potentially large number of lost opportunities – opportunities that might remain unidentified and will very rarely be utilized. This area or set of lost opportunities may thus be called the project’s ‘blind spot’.

**Finding 7: Project literature’s inconsistency in use of the terms ‘uncertainty’ and ‘uncertainty management’**

During our research, it became apparent that existing theory mainly focuses on managing risks and not on managing uncertainty, which consists of handling threats and opportunities. Table 11 summarize the different definitions of uncertainty and risk. Table 11 shows that in some standards the terms ‘uncertainty’ and ‘risk’ are considered the same, and in others as differing in meaning (C. Chapman & Ward, 1996), and (Hillson, 2004; Hillson & Simon, 2012) argue that opportunities should be a part of the risk process. Uncertainty has two forms: threats and opportunities. (Galbraith, 1977) regards uncertainty as the difference between the amounts of information required to perform the task and the amount of information already possessed by the organization, and that decisions and task are uncertain because of lack of knowledge.

**Finding 8: Norwegian companies are inconsistent in their use of the term ‘uncertainty’**

All of the companies in the PUS project said that uncertainty has upsides and downsides, but they were not consistent how they used the term uncertainty:

- Two of the PUS companies preferred the term ‘risk’ and said that upside risk is equivalent to ‘opportunity’ and downside risk is equivalent to ‘a risk’.

- Four of the PUS companies preferred the term 'uncertainty' and said that upside or positive side is equivalent to opportunity and the downside or negative side is equivalent to a threat.

Does this lack of consistency matter in terms of how companies deal with uncertainty in their projects?

In the 2010 PUS survey we asked the following three questions:

1. Is uncertainty management used in projects in your company?
2. What is the uncertainty management focus in the project you are part of today?
3. What does uncertainty management mean in your company?

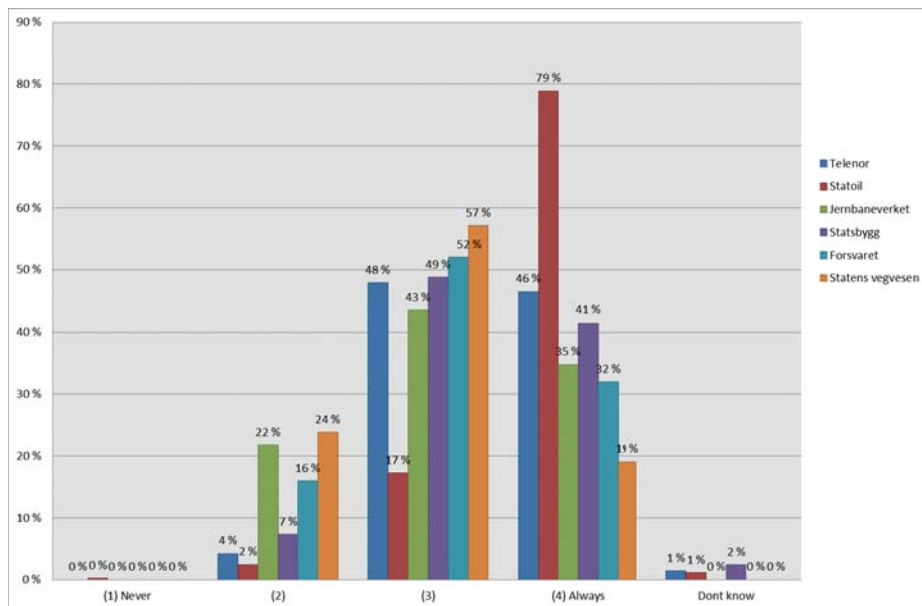


Figure 21 Is uncertainty management used in project in your company? (A. Johansen, Langlo 2013)

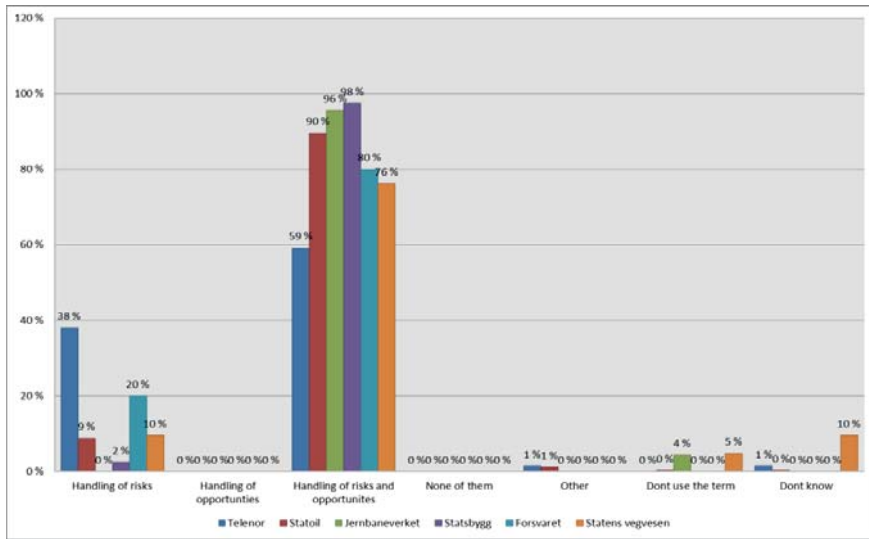


Figure 22 What does uncertainty management mean in your company? (A. Johansen, Langlo 2013)

The majority of the respondents said that uncertainty management was in use in their company, and was about handling risk and opportunities. They also said that uncertainty management in their projects mainly focused on risk and only part of the time on opportunities. This suggests that there is still some way to go before managing opportunities will be given the same attention as managing threats in most of the companies that we studied. It also suggests the respondents considered that dealing with opportunities could be important part of the uncertainty management process and they knew that their company’s intention was for opportunities to be identified and exploited in the uncertainty management process.

**Finding 9: Uncertainty management in the companies mainly focused on opportunities, threats, and risks in the planning phase and threats and risks in the execution phase of the project**

The response to the question: ‘What is the uncertainty management focus in the project you are part of today?’ shows that most of the companies’ focused mainly on risk: 76% responded that it was mainly on risks, but also on opportunities, 15% said the uncertainty management had an equal focus on risk and opportunities, and just 7% responded that the uncertainty management only focused on risks. (see figure 23)

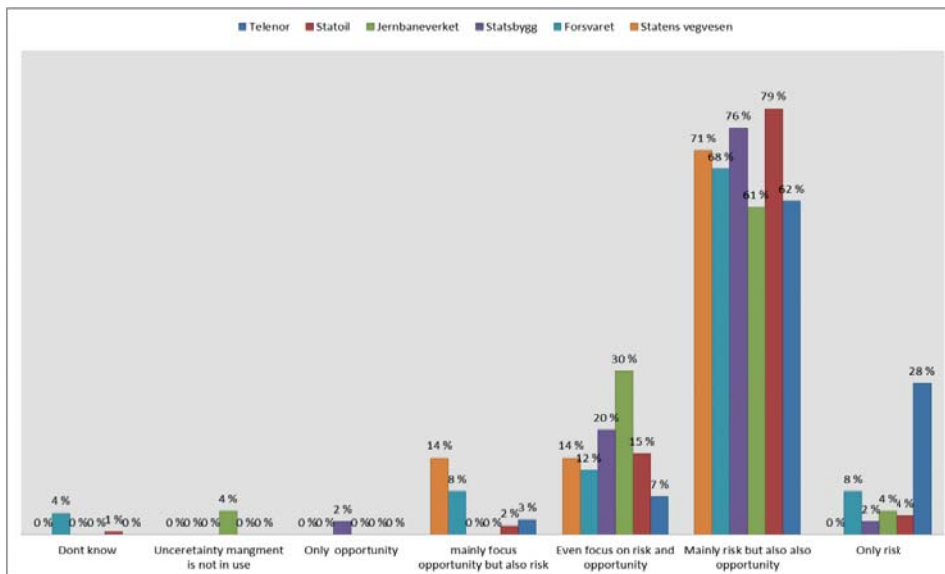


Figure 23 What is the uncertainty management focus in the project you are part of today? (A. Johansen, Langlo 2013)

However, the intentions expressed during the survey do not seem to be reflected in the contents of the projects' risk registers. During our research, it became apparent that many of the companies mainly focused on managing risks and were less concerned about handling the opportunities, which means that a lot of projects acted as though all uncertainty was a risk and hence had negative value for the project.

**Finding 10: Tools and methods for handling uncertainty are available yet finding and exploiting or utilizing opportunities are still a problem in many projects**

In the 2010 PUS survey, we asked the following two questions:

1. Does your company have a standardized tool or system that should be used in all projects?
2. Are the tools that the company provides adequate for your uncertainty management work?

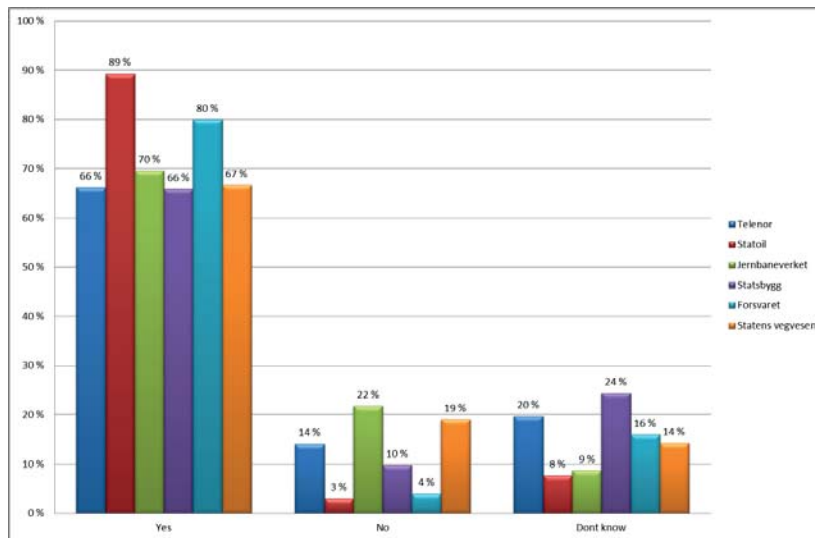


Figure 24 Does your company have a standardized tool and/or system that should be used in all projects? (A. Johansen, Langlo 2013)

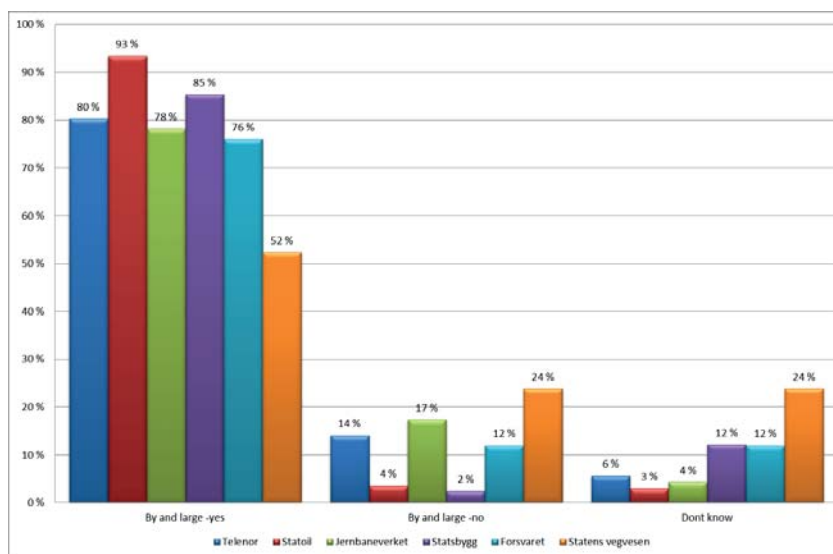


Figure 25 Are the tools that the company provides adequate for your uncertainty management work? (A. Johansen, Langlo 2013)

Two companies had self-made Excel spreadsheets for managing and reporting uncertainty. One company had self-made tools (e.g. Health Check) that monitored the teams' understanding of the performance during the process of delivering the project. One company had a self-made cost uncertainty tool with an add-on uncertainty matrix (Anslag 4.0). Two companies had web-based integrated tools (PIMS Web and DNV's EasyRisk Manager) that were linked to other PM tools in the companies. The tools were standardized in all of the companies and the majority of the respondents were more or less satisfied with the tools that their companies offered for uncertainty management. However, there are still a lot of potential opportunities that are not investigated and exploited in

Norwegian projects. The two studies done in the PUS project ((Krane, et al., 2010); (Krane, et al., 2014) came to more or less the same result. The 2009 study conducted by (Krane, et al., 2010) analysed the risk registers of seven large projects and revealed that 81% of the risk elements could be categorized as threats, 3% as opportunities, and 16% could turn out as both threats and opportunities

In spring 2013 we did a follow-up study of five of the cases that was a part of the PUS projects. We counted threats and opportunities in the planning and execution phases and asked the projects how well they did in the end – How many opportunities were exploited and what was the effect for the project? Which threats materialized and what were the consequences for the project in the end? The total number of opportunities exploited in the five cases ranged from 7 to 9, while total numbers of threats that had economic consequences was in the range 100–110 (Krane, et al., 2014).

Some of the companies had systems that made identification and following up on opportunities possible. The trends were clear: it does not matter if the tool supports dealing with threats and opportunities if the project team does not see the benefits of the opportunities and the project owners do not request the results and follow-up on opportunities.

**Finding 11: Project owners and project managers may differ in their views of what are threats and opportunities**

The topic of project owners and managers differing in their views of what constitute threats and opportunities has been discussed in several of the papers presented in this thesis (e.g. Papers 2, 3, 6, 8, 10, 12, 14, and 15, as well as in several of the conference papers developed and presented in the PUS project and in the post-PUS period. This topic was first discussed in three papers: ‘Who owns a project’ (N. Olsson, et al., 2007), ‘Uncertainty management in a project owner perspective: Case studies from governmental projects in Norway’ (Langlo et al., 2007), and ‘From protective to offensive project management’ (Rolstadås & Johansen, 2008).

Langlo et al. (2007) present six dilemmas:

1. Some uncertainties can be treated as a risk by a project organization, while the same uncertainties can be treated as opportunities by the project owner.
2. While a line organization often initiates a project to master a more complex environment or situation than normal, the project organization itself often uses a closeout strategy to minimize risk. This strategy often results in less potential for including improvements and managing changes during project execution than expected by the line organization.
3. Tangible project uncertainty is prone to underestimation due to two conditions. First, contextual demands in complex and long-term projects usually develop considerably during project execution, leading to increased uncertainty. The project often finds itself in a situation where it cannot report this uncertainty without the probability of receiving a stop order. Second, this often leads to the project overrating the accuracy and quality of its available information and underrating the tangible uncertainty reported to the line organization at decision gates.
4. In order to maximize chances being perceived as successful, a project will in the early phases often actively work to widen its financial frames and to obscure its goals, thus hiding an increased total cost for the line organization.

5. In order to maximize benefits or return on investment in a life-cycle perspective, it is necessary to understand the project and its complexity in both totality and detail. Such an understanding requires continuous monitoring of its development, and the project owner is seldom in a position to follow the project on a daily basis.
6. When intervening or participating in project uncertainty management, there is a potential risk of a project owner to take over the responsibilities and the role of the project manager either completely or partially. In turn, this will most likely result in increased internal project uncertainty.

(Rolstadås & Johansen, 2008) conclude that there is a major incompleteness in the way risk is managed today. The typical strategy is protective, trying to develop a robust plan and minimize risk exposure and sensitivity at the front end. They also suggest that projects need to move from a protective management strategy to an offensive management strategy.

Rolstadås and Johansen's discussion was followed up in a later paper, titled 'Opportunities in projects and the role of project owners' (A. Ekambaram, Johansen, Agnar, Jermstad Ole 2010). This paper presents the concept of first, second, and third order consequences. We suggest that opportunities can produce effects and benefits for stakeholders of a project that is executed and after it is delivered. The first order consequences emerge within the framework of the execution of a project and deliverance of the project's result objective. In this respect, opportunities are connected to achieving the project's result objective, and particularly improving the result objective so that the project delivers a product or service that is better than anticipated. Second order consequences are the effects that emerge after the project is completed. These effects include benefits to the organizations that have been involved in the project, such as access to new markets and technology, development of new knowledge and competence within the respective organizations, and taking care of patients as a result of constructing a university hospital. The third order consequences are the broader effects of the project on the society. Opportunities in this regard encompass the establishment of new organizations and services as the result of the completion of the project. We suggest that close cooperation between project managers and project owners would be beneficial in uncertainty management and that a broader perspective and focusing on second and third order consequences would make project managers more aware of the importance of dealing with opportunities.

### 3.6 Contribution to research

Thus far in Chapter 3 I have presented some of the practical results from the PUS project and summarized some of the findings after more than six years of focus on developing better practice in uncertainty management in Norway. The Concept research programme together with the PUS project are the two largest academic contributors to growing maturity in uncertainty management in public and private project in Norway the last decade. Both initiatives have played an important role in how uncertainty is analysed and managed in public and private companies in Norway. The research has found evidence of a clear positive effect of the long-term improvement efforts within project uncertainty management in several areas. The main findings are as follows:

- An indication that project uncertainty management maturity has increased as a result of the focused improvement efforts
- Increased ability to meet cost targets

- Increased active involvement of project owners in project uncertainty management

The research has also shown that there still is considerable room for improvement, regarding the following:

- Possible increased estimates due to too many contingencies in the planning phase
- Projects still do not fully understand the uncertainty picture
- The blind spot of project risk management, which indicates that opportunities are lost
- Project literature is inconsistent in the use of the terms uncertainty and uncertainty management
- Norwegian companies are not consistent in how they use the term uncertainty
- Uncertainty management in the analysed projects focused on opportunities and threats or risks in the planning phase, and only on threats or risks in the execution phase of the project
- Tools and methods for handling uncertainty are available and in use in many projects, but finding and exploiting or utilizing opportunities is still a problem in many projects
- Project owners and project managers may have different views on what are considered threats and opportunities. The typical strategy is protective, trying to develop a robust plan and minimize risk exposure and sensitivity at the front end.

The joint effort of focus on uncertainty management has improved the maturity regarding uncertainty management in the companies in Norway. However, this is still no guarantee of success in all projects, and higher maturity in uncertainty management does not necessarily mean that every project is efficient in its planning and execution. We still do not know whether projects have been better at estimating or whether their estimations are more realistic today than in year 2000, or whether they simply have been cleverer at raising their budgets. We do not know how many of the uncertainties that are identified in the early uncertainty analyses eventually materialize or how many do not materialize. We cannot blame project managers, who are responsible for big uncertain projects, for not having a time and cost buffer for handling uncertainty in their projects. It should not come as a surprise that project managers try to avoid changes in the scope in the execution phase even though that will have a severe effect on the handling of opportunities. Avoiding changes means avoiding opportunities, and it means that for many projects uncertainty management is still the same as risk management and that many projects spend most of their time on managing the threats.



## 4 Projects – from delivering a unique task to a tool for delivering value for the project owners

Since the early 1950s, scholars have produced a huge numbers of textbooks, project management standards, company specific routines, and papers that have impacted on how projects are planned and executed globally and nationally. The focus in these works varies from delivering an unique project within cost, time, and quality, focusing on work breakdown, planning techniques as scheduling and cost estimation towards project organization, project leadership and project governing, and projects as business tool (Artto K., 2011; Peter W.G Morris, 2004; Packendorff, 1995; Rolstadås, 2008; Rolstadås, et al., 2011; Rolstadås & Johansen, 2008; Söderlund, 2011b). Some of the theories are considered global standards and some of them have been designed and based on Norwegian culture and types of projects that are common in Norwegian organizations and companies.

This chapter outlines some of the most significant contributions from the global and Norwegian project management field. In addition, the project concept, project owner, stakeholder, and uncertainty and risk, and how these terms are dealt within the project literature are discussed more in detail.

This chapter is based on following papers:

- Paper 5 – ‘Effects of long-term improvement efforts within project uncertainty management’
- Paper 14 – ‘From protective to offensive project management’
- Paper 15 – ‘Who owns a project?’

### 4.1 What defines a project?

‘Project is a social construction construct and our understanding of what it entails has evolved over the year, and is continuing to do so’ (Rolstadås & Johansen, 2008).

It has been claimed that the word ‘project’ comes from the Latin word *projectum* from the Latin verb *proicere*, ‘before an action’, which in turn comes from *pro-*, which denotes precedence, something that comes before something else in time (e.g. Morris, 2004). The word ‘project’ thus originally meant ‘before an action’ and it refers to a plan of some type, not to the act of executing the plan (Wikipedia). The *Oxford English Learners Dictionary* defines ‘project’ as a ‘plan for a scheme or undertaking’.

The fact that a project is a social construction has contributed to an ongoing debate on what characterizes a project, what should be considered as project, what type of theory is needed, and what should be included in the body of knowledge relating to projects.

The five different Project Management Knowledge Standards and scholars worldwide have debated the term ‘Project’ since the mid-20th century. The debate on what a project is or what should be considered as project and what it is not a project is not just an academic debate. If our understanding of what constitutes a project changes over time, it will most likely have an impact on the theory, and this means that the body of knowledge will need to be changed and updated too. How we define ‘project’ has impact on what we consider to be project management and it has impact on what we consider as good theory and good practice.

Söderlund says that there are two main theoretical traditions in project management research. The first tradition has its roots in engineering science (Rolstadås, et al., 2011). Planning techniques and methods of project management, including the recent emphasis on uncertainty quantification and risk management, have been the major focus in this tradition. This thinking is in accordance with (Packendorff, 1995), who claims that a number of writers have traced the origins of project management research and knowledge to various types of planning techniques, such as PERT (Programme Evaluation and Review Technique) and CPM (critical path method). The second tradition has its intellectual roots in the social sciences and focuses especially on the organizational and behavioural aspects of projects. Söderlund (2004) calls the first tradition the engineering tradition and the second tradition the social science tradition. In a similar distinction between project management traditions, (Crawford, et al., 2006) use the terms 'hard' and 'soft' respectively (for more detailed information see also (Pollack, 2007)).

The engineering and science tradition see a project as more or less closed system, the main purposes of which is to deliver a unique task. Some call this tradition a 'system approach' (e.g. Morris 2004), and some others say that in this tradition a project has a task perspective (Andersen, 2008).

The main focus in the engineering and science tradition has from the beginning been on developing more or less a universal standard that provides proper guidelines on how to manage on single project. At least five different project management knowledge standards have been developed over the last 30 years (PMBOK® IPMA Competence Baseline, APM BoK, ISO 21500, and PRINCE2) with the same goal: to provide a universal context-free framework that will fit 'most of the projects most of the time' and that can be used to guide the development and assessment of project personnel. The five different bodies have slightly different solutions to the problem, and each of them starts with how they choose to define project.

The PMBOK defines a project as follows:

*A project is a temporary endeavour undertaken to create a unique product, service or result* ((PMBok, 2000)

In this context, 'temporary' means that every project has definite beginning and a definite end, whereas 'unique' means that every project is different in some distinguishing way from all other products or services. In the third edition (2013) of the PMBOK, the terms *temporary* and *unique* are clarified more in detail:

*Temporary* means that every project has a definite beginning and definite end. The end is reached when the project objectives have been achieved, or [it] becomes clear that the objectives will not, or cannot be met, or the need for the project no longer exists and the project is terminated. Temporary does not necessarily mean short in duration; many projects last for several years. In every case, however, the duration of a project is finite. Projects are not ongoing efforts. In addition, temporary does not generally apply to the product, service or result created by the project. Most project are undertaken to create a lasting outcome.

*Uniqueness* is an important characteristic of project deliverables. For example, many thousands of office buildings have been developed, but each individual facility is unique – different owner, different design, different location, and different contractors and so on. The presence of repetitive elements does not change the fundamental uniqueness of the project work.

According to the PMBOK, *project management* is the application of knowledge, skills, tools, and techniques to project activities in order to meet the project requirement.

(Peter W.G Morris, 2004) claims that the PMI's view, as express in the PMBOK, aligns project management with execution management, namely the accomplishment of stated objectives, most classically defined as accomplishing the project on time, within budget, within scope: 'here is the objective, go do it'. Furthermore, Morris is rather critical of how the PMBOK fails to refer to the management of frontend issues, exogenous factors, strategy or human factors. He argues that it is a product of the 'traditional' paradigm and the information processing paradigm feeds into this. The PMBOK is epistemologically closely associated with positivism, seeking general explanations and solutions for practice, and tending to disregard context (Smyth & Morris, 2007).

The IPMA Competence Baseline defines a project as (Baseline, 1999):

*A project is a time and cost constrained operation to realise a set of defined deliverables (the scope to fulfil the project's objectives) up to quality standards and requirements.*

The standard suggests that project management involves three competence areas – contextual, behavioural, and technical – and they provide a framework that covers project, programme, and portfolio management.

The APM BoK (Dixon, 2000) and PRINCE2 standards have a more business-oriented approach to the management of projects.

The APM BoK provides the following definition of a project:

*A unique, transient endeavour undertaken to achieve a desired outcome.*

Morris ((Peter W.G Morris, 2004) states:

the management of projects as a broader way of representing the discipline: managing projects within their business or social context, managing them to achieve business success: managing – or at least influencing – the project's environment, or context, that can so affect outcome success, as well as the intra-project processes and practices of definition and delivery. And this needs to be addressed in the project management body of knowledge standards.

The APM view on the management of projects claims to be broader than the PMI's approach.

The PMI's approach introduces the sponsor or the project owner as an important stakeholder and it introduces the idea that project management should not only focus on whether the project will be accomplished on time, within budget, and according to scope, but whether the business success is met too. Project success should be measured against the project's key performance indicators (KPIs) (i.e. whether it justifies the effort and the risk expended in undertaking the project). Indeed, it could be that the original baseline targets are no longer relevant, but rather that it is in the sponsor's business interests for the project to exceed its baseline cost, schedule, or scope targets.

According to the PRINCE2 standard, a project can be defined as follows:

*A management environment that is created for the purpose of delivering one or more business products according to specified business case. (Bentley, 2009; Paul, 2003)*

A PRINCE2 project will have the following characteristics:

- A finite and defined lifespan
- Defined and measurable business products
- A corresponding set of activities to archive the business products
- A defined amount of resources
- An organizational structure with defined responsibilities, to manage the project

The ISO 21500 (2012) definition of a project is as follows:

*A unique set of processes consisting of coordinated and controlled activities with start and end dates, performed to achieve project objectives. Achievement of the project objectives requires the provision of deliverables conforming to specific requirements.*

A project may be subject to multiple constraints as — the duration or target date for the project, the availability of the project budget; the availability of project resources, such as people, facilities, equipment, materials, infrastructure, tools and other resources required to carry out the project activities relating to the requirements of the project, factors related to health and safety of personnel the level of acceptable risk exposure, the potential social or ecological impact of the project, laws, rules and other legislative requirements. Although many projects may be similar, each project is unique. Project differences may occur in the following ways

- Deliverables provided
- Stakeholders' influence
- Resources used
- Constraints
- The way processes are tailored to provide the deliverables.

Every project has a definite start and end, and is usually divided into phases. Projects are usually organized into phases that are determined by governance and control needs. These phases should follow a logical sequence, with a start and an end, and should use resources to provide deliverables. In order to manage the project efficiently during the entire project life cycle, a set of activities should be performed in each phase. Project phases are collectively known as the project life cycle. The project life cycle spans the period from the start of the project to its end. The phases are divided by decision points, which can vary depending on the organizational environment. The decision points facilitate project governance. By the end of the last phase, the project should have provided all deliverables.

In Norway a similar debate has been ongoing and in the 1990s. It led to a terminology project being initiated as a part of the research programme 'Project 2000 – (1994–2000). At that time, 'project' was defined as follows:

*A unique endeavor with a clear objective and defined scope to be undertaken within a time and cost limit. (Kilde et al., 1997; my translation)*

In this engineering tradition the project is fundamentally about delivering an objective during a defined life cycle (Peter W.G Morris, 2004).

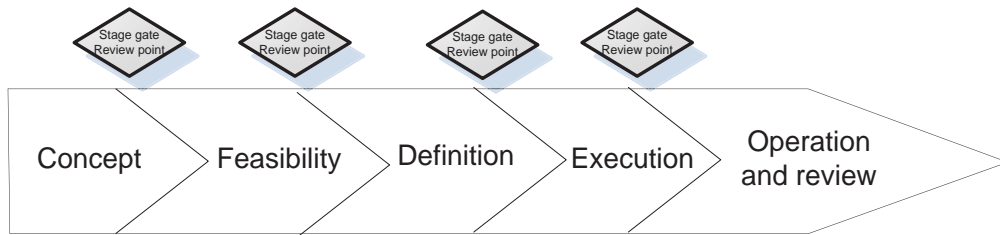


Figure 26 The project life cycle (Morris, 2004).

Morris says that the one thing that distinguishes projects from non-projects is that all projects, no matter how complex or trivial, go through a common life-cycle development sequence. Whole organizations can be set up to achieve specific objectives within given time and cost constraints, and that will consume resources. (The Apollo programme was not a project.) However, it is the act of going from concept, through definition, development, and build, to handover. In this respect, several different life-cycle models exist that truly distinguish projects from non-projects. PRINCE2 points out that these projects are different from the normal operation of the organization in that they

- have specific objectives to deliver new benefits to the taxpayer, companies, the general public, the government, the sponsoring organization, stakeholders, and/or delivery partners
- may introduce significant changes to the way the business operates
- create new outputs and/or deliverables that will enable benefits to be realized
- have a specific, temporary management organization, and governance arrangements set-up for the duration of the project are susceptible to risks not usually encountered in the day-to-day operation of the work of the organization
- involve a range of stakeholders from different parts of the organization and beyond
- may use methods and approaches that are new or unfamiliar.

This tradition has had a strong focus on the project delivery and it should be defined according to the triple constraints (i.e. time, cost, and quality) that are often referred to as the 'iron triangle'.

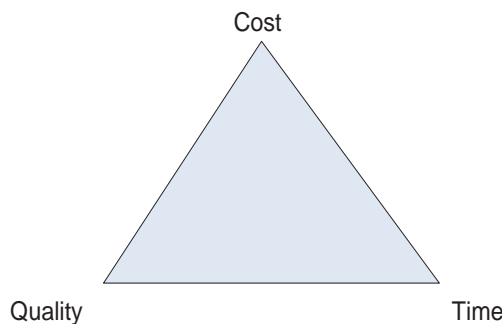


Figure 27 The iron triangle (Atkinson, 1999)

The different project definitions describe above all have the following in common: they all state that projects have defined start and end (time constraints); they have a limited budget (cost constraints); and they will try delivering something (an object) at the end, according to certain specifications

(quality). In addition, all of the definitions state that a project is a more or less unique endeavour with a set of stakeholders that have to be managed in the planning and execution of the project. They also state that projects go through a definition, planning, executing, and closing phase. Also, all of the project definitions state that each project is planned and executed by a temporary organization that will be demobilized when the project objective is delivered (see Figure 26

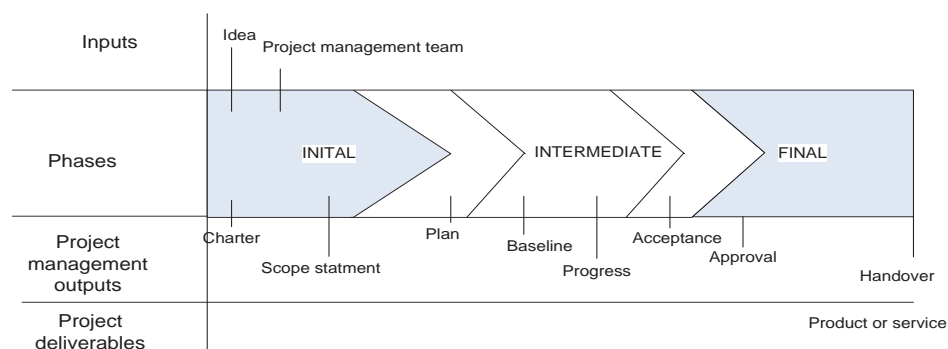


Figure 28 Typical sequence of phases in a project life cycle (PMBOK, 2013)

#### 4.2 Project classification

The definition of project management as a theory raises a fundamental question:

Is it possible to describe a theoretical framework that fits all types of project, one that fits small as well as big projects, projects that have a long time span as well as short projects with a small budget, small as well as multibillion projects, and a theory that is independent of the line of business, independent of types of deliverables, and independent of context and stakeholders involvement?

The trend for establishing different standards and bodies of knowledge in the field of project management is a widespread phenomenon. This supports the idea that it is possible to make a more or less generic theory, and that it is possible to standardize PM in knowledge areas that can be used to guide the development and assessment of projects. I argue that most of the project community maintains that not possible to develop one theory that fits 'most of the projects most of the time'. Many other scholars have reached the same conclusion (Bredillet, 2008; Crawford, et al., 2006; R. Müller & J. R. Turner, 2010; Rolstadås, 2008; Shenhar & Dvir, 2007), and have pointed out that PM theory needs some type of classification of projects so that project management teams can choose the proper tool and concepts depending on their project needs.

According to Rolstadås (2008), (Shenhar & Dvir, 2007) and (R. Müller & R. Turner, 2010), several different classifications are used in the project community. Some organizations differentiate between customer projects (i.e. external projects) and internal projects, some make their classification based on the line of business (e.g. defence project, research and development (R&D), facilities construction, information systems (software) projects, and events projects), some make their classification based on typical project characteristics or attributes such as project uncertainty, pace and complexity or novelty, complicity, pace and technology, or duration, risk, complexity, and innovation), and some make their classification based on leadership style (Crawford, Hobbs, & Turner, 2005; R. Müller & R. Turner, 2010; Müller, Geraldi, & Turner, 2012; Shenhar, Dvir, Lechler, & Poli, 2002). A further type of classification in use is based on end user and type of results, which leads to classification in *pre-*

*projects* (in which the purposes defines the main project) and *main projects* (which deliver the project objectives) (Rolstadås, 2008).

#### 4.3 Project actors and roles

There are three different perspectives on risk in a project: the owner perspective, the project management perspective, and the contractor perspective. The owner has overall responsibility for the project charter and for approval (at a high level) of the design, approach, and plans (Andersen, 2008). The project management is responsible for the execution of the project as a whole and the delivery of the project results. The contractor is responsible for executing the deliverables according to the contracts. The relationship between the owner, project management level, and the contractor is regulated by an internal contract (i.e. business cases or a project charter) or through an external contract comprising a contract format and a pricing format (Rolstadås, 2008, 2014).

The owner level, project manager level, and the contractor level may carry different risks in a project. For example, the reliability and the performance of the contractor may be a risk on the owner's side, and the feasibility of the fabrication technology may be a risk on the contractor's side. The owner and contractor may also share risk in a project. This is typical for the handling and compensation of variations depends on the contract and the pricing format. Lastly, a risk on the side of the owner may turn out to be an opportunity on the contractor side. This is the case if, for some reason, the owner has to make substantial changes to the work scope or if there are errors in the design provided to the contractor as part of the contract. In both cases, the contractor is in a strong position to negotiate time and cost compensation.

Project stakeholders are either actively involved in a project or their interests may be positively or negatively affected by a project (N. Olsson, et al., 2007); (A. Johansen, Eik-Andresen, & Ekambaram, 2014). The PMI defines stakeholders as individuals and organizations who are actively involved in the project or whose interests may be positively or negatively affected as a result of project implementation or successful project completion (PMBok, 2000). According to (McElroy & Mills, 2000), project stakeholders are persons or groups of people who have a vested interest in the success of a project and the environment within which the project operates. In a study of large engineering projects, (Olander & Landin, 2005) found it important for a project management team to identify stakeholders that can affect a project, and then to manage their differing demands throughout the project stages. (Mikkelsen & Riis, 2011) point out that stakeholder analysis is not based on a democratic process to ensure equal rights or equal representation to all stakeholders (Mikkelsen & Riis, 2011). On the contrary, stakeholder management could be said to be a process describing the project's position in a political field of force between stakeholders with conflicting and congruent interests.

##### **Project owner**

Simply put, ownership gives control and responsibility. In economic terms, ownership gives residual control rights, and residual profit responsibility (Foss & Foss, 1995). Control rights give the owner full rights of use, possession, and disposal of a resource. Within the legal framework, an owner does not need to be accountable to anyone else (Hart, 1995). Profit responsibility means that the owner is responsible for both the cost and income related to the resource. That these rights are residual means that the owner can lease out or in other ways delegate the authority of the owned resource to others (Grünfeld & Jakobsen, 2006); Olsson et al., 2008).

A project owner bears the owner rights and responsibilities of the project (Per T. Eikeland, 1998). According to (Per T. Eikeland, 1998), the project owner takes the risks related to the cost and future value of the project. Both types of risk can to a certain extent be transferred to other actors in the project. (Samset, 2003) uses the term 'financing party' in a meaning similar to 'project owner'. According to (Samset, 2003), as a rule financing parties or owners have their main interest first and foremost linked to the long-term effects of the project.

### **Project users**

The users of a project delivery can be described using either a wide or narrow definition. In the wide definition, users include everyone who uses the results of the project (e.g. the building, hospital, or railway line). During the project preparation and execution, users are not easily identified. This means that projects usually interact with user representatives who act on behalf of those who intend to use the results of the project. In a narrow definition, users means the users' representatives. These user representatives are not necessarily representative of the average user during the lifetime of the final product of the project. There can also be different layers of users, and a distinction can be made between primary and secondary users. Primary users are usually professional users of a project's delivery, such as the personnel working in a new building (e.g. hospital or office) or the train operators on a new railway line. Secondary users are the customers of these professional users, such as patients in a hospital or passengers on a train running on the new line. The distinction between primary and secondary users may be unclear, but such a distinction is important for an analysis of project stakeholders.

### **Project manager**

In a project, many people will call themselves 'project manager', usually meaning that they are project managers of their organization's part of the project. However, the project manager acting on behalf of the project owner is responsible for the overall management of a project (Per T. Eikeland, 1998).

### **Governance and accountability**

According to (Stame, 2006), governance is related to 'the process of governing', in contrast to the 'institution of government'. (Samset, Berg, & Klakegg, 2006) describe 'governance regimes' as the processes and systems that need to be in place on behalf of the financing party to ensure successful investments. The terms 'good governance' and 'governance' can be used in the same meaning (Grünfeld & Jakobsen, 2006). In more general terms, governance deals with the processes and systems by which an organization or a society operates. (Kaufmann & Vicente, 2005) relate governance to the traditions and institutions by which authority is exercised for the common good.

Corporate governance is the set of processes and policies affecting the way a corporation is directed, administered, or controlled. Corporate governance also includes the relationships among stakeholders, including shareholders, top management, and the board of directors, as well as employees, suppliers, customers, and regulators, among others.

An important theme of corporate governance deals with mechanisms to ensure good behaviour and to protect shareholders' interests. Corporate governance codes have been developed in different countries. Compliance with these governance recommendations is generally not mandated by law, although the codes are linked to stock exchange listings, as is the case for the Oslo Stock Exchange. In Norway, listed companies have to practice corporate governance in accordance with the Norwegian



Code of Practice for Corporate Governance (Norsk Utvalg for Eierstyring og Selskapsledelse, 2006). In other countries, companies may not need to follow the recommendations of their respective national codes, but they must disclose whether or not they follow the recommendations in those documents.

In a project context, the APM defines the governance of project management as follows:

Governance of project management (GoPM) concerns those areas of corporate governance that are specifically related to project activities. Effective governance of project management ensures that an organisation's project portfolio is aligned to the organisation's objectives, is delivered efficiently and is sustainable. (Dixon, 2000)

The APM definition is directed towards the relation between an organization and the projects carried out by the organization. Governance thus means to ensure that the projects are carried out in accordance with the overall objectives of the organization.

Accountability can be used synonymously with concepts such as answerability, responsibility, and liability. As an aspect of governance, accountability has been central in discussions related to problems in both a public and business context. Accountability is frequently seen as an important means of achieving governance. In the UK, accountability has been formally identified by the Government since 1995 as one of the Seven Principles of Public Life argue that an ambition to achieve accountability through openness and transparency fits well with the rationalist view of deciding, but fits badly with what they claim to be the reality of good decisions.

(Flyvbjerg, Bruzelius, & Rothengatter, 2003) argue that the involvement of private capital in public investments can serve as a tool for accountability. Their idea is that private ownership gives incentives for scrutiny of a project in a way that contributes to realistic estimates of future costs and revenue from the project. In both the public and private sectors, a key issue related to governance is that an executing stakeholder does not necessarily have the same incentives as the owners who finance the endeavour. In a company, the managing director can be seen as the executing actor, while for public projects it is often an agency or a project manager.

To summarize, governance is seen as initiatives originating at the owner level (including mechanisms for accountability), whereas in practice accountability is represented by the justification of, for example, decisions and information flowing from the executing level to the owners.

#### **Why focus on project owners?**

As (Grünfeld & Jakobsen, 2006; N. Olsson, et al., 2007) point out, the combination of control, along with the responsibility for both cost and income from the owned resource, puts owners in a special position. A stakeholder who has both control and profit responsibility has incentives to maximize the value creation related to the resource. If a stakeholder has control, but no responsibility for results, there is a risk that the control might be used to fulfil their own interests. Similarly, to have ultimate responsibility but no control is a demanding situation.

Most literature on project ownership focuses on one owner having all the characteristics of an owner, and is based on one stakeholder who takes the risks related to the cost and future value of the project.

A governance perspective aims at securing that an executing body works in accordance with the owner's interests. Such an executing body is equivalent to a project in our cases, whereas a corporate governance perspective focuses on the management of a company. The (APM, 2006) point out that project governance aims at ensuring that an organization's project portfolio is aligned to the organization's objectives. Using a governance frame of reference, what is right for the project owner is by definition right for the project. Ultimately, the owner takes responsibility for the value of the project. When it comes to stakeholder management, a governance perspective means that owners are a special type of stakeholder.

A traditional owner is a stakeholder who takes the risk related to both the cost and future value of the project. Such a stakeholder has incentives to analyse and follow up a project based on weighing the costs against the benefits. Most stakeholders in governmental projects have their main incentives on either on the cost side or the benefit side of a project. Even though the relevant ministry will have an interest in weighing costs against benefits for the investments within their responsibility, our studies included also projects involving more than one ministry.

#### 4.4 The Norwegian evolution of development of project management

Norwegian project management history is closely related to a historical event that occurred in the autumn of 1969: the discovery of oil on the Norwegian continental shelf. The discovery of oil gave birth to the Norwegian state oil company, Statoil (in 1972) and Saga (in 1972), and a traditional shipyard was restructured to deliver offshore construction. The introduction of oil and gas projects was demanding for the suppliers as well as for the new Norwegian oil companies; limited experience combined with lack of tools and methods for managing these large and very complex projects was a bad combination, and resulted in huge cost overruns for most of the oil and gas projects in the early 1970s. The development of project management theory in Norway followed the trends in the UK and the USA in the same period: a project was considered to be a tool directed towards creating results (Hetland, 1992). The development has also been oriented towards adopting and developing tools for planning and controlling activities (Rolstadås, 2008). The work logic is characterized by working in phases, modularization, and specialization (Söderlund, 2004). In the 1990s different organizations (e.g. the Project Management Institute (PMI) and International Project Management Association (IPMA)) developed 'bodies of knowledge' (PMBoK, 2000) and the IPMA Competence Baseline 2.0 (1999), which outlined competence areas within project management.

#### 4.5 Development of uncertainty – risk management in Norway

In Norway, project risk and uncertainty management has been in continuous focus in research and development since the mid-1970s. By the early 1980s, with two different schools of thought had emerged: the risk school and the uncertainty school.

##### **The risk school**

The risk school, in common with the project management field, has its origins in the American defence industry (Rausand & Utne, 2009). The risk school started in the same time period as the first PM theory was developed in the late 1940s and early 1950s. The first standard in risk and reliability standard (MILS-STD 1629) was published in 1949 and focused on failure modes and effects analysis (FMEA). In 1962 the fault tree analysis was developed as a part of the rocket launch programme Minuteman and in 1969 the systems security standard (MIL-STD 882), based on the demands were developed in the same project, was published. Fault tree analysis was an important method in the

early days of the nuclear power plant development. The huge inquiry into the safety of 100 power plants in the early 1970s was a millstone in the development of the risk methodology presented in the WASH 1400 report or the Rasmussen report in 1975. In the same period, a team of British researchers developed HAZOP as a part of their tool to prevent accidents in the oil and gas sector. The driving forces were investigations of accidents and efforts to avoid risk that could potentially harm humans or the environment.

In 1991 the Norwegian standard NS 5814 Requirement for Risk Analysis (Krav til risikovurderinger) was published and became a starting point for the risk school at the Norwegian Technical University (NTH). Rausand (1991) published the 'Risk Analysis: Guidance on NS 5814' and this work was followed up by 'Risk analysis: Theory and methods' (my translation) (Rausand & Utne, 2009) and 'Risk assessment – theory methods and applications' (Rausand, 2013)

The risk school deals with risks related to technical and sociotechnical systems, regarding:

- Events that may occur in the future
- Events that have *unwanted* consequences for assets that needs to be protected.

Researchers belonging to the risk school do not cover all aspects of risk; rather, their main focus is on *accidents* that may give *negative outcomes* (i.e. some type of loss or damage). From this school's perspective risk analysis is a proactive approach that uses available information to identify hazards and to estimate the risks to individuals, property, and the environment. Furthermore, when risk analysis and risk evolution are carried out in a joint process, the term risk assessment applies. The term risk management is used in the total concept, and consists of three steps: risk analysis, risk evolution, and risk control. Risk management is defined as a continuous management process with the objective to identify analyse and assess potential hazards and to introduce risk control measures to *eliminate or reduce potential harm* to people, the environment, or other assets. Thus, according to the risk school, risk is equivalent to 'bad' or 'unwanted' because risk is a about unwanted consequences. Positive risks or opportunities have no place in this school. The risk school has had considerable impact due to the fact that much attention was paid to health, environment, and safety (HES) in the Norwegian offshore industry in the 1980s and 1990s. When the Norwegian Government presented its zero casualty vision for the industry, it embraced the risk school's thinking as a means to achieve this goal.

### **The uncertainty school**

The uncertainty school was established slightly earlier than the risk school, and researchers from the project management and construction field at NTH adapted the uncertainty concept originally introduced by Steen Lichtenberg. Lichtenberg developed his methods for calculating the cost of major projects (i.e. the successive principle of cost estimation) in the 1970s and 1980s, together with researchers from Stanford University and MIT in the USA, Loughborough University in the UK, Chalmers University of Technology in Sweden, and not least the Norwegian Technical University (NTH) in Trondheim. According to Lichtenberg, the essence of the 'Successive Principle' is as follows:

The Successive Principle can handle the uncertainty or contingency in projects, budgets and plans in a controlled, efficient and scientifically based manner. Using a consistent top down procedure you in successive steps clarify the many uncertain factors. In this manner, it besides other valuable benefits - has documented an ability to largely eliminate unplanned budget overruns and delays. (Lichtenberg, 1990)

Lichtenberg also states that the research behind the 'Successive Principle' is based on the new scientific paradigm that accepts and deals with uncertain and fuzzy issues. The aim of the research into the 'Successive Principle' has been to allow professionals to calculate the projected total cost or duration of new projects or ventures in a more realistic and controlled manner, and more focused on the relevant future uncertainties. Lichtenberg uses the term uncertainty, and from the beginning it has been a neutral concept and should have a broader view than the risk concept, which deals only with the downside. For Lichtenberg, uncertainty means that something could go faster, or activities or the project could cost less than planned, or it could take a longer time or cost more than planned. Lichtenberg's concept was adopted by Norwegian project management researchers from Norwegian Technical University (NTH), since the early 1990s uncertainty analysis has been used as a term when projects have wanted to find the expected cost or time. (Klakegg, 1994) were introduced and adopted by consultants and practitioners in the same period. Today, the step-by-step approach and uncertainty analysis are established as the dominating concepts in Norway, and the methods are used for estimating expected cost and time and finding the uncertainty factors that could affect the project objectives in a positive (opportunities) or negative (threat) way. The term uncertainty management is used in the set of processes for identifying the positive and negative events or activities that may or may not happen, quantifying the expected effect, prioritizing, planning response, implementation of responses, and follow-up.

The differences between the risk management school and uncertainty management school in Norway have influenced the way projects have managed threats and opportunities since the 1990s. There has been a consistent, yet fragmented, development consisting of several initiatives: a combination of joint research efforts, intra-company competence developments, and governmental regulations. These efforts include work done by scholars from the Norwegian Technical University (NTH) on risk and uncertainty management during the 1980 and 1990s, research on uncertainty done in the research programme Project 2000 (established in 1994), research on uncertainty as a learning arena, and practical and uncertainty management in a project owner perspective (the PUS project) initiated by Norwegian Centre for Project Management. Also, the Concept research programme at NTNU has had several research projects on uncertainty analyses, methodology, modelling estimation and calculation, context and foundation, methodological errors in data and analysis, and cost uncertainty in large public investment projects.

#### **Uncertainty management in the research programme Project 2000 (PS 2000)**

In the 1980s and 1990s major public investment projects experienced lack of success and repeated failures. Several major investment projects in the energy sector experienced also cost overruns and delays. There was a growing concern that more competence on risk management in projects had to be developed.

In 1993, Project 2000 (PS2000) was established as a joint research programme by Norwegian industrial partners and partners in Norwegian public sector. The main goal was to ensure and further advance the competitiveness of Norwegian industry and the public sector by developing and implementing competence in the identification, evaluation, planning, and execution of projects.

The PS 2000 revealed the need for increased attention on the early phase of projects. The need for new evaluation schemes for projects arose based on these challenges. PS 2000 was concluded at the end of 1999, and the results were comprehensive and addressed many of the different knowledge

areas. Uncertainty management was a research topic throughout the six consecutive years of the research programme, and was thus the most important topic in the programme. In the final summary report (Andersen Bjørn, 1999), uncertainty management was identified as an important issue for project success in the future, and as especially important in order to utilize the full potential of opportunities in projects.

### The Norwegian Ministry of Finance and the Concept research programme joint Quality Assurance scheme

In the year 2000, the Norwegian Government introduced a quality assurance scheme whereby an external review would be conducted for all public investment projects with expected budget above NOK 500 million before they would be authorized for execution. For the research presented in this thesis, the documentation from the scheme has provided an opportunity to look into predictions of costs in a stream of projects planned and executed under a common framework for project improvement and how these costs have developed during project execution. The research programme Concept was established in 2000 in order to carry out trailing research on the quality assurance scheme and all actors that involved in the scheme.

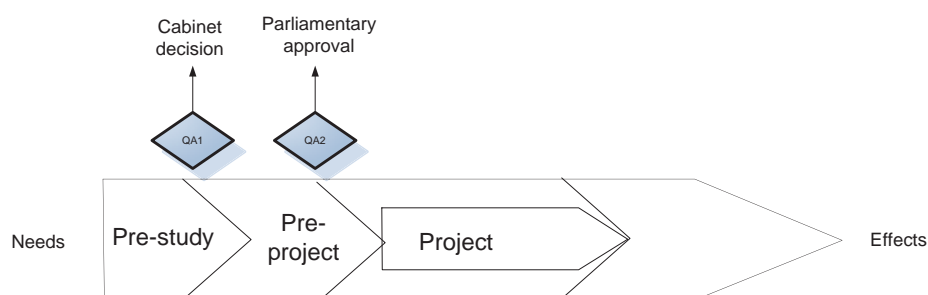


Figure 29 The Norwegian Quality Assurance scheme

The project approval process was implemented in 2000 by the Norwegian Department of Finance. The first exercise put in place was mandatory quality assurance and uncertainty analysis of projects – known as ‘Quality Assurance 2’ (QA2). These analyses were carried out by external consultants on behalf of the responsible ministry before the project was presented to Parliament to be authorized for execution. The aim of QA2 is to evaluate the professional quality of the basis for the chosen alternative. The more particular focus regarding revision of cost estimates and identifying major risks should be seen in light of the specific goal of the quality assurance. It is a tool for evaluating the quality of information and for providing new information on the basis of which the decision-makers can judge the project.

In 2005, the Norwegian Government introduced an exercise to be carried out at the end of the pre-study phase, just prior to Government’s decision on whether pre-planning should be carried out – ‘Quality Assurance 1’ (QA1). The purpose of QA1 is to ensure a rational and realistic choice of concept. In conformity with QA2, QA1 is mandatory and consists of external review to judge the project. QA1 also supplements the existing exercise. It aims to ensure that realistic and informative analyses are made available at an early stage and that the initiation process and choice of the project as conceptualized is subject to actual political steering.

The Norwegian QA scheme and the Concept research programme have been running since 2000. In 2005, Concept launched several projects in which they addressed the question of whether upfront assessment and quality assurance guard against underestimation of cost. To carry out this assessment, the cost estimates from the early stages of definition to completion in transportation infrastructure projects were analysed. Previous studies in this area have compared budgeted costs (costs at the time of decision to build) with actual outcomes, often on the basis of unsystematic selections of diverse, although large, samples of projects. The Concept study was concerned with investigating the cost development from the early stages of definition to completion in a stream of projects planned and executed under a common framework for project improvement. In 2006 Magnussen Olsson and Klagegg made the first attempt to analyse the development of cost estimates in the early stages of projects subjected to upfront assessment and quality assurance (Klagegg, Williams, & Magnussen, 2009; Magnussen, 2010). As pointed out by (Venkataraman & Pinto, 2008), the importance of estimating project costs originated from when estimates became standards against which future costs would be compared. Although estimates become more accurate as decisions are made and uncertainties resolved, they are also the chief means for assessing project feasibility, in the sense that a comparison of cost estimates with estimates of revenues is crucial for determining whether it is worthwhile continuing a project. The decision to finance and execute the project is based on estimates, and estimates are influenced by historical data. Therefore, cost estimation is among the factors that influence project success. In 2010, the Concept project concluded the study of more than 100 projects that gone through the QA scheme and summarized how emphasis on reviews of cost in the front end of major projects might contribute to more consistent achievements in project success.

#### **Uncertainty management in Norwegian Centre for Project Management (NSP)**

Norwegian Centre for Project Management (NSP), established in 1999, was the realization of the third main goal of PS 2000; a permanent competence centre for project management where practitioners and academics could meet and develop future project management competence.

Uncertainty management was once again put high on the agenda when in 2005 the Norwegian Centre for Project Management, together with six partners, launched the PUS project. The project had duration of approximately five years and involved six major Norwegian public and private 'project-intensive' companies and organizations. The main focus of the project was to develop knowledge and insights into how uncertainty management should be executed throughout project execution to take advantage of opportunities and manage all threats in an appropriate manner. The mantra in the project was to ensure that the project owner was actively involved in the uncertainty management process.

#### **4.6 The development of the risk management knowledge area**

Risk and uncertainty have been subjects of interest for mankind for a long time. When mankind started playing games and gambling there arose a need for understand probability, and this also marked the start of the development of uncertainty and risk as concepts and theories (Bernstein & Bernstein Peter, 1996). In their book *Against the Gods: The Remarkable Story of Risk*, Bernstein and Bernstein Peter (1996) point to a list of important discoveries that have made an impact on today's understanding and management of risk:

- Introduction of numerical measures for probability – B. Pascal, 1662
- Estimating of average – J. Graunt, 1662
- The concept of insurance – E. Lloyd, 1696
- Utility as a part of the risk concept – D. Bernoullis, 1731
- Statistical interference – T. Bayes, 1764
- Utility theory (about how people make decisions) – J. Bentham, 1789
- Central limit theorem – P.-S. Laplace, 1809
- The bell curve/Gauss curve – G. F. Gauss, 1810
- Normal distribution, regression to the mean, and correlation – F. Galton, 1877
- Decision-making under uncertainty (separating risk and uncertainty) – F.H. Knight, 1916
- Uncertainty as the core of the new economic theory (We are not prisoners of an inevitable future – uncertainty makes us free. Uncertainty means that we simple do not know the future) - J. M. Keynes, 1921
- Game theory – J. V. Neumann, 1926

The developments in understanding of risk and uncertainty have been evolving since the mid-1600s and the development of the different concepts came from all different parts of academia. Risk and uncertainty had been a part of economic studies, psychology (decision theory), insurance, finance, and engineering disciplines such as safety and reliability studies, to mention some. As I mentioned in Chapter 1, the Nordic work with uncertainty management started in the late 1990s, after the following books had been published: *Prosjektplanlegging i en foranderlig verden* (Project planning in a changing world) (Lichtenberg, 1990); *Prosjektledelse under usikkerhet* (Project management under uncertainty) (Christensen & Kreiner, 1991); *Trinnvis-prosessen* (The step-by-step approach) (Klakegg, 1993); and *Uncertainty as Benefit* (Husby et al., 1999). In UK, the books *Project Risk Management: Processes, Techniques and Insights* (Chapman & Ward, 1996; 1997), and *PRAM: Project Risk Analysis and Management Guide* (Simon, et al., 1997) were published in the same time period. (Stephen J Simister, 2004) continued on this path and developed a generic risk management model based on publications from national standards produced by the British Standards Institute, Canada Standards Association, and Standards Australia, as well as by professional institutions (Institution of Civil Engineers (ICE, 1998), Japan Project Management Forum (2002), Project Management Institute (2008), and the Association of Project Management), and government departments (United States Department of Defence (USDOD) (2003), and the UK Office of Government Commerce (OGC) (2002)) (Stephen J Simister, 2004). Simister's risk model presents the basic idea of having a continuous, repetitive, and iterative process – the idea that risk management is more than isolated exercises and analyses (Figure 30).

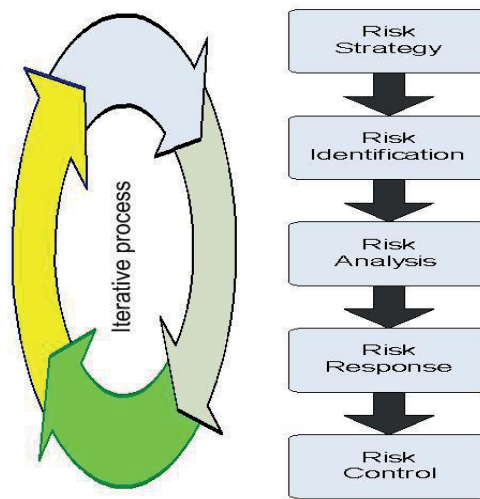


Figure 30 Risk management process (Simister, 2004)

(Stephen J Simister, 2004) underlines the importance of undertaking risk management as a structured, formal process aligned with the overall project management approach. He claims that the risk management process should be commenced as early as possible in a project life cycle, and that the process has to be undertaken on an iterative basis since each assessment is a snapshot in time. and have elaborated upon Simister's risk management process in the updated version of their book titled *Project Risk Management: Processes, Techniques and Insights* (C. Chapman & Ward, 2007). They divide project uncertainty into five areas:

1. Variability associated with estimates
2. Uncertainty about the basis of estimates
3. Uncertainty about design and logistics
4. Uncertainty about objectives and priorities
5. Uncertainty about fundamental relationships between project parties

According to Ward and Chapman, all areas of uncertainty are important and generally they become more fundamentally important to project performance lower down the list, and the areas affect one another. In this context I claim that project uncertainty in at least the last two areas in the list depend upon the involvement of the project owner and other stakeholders in the uncertainty management process.

#### 4.7 Uncertainty versus risk

Uncertainty and risk have been debated in the project management community for more than four decades. Some consider them synonyms and some consider them as two separate terms with different interpretations, but both terms are used in connection with management. That means that how we define uncertainty and risk also has a direct impact on how we define and understand uncertainty management and risk management.

The debate has taken different directions. Some scholars (e.g. Aaltonen, Lechler, & Artto, 2012) are concerned about the origin of the concept and they refer to the early work of the economists Knight



and Keynes and their work on economic theory published in 1921 as the starting point of defining risk and uncertainty. Other scholars claim that risk, probability and uncertainty were understood much earlier than 1921 (Bernstein & Bernstein Peter, 1996).

According to (Bernstein & Bernstein Peter, 1996), the first work on probability and risk was published by De Movire in 1711, titled *De Mensura Sortis* (which translates literally as 'On the measurement of lots'). De Movire's work was later translated and expanded in an English version titled *The Doctrine of Chance* (De Movire 1718). De Movire said that 'The risk of losing any sum is the reverse of exaptation; and the true measure of it is, the product of the sum adventured multiplied by the probability of the loss' (De Movire, 1718). De Movire's work is among the first to suggest that that risk is linked to the probability of a negative outcome. He also developed 'De Movire's distribution', which today is known as the normal or bell curve, and plays vital part in calculations of uncertainty.

In their paper 'The influence of ergodic economic theory on the foundations of theorizing on projects', (Aaltoen, 2012) introduce the concepts of ergodic<sup>1</sup> and non-ergodic perspectives to shed light on the different schools of thoughts. They claim that scholars of economic theory divide between two broad views as to what extent future events in the world are predictable, which generates a difference in the worldview ('Weltanschauung') of the holders of the two views. Aaltonen et al. (2012) further argue that an ergodic view holds that all future events are, in principle, predictable from a sufficiently accurate and 'correct' understanding of the past. This implies that there are laws according to which the world unfolds in time to define all the future states of the world. According to ergodic theory in its extreme sense, all future events, in some sense, have already existed today and therefore is time irrelevant. Scholars with non-ergodic perspectives hold that it is not possible to give forecasts to determine all the states of the future world in advance. According to the non-ergodic theory, future events do not exist in any conceivable way as of yet and time is quintessential. Scholars with an ergodic view argue that we can know the future states of the world, which can be derived from past and current states of the world with the help of laws to be discovered, whereas scholars with an non-ergodic view argue that knowing all things in the future in advance is not possible no matter how accurately or completely the past and the present states of the world are observed. The two schools (ergodic and non-ergodic) define uncertainty and risk in different ways and Aaltonen et al. (2012) have summarized some of the views from different disciplines on the topic (see Table 9).

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<sup>1</sup> Ergodic theory (*ergon* work, *hodos* way) is a branch of mathematics that studies dynamic systems with an invariant measure and related problems. Its initial development was motivated by problems of statistical physics (Wikipedia)

Table 9 Sources of ergodic and non-ergodic theory in scientific disciplines (Aaltoen, 2012)

Uncertainty vs risk	Ergodic theory	Non-ergodic theory
Uncertainty in economics	<p>It is possible to acquire all the necessary knowledge about the future in principle. Future events can be predicted with probabilities. Hence, uncertainty reduces to estimates on risk. In the mainstream economic perspective, uncertainty is synonymous with probabilistic risk. True uncertainty is unknowable and unpredictable. Future events cannot be fully predicted. Hence, uncertainty is not reducible to estimating risk.</p> <p>Investment implies a structural modification of the production system, the results of which cannot be objectively predicted</p>	<p>True uncertainty is unknowable and unpredictable.</p> <p>Future events cannot be fully predicted.</p> <p>Hence, uncertainty is not reducible to estimating risk.</p> <p>Investment implies a structural modification of the production system, the results of which cannot be objectively predicted</p>
Risk in economics	<p>Risk arises from lack of information; if knowledge increases then uncertainty reduces.</p> <p>There are no limits to the amount of information and the ability to process it. Risk is proportional to the variance of return.</p> <p>In principle, risk is knowable either as an exact probability estimate or as a probability distribution.</p> <p>Probability calculus and statistics are used as tools.</p> <p>Risk can be insured against.</p>	<p>Risk cannot be compared with uncertainty, nor can uncertainties compared with each other. 'Immensurable uncertainty must be taken in a sense radically distinct from the familiar notion of measurable risk</p> <p>Some events cannot be insured against, such as 'Acts of God'.</p> <p>Inquiry, judgment, common sense, and intuition used as tools in managing risk.</p> <p>Too much information may hide a relevancy, attention, perception, and cognitive or framing issue</p>

Other scholars who have reviewed earlier research on project risk (Zhang, 2011) discuss whether risk as phenomena essentially are objective or subjective, without drawing the historical lines back to the work by (Knight, 1921) and (Keynes, 1921). Zhang (2011) categorizes his findings into two schools: 'the risk as an objective fact' and 'the risk as a subjective construction'. He says that both schools have different definitions of risk, and recommends different analytical methods and different policies for managing risks. 'The school of risk as an objective fact' considers that: risks objectively exist and are probabilistic in epistemology; risk analyses are objective, technical, and neutral activities; and the management policies made based on the knowledge produced from an objective risk analysis are the

outcome of rational decision-making. By contrast, 'the school of risk as a subjective construction' considers that risks are subjective and constructed phenomena, and have multiple epistemological dimensions. These dimensions dominate the others depending on the observers, the context they choose, and the perspective they adopt. Therefore, risk analyses are not objective and neutral activities but rich in values.

(Miller & Lessard, 2001) state that risk is the possibility that events and their resulting impacts and dynamic interactions may turn out differently than anticipated. Furthermore, the claim that risk is often viewed as something that can be described in statistical terms, whereas uncertainty applies to situations in which potential outcomes and causal forces are not fully understood. Miller and Lessard refer to both as risks and argue that risks are multidimensional and thus need to be unbundled to gain a clear understanding of causes, outcomes, and drivers. In a well-known IMEC benchmarking study of 60 large projects from all over the world, Miller and Lessard classified risk types and reported that big projects will normally have to deal with the following:

- Completion risk – technical risk, construction risk, operational risk
- Market-related risk – demand risk, financial risk, supply risk
- Institutional risk – regulatory risk, social acceptability risk, sovereign risk.

Furthermore, Miller and Lessard state that many of these risks emerge over time:

Projects that appeared sound at a point in time suddenly become ungovernable. Risks combine and interact to create turbulence. Many risks are linked to the life cycle of the project: regulatory risks, for instance, diminish very soon after permits are obtained: technical risks drop as engineering experiments are performed. Some risks, especially market-related ones continue as they are partly independent of project life cycle. Global market risks that are outside the control of virtually all players. (Miller & Lessard, 2001)

(De Meyer, et al., 2002) share some of the same ideas as (Miller & Lessard, 2001) but suggest a slightly different solution. They suggest that uncertainty-based should be forward thinking and that different types of project needs different types of uncertainty management styles. According to (De Meyer, et al., 2002), projects can be grouped in four categories or types (variation, foreseen uncertainty, unforeseen uncertainty, and chaos), which need different uncertainty management approaches:

*Variation* comes from many small influences and yields a range of values on a particular activity — activity X may take between 32 and 34 weeks, for example. At the start of projects characterized by variation, managers know the sequence and nature of activities and have clearly defined objectives. The project plan is detailed and stable, but schedules and budgets vary from their projected values. A shifting schedule causes the critical path (the train of activities that determines overall project duration) to move, forcing project managers to monitor variations across the board, not just critical activities. (De Meyer, et al., 2002)

'*Foreseen uncertainties*' are identifiable but the team will not be sure whether the foreseen event will occur. Unlike variation, which comes from combined small influences, foreseen uncertainty is distinct and may require full-blown risk management with several alternative plans (De Meyer, et al., 2002).

'*Unforeseen uncertainty*' cannot be identified during project planning. There is no 'Plan B'. The team either is unaware of the event's possibility or considers it unlikely and does not bother to create contingencies. 'Unknown unknowns,' or 'unk-unks,' as they are sometimes called, make people uncomfortable because existing decision tools do not address them. However, unforeseen uncertainty is not always caused by spectacular out-of-the-blue events. It also can arise from the unanticipated interaction of many events, each of which might, in principle, be foreseeable. Unforeseen uncertainty occurs in any project that pushes a technology envelope or enters a new or partially known market (De Meyer, et al., 2002).

Whereas projects subject to unforeseen uncertainty start out with reasonably stable assumptions and goals, projects subject to *chaos* do not. Even the basic structure of the project plan is uncertain, as is the case when technology is in upheaval or when research, not development, is the main goal. Often the project ends up with final results that are completely different from the project's original intent (De Meyer, et al., 2002). De Meyer et al. suggest different uncertainty management roles and tasks for their four categories of projects (see Table 10)

Table 10      Uncertainty management roles and tasks according to type of uncertainty in the project

Type of uncertainty	Project manager's role	Managing tasks
Variation	<p><b>Troubleshooter and expeditor</b></p> <p>Managers must plan with buffers and use disciplined execution</p>	<p><b>Planning</b></p> <ul style="list-style-type: none"> <li>• Simulate scenarios</li> <li>• Insert buffers at strategic points in critical path</li> <li>• Set control limits at which to take corrective action</li> </ul> <p><b>Execution</b></p> <ul style="list-style-type: none"> <li>• Monitor deviation from intermediate targets</li> </ul>
Foreseen uncertainties	<p><b>Consolidator of project achievements</b></p> <p>Managers must identify risks, prevent threats, and develop contingency plans.</p>	<p><b>Planning</b></p> <ul style="list-style-type: none"> <li>• Anticipate alternative paths to project goal by using decision-tree techniques</li> <li>• Use risk lists, contingency planning, and decision analysis</li> </ul> <p><b>Execution</b></p> <ul style="list-style-type: none"> <li>• Identify occurrences of foreseen risks and trigger contingencies</li> </ul>
Unforeseen uncertainty	<p><b>Flexible orchestrator and networker as well as ambassador</b></p> <p>Managers must solve new problems and modify both targets and execution methods</p>	<p><b>Planning</b></p> <p>Build in the ability to add a set of new tasks to the decision tree. Plan iteratively.</p> <p><b>Execution</b></p> <p>Scan the horizon for early signs of unanticipated influences</p>
Chaos	<p><b>Entrepreneur and knowledge manager</b></p> <p>Managers must repeatedly and completely redefine the project</p>	<p><b>Planning</b></p> <ul style="list-style-type: none"> <li>• Iterate continually, and gradually select final approach</li> <li>• Use parallel development</li> </ul> <p><b>Execution</b></p> <ul style="list-style-type: none"> <li>• Repeatedly verify goals on the basis of learning; detail plan only to next verification</li> <li>• Prototype rapidly</li> <li>• Make go/no-go decisions ruthlessly</li> </ul>

The PMI defines risk as ‘an uncertain event or condition that, if it occurs, has a positive or negative effect on a project’s objectives’ ((PMBok, 2000)p. 373). Risk is usually calculated as the probability of a desired outcome multiplied by the consequences if that outcome should occur. According to the PMI’s definition, risk can be both positive and negative. Often, positive risk is referred to as ‘opportunity’. Risk can mean negative risk, but it can also mean both positive and negative risks, according to the PMI definition.

From experience, I have found that normally when risk is discussed there is a tendency for only one element of the operational part to be considered, namely the negative side (or threats) of the uncertainty. Operational uncertainty connected to internal circumstances in the project can normally be controlled by the project management team, and may relate to, for example, resource variations, productivity, coordination, and team spirit and culture. Some authors, such as (Richard Westney & Dodson, 2006) and (Rolstadås & Johansen, 2008) refer to operational uncertainty as tactical risk. The aforementioned authors have also introduced the term strategic risk, which is the prospective impact on earnings or capital from adverse business decisions, improper implementation of decisions, or lack of responsiveness to industry changes. This type of risk is beyond the control of the project team, but may be controlled by the project owner or sponsor. It is a function of the compatibility of an organization's strategic goals, the business strategies developed, the resources deployed, and the quality of the implementation. In addition to operational and strategic risks, there is contextual risk. Contextual risk is connected to circumstances outside the project that may influence the scope of work and the performance of the organization. Examples include competing projects, changes in ownership and management, legislation and governmental directives, media attention, extreme market conditions, and accidents. Contextual risk also includes ‘black swans’. A black swan meets three criteria: it is an outlier; it carries extreme impact; and human nature makes us concoct explanations for its occurrence after the fact, making it seem explainable and predictable (Kerzner, 2009).

The time, the level of detail, and the type of risk constitute what Rolstadås and Johansen refer to as ‘the three dimensions of project risk’ as illustrated in Figure 31. The authors claim that most projects have a major focus on only one of the dimensions: the level of detail. Risk analysis is usually executed during the pre-study or the planning phase (front end loading), but most of the time it is not followed up and managed over time. Most risk analysis is directed towards managing the operational risk. The contextual risk is often neglected. Offensive project management takes all three dimensions into account.

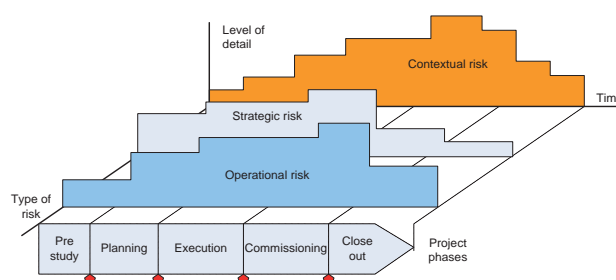


Figure 31 The three dimensions of project risk (Rolstadås & Johansen, 2008)

It is well accepted that risk vary over time. Most authors discuss operational risk and paint a picture where it is gradually reduced to zero, as indicated by the blue field in Figure 32 which also shows strategic and contextual risks. It is important to note that the strategic and contextual risks will have a residual value by the end of the project. This residual value cannot be eliminated by a protective risk management strategy aiming to predict the future.

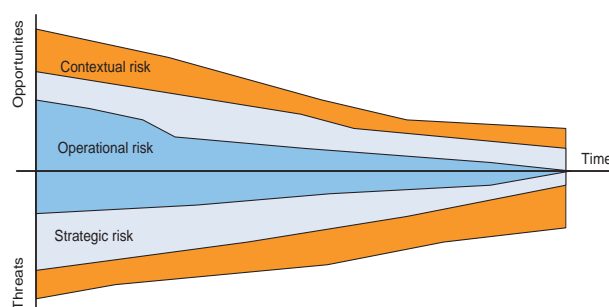


Figure 32 Risk development during the project life cycle (Rolstadås & Johansen, 2008)

(Miller & Lessard, 2001) distinguish between approaches in two categories of risk management decisions: theoretical approaches and managerial approaches. In decisions, theoretical approaches to risk are assumed to be exogenous and in managerial approaches it is assumed that risk depends on the interaction between exogenous risk drivers, managerial choices during the front end, and the shaping of risk drivers throughout the process. Miller and Lessard use the metaphor 'project gamble' for the decision theoretical approach to risk management and state that in the decision theoretical approaches the sponsors attempt to identify options and probabilities. Based on this analysis, the sponsors will select a move with a high pay-off as possible and as high probability as possible, and then they will wait for the probabilities to materialize. In the managerial approaches, risk management is not about waiting for the probabilities to yield a 'win' or a 'loss,' but about hard daily work and trying to influence the outcomes and turn the selected initial option into a success. In the managerial approach seen from the project management perspective, risk management is about identifying risk, managing, and keeping a focus on the goal, and their choices under changing conditions, and often succeeding against the odds.

#### **Ambiguity (more than one meaning)**

Part of the debate on risk and uncertainty can be linked to the term 'ambiguity'. When projects are in the early definition phase, it will be unclear what is to be delivered, what types of solutions will be most effective, and what types of organization will be most appropriate; there will be a high level of uncertainty and ambiguity in this phase of the project (C. B. Chapman & Ward, 1997).

According to (Betts & Lansley, 1995; Kolltveit, Karlsen, & Grønhaug, 2007), it is common for uncertainty to be understood as lack of information. (Artto K., 2011) suggest that uncertainty can be defined as follows:

The difference between the amounts of information required to perform the task and the amount of information already possessed by the organization.

Based on Artto and Kujala's definition, (Brun, 2012; Brun & Sætre, 2009) argue that uncertainty can be reduced by the provision of more information. In contrast to uncertainty, ambiguity can be understood as different interpretations of the same piece of information; hence, ambiguity is not reduced by the provision of more information. I argue that either ambiguity is a part of non-ergodic view of risk or that ambiguity is one of many causes of uncertainty in different phases of the project.

(Chapman & Ward 1997) state that ambiguity is a part of uncertainty, and that uncertainty is present throughout the project life cycle but is particularly evident in the early stage. According to Chapman and Ward, there are five uncertainty areas in projects: (1) the variability associated with estimates of project parameters, (2) the basis of estimates of project parameters, (3) design and logistics, (4) objectives and priorities, and (5) relationships between project parties.

### **What about uncertainty?**

According to Chapman and Ward (1997),

Uncertainty in the plain English is a sense of 'lack of certainty' is in part about 'variability' in relation to performance measures like cost, duration, or 'quality'. It is also about 'ambiguity' associated with lack of clarity because of the behavior of relevant project players, lack of data, lack of detail, lack of structure to consider issues, working and framing assumptions being used to consider the issues, known and unknown sources of bias, and ignorance about how much effort it is worth expending to clarify the situation. (C. B. Chapman & Ward, 1997)

Uncertainty can also be defined as 'a state of having limited knowledge where it is impossible to exactly describe existing state or future outcome' (Wikipedia 2008). Other definitions of uncertainty focus on more than one possible outcome or on the gap between needed and available information (Torp O, 2008). Some scholars state that uncertainty is connected to an event, and that it may be a desired or a non-desired outcome of the event. Uncertainty is often said to have its root cause in lack of available information, available knowledge, or competence (Christensen & Kreiner, 1991).

In a project context, uncertainty management has traditionally been synonymous with risk management (Hillson & Simon, 2012). However, some scholars maintain that uncertainty can be positive or negative, respectively as opportunities and threats (Loch, et al., 2006; O. Perminova, et al., 2008), and that uncertainty management should be separated from risk management. Some use the term risk management to denote exclusively managing threats, while others consider risk management as an umbrella term describing the management of both threats and opportunities (Hillson, 2004). Traditionally, both project literature and project practice have focused considerably on identifying, evaluating, and managing threats, or, as some call it, risks (Stephen J Simister, 2004; Ward & Chapman, 2003). Since the mid-2000s, there has gradually been a stronger focus on how to manage the opportunities facing the project (Hillson, 2004). Ward and Chapman (2004) have introduced the term uncertainty management, in preference to the term risk management and opportunity management. Their ideas are supported by Hillson (2004). Ward and Chapman (1996) have promoted the idea of focusing on exploiting opportunities as well as mitigating risks. (Rolstadås, et al., 2011) suggest that uncertainty may be both negative and positive for a project. Negative implications of uncertainty are labelled risk factors, whereas positive implications of uncertainty are labelled opportunity factors. Both types of implications may have consequences for a project if they occur. They refer to risk as the consequence of an unwanted event multiplied by the probability of the event, and opportunity as the opposite of risk (i.e. events with positive consequences).



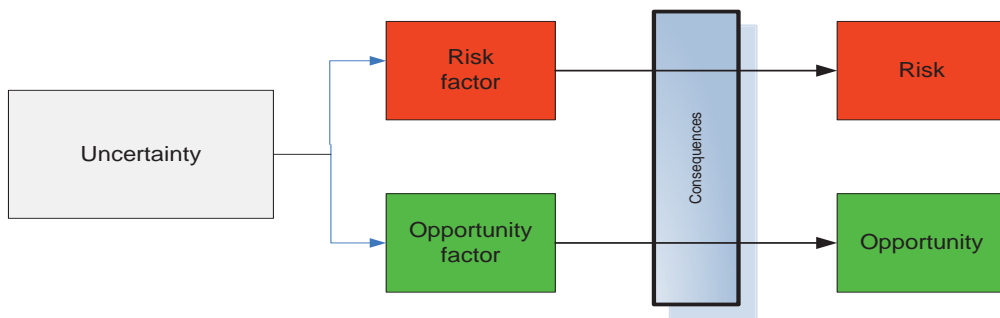


Figure 33 Relationship between uncertainty and risk (Rolstadås, et al.)

(Rolstadås, et al.) state that uncertainty in projects may take a number of very different forms, and they propose a structure for categorizing uncertainty into controllable and non-controllable factors.

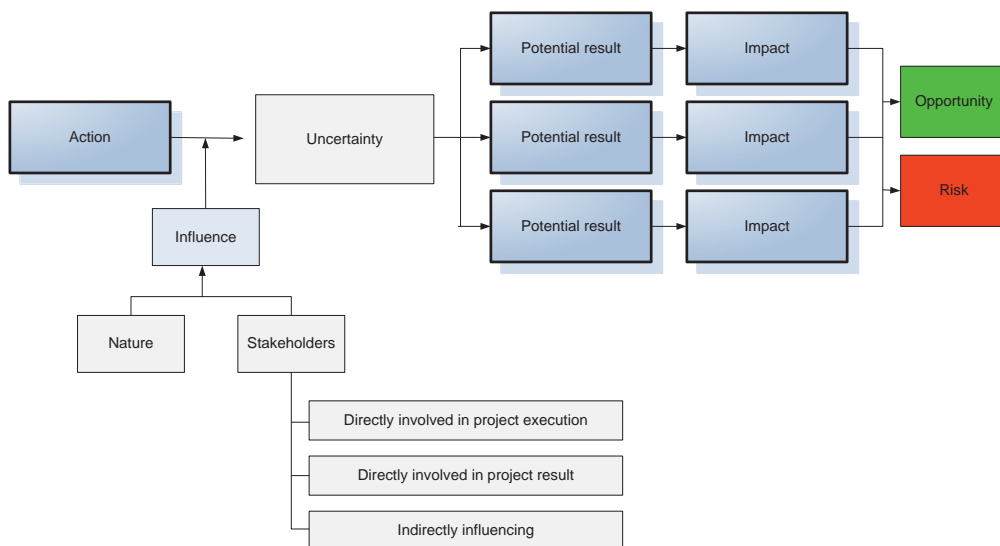


Figure 34 Uncertainty and risk (Rolstadås, et al.)

Some researchers use the term risk management exclusively to denote the management of threats, and others consider risk management as an umbrella term for describing the management of both threats and opportunities (Hillson, 2004). According to Hillson, risk arises from uncertainty, and is about the impact that uncertain events or circumstances could have on the achievements of goals. This leads to a definition that combines two elements – uncertainty and objectives – and Hillson states that ‘A risk is any uncertainty that, if it occurs, would have an effect on achievement of one or more objectives’ (Hillson, 2004). He also points out that risk has been considered synonymous with threat, but this is not the only perspective considered today. If the uncertainty is beneficial, positive, or welcome for the objective then the risk becomes synonymous with opportunity.

According to Hillson (2004), the practitioners are divided into three ‘camps’, according to their use of terminology (see Figure 35).



Figure 35 Risk – the definition debate (based on (Hillson, 2004)

Practitioners in Hillson’s Group A insist that the ‘traditional approach’ must be upheld, and reserve the use of the term risk for bad things that happen and opportunities for the good things that should be treated differently using a distinct process. Practitioners belonging to Group B believe that there are benefits to be gained from treating threats and opportunities together, and that scope of the risk management should handle both in the same process. Practitioners in Group C are apparently unconcerned about definitions and jargons, and are more focused on doing the job. This group emphasizes the need to deal with all types of uncertainty without worrying about which labels to use.

Hillson’s three camps of practitioners indicate that the perception of what should be in focus in risk management varies, and this has subsequently resulted in differences in theoretical textbooks as well as in governing documentation and practice in project organizations. Many organizations still mainly focus on threats in their risk management processes. Hillson (2004) also points out that today the majority of risk standards and guidelines use a broad definition of risk, including both upside opportunities and downside threats.

(Raz & Hillson, 2005) conducted a comparative review of nine different risk management standards and concluded that the different standards had different definitions of ‘risk’ (see Table 11). According to Raz and Hillson, some of the standards had a negative definition (e.g. risk is injury or loss), some had neutral definitions (e.g. regarding the chance of something happening that will have an impact upon objectives), and some had what they defined as a broad definitions (e.g. an uncertain event or set of circumstances which, should it or they occur, will have a either positive or negative effect on the achievement of objectives).

In Table 11, I summarize the different definitions of uncertainty and risk that I have found as part of the literature review done for this thesis. The term risk and uncertainty is used in many different fields, and I have therefore also included some definitions that have relevance for the project management but that have their origins outside the field of project management.

Table 11 Definitions of uncertainty and risk

Source	Uncertainty – neutral 'Lack of knowledge/variability' 'Incomplete knowledge' 'Unknown probability' 'Opportunities and threats' Uncertainty means unknown probability We can say that something is uncertain when our information is correct and events fail to happen, or when our information is incorrect and event does happen	Risk – negative Risk – neutral Risk – opportunities and risk
(Bernstein & Bernstein Peter, 1996)		Risk a chance of loss (The Doctrine of Chance (1718)) The risk of losing any sum is the reverse of exaptation, and the true measure of it is the product of the sum adventured multiplied by the probability of the loss
Keynes 1921	Uncertainty is a state in which individual actors find it impossible to attribute a reasonably. Definite probability to the expected outcome of their choice Uncertainty is the situation when it is not possible to calculate risk	Risks as opposed to uncertainty is assumed calculable within the premises of probability theory, and is thus controllable
(Knight, 1921)	True uncertainty is unknowable and unpredictable pp.210–211 You cannot be certain about uncertainty	In principle, risk is knowable either as an exact probability estimate or as a probability distribution, (pp. 204). Probability calculus and statistics as tools (pp. 214–220).
Galbraith 1977	The difference between the amounts of information required to perform the task and the amount of information already possessed by the organization	–

Source	<p>Uncertainty – neutral</p> <p>‘Lack of knowledge/variability’</p> <p>‘Incomplete knowledge’</p> <p>‘Unknown probability’</p> <p>‘Opportunities and threats’</p>	<p>Risk – negative</p> <p>Risk – neutral</p> <p>Risk – opportunities and risk</p>
(I. V. Perminova, Grechishcheva, & Petrosyan, 1999)	<p>‘a context for risks as events having a negative impact on the project’s outcomes, or opportunities, as events that have beneficial impact on project performance.’</p>	-
(Lichtenberg, 2000)	<p>Lack of knowledge/variability</p> <p>While we normally know, to some extent, the impact of a risk, we have no such knowledge in the case of uncertainty</p> <p>It may be better or worse than expected, it may be widely different or only moderately so, or it may lead to the anticipated outcome</p>	<p>Risk: possible event that would have a reasonably major negative or positive impact and that may or may not occur</p>
(Miller & Lessard, 2001)	<p>Uncertainty applies to situations in which potential outcomes and causal forces are not fully understood</p>	<p>Risk is the possibility that events, their resulting impacts and dynamic interactions may turn out differently than anticipated.</p> <p>Risk is often viewed as something that can be described in statistical terms.</p>

<p>Source</p>	<p>Uncertainty – neutral  'Lack of knowledge/variability'  'Incomplete knowledge'  'Unknown probability'  'Opportunities and threats'</p>	<p>Risk – negative  Risk – neutral  Risk – opportunities and risk</p>
<p>(Ward &amp; Chapman, 2003)</p>	<p>Risk (upside or downside) is a source of uncertainty  An uncertain event or set of circumstances, which should they occur would have either a positive or negative effect on achievement of objectives</p>	<p>'Risk is the probability of a downside risk event multiplied by its impact' – may have their value in special circumstances (p. 9)  'The purpose of Risk management is to improve project performance via systematic identification appraisal and management of project – related risk' (p. 9)  'Lack of certainty' is in part about "variability" in relation to performance measures like cost, duration, or quality  It is also about 'ambiguity' associated with lack of clarity because of the behaviour of relevant project players, lack of data, lack of detail, lack of structure to consider issues, working and framing assumptions being used to consider the issues, known and unknown sources of bias, and ignorance about how much effort it is worth expending to clarify the situation</p>

Source	<p>Uncertainty – neutral</p> <p>‘Lack of knowledge/variability’</p> <p>‘Incomplete knowledge’</p> <p>‘Unknown probability’</p> <p>‘Opportunities and threats’</p>	<p>Risk – negative</p> <p>Risk – neutral</p> <p>Risk – opportunities and risk</p>
<p>(Lindley, 2006)</p> <p><i>Understanding Uncertainty</i></p>	<p>There are some things that you know to be true, and others that you know to be false; yet, despite this extensive knowledge that you have, there remain many things whose truth or falsity is not known to you We say that you are uncertain about them You are uncertain, to varying degrees, about everything in the future; much of the past is hidden from you; and there is a lot of the present about which you do not have full information</p> <p>Uncertainty is everywhere and you cannot escape from it.</p>	-
<p>(Rausand &amp; Utne, 2009)</p>	<p>Uncertainty is measurement of how sure people are about the results of a risk analysis</p> <p>Aleatory uncertainty is natural variation or accidental occurrence</p> <p>Epistemic uncertainty – lack of knowledge about possible future outcome</p>	<p>The word risk comes from the Italian language and has its origins in ‘risicare’ and means ‘to dare’</p> <p>Risk is defined as a combination of probability and consequence of and unwanted event</p>

Source	<p>Uncertainty – neutral</p> <p>‘Lack of knowledge/variability’</p> <p>‘Incomplete knowledge’</p> <p>‘Unknown probability’</p> <p>‘Opportunities and threats’</p>	<p>Risk – negative</p> <p>Risk – neutral</p> <p>Risk – opportunities and risk</p>
<p>Norwegian Standard</p> <p>NS-ISO 3100:2009</p> <p>Risk management</p>	<p>Uncertainty is the state, even partial of deficiency of information related to, understanding or knowledge of an event, its consequence, or likelihood</p>	<p>Effect of uncertainty on objectives</p> <p>An effect is a deviation from the expected – positive and/or negative</p> <p>Risk is often characterized by reference to potential events and consequences or a combination of these</p>
<p>(C. Chapman &amp; Ward, 2011)</p>	<p>Recognized lack of certainty has to include ‘the unknowable’, but sometimes uncertainty is usefully viewed as ‘incomplete knowledge’, which can be reduced at a cost, or by the unfolding of the project life cycle.</p>	
<p>(Rolstadås, et al.), 2011</p>	<p>Uncertainty is connected to the outcome of an event and can be expressed with a probability.</p>	<p>Risk is defined as the probability that an event will occur multiplied by consequence involved if it occurs</p>



<p>Source</p>	<p>Uncertainty – neutral          ‘Lack of knowledge/variability’          ‘Incomplete knowledge’          ‘Unknown probability’          ‘Opportunities and threats’</p>	<p>Risk – negative          Risk – neutral          Risk – opportunities and risk</p>
<p>(Artto K., 2011)</p>	<p>The difference between the amount of information required to perform the task and the amount of information already possessed by the organization</p> <p>Uncertainty may be attributable to imperfect information about the future, and the information can be imperfect because it does not exist, has not been acquired, or cannot be applied to the project. However, uncertainty can arise because of circumstances or events that include risk</p> <p>We can talk about decision making under uncertainty, in which risk has a central role.</p> <p>In some circumstances uncertainty is interpreted as a neutral term that does not describe the goodness or badness of a situation; in this case, uncertainty can contain both unfavourable risk and favourable <i>opportunity</i>.</p>	<p>Risk is an event with a certain probability of realization that may affect the project schedule, cost, or scope.</p> <p>Once the risk event occurs or is realized, the risk becomes a firm fact with no related probability for realization</p> <p>Project risks vary in type and magnitude and their effects may be negative or positive</p> <p>Risk can be unfavourable or favourable and a risk may exist because of the stochastic nature of project events, imperfect information, or their combined effects</p>

Source	<p>Uncertainty – neutral</p> <p>‘Lack of knowledge/variability’</p> <p>‘Incomplete knowledge’</p> <p>‘Unknown probability’</p> <p>‘Opportunities and threats’</p>	<p>Risk – negative</p> <p>Risk – neutral</p> <p>Risk – opportunities and risk</p>
<p>CONCEPT-rapporten <i>Felles begrepsapparat for kvalitetssikring av kostnadsoverslag</i> (my translation)</p>	<p>Uncertainty is defined as lack of knowledge of the future</p> <p>The difference between the amounts of information required to make certain decision and the available information at decision point</p> <p>Can lead to profit or loss compared to the expected outcome, can lead to risk and opportunities</p>	<p>Risk is the negative outcome of uncertainty Opportunity is the positive outcome of uncertainty</p> <p>Risk can be defined as a combination of probability and consequence of and event</p>
PMBOK 2000	<p>An uncertain event or condition that will have an impact upon that, if it occurs, has a positive or negative effect on a project objective</p> <p>Includes both threats to the project objectives and opportunities to improve on those objectives</p>	<p>Project risk is an uncertain event or condition that, if occurs, has a positive or a negative effect on at least one project objective, such as time, cost, scope, or quality</p> <p>Downside risk = threat</p> <p>Upside risk = opportunity</p>
APM Bok	No clear definition	<p>Risk is an uncertain event or set of circumstances that, should it/they occur will have an effect on the achievement of the project’s objectives (threats and opportunities).</p>
IPMA	Uses ISO 21500	Uses ISO21500

<p>Source</p>	<p>Uncertainty – neutral  'Lack of knowledge/variability'  'Incomplete knowledge'  'Unknown probability'  'Opportunities and threats'  No clear definition</p>	<p>Risk – negative  Risk – neutral  Risk – opportunities and risk</p>
<p>ISO 21500</p>		<p>Identification of risks is to determine potential risk events and their characteristics that, if they occur, may have a positive or negative impact on the project objectives.</p> <p>Risks with a potential negative impact to the project are referred to as 'threats', whereas risks with a potential positive impact on the project are referred to as 'opportunities'.</p> <p>The purpose of 'threat risks' is to develop options and determine actions to enhance opportunities and reduce threats to project objectives.</p> <p>Risk treatment includes measures to avoid the risk, to mitigate the risk, to deflect the risk, or to develop contingency plans to be used if the risk occurs</p> <p>The purpose of 'control risks' is to minimize disruption to the project by determining whether the risk responses are executed and whether they have the desired effect</p>

<p>Source</p>	<p>Uncertainty – neutral  'Lack of knowledge/variability'  'Incomplete knowledge'  'Unknown probability'  'Opportunities and threats'</p>	<p>Risk – negative  Risk – neutral  Risk – opportunities and risk</p>
<p>ISO 3100  Risk management</p>	<p>No clear definition</p>	<p>Risk can be defined as the combination of the probability of an event and its consequences  In all types of undertaking, there is the potential for events and consequences that constitute opportunities for benefit (upside) or threats to success (downside)  Risk management is increasingly recognized as being concerned with both positive and negative aspects of risk, and therefore this standard considers risk from both perspectives  In the safety field, it is generally recognized that consequences are only negative and therefore the management of safety risk is focused on prevention and mitigation of harm</p>

<p>Source</p>	<p>Uncertainty – neutral  'Lack of knowledge/variability'  'Incomplete knowledge'  'Unknown probability'  'Opportunities and threats'</p>	<p>Risk – negative  Risk – neutral  Risk – opportunities and risk</p>
<p>PRINCE2</p>	<p>No clear definition</p>	<p>The chance of exposure to the adverse consequences of future events</p> <p>Two types of risk – business risk and project risk:</p> <p><i>Business risk:</i> This covers the threats associated with a project not delivering products that can achieve the expected benefits. It is the responsibility of the project board to manage business risks.</p> <p><i>Project risk:</i> This is the collection of threats to the management of the project and hence to the achievement of the project's end results within cost and time.</p> <p>These risks may be managed on a day-to-day basis by the project board, project manager or team leader</p>

<p>Source</p>	<p>Uncertainty – neutral</p> <p>‘Lack of knowledge/variability’</p> <p>‘Incomplete knowledge’</p> <p>‘Unknown probability’</p> <p>‘Opportunities and threats’</p>	<p>Risk – negative</p> <p>Risk – neutral</p> <p>Risk – opportunities and risk</p>
<p>Wikipedia, 2014</p>	<p>Uncertainty: The lack of certainty; a state of having limited knowledge in which it is impossible to describe exactly the existing state, a future outcome, or more than one possible outcome.</p> <p>Measurement of uncertainty: A set of possible states or outcomes where probabilities are assigned to each possible state or outcome – this also includes the application of a probability density function to continuous variable</p>	<p>Risk is the potential of losing something of value, weighed against the potential to gain something of value</p> <p>Values (such as physical health, social status, emotional well-being or financial wealth) can be gained or lost when taking risk resulting from a given action, activity and/or inaction, foreseen or unforeseen</p>

**Implication for the thesis: What kind of definitions should we choose – uncertainty or risk?**

As Table 11 shows, the term risk has neutral and negative meanings, depending on which source are consulted. However, I argue that the term risk is mostly understood as a combination of probability and consequence of an unwanted event. Also, I suggest that risk analyses and uncertainty analyses performed within projects are different concepts, and use different methods and tools. In addition, I argue that risk management and uncertainty management deal with different things and that project managers need both concepts.

(C. Chapman, 1997; C. B. Chapman & Ward, 1997; Hillson & Simon, 2012) all suggest that risk can consist of two parts: threats and opportunities. This understanding has strong similarities to how the uncertainty school in Norway has defined uncertainty, namely as something that deals with threats and opportunities. However, I argue that if we adopt that view in Norway, we will lose the distinction between risk as concept and uncertainty as concept. In addition, I argue that that the definition of risk as a combination of probability and the consequence of an unwanted events is close to most people’s understanding of the term risk (Rausand & Utne, 2009).

The term uncertainty has several meanings, as shown in Table 11. Some point to the lack of knowledge, some point to potential outcomes and causal forces that may happen in the future, and some point to the positive or negative effects that uncertainty will have on a project objective. In Paper 9 (Johansen et al., 2012b), we suggest that the uncertainty can be defined as controllable and non-controllable factors that may occur, and variation and foreseeable events that occur during a project execution and that have a significant impact on the project objective.

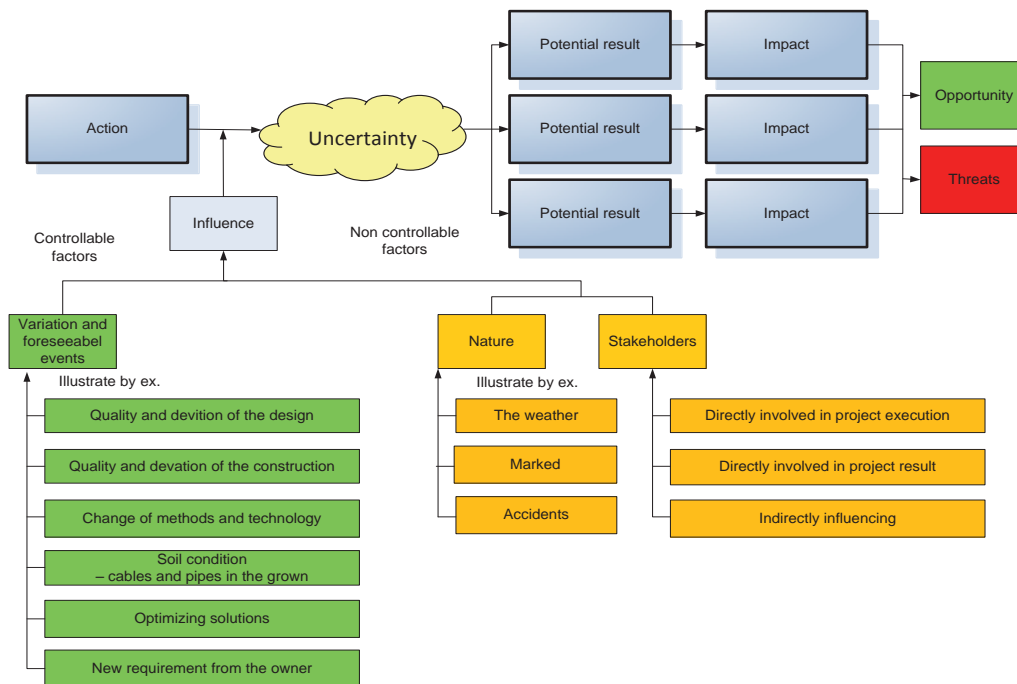


Figure 36      Uncertainty – opportunities and threats

I suggest that threats are factors, variations, and events that may lead to undesired changes to the project objective and result in a loss of benefits for the project owner. Opportunities are factors, variations, and events that may lead to higher benefits for the project or for the project owner. There could be changes that make the project able to deliver the same quality in less time or at a lower price than was agreed upon at the beginning of the project. Also, some factors, variations, and events will cause changes that can make the project deliver higher functionality or lead to positive net present value (NPV) after the project is delivered. (Rolstadås, et al., 2011) state that uncertainty is connected to the outcome of an event and can be expressed as a probability.

I support Rolstadås et al.'s view. However, I also believe that this link to probability is a part of the problem with the term uncertainty; it makes the term uncertainty equal to the term risk, since probability is so strongly linked to our understanding of risk. (C. B. Chapman & Ward, 1997) state:

Uncertainty in the plain English sense of 'lack of certainty' is in part about 'variability' in relation to performance measures like cost, duration, or 'quality'. It is also about 'ambiguity' associated with lack of clarity because of the behavior of relevant project participants, lack of data, lack of detail, lack of structure to consider issues, working and framing assumptions being used to consider the issues, known and unknown sources of bias, and ignorance about how much effort it is worth expending to clarify the situation.

The work done by De Meyer et al. (2002) suggests that there is more to term uncertainty than 'probability of future outcome'.

#### 4.8 Contribution to research

In this chapter (Chapter 4), I have presented my contribution to development of new theory by summarizing the development of the PM field and uncertainty field by showing how the terms uncertainty and risk have been developed since the 1600s. The definitions of uncertainty and risk are summarized in Table 11.

I have concluded that the term uncertainty consists of two possible future outcomes: threats and opportunities. Both may happen with some type of probability and they may give a positive or negative affect on the project performance. Uncertainty can be linked to traditional performance criteria (see Figure 27) or future benefit for the owner. If a threat happens, the project will underperform and it will spend more money or time, and give poorer quality or deliver less value than expected to the project owner. If an opportunity is exploited, the project will 'over perform'. It will deliver more at the same cost or the same quality for less money, and faster than planned.



## 5 Uncertainty – analyses and management

In Chapter 5, I introduce three myths about uncertainty. These myths are important as basic explanatory models. However, they also implicitly bring with them a range of challenges. These challenges should be considered seriously, particularly when uncertainty has to be managed in projects. Today, uncertainty analyses are more or less mandatory in large infrastructure projects in Norway, yet how good are they and what are the challenges regarding how Norwegian uncertainty analyses is practised today? These questions are addressed in the second part of this chapter.

The empirical data from cases studies suggest that projects are not capable of identifying and dealing with all of the uncertainty from the beginning of a project, and that uncertainty analysis must therefore be repeated during the project execution. Additionally, the empirical data suggest that there is far more uncertainty in the execution phase of the project than the international AACC standard and the Norwegian Government recommends.

From the literature that I have reviewed and the empirical data presented in Papers 1, 5, 7, 8 and 9 have I deduced five characteristics of how uncertainty is seen in most projects today:

1. Projects with fixed goals, budget, and time schedules are only possible if the project team can control everything within them (the operational uncertainty is zero from the beginning of the project) and if they can be totally isolated from the outside world (the contextual uncertainty is zero).
2. No deviation or change in a project's goals and plans is unrealistic in any project.
3. Zero uncertainty means that 'as planned' is the best the project owner can hope for.
4. Avoiding uncertainty has a cost - uncertainty can be avoided and transferred, but it has an impact on cost, time, and the potential benefit from the project.
5. Seen from a project's perspective, the uncertainty should be as low as possible when projects start, and the projects should avoid variation and changes of plan at any cost. Uncertainty seen from the owner's perspective can be different – uncertainty is to a certain extent desirable, as it gives the owner more flexibility and opportunities.

I suggest that these statements summarize how uncertainty as a phenomenon is connected to and treated in projects in Norway today, and in this chapter I present the theory and empirical data that support this statement.

This chapter is based on the following papers:

- Paper 1 – 'Uncertainty analysis – 5 challenges with today's practice'
- Paper 5 – 'Effects of long-term improvement efforts within project uncertainty management'
- Paper 7 – 'Uncertainty management – Myths and realities'
- Paper 8 – 'Improving uncertainty management in projects by collaborating in an inter-organizational research project'
- Paper 9 – 'Exploring uncertainty and flexibility in projects: Towards a more dynamic framework?'

### 5.1 Myths about uncertainty – assumptions and limitations

There are many myths and different explanatory models that are related to uncertainty in projects.

In many projects, it is assumed that:

1. Uncertainty is reduced to zero towards the end of the execution phase
2. There are substantial amounts of both opportunities and threats at the start of a project
3. Uncertainty is understood in the same manner within and outside the project (everyone has the same understanding of the uncertainty that is associated with the project)

#### **Myth 1: Uncertainty is reduced to zero towards the end of the execution phase**

The basis for Myth 1 is that uncertainty defined as the 'difference between currently available information and required information when making a decision' (Christensen & Kreiner, 1991, p. xx), decreases over time. This can be justified by the common experience that more information is acquired as time passes, and also that we make choices and decisions throughout the project cycle. Regarding the latter, it may be assumed that uncertainty is closely linked to the flexibility that exists until certain decisions have been taken during the course of the project. Such flexibility is normally quite considerable at the start of the project and gradually decreases as the project approaches the handover. If this assumption is correct, we can expect that the uncertainties will approximately be equal to zero at the handover of the project.

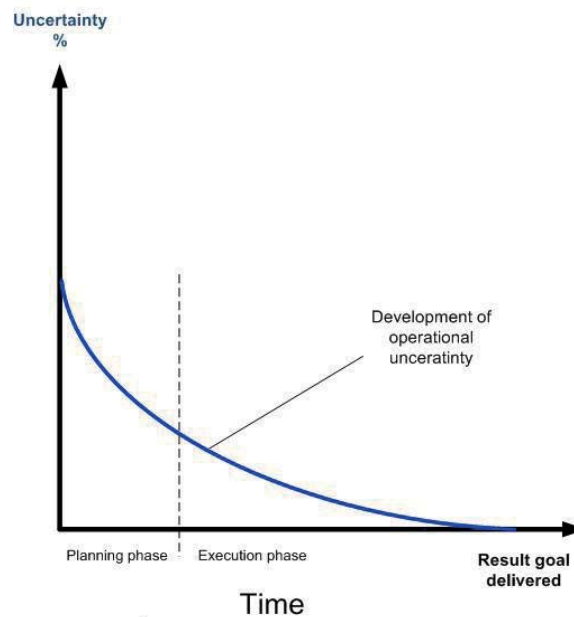


Figure 37 Myth 1: Uncertainty during the course of projects (A. Johansen, Krane, Ekambaram, Steiro, 2012)

For many projects, uncertainty and flexibility are related to each other to a certain degree (Olsson, 2006). Here, I will consider an example a case in which one has the options to choose between the concept of road and the concept of rail as a solution to a need for transport infrastructure. Then, the choice of one option will automatically mean that all uncertainty associated with the alternative option will simply disappear. This condition will also reduce the total uncertainty accordingly.

However, similarly, flexibility will also be reduced in the project, because one must choose one of these solutions (options). A simple model, which is often used for this declining uncertainty, is illustrated in Figure 37 (e.g. Samset, 2003; Rolstadås et al., 2011). The model has two other aspects:

1. The uncertainty will decrease approximately linearly during a large part of the course of the project; it will be highest in the planning phase and will decrease in the execution phase.
2. Risk management will primarily deal with reducing uncertainty that the project encounters with respect to its result-oriented goals.

This model (and Figure) legitimizes the project's aim to reduce the uncertainty associated with the result-oriented goal, since this is the primary goal of the project management team. Hence, risk management in the project will be primarily aimed at the result-oriented goal, and will deal with the following alternatives (Krane et al., 2010):

- Finding uncertain conditions that help the project to achieve its result-oriented goals faster, more cheaply, or with the same quality at a lower cost (opportunities)
- Preventing conditions that might make the project more expensive, cause it to take longer time, or contribute to deviating from the goal.

It may be questioned whether Figure 37 really reflects the experiences that many projects have or whether it should be reconsidered. With projects carried out in interaction with a dynamic, evolving world, new uncertainties are likely to be introduced, also at late stages of the project. For instance, this may be caused by political decisions or market developments. Many projects experience that uncertainty varies during their course and that it is not reduced linearly in many parts of the project cycle (see Figure 37) (Rolstadås et al., 2011). On the one hand, to some extent the uncertainty decreases with the choices that are made during the course of the project. On the other hand, new opportunities and threats may occur in the execution phase. It is therefore a myth that uncertainty almost vanishes towards the end of the execution phase, and that a project manager will be able to:

- Identify all relevant conditions of uncertainty in the planning phase of the project
- Consider how much impact the different uncertain condition will have on the project results
- Assess which of the uncertain conditions will actually happen.

The uncertainty found in a project can be one of three different types (Rolstadås & Johansen, 2008):

1. Operational uncertainty (internal uncertainty). This can be related to the choice of concepts in the planning phase and technical uncertainties in the implementation phase.
2. Strategic uncertainty (external uncertainty). This can be related to the project owner's changing strategic considerations of the project. However, it is also related to how the owner perceives achieving the best possible business profile at the completion of the project.
3. Contextual uncertainty (external uncertainty). This is related to the external environment that the project is a part of.

For example, competing projects in the market, market fluctuations, and economic conditions could give rise to 'Type 3' uncertainty. Likewise, the choice of social values, such as those against counter-cyclical measures initiated by governments in some countries during the financial crisis in late 2008 and 2009, can be a source of such uncertainty, both positive and negative in terms of opportunities and threats. This distinction implies that uncertainty will have a more fluctuating or pulsating course

than shown in Figure 37. In addition, the uncertainty can increase and decrease throughout the course of the project, due to external uncertainties (see Figure 38).

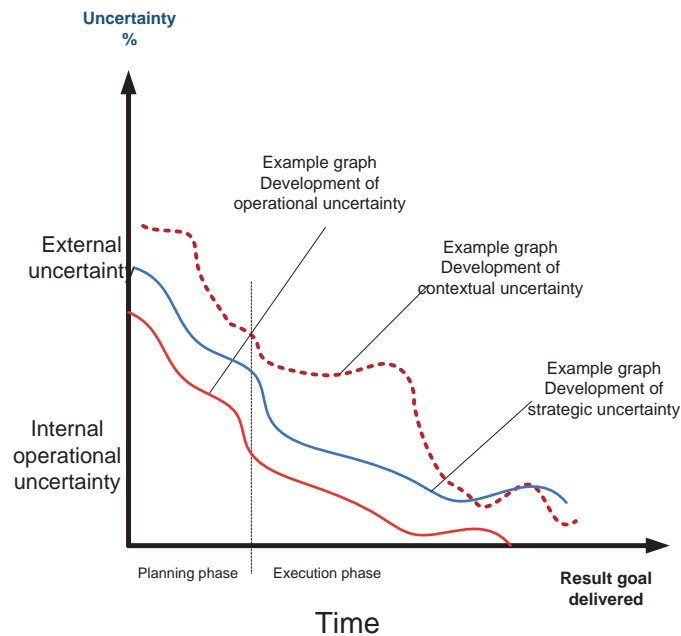


Figure 38 Uncertainty during the course of projects – internal and external uncertainty (A. Johansen, Krane, Ekambaram, Steiro, 2012)

The level of uncertainty may rise and fall through the entire course of the project. When the project management makes its choices and clarifications, they will experience that the uncertainty has reduced. However, since the project is a part of a larger whole, many projects experience that uncertainty may increase again if the parent organization makes new choices and priorities. The level of uncertainty may also be a result of society evolving and changing during project execution. (Midler, 1995) points to the non-linearity in the learning processes and the production processes of the project. This is illustrated by curves characterized by numerous jumps during the execution of the project. Projects that have a long duration (i.e. two or more years) may experience that the conditions and requirements change several times during their course. The real uncertainty that the project has to deal with does not necessarily decline in a linear manner. Moreover, it is not sufficient to handle only internal uncertainty if the project wants to achieve success.

**Myth 2: There are substantial numbers of opportunities and threats at the start of a project**

The nature of uncertainty gradually becomes better understood as the project goes through its development phases, and hence a better understanding of the consequences of uncertainty will emerge. The consequences of uncertainty are said to have an upside (opportunities) and a downside (threats) with respect to the project. In common with Myth 1, it can be assumed that these opportunities and threats will be reduced in the course of the project, based on active choices and conscious management of the project. While such an understanding of a ‘dualism’ in the uncertainty has evolved, it is implicitly also taken for granted that negative and positive uncertainty has a

'symmetrical' development, with a steady decrease during the course of the project, as shown in Figure 39. In other words, when it is assumed that the uncertainties will decrease as the project work goes ahead, it is also assumed that the project's negative and positive uncertainties will decrease equally during the course of the project, and that there will be equal numbers of negative and positive uncertainties when the project is almost ready to be handed over. This assumption does not fit well with most project managers' experiences (Miller & Lessard, 2001).

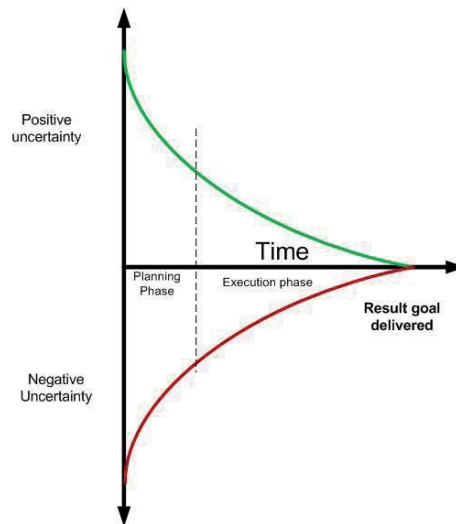


Figure 39 Myth 2: Positive and negative uncertainty decreases during the course of projects (A. Johansen, Krane, Ekambaram, Steiro, 2012)

I have previously argued that when an idea for a new project arises, then there are no negative or positive uncertainties. There is only a wish or an expectation from those who initiate the project that the project should create a positive change. This means that the project is, in itself, an opportunity to create a positive change for the project owner. The understanding of negative and positive uncertainty is only established at the planning phase of the project when the objectives and limits are set during the project start-up. Therefore, there are strong indications that uncertainties do not have a symmetrical shape, and that positive and negative uncertainties will diminish in different ways (unequally) during the course of a project.

When a project is carried out, project members will typically experience that they have to choose among various concepts, all of which have positive and negative outcomes. If, for example, one chooses to build a building on Site A, all uncertainties that are related specifically to Site B will become irrelevant and disappear (i.e. both positive and negative uncertainties will lapse.) This will also lead to the project subjectively assessing the uncertainty as relatively much lower, which for example means that the uncertainty will be considered lower because project management expects that the final costs will be lower if a building is constructed on Site A instead of on Site B. Furthermore, it means that the negative uncertainty is diminished by the choice of Site A, and the positive uncertainty is in principle the same after Site A has been chosen. However, from Figure 39, one could assume that the positive uncertainty would be reduced accordingly. One might also think that the negative and positive uncertainties presented in Figure 39 can indicate something about

how much variation one might expect compared to what has been assumed in the project's plans and budget. By adopting such an approach, one can assume that it is possible and common to utilize positive and negative uncertainties throughout the entire course of the project. However, this is inconsistent with what one could expect to see when studying ongoing projects as well as completed projects. According to Miller and Lessard (2000) and (Krane, et al., 2010)

- Uncertainty only to a limited degree decreases symmetrically during the course of a project. Uncertainty varies based on the decisions that the project makes, the tactical choices that are made in the parent organization, and society's changing demands and expectations. Project management takes advantage of the positive uncertainty as early as possible in the project. However, such positive uncertainty is not sought after and it is not visible in the execution phase.
- Negative uncertainty is highest in the start phase, but it is not uncommon that negative uncertainty is high during periods of the project execution phase. Uncertainty management, seen from the project's point of view, deals largely with reducing the likelihood of adverse events or the consequences of adverse events. This means that the project's uncertainty management tends to be risk aversion (i.e. due to a reluctance to take risks).
- The uncertainty management of the project has little focus on future benefits and functionality for the project owner.

The effects are illustrated on the right-hand side of Figure 40, and differ from the 'ideal' reduction over time, shown on the left-hand side (and also presented in Figure 39 above and discussed in connection with that Figure).

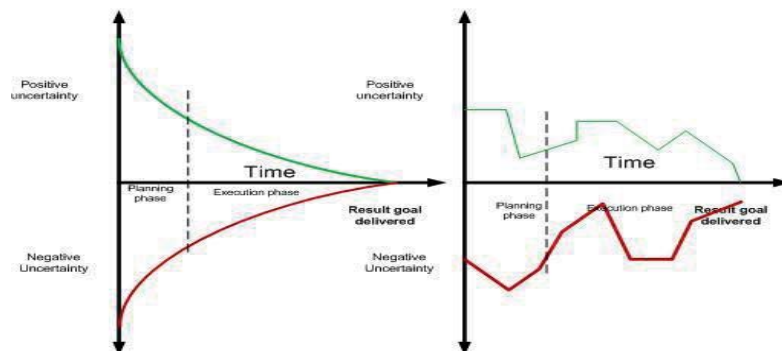


Figure 40 Positive and negative uncertainty – ideal and real (A. Johansen, Krane, Ekambaram, Steiro, 2012)

How uncertainties are assessed is related to how individuals or organizations are measured. Whether uncertainties are high or low, or positive or negative is never assessed 'in a vacuum'. Rather, such assessments must always be done in an appropriate context. This is always about how individuals or groups are affected or held responsible for the choices they make during the project. To a large extent, willingness to live with uncertainty deals with whether one is negatively or positively affected by the uncertainty as an individual and as a group, and how much the project earns or loses on exploring uncertainty.

At the initiating stages of a project, uncertainties rarely have any distinct character of threats or opportunities. When initiated, the whole project will normally appear as an opportunity, or the implementation of one. It is not until the project and its course towards an implementation is defined (to a certain degree) that threats are defined.

I will now briefly consider the situation of an 'ordinary' uncertainty analysis or risk analysis during the implementation phase of a project, where the results of the analysis may be plotted in a grid, as shown in Figure 41.

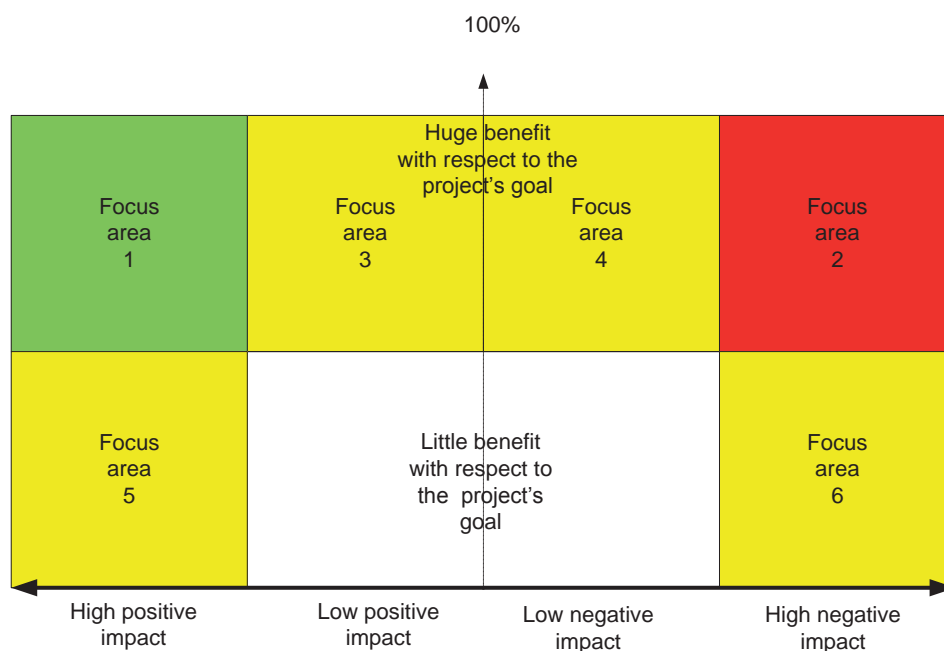


Figure 41 Focus areas based on benefits to the project (A. Johansen, Krane, Ekambaram, Steiro, 2012)

Figure 41 shows the conditions under which different issues will receive different levels of attention from the project management. The project management will initially focus on the issues that matter most to the project's success. This means that in a normal situation the project management will work actively to exploit the positive uncertainty that gives the greatest benefits – this is evaluated with respect to the project objectives (Focus area 1 in Figure 41). Moreover, the project management

will work actively to reduce the probability of experiencing the highest negative uncertainty (Focus area 2). Then, the project management will prioritize uncertainties that lie in Focus areas 3 and 4, since these uncertainties will provide the greatest benefits with respect to achieving the project's objectives. Finally, the project management may focus on the uncertainties that represent a large positive uncertainty or large negative uncertainty, but which give less contribution to the project's objectives (Focus area 5 and 6).

The uncertainty that the project will experience will vary during its course. Moreover, each stakeholder of the project will have their own understanding of the extent of the uncertainty and how it is assessed (i.e. whether the uncertainty is negative or positive) (Hillson & Murray-Webster, 2007; Hillson & Simon, 2012). Their understanding will also be influenced by the objectives that each stakeholder focuses on. Studies of project practices show that projects only to a small extent actively seek opportunities in the execution phase (Hillson, 2004; A Johansen, A Ekambaram, & L Hald, 2012; Krane, et al., 2014). This does not mean that such opportunities do not exist there; it only means that many projects miss opportunities because they lack focus on this issue when it comes to managing uncertainty.

**Myth 3: Uncertainty is understood in the same manner within and outside the project (everyone has same understanding of the uncertainty associated with the project)**

When a project starts, there is uncertainty about the future needs; hence, there is also uncertainty regarding objectives and deliverables. Uncertainty is also linked to the execution of various activities, cost and time needed for the activities, and whether the project will produce the intended deliverables with the quality that the project owner and the parent organization expect. Therefore, most of the choices and decisions that the project management has to consider are uncertain in principle, whereas 'all' decisions that the project manager makes will be based on more or less uncertain assumptions. The choices and decisions will also be based on some fundamental information that is a more or less correct at the time of decision-making. Many projects deal with uncertainty as if it were 'objective', and that it is possible to identify and quantify uncertainty at the project start-up. It is assumed that 'everyone' related to the project have almost the same perception of what is uncertain. It is further assumed that there is a common understanding of how uncertainty can affect the project, either positively or negatively (Krane, et al., 2010). Studies of larger infrastructure projects suggest that this is not the case (Krane, et al., 2010; Miller & Lessard, 2001) and argue the following:

- Uncertainty is looked at and assessed subjectively by the project management, and threats or negative uncertainty dominates most presentations of identified uncertainties.
- The project owner is less involved in the assessment of uncertainty.
- Uncertainty management is largely based on the project management's framework and perspective.

Stakeholders' experiences and understanding of how much uncertainty the project actually faces as it progresses is largely subjective. This means that there are no exact measures regarding the uncertainties that projects have to deal with during their course (i.e. the extent of those uncertainties). How the stakeholders of a project perceive the uncertainty of the project and its context is closely related to what kind of experience and competence they have. Their perception will also depend on the clarity of stakeholders' understanding about the process that will lead to the



objective (i.e. how the project will evolve). Thus, an experienced project owner or project manager will most likely understand and evaluate project uncertainties quite differently from recently graduated project managers (Langlo et al., 2007; Rolstadås & Johansen, 2008). Similarly, an organization that has undertaken many complex projects will consider uncertainty differently compared to a one-time project owner or a newly formed company. One challenge that they all have in common is making an objective assessment of the uncertainties; in the best case, this type of objective assessment can only be done first after the project has been delivered.

It has been claimed that the project's real uncertainty can seldom be estimated objectively while the project is in progress, and it can only be considered reasonably objectively after completion (Christensen & Kreiner, 1991). How uncertainty is assessed in a project is influenced by individual events that the project organization experiences. However, it is also affected by how the various members of the organization interpret events happening within and outside the project, and by the conditions and/or elements that the project owner and society emphasize while the project is being carried out. Issues such as what type of attention uncertainty management receives and which areas receive attention are largely based on the way individuals and groups are measured. The project owner and the project management have different roles and thus different assessments of what issues in the project there is uncertainty related to (N. Olsson, et al., 2007). Langlo, Johansen, and Olsson discuss six dilemmas faced by the project owner and the project leader in (Langlo, et al., 2007). This will also affect how the project's uncertainty is evaluated and presented. Both the project owner and the project manager have subjective perceptions of the uncertainties that the project faces, and they will interpret differently the information base that is available throughout the course of the project. It is up to the project owner and the project management to decide who will focus on which areas of uncertainty. It is also up to the owner to decide whether the project management should look beyond the project objective and whether responsibility for functionality and for future needs should be included in the mandate of the project management. Without guidance from the project owner in this matter, the project can be expected to focus on uncertainty management towards its result-oriented goals and not towards effect-oriented goals or society-oriented goals.

## 5.2 Planning – time and cost estimation

The GAO Cost Estimating and Assessment Guide (Estimating & Guide, 2010) presents 12 key steps that are essential to producing high quality cost estimates:

1. Define the estimate's purpose
2. Develop an estimating plan
3. Define the project (or programme) characteristics
4. Determine the estimating structure [e.g. work breakdown structure, WBS]
5. Identify ground rules and assumptions
6. Obtain data
7. Develop a point estimate and compare to an independent cost estimate
8. Conduct a sensitivity analysis
9. Conduct a risk and uncertainty analysis
10. Document the estimate
11. Present the estimate for management approval
12. Update the estimate to reflect actual costs and changes

The Cost Estimating and Assessment Guide also states that ‘most cost estimates have common characteristics, regardless of whether the technical scope is traditional (capital funded, construction, equipment purchases, etc.) or nontraditional (expense funded, research and development, operations, etc.)’ (Estimating & Guide, 2010). The most common characteristics are levels of definition, requirements (end usage and/or purpose), and techniques used. These characteristic levels are generally grouped into cost estimate classifications. Typically, as a project evolves, it will become more definitive. Determination of cost estimate classifications helps ensure that the cost estimate quality is appropriately considered. Classifications may also help determine, for example, the appropriate application of contingency, escalation, and use of direct/indirect costs (as determined by cost estimate techniques). Standards for cost estimation processes for projects (e.g. produced by AACE International) describe a cost estimation process in which a detailed base estimate is built with a bottom-up approach. The project should start by determining the estimating structure (i.e. work breakdown structure (WBS)), and the developing a point estimate and comparing it to an independent cost estimate, and finally following this up with an uncertainty analysis of the estimate, often with a top-down approach. The purpose of the uncertainty analysis is to identify the confidence level (e.g., 80% or 85%), identify uncertainties, and develop an allowance to mitigate the cost effects of the uncertainties.

### 5.3 Uncertainty analyses in practice – the Norwegian approach

In the early 1970s, Steen Lichtenberg together with researchers from Stanford University and MIT in the USA, Loughborough University in the UK, Chalmers University of Technology in Sweden and the Technical University of Norway in Trondheim (NTH) developed a new approach for calculating the cost of big projects, called the Successive Principle of cost estimation (Lichtenberg, 2000)). As mentioned under section 4.5 did Lichtenberg use the term uncertainty, and it was from the beginning a neutral concept and it was intended to have a broader view than risk concept, which only dealt with the downside, such as unexpected delays and higher costs. For Lichtenberg, uncertainty just meant that something could go faster or the project could cost less than planned, or it could take longer time or cost more than planned. This concept was adopted by Norwegian project management researchers from NTH, and from the early 1990s uncertainty analysis was used as the concept to find the expected cost or expected time for projects and the variability of cost and time, given by the standard deviation. The step-by-step approach (the Norwegian evolution from the successive principle) and stochastic estimation were introduced and were disseminated, together with the uncertainty analysis concept, among consultants and practitioners in the same period. The Nordic tradition in uncertainty analysis is typically a group process led by a facilitator who is an expert on uncertainty analysis and by a resource group of experts within the areas of the project (Klakegg, 1994). Typically, 10–20 experts are involved in the process, and it lasts between 1 and 4 days. It is a top-down approach and typically a type of Monte Carlo simulation tool is used, whereby the time or cost model can be developed from the input from the resource group involved in the process. The model may be complex or simple, depending on the purpose. However, if a simple model does the job and if the results are reliable enough for the purpose, a simple model is preferable.

The uncertainty analyses process can be divided in three phases: (Table 12) (Rolstadås, 2008); Torp et al., 2008; Klakegg et al., 2009; Klakegg, 1994; Simister, 2004; Hillson & Simon (2007)

1. Phase 1 – Purpose of analysis (address the six Ws of the risk management process ((Ward & Chapman, 2003)
2. Phase 2 – Uncertainty analyses
3. Phase 3 – Documentation of the result of the process

Table 12 The uncertainty analyses – step-by-step approach (A. Johansen, Sandvin, Torp, Økland, 2014))

Phases	What	Technique
<b>Purpose of analysis</b>	<ol style="list-style-type: none"> <li>1. Defining the objective for UA</li> <li>2. Defining what should be calculated</li> <li>3. Defining a cost structure for the base alternative</li> <li>4. Establishing the UA model in a cost estimation tool</li> </ol>	Crystal ball or similar tools
<b>Uncertainty analysis</b>	<ol style="list-style-type: none"> <li>5. Identifying the opportunities and threats</li> <li>6 Estimation of the cost for all elements, Low estimate – most likely estimate and high estimate</li> <li>7. Estimation of the uncertainty all elements impact</li> <li>8. Finding expected value E(P) and Varian's Var (X) for cost elements, factors, and for the total project</li> <li>9. Develop uncertainty response to the 'top ten' uncertainties</li> </ol>	Successive principal Triple estimate Monte Carlo Probability curve Tornado diagram
<b>Documentation</b>	<ol style="list-style-type: none"> <li>10. Report – documentation of the process and its premises presenting most likely cost for the project (P50 estimate) and continece</li> <li>11. Top ten list – most important opportunities and threats</li> <li>12. Cuts – list of elements that can be taken out of the scope</li> </ol>	Uncertainty matrix Uncertainty log

The end result from this process is a picture that describes which cost items or uncertainty factors are most uncertain and a probability distribution of the cost or time estimate for the project, with expected costs and the uncertainty measured as standard deviation.

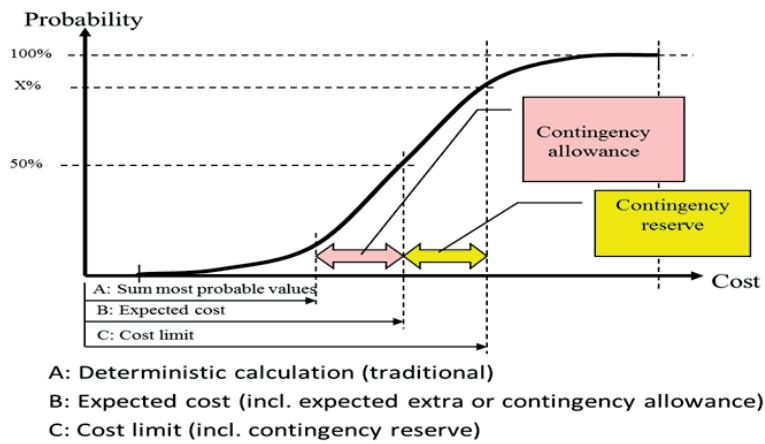


Figure 42 Probability distribution of the cost estimate for a project (A. Johansen, Sandvin, Torp, Økland, 2014)

The steps for estimating the cost of uncertainty (listed in Table 12) are typically used in the early phase of the project and the method is closely related to the thinking behind stage-gate models (Johansen et al., 2012b). A stage-gate model used in Norwegian public project is illustrated in Figure 43.

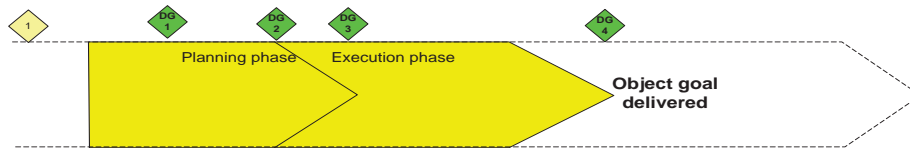


Figure 43 Stage-gate model (A. Johansen, Sandvin, Torp, Økland, 2014)

Johansen et al. state:

The logic in the stage gate model is based on the principle that one starts with different alternatives (concepts) and develops them up to a stage gate, where the project owner decides which concept should go over to the next stage. (A. Johansen, Sandvin, Torp, Økland, 2014)

This statement corresponds to the thinking described in both the GAO Cost Estimating and Assessment Guide and the AACE International’s Cost Estimate Classification system. The uncertainty analysis is therefore an important tool for picking the right project at Decision Gates 1 and 2, and in term of establishing the budget that the project should stick to after passing Decision Gate (DG) 3, where the budget is authorized and controlled. The American standard suggests that accuracy range at DG 3 should be between -10/-20 (low) and +10/+ 30 (high).

This view is supported by Rolstadås and Johansen (2008) and Johansen et al. (2012)a, who suggest that the uncertainty found in a project can be of three different types: operational uncertainty (internal uncertainty), strategic uncertainty (external uncertainty), and contextual uncertainty (external uncertainty). They also suggest that the uncertainty can increase and decrease throughout the course of the project due to external uncertainties (see Figure 44).

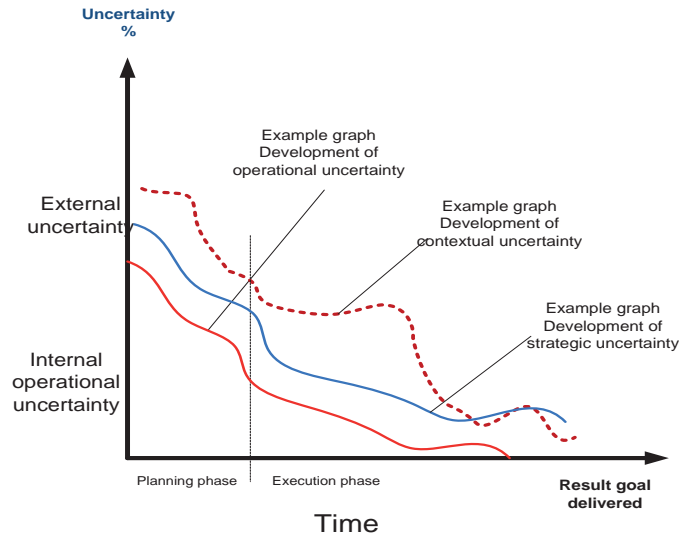


Figure 44 Uncertainty during the course of projects – internal and external uncertainty (A. Johansen, Krane, Ekambaram, Steiro, 2012)

For example, competing projects in the market, market fluctuations and economic conditions could give rise to 'Type 3' uncertainties. Likewise, choice of social values such as those against counter-cyclical measures that were initiated by governments in some countries during the financial crisis in late 2008 and 2009 can be a source of such uncertainty, both positive and negative in terms of opportunities and threats. The uncertainty can increase and decrease throughout the course of the project due to external uncertainties (see Figure 40). The uncertainty may rise and fall through the entire course of the project. When the project management makes its choices and clarifications, they will experience that the uncertainty is reduced. However, since the project is a part of a larger whole, many projects experience that uncertainty may increase again if the parent organization makes new choices and priorities. It may also be a result from the society evolving and changing during project execution. Projects that have a long duration (i.e. three years or more) may experience that the conditions and requirements change several times during the course of the project. The real uncertainty that the project has to deal with does not necessarily decline in a linear manner. Moreover, it is not sufficient to handle only internal uncertainty, if the project wants to achieve success for the key stakeholders.

As pointed out by (Venkataraman & Pinto, 2008), the importance of estimating project costs increases as the estimates become the benchmarks against which future costs are compared and evaluated. It is therefore interesting to know whether the uncertainty analyses are a reliable tool for supporting the cost estimation process and whether the results of the uncertainty analysis reflects the end cost of the project.

The AACE International's Cost Estimate Classification system states that concept screening and feasibility studies estimates typically should have variation between -30% to +50% and -20% to +30% at budget authorization and control. In Norway it appears that uncertainty analyses provide results

that are significantly more precise than the AACE standard suggests, the results from the analyses are typically in the range of -10% to +10% on a Class 3 estimate. In the period 2006–2007, 56 large public projects were investigated in Norway. The average standard deviation is shown in Table 14 (in the section ‘Realistic standard deviation in all phases of the project challenge’) for different types of projects. The average in total was calculated as 10.5%. For single projects, it varied from 4% to 21% (Table 13).

Table 13 Cost uncertainty and standard deviation (A. Johansen, Sandvin, Torp, Økland, 2014)

Type of project	Cost uncertainty, standard deviation (%) Effect
Roads	11.4%
Public buildings	9.8%
Defence procurement	8.5%
Railway	14%
ICT	7%
Other	12%

Still, the following questions remain: Can we really trust the results from this process, and is this a realistic picture of the uncertainty? Are we able to calculate a realistic expected value, compared to the final costs of the project?

#### 5.4 Five challenges that influence the results of the uncertainty analyses

Paper 1 (‘Uncertainty analysis – 5 challenges with today’s practice’ (A. Johansen, Sandvin, Torp, Økland, 2014))

discusses five challenges that influence the results of uncertainty analyses:

1. The expected value/the base case challenge
2. The detail challenge
3. Realistic standard deviation in all phases of the project challenge
4. The human/team challenge
5. The lost opportunity challenge

**The expected value/the base case challenge.** In Norway, we use uncertainty analyses in the early stage of the project screening to find the expected value of the different concepts that are analysed. The purpose of the process is more about identifying the ‘right project’ than finding the right expected value. This means that mutual relations between different concepts of uncertainty and expected value are often more important than estimating the true expected value of the different concepts in the early stage of the process. In turn, this means that a project that is chosen as the ‘best project’ does not necessarily signal the true and correct end cost in the two or three first uncertainty analyses conducted in the project. This challenge is illustrated in Figure 45, which shows

the result of seven uncertainty analyses from a building project that ended up with seven different answers to the question of what was the expected value of the project, and how to increase the value of the project throughout the project process.

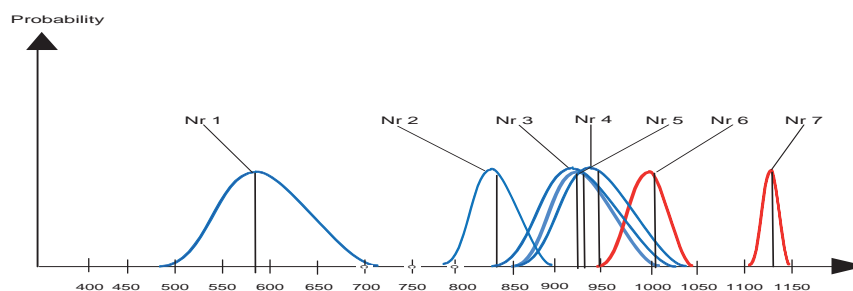


Figure 45 Seven uncertainty analyses in a project – 1–5 in the planning phase, and 6–7 in the execution phase (A. Johansen, Sandvin, Torp, Økland, 2014)

The building project represented in Figure 45 may serve to illustrate how uncertain projects really are and how poorly some projects perform in term of ‘guessing’ their expected end value. However, it also indicates that what we plan for in the early stage of the project will not necessarily be the same at the completion of the project. We suggest that in many cases what we estimate in the uncertainty analysis is the base case, which means what we believe at the current stage of the process will be delivered at the end of the project. Furthermore, we estimate this as accurately as possible at the current stage. Estimating the cost of the project without really knowing what the end result is going to be will mean delivering estimates with a high level of uncertainty. Still, to secure project approval we need estimates with relatively low uncertainty. Based on our experience, we suggest that in most cases projects give estimates that are as good as can be expected, based on the available information. The uncertainty analysis can send out two sets of wrong signals: they can give poor signals to the owner in terms of expected end cost and they can underestimate the uncertainty.

The uncertainty analyses indicated by ‘Nr 2’ in Figure 45 estimated the costs to .840 million NOK with a relative standard deviation of +/-5.2%. Compared to the end result, the uncertainty at that stage was in reality was much higher. A more realistic range of uncertainty seems to be 840 + 30%, although uncertainty in this range would be considered unacceptable. In the building case (i.e. reported in Johansen et al. 2014c), we saw that the project delivery in term of m<sup>2</sup> increased by 25% and that the end time was adjusted by two years between the third and fourth analyses (the two analyses with a six-month interval) and both analyses had a low level of uncertainty. However, the first four analyses were based on wrong assumptions in terms of size and capacity compared with what the project ended up building: all four analyses fell short in predicting the project’s final cost, even they appeared to be certain of the result. It thus seems as though no one had really questioned whether the base case was realistic and correct compared to what the project should deliver. In other words, one has to be very sure about something that one is very unsure about delivering.

**The detailed problem.** The uncertainty analysis method that we discussed was designed to be a top-down approach for the early phase of the project life cycle. The method was designed to find the

expected value and expected time based on limited information in the early stage of a project life cycle. Ideally, the process should focus on the big picture and not on all the details. It should focus on the most important items: uncertainty factors or contracts with the largest uncertainty, and activities that are most important for achieving the project objectives. Based on our experience, we have observed that many of the uncertainty analyses conducted in Norway have drifted away from the original concept. Currently, there are two trends:

1. The uncertainty analyses are used at later stages of the process when more details are available. This means that projects can bring more elements and more details into the uncertainty analyses.
2. Project sizes are increasing. This means the need for more subprojects and, in turn, that more activities will appear in the process.

Unfortunately, both trends also mean that the uncertainty may be lost in the calculations and estimation of the details. In the period 1995–2005, NOK 500 million was considered a cost that characterized a big project by Norwegian standards, and the uncertainty analyses typically had 20–35 elements estimated in the process. Today, the average project size in the public sector is often higher than NOK 1 billion and on average the numbers of elements have increased to + 50. Seen from the project perspective, the details are necessary to give realistic estimates during the process, and there will be scepticism towards estimates as to the results if the uncertainty analyses are to be aggregate the uncertainties. From an uncertainty analytical perspective, we know that too detailed models will mean that uncertainty will be ‘calculated away’. Today, we see a trend for projects to intend to combine the better of the two mindsets by allowing detail structures with a lot of elements and discussing factors and overall conditions in the same process. The process of identifying uncertainty is good for the project team, which will feel that the results are realistic and reliable. The resulting level of uncertainty is unfortunately often unrealistically low in the vast majority of cases that we have seen using this approach. If the goal is to avoid calculating away the uncertainty, either the analysis must be performed at a high level (i.e. with fewer details in the analyses and using uncertainty factors that maintain contextual variables) or highly sophisticated models need to be created, in which correlations between items and factors are maintained.

**Realistic standard deviation in all phase of the project challenge.** Textbooks and company standards operate with uncertainty expressed as standard deviations that typically should be +/-50% or +/-40% in the beginning before passing DG1, +/-25% between DG 1 and DG 2, and typically +/-10% when the project passes DG 3, and thereafter it will decline to zero when the project is handed over (Figure 46).



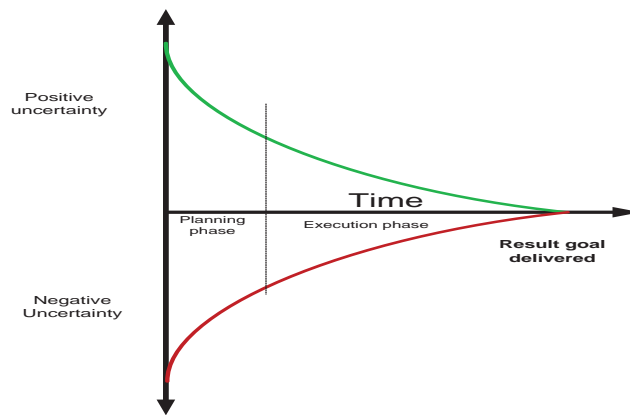


Figure 46 Declining uncertainty during the project life cycle (A. Johansen, Krane, Ekambaram, Steiro, 2012)

The AACE International's Cost Estimate Classification system states that concept screening and feasibility studies' estimates typically should have variation between -30% to +50% and -20% to +30% at budget authorization and control. My study of more than 150 uncertainty analyses performed since the year 2000 reveal a different pattern. The standard deviation in per cent is normally considerably lower than suggested by the AACC standard.

Table 14 Project types and numbers by project phases (concept screening analyses; feasibility studies and planning phase budget, authorization, and control; and check estimate bid/tender) (A. Johansen, Sandvin, Torp, Økland, 2014)

Phase	Type of project	Total no. of projects/analysis	Standard deviation (%)
Concept research programme screening analyses	Public buildings	34 projects (schools)	From 13.7% to 21% average 16.1%
	Road project	16 tunnel/bridges 15 tunnel/bridges	From 12% to 24% average 20.56% From 11% to 26% average: 19.26%
Feasibility studies and planning	Public buildings (e.g. schools, theatres)	6	From 6% to 12% average: 8%
	Hospital	20	
	Road	15+	
	Railway	15+	
Check estimate bid/tender	Road project	3	From 1% to 3% average: 2%

Based on our experience, our finding was that recommended uncertainty level according to the AACCC standard is rare in Norwegian analyses and that the uncertainty analyses often give a considerably more accurate result than the standard suggest. The range of standard deviations we had observed in uncertainty analyses since the year 2000 is summarized in Table 15.

Table 15 Theoretical and empirical level of standard deviations in five phases (A. Johansen, Sandvin, Torp, Økland, 2014)

Analysis phase	(Standard deviation) Opportunity		(Standard deviation ) Threat	
	Theoretical	Empirical	Theoretical	Empirical
1 Concept screening	-40%	<b>-20%</b>	+50%	<b>+30%</b>
2 Study or feasibility	-25%	<b>-15%</b>	+30%	<b>+20%</b>
3 Budget authorization	-20%	<b>-10%</b>	+25%	<b>12%</b>
4 Control or bid/tender	-10%	<b>-5%</b>	+15%	<b>8%</b>
5 Check estimate	-5%	<b>0</b>	+5%	<b>5%</b>

The statistics presented in Table 15 indicate that a high share of the uncertainty analyses from Norwegian projects shows an unrealistically low level of uncertainty, and we suggested that this has to do with the challenges mentioned earlier.

**The human/team challenge.** When uncertainty is discussed in projects, project managers tend to think that we discuss more or less objectively and that uncertainty is interpreted more or less in the same way by all the participants in the process. However, this is not necessarily the case. (Hillson, 2004) state that people’s chosen state of mind, mental view, or disposition with regard to facts or states matter when they interpret uncertainty.(Hillson & Simon, 2012) label this ‘risk attitude’. People’s attitudes to risk will influence project members’ behaviour; hence, if an uncertain event is observed or presented in an uncertainty analysis process, different participants will understand the situation as favourable or as unfavourable or even hostile depending on their personal attitude towards risk. There is also evidence showing that situational factors, such as training, role, and how accountable the different participants are in relation to the end results (Flyvbjerg et al., 2003) have an influence on the project members’ attitudes towards risk.

There are also some pitfalls when analysing uncertainty in group sessions. (Hillson & Murray-Webster, 2007) discuss group risk attitudes and heuristics, and list five common heuristics in groups working with identifying risk: group thinking, the Moses factor, cultural conformity, risk shift, and cautious shift. They also point out that often these group heuristics do not occur alone or in isolation, and that they reinforce causal relationships between them, potentially resulting in the effects of the above mentioned factors becoming even more severe in the uncertainty analysis process. A group offers more insight and experience than a single person, which explains why groups are very often used when uncertainty is discussed (Austeng & Hugsted, 1993; Klakegg, 1993). Individual heuristic

and group thinking may affect how well the group performs in an uncertainty analysis process. Hence, the results of the process will depend on the skills and attitudes of the individuals who participate in the process, and the results of the process clearly will not be objective. The participants in an uncertainty analysis will often be held accountable for the cost estimates they provide. There is therefore an obvious risk that those who provide estimates will actively add a 'buffer' to the cost estimate or add unrealistically high uncertainty factors to ensure that the end result of the process will give a 'high enough' expected value. Although all participants in the analysis will be asked to prepare basic estimates based on a cost breakdown structure without allowance, and although we tell them that the use of triple estimate and uncertainty factors will address the uncertainty in the estimates, we have constantly found that a buffer is added when cost estimates are discussed. To deal with this challenge, the project management team must have great insight into the price structure of every component of the cost estimate, and very often this is almost an impossible task in large projects. To check whether the results of the process are fair, either they can use independent experts or they can use benchmarking to check whether the estimate is reliable on a higher level. Still, the challenges remains unresolved: Which of the estimates can the project team trust? How is the big buffer in the estimates? How much do the different stakeholders' expertise, experiences, and type of personalities influence the estimation of the uncertainty?

**The lost opportunity challenge – the blind spot of uncertainty.** From our experience as consultants and our experience in the PUS project, we saw the same pattern: when threats and opportunities were handled in the same process, far fewer opportunities than threats were identified and discussed in the process. Often 70–100 threats were discussed compared to 5–10 opportunities. In spring 2013, we did a follow-up study of five of the cases that were a part of the PUS projects. We counted threats and opportunities in planning and execution phases and asked the projects how they did in the end: How many opportunities were exploited and what was the effect for the project? Which threats materialized and what were the consequences for the project in the end?

In the five cases that we studied, 7–9 opportunities had been exploited, and 100–110 threats had had economic consequences. This pattern was more or less similar in all five cases that we examined, which raised the following questions: Why are there so few opportunities in projects? Is it likely that threats are many and opportunities are few in all projects? Why are so few opportunities exploited in the end? (Krane, et al., 2014)

## 5.5 The uncertainty management process

A number of authors have covered the subject of uncertainty management process the recent years (Klakegg, Simone et al 1997, 1993; Torp 2008 Simister 2004; Langlo, et al 2007 Johansen, Torp, Økland 2013; Hilson & Simon 2012: Johansen, Halvorsen et al 2014 )

Their findings are summarized in the generic uncertainty management process shown in Table 16.

Table 16 Generic uncertainty management process (A. Johansen, Langlo 2013)

Step	Step description
Initiation – Establishing the context	Define objectives for the uncertainty management process <ul style="list-style-type: none"> <li>- Some standard/textbooks use the terms ‘initiate’ or ‘identify’ the context</li> <li>- Some make a link between objectives and stakeholders</li> </ul>
Identification key stakeholders	Identify key stakeholders
Identification and assessment	Identify relevant uncertainties Quantify the probability and the possible impact on the project’s objectives
Evaluate and prioritize	Finding the ‘top ten’ opportunities and threats
Planning response	Develop response; allocate responsibility and time frame for execution of the response
Implementation response	Execution of agreed response <ul style="list-style-type: none"> <li>- Exploit, share or enhance the opportunities – take advantage of opportunities that will benefit the owner, their customers or the project itself</li> <li>- Avoid transfer or mitigate the threats – reduce the likelihood or the impact of negative events, which if they were to occur would have a negative effect on, for example, the objective, scope, resources, and frame conditions</li> </ul>
Review	Control – Did the response have the desired effect?
Follow-up and reporting	Updating the uncertainty register (UR) <ul style="list-style-type: none"> <li>- Assessments of the uncertainties in the uncertainty register</li> <li>- Take out opportunities and threats that are no longer valued</li> <li>- Identify new opportunities and threats</li> <li>- Plan and execution of new response</li> </ul>

This generic process describes nine steps that should be included in a continuous and iterative uncertainty management process Figure 55 illustrates the nine different steps.

The basis for the generic uncertainty management process and the main elements within it are briefly presented in the following (for more details see Chapter 8). Stephen J. Simister (2004) has developed a generic risk management model based on publications from national standards bodies (British Standards Institute, Canada Standards Association, and Standards Australia), professional institutions (Institution of Civil Engineers (ICE, 1998), Japan Project Management Forum (2002),

Project Management Institute (2008), and the Association of Project Management), and government departments (USDOD, 2003 and the UK OGC 2002). His risk model presents the basic idea of having a continuous, repetitive and iterative process; the idea that risk management is more than isolated exercises and analyses. Simister's model is presented in Figure 30 (see Section 4.6). Further, Stephen J. Simister (2004) underlines the importance of undertaking risk management as a structured, formal process aligned with the overall project management approach. The Norwegian research project 'Practical Uncertainty Management in a Project Owner's Perspective' (the PUS project) proposed a similar model and the project also suggested that opportunities and threats should be analysed and managed through the whole project life cycle (see Figure 47).

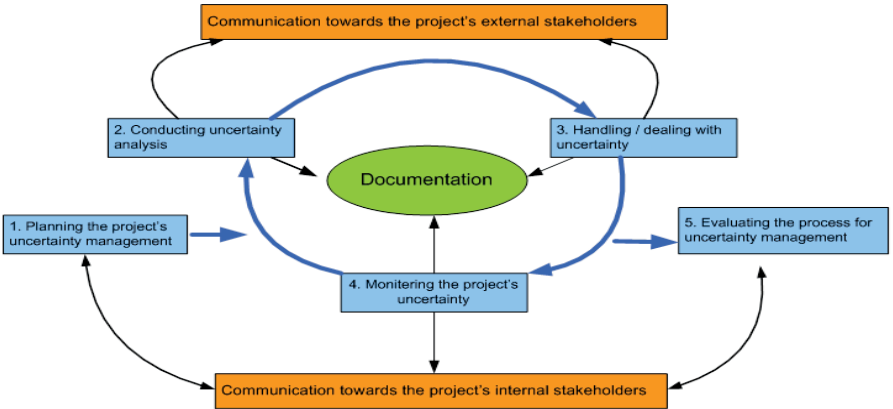


Figure 47 Practical uncertainty management process (www.prosjektnorge.no/pus/)

The third aspect that we used in our research was the utilization of tools and techniques involved in uncertainty management for analysing, estimating, and structuring the response and follow-up of each uncertainty element. Examples of what can be considered techniques are: brainstorming, checklists, interviews, Delphi methods, and expert opinion. Examples of what we considered tools are: cost estimation tools, a risk scoring matrix, maturity models, situation maps, risk cubes, and Boston charts, to mention a few. Figure 48 shows a typical uncertainty matrix as an example of a tool that was actively used in uncertainty management in organizations involved in the PUS research project.

Uncertainty - matrix	Consequence							
	Opportunity				Threat			
Likelihood	Extra large >10 mill	Large 2 - 10 mill	Medium 0.5 - 2 mill	Small < 0.5 mill	Small < 0.5 mill	Serious 0.5 - 5 mill	Critical 5 - 20 mill	Catastrophic 20 mill +
Almost certain >50 %	<del>A</del>	E				(4)	<del>1</del>	
Likely 25-50%		B	C		4	<del>6</del>	2, 10, 11	
Possible 5-25%		(C)	D			7	5, 9	
Unlikely 1-5%						8		
Rare <1%								

Figure 48 Uncertainty matrix used in uncertainty management in organizations involved in the PUS project

The matrix is used to illustrate both threats and opportunities simultaneously. It should be noted that the consequence scale is different from threats and opportunities. This is due to the fact that opportunities normally have less impact than potential threats. Using the same scale would probably present the opportunities as less attractive. The matrix can also be used to illustrate how uncertainty elements change as a consequence of responses taking effect, changes in context, or simply the passage of time.

#### 5.6 Results of uncertainty management in the energy sector and the public sector

The first part of the study presented in this section (Section 5.6) was a part of Hans Petter Krane's doctoral thesis research (Krane, et al., 2011) and the second part of the study was done by Johansen and Krane in spring 2013 (Krane, et al., 2014). The studied projects studied may all be characterized as engineering and construction projects, and they were all large projects (i.e. projects with total costs of EUR 100 million or more). They were selected to represent a broad range of projects regarding size, project phase, and project culture. The studied projects were in different phases, varying from one that had not yet made all conceptual decisions to one that was close to takeover and start-up of production; the others were at different stages between these extremes. Regarding their organizational relations, most of the projects were quite complicated, both because ownership of the project results would be split and because suppliers and contractors to the projects were many and diverse. For the first research question, regarding when the risks are identified, the projects' identification of risks as opportunities ('positive risks') as opposed to threats ('negative risks') were examined. The results are listed in Table 17 and Table 18.

Table 17 Distribution of identified uncertainties– threat/opportunity categories in the energy sector (Krane, et al., 2014)

Project	Phase I			Phase II			Phase III			TOTAL
	Opportun.	Threats	Oppo./thre.	Opportun.	Threats	Oppo./thre.	Opportun.	Threats	Oppo./thre.	
Proj A	0	0	0	4	92	14	0	0	0	110
	0%	0%	0%	4%	84%	13%	0%	0%	0%	100%
Proj B	0	0	0	0	4	1	0	39	5	49
	0 %	0%	0%	0%	8%	2%	0%	80%	10%	100%
Proj C	5	0	11	0	0	0	0	35	2	53
	9%	0%	21%	0%	0%	0%	0%	66%	4%	100%
Proj D	0	0	0	0	35	0	0	261	3	299
	0%	0%	0%	0%	12%	0%	0%	87%	1%	100%
Proj E	3	29	28	1	41	23	1	31	4	161
	2%	18%	17%	1%	25%	14%	1%	19%	2%	100%
Proj F	0	0	0	15	75	37	12	245	82	466
	0%	0%	0%	3%	16%	8%	3%	53%	18%	100%
Proj G	0	0	0	0	25	0	0	166	5	196
	0%	0%	0%	0%	13%	0%	0%	85%	3%	100%
TOTALS	8	29	39	20	272	75	13	777	101	1334
	1%	2%	3%	1%	20%	6%	1%	58%	8%	100%

In Table 17, data are given for each project phase: Phase I – ‘Concept development’, Phase II – ‘Design’, and Phase III – ‘Detail design, construction, and test’. The first row gives the number of risk elements for each project. The second row gives the percentage of the total of risks for the respective projects.

Table 18 Threats and opportunities in the planning and execution phase of public sector projects (Krane, et al., 2014)

		Opportunities		Threats	
		Number	Consequence (NOK)	Number	Consequence (NOK)
Case 1	Planning 2005–2009	11	50–70 million	14	+160–190 million
	Execution 2009–2012	5	30–50 million	26	+190–200 million
	Actual outcome:	2	20–30 million	22+	+ 180–200 million
Case 2	Planning 2001–2006	2	1 million	21	Delays and 25–35 million
	Execution 2007–2010	1	> 0.100 million	31	25–35 million
	Actual outcome:	0	0	30+	+40 million
Case 3	Planning 2001–2011	2	15–20 million	52	Delays and 12–16 million
	Execution 2011–2014	4	14–16 million	23	Delays and 30–40 million
	Actual outcome:	3	10–15 million	18	Delays 3 months +75–100 million
Case 4	Planning 1999–2007	8	30–40 million	7	20–30 mill
	Execution 2007–2010	2	Effect not clear	26	Delays and 20–60 million
	Actual outcome:	4	15–30 million	8	30–50 million
Case 5	Planning 2001–2006	0	0	12	20–40 million
	Execution 2006–2011	0	0	14	20–40 million
	Actual outcome:	0	0	4	15–25 million

The data in Table 18 show that only 7–9 opportunities were exploited and that at least 100–110 threats had economic consequences for the five cases studied:

1. Case 1: 17 opportunities were identified and 2 were exploited; 40 threats were identified and 22 of them had economic consequences – increased cost, +180 to 200 million NOK
2. Case 2: 3 opportunities were identified and none were exploited, +50 threats were identified and +30 of them had economic consequences – project delays and increased cost +40 million NOK
3. Case 3: 6 opportunities were identified and 3 were exploited, reduced cost 10–15 million NOK; +50 threats were identified and 18 of them had economic consequences – project delays and increased cost +75–100 million NOK
4. Case 4: 10 opportunities were identified and 2 were exploited, reduced cost 15–30 million NOK; 33 threats identified and 8 of them had economic consequences – increased cost +30–50 million NOK



5. Case 5: No opportunities were identified and none were exploited; 28 threats identified and 3–5 of them had economic consequences – increased cost +15–25 million NOK.

The pattern is more or less similar for all the five cases in the public sector study: they all had much focus on threats, many of which became a reality because the projects were not capable of taking measures to avoid them. There were substantially fewer opportunities and even fewer of those were followed up and exploited in the end.

The data from the two different studies conducted by Krane et al. (Krane, et al., 2014; Krane, et al., 2010) show more or less the same pattern: there were many more threats than opportunities in the uncertainty and risk registers. Also, the opportunities identified in the execution phase were few and often not exploited at all. Our case (i.e. reported in Paper 4) shows that the private sector and public sector cases had more or less the same focus on threats, and that private projects were not better at exploiting opportunities than public projects. All of our projects seemed to be quite conservative towards new ideas and change, and they were not seeking new opportunities in their execution phase. Some opportunities were identified late in the project in uncertainty analysis workshops, but identifying new opportunities did not mean that the project actually utilized the opportunities after the workshops were over.

If a project management team believes that they have enough money and time to deliver what has been agreed upon with the project owner, then their motivation and interest in new opportunities will normally be limited. They may consider the list of opportunities as a gamble, because it means that they need to change part of the process or concept, and this in turn may be a gamble as the project management team will not be paid for such changes or any benefit derived from them.

By contrast, if a project management team believes that the budget is too small or tight, they will start to seek opportunities and more actively exploit new ideas. They will also be willing to make changes to the concept, so that they will deliver according to budget. Cases 1, 3, and 4 in the public sector all had tight budgets, and this made them exploit opportunities more actively than in the other cases.

Our studies of project practices (i.e. reported in Paper 4) indicate that projects only to a small extent actively seek opportunities in the execution phase. This does not mean that such opportunities do not exist there; it only means that many projects miss possible opportunities because they lack focus in this respect when it comes to managing uncertainty.

## 5.7 Contribution to research

This chapter has described three myths about uncertainty and five challenges that influence the result of uncertainty analyses conducted in Norway today. I have presented empirical data that prove that many projects still do not deal with threats and opportunities in a balanced way. The empirical data from the studies show more or less the same pattern: there are much more threats than opportunities in the uncertainty registers. Opportunities that were identified in the execution phase of studied projects were few and often not exploited at all. The studied cases show that the private sector and public sector had more or less the same focus on threats. Furthermore, my empirical data suggest that projects owned by private companies are not better at exploiting opportunities than projects owned by public companies.

## 6 Uncertainty – the human aspect

An organization can be described as comprising identities that are connected together by boundaries and a shared culture and structure. According to (Jacobsen, Thorsvik, & Lev, 2005), the separate elements in an organization's social system share three mutual components: (1) the task that should be delivered, (2) the technology needed to deliver the task, and (3) the resources needed to deliver the task and use the technology. In this chapter, I present some of the challenges in terms of how organization and people that are an essential part of project interpret and deal with uncertainty.

This chapter is based on the following papers:

- Paper 4 – 'Exploiting opportunities in the uncertainty management'
- Paper 5 – 'Effects of long-term improvement efforts within project uncertainty management'
- Paper 6 – 'Living uncertainty management – An approach to learning and improvement in project-based organizations'
- Paper 8 – 'Improving uncertainty management in projects by collaborating in an inter-organizational research project'
- Paper 9 – 'Exploring uncertainty and flexibility in projects: Towards a more dynamic framework?'
- Paper 13 – 'Opportunities in projects and innovative thinking'

Research on organizations and projects has shifted focus from developing tools and techniques to understanding human behaviour (Smyth & Morris, 2007). As a result, project management scholars acknowledge that that projects' context and the humans involved in projects matter, and that there is a need to understand organizational culture and the processes that lead to development and changes in organization. (Alvesson & Willmott, 1996) have developed four different perspectives on analysing organizational culture: (1) a wide perspective that consider culture as a unique and uniform characteristic; (2) a perspective that deals with organizations as a meeting arena for different cultures and subcultures that coexist within an organization; (3) a more local perspective that analyses the different subcultures; and (4) a perspective that characterizes organizations in different cultures.

Our understanding of how good or bad projects with regard to uncertainty management depends on our ability to understand how people in organizations react to uncertainty and our ability to understand the organizational culture that we study. That means that our understanding of uncertainty management depend on our ability to interpret the different organizational cultures with which we interact. Different organizations can have different cultures for dealing with uncertainty management and therefore provide different guides and tools and have different strategies for giving support and training on the topic. We therefore need to understand how organizational culture is built and what types of processes that are going on between the organization and the project team if we aim to study the implementation of uncertainty management in projects (Amdahl, 2009).

### 6.1 Uncertainty – objective facts or subjective beliefs?

When uncertainty is discussed in projects, it is assumed that it is done more or less objectively and that uncertainty is interpreted more or less in the same way by all participants in the process. However, this is not necessarily the case. (Hillson & Murray-Webster, 2007) state that the mental view regarding facts when people interpret uncertainties is not objective, and they identify this as

risk attitude. People's risk attitude will affect project members' behaviour; different participants can understand a given situation as favourable or unfavourable or even hostile depending on their personal attitude towards risk. Also, situational factors, such as knowledge, role, and how accountable the different participants in the project are to the end result, will influence project members' attitudes towards risk (Flyvbjerg, et al., 2003). There is also evidence to suggest that situational factors, such as training, role, and how accountable the different participants in the project are for the end result, will influence project members' attitude towards risk (Flyvbjerg, et al., 2003).

(Hillson & Murray-Webster, 2007) list six situational factors that influence how people involved in a project react to a given uncertainty:

1. Level of relevant skills, knowledge, or expertise – prior knowledge or not, skills or not?
2. Perception of probability and frequency of occurrence – unlikely or not?
3. Perception of impact magnitude, whether the severity of negative threats or the number of positive opportunities – high or low, perceived as positive or negative impacts?
4. Degree of perceived control or choice in the situation (manageability) – high or low manageability?
5. Closeness of the risk in time – in the near future or farther away in time?
6. Potential for direct consequences – impact on the group or others?

It is therefore likely that the results of uncertainty analysis processes are rather subjective and dependent on the knowledge and personality of the participants. (Hillson & Murray-Webster, 2007) add what they call heuristic factors in order to understand the behaviour towards risk. Heuristic factors are underlying psychological factors that operate on the subconscious level, and are therefore less controllable. They help to simplify the decision-making process, reduce the amount of data to be considered, and lead the individual more rapidly to a decision. Heuristic factors can explain individual errors in identifying and analysing uncertainties. Understanding heuristics can therefore make us aware of pitfalls that may occur in the uncertainty process. According to (Hillson & Murray-Webster, 2007), typical underlying heuristics are:

1. Group thinking – members of cohesive group prefer unanimity and suppress dissent
2. The Moses factor –describes a situation where one person's risk attitude is adopted against the personal preferences of other group members
3. Cultural conformity – making decisions that match or follow the group or organizational norm
4. Risk shift – organization more risk seeking than its constituent individuals members
5. Cautious shift – more risk averse than its individual members

(Hillson & Murray-Webster, 2007) also point out that these group heuristics often do not occur alone or in isolation, and they reinforce causal relationships between them. This can lead to severe biases in the uncertainty analysis process. Johansen et al. point out that the stakeholders' experiences and understanding of how much uncertainty the project actually faces as it progresses will be largely subjective (A. Johansen, Eik-Andresen, et al., 2014). As a consequence, there are no exact measures regarding the uncertainties that the projects have to deal with during their course (i.e. how many uncertainties exist). The way project stakeholders perceive the uncertainty of the project and its context is closely related to the type of experience and competence they have. Their perception also

depends on how clearly they understand the process that will lead to the objective (i.e. how the project will evolve). Thus, an experienced project owner or project manager will most likely understand and evaluate the uncertainties of a project substantially differently from recently graduated project managers (N. Olsson, et al., 2007; Rolstadås & Johansen, 2008). Similarly, an organization that has undertaken many complex projects consider uncertainty differently compared to a one-time project owner or a newly formed company. One challenge that they all have in common is that making an objective assessment of the uncertainties; in the best case, this sort of objective assessment can only first be done after the project is delivered. It has been claimed that the project's real uncertainty can seldom be estimated objectively while the project is in progress, and it can only be considered reasonably objectively and after the completion of the project (Christensen & Kreiner, 1991). (A. Johansen, Krane, Ekambaram, Steiro, 2012).

## 6.2 What has uncertainty management to do with learning?

The ambition of the PUS project was to focus on leadership and culture connected to practical management of uncertainty in major public and private projects. At the beginning of the project, the focus on learning and knowledge creation was not clearly expressed. In fact, one of the funding bodies (i.e. partner) emphasized that the topic of learning and knowledge creation should not be a part of the scope of the project. However, during the second year of the research project, it became clear to the six industrial organizations (public and private organizations in Norway) that developing new knowledge in uncertainty management required them to deal with the topic of learning and knowledge creation (Loch, et al., 2006).

If projects should be efficient in dealing with uncertainty, they need to understand, interpret, and handle uncertainty both within and outside them. Projects must understand their circumstances and the impact of the efforts that they have initiated. If there is no focus on learning and knowledge creation as projects progress, the process of managing uncertainty will not be efficient. The mother organization, which is responsible for training and developing new methods, needs a strong focus on learning and knowledge sharing so that the new methods, tools, and techniques are actually applied in 'all' projects.

The learning and improvements that the six organizations achieved were based on an approach called 'living uncertainty management', which is a continuous active approach to managing uncertainty that was applied in the PUS project. The aim of this approach is to discuss how to integrate uncertainty as a dynamic part of project management. In order to make uncertainty management 'living', dealing with uncertainty needs to be an essential element of project team members' everyday routines (Agnar Johansen, Anandasivakumar Ekambaram, & Linda Hald, 2012)

Since the start of the new millennium, several authors have written about uncertainty management (e.g. Johansen et al., 2006; Hillson, 2004; Hillson & Murray-Webster, 2007; Hillson & Simon, 2012); (Jaafari, 2001), 2001; (C. Chapman & Ward, 1996, 2011); Torp et al., 2008; Loch et al., 2006). Most of their books and articles focus on the uncertainty management process by substantially dealing with technical part of the management issues that projects need to understand in order to handle uncertainty in projects. Loch et al. (2006) are representative of a few authors that suggest that dealing with uncertainty has something to do with learning, and they suggest that three types of learning occur in projects in general: single-loop, double loop, and deuterio learning. They find close link between uncertainty management in projects and knowledge creation.

(Loch, et al., 2006) state that single-loop learning will occur when a project analyses and detects deviations from the plan. Based on the findings, the project will then take new actions to eliminate the deviation and comply with the plan. Double-loop learning occurs when the project or the mother organization detects deviations in the processes, methods, or the techniques that are involved. Then, based on the findings, the project or the mother organization will choose to modify or create new processes, or correct the deviation or errors by modifying the plans, norms, and policies. The third level of learning, deuteron learning, involves changing the way the organization detects and acts on deviation in projects.

(Argyris & Schön, 1996) are prominent researchers on single-loop and double-loop learning within the context of organizational learning. Both types of learning can also be seen in connection with sense-making in organizations (Weick, 1995) and reflective practitioners (Schön, 1991).

### 6.3 Living uncertainty management – a tool for learning and knowledge creation

How did the partners in the PUS project address learning as part of developing new methods and techniques in the field of uncertainty management? When the PUS project started, the six different companies had different levels of maturity in the field of uncertainty management. Two of the companies had long experience and very well defined methods and techniques. Four of the companies were less mature with regard to uncertainty management. Since the six companies had different experiences with respect to uncertainty management, they chose to focus on different learning strategies. Learning includes, among other things, reflection – asking questions and viewing situations from different angles. Reflecting on the current situation and continuously evaluating it can contribute to learning when it comes to managing uncertainty in projects.

The above-described continuous evaluation of uncertainty elements can be done by asking fundamental questions regarding what the project or organization does, such as:

- Why do we do that we do?
- Why do we do it the way we do?

These questions are mentioned by (Hammer & Champy, 1993) in connection with business process re-engineering (BPR). These questions can also be used in the context of reflection and exploration describe here in connection with opportunities in projects. Asking fundamental questions can lead the project or organization to identify and utilize new opportunities both internally and externally. Asking fundamental questions can be seen in connection with what Schön calls the reflective practitioner:

A practitioner's reflection can serve as a corrective to over-learning. Through reflection, he can surface and criticize the tacit understanding that have grown up around the repetitive experiences of specialized practice, and can make new sense of the situation of uncertainty or uniqueness which he may allow himself to experience. (Schön, 1991, p. 61)

Schön's description highlights the possibility of new ways to approach and tackle the situation at hand. He describes two aspects of reflection: Reflection-in-action and reflection-on-action. Reflection-in-action is about reflecting on an action while the action is ongoing, whereas reflection-on-action is about reflecting on what has happened. These two types of reflections can be seen in connection with learning and uncertainty management in the PUS project.

In all six companies the PUS project there were several instances of active participation by researchers in uncertainty analysis sessions. This can be seen as an instance of reflection-in-action, as the reflective process occurred in real time as an integral part of the uncertainty analysis. The researcher led or facilitated the uncertainty analysis sessions (i.e. using action research) in order to identify and deal with the uncertainty elements that the projects encountered. In this respect, the learning can primarily be seen in connection with single-loop learning.

Five of the companies developed training courses in uncertainty management and uncertainty analysis. This can be seen as a result of reflection-on-action. The courses were developed to equip the project participants with the required knowledge and competence to approach and handle uncertainty in their projects. In other words, establishing the courses can be seen as an effort to institutionalize the knowledge in such a way that the knowledge would be shared and applied in future projects. Although the development of the courses could include elements of double-loop learning, the actual conducting of the courses could be related to single-loop learning – the courses aimed at sharing or enforcing a norm within which a better approach to uncertainty management could be explored and practised.

All six companies had seminars on the topic of uncertainty management during the project.

Three of the companies needed to develop system and models for uncertainty management. They all started by defining the process and testing it in pilot projects, together with researchers from the PUS project. This can be seen as a learning strategy. The strategy also incorporated institutionalization of new methods and techniques that were developed with respect to the pilot project. This institutionalized knowledge was planned to be applied in other, future circumstances.

Two of the companies developed control systems with respect to uncertainty management. This can be seen as a mechanism for checking how well systems and methods are institutionalized. The purpose of the control systems suggests reinforcement of single-loop learning.

Three companies performed benchmarking of the process of uncertainty analysis. This can be seen as an effort to identify possibilities for improvement. Such identification could lead to single-loop learning (institutionalizing the best practice within the existing norms and policies) and/or double-loop learning (changing the existing norms and policies). It can also lead to deuteron learning, at least to a certain extent, since the benchmarking could change the way organizations detect errors and take actions.

Three companies participated in writing and publishing research papers together with researchers from the PUS project. This can be seen as a compact, intense process to present some of the research results by researchers and practitioners collectively looking at the issue of practical uncertainty management with theoretical point of view. Reflecting on theory and practice, making this reflection in a concise manner, and presenting it to other researchers and practitioners would start a positive learning circle.

All six companies participated in forums and conducted seminars to share their knowledge and reflect on the current practices in connection with uncertainty management in projects. A website was established by the PUS project to share new methods, processes, and techniques that were developed in the project (<http://www.prosjektnorge.no/index.php?pagelid=374>). The forums and

seminars, and indirectly also the website, promoted a form of open knowledge sharing across company boundaries. This manner of sharing could lead companies to detect errors and deviations, and deal with them in a better way, including changing their norms and policies with respect to uncertainty management practices (which is represented by double-loop learning).

Although the above description illustrates a positive picture, the efforts to make this positive impact was not completely free of challenges. One such challenge was the frequent organizational changes that took place (for reasons that were unrelated to the PUS project) in one company. The company had to focus much more on the organizational changes than on participating actively in the PUS project as they had originally wished. Another challenge was that a new tool for managing uncertainty would not always be accepted wholeheartedly by everyone who was expected to use it. Providing proper training could be a solution in this regard. Despite facing such challenges, the PUS project managed to create some value in the industry.

Most of the projects needed to deal with uncertainty, and in this respect learning and knowledge creation are an essential part of an effective uncertainty management process. The classic project management approach focuses on predicting as accurately as possible what is going to happen and tries to establish a form of bandwidth within which one can expect project deviations. In this regard, front-end engineering becomes important, and sophisticated tools for assessing and analysing risk are frequently applied.

Systematic learning and reflection make it possible to move decisions points from the front of the project where the information is limited, to towards the back where the information about the needs is more developed. Our approach to uncertainty with a focus on learning can be compared to the following description uncertainty management in projects provided by (O. Perminova, et al., 2008)

key elements in managing uncertainty are reflective learning and sense making as enablers of flexibility and rapidness in decision-making regarding the choice of alternative actions in response to the situation. At the same time, standardized and modularized processes and procedures constitute a necessary basis for supporting reflective processes. All of these measures can be regarded as important tools for project managers to recognize and establish the core competences, and thus perform rather than simply conform to the plan. Continuous following of such procedures at different stages of the project is an essential part of project success.

The final sentence in the above points to the aspect of 'living uncertainty management'. Learning is not a one-time or few-times event. It is an ongoing, dynamic process that has the potential to create new approaches and solutions to deal with uncertainty in projects in a timely manner.

#### 6.4 The role of the project owner

Traditional ways of managing uncertainty have focused much on project objectives, and mainly on threats rather than opportunities. This traditional approach has limitations, especially when it comes to creating or ensuring a wider effect that is to be produced by the project when it is completed. A project may be completed according to a predefined frame of cost, time, and quality. However, the purpose of the project (i.e. the intended effect of the project) may not be achieved. Furthermore, the traditional approach tends to assume that the world is stable and predictable. The PUS project acknowledged that the world in which projects are a part of is dynamic, unpredictable, and complex, and proposed a broader perspective: the project owner perspective (Ekambaram A, 2013b). A project owner has rights to and is responsible for the project. (N. Olsson, et al., 2007) state:

The beauty behind the concept of a project owner lies in the fact that a project owner has incentives for weighing costs against benefits for a project. Project owners are therefore expected to strive for project governance aimed at maximizing the value from the project.

The project owner perspective provides a broader understanding of managing uncertainty in projects. This perspective can be helpful to understand important aspects that influence a project (including aspects that lie outside of the realm of traditional project management) as well as interrelation between the aspects. This understanding, which can be achieved through cooperation between the project manager and the project owner, can help in dealing effectively with uncertainty in projects. Good cooperation between a project manager and a project owner can produce a holistic understanding of the project, which can in turn help to identify and/or create opportunities in the project. (N. Olsson, et al., 2007) emphasize also the importance of having a holistic approach in projects in order to identify and materialize opportunities.

#### 6.5 Stakeholder benefit assessment – project success through management of stakeholders

A project stakeholder can be defined in many different ways. The three project management standards define stakeholders respectively in three different ways:

- PMBOK (2008, p. 246): 'Persons and organizations such as customers, sponsors, the performing organization, and the public that are actively involved in the project, or whose interests may be positively or negatively affected by the execution or completion of the project'
- ICB (IPMA, 2006, p. 42): 'People or groups, who are interested in the performance and or success of the project, or who are constrained by the project'
- PRINCE2 (2009, p. 313): 'Any individual, group or organization that can affect, be affected by, or perceives itself to be affected by an initiative programme, project, activity, risk'

Stakeholders are also discussed in project management literature focusing on uncertainty and risk (C. Chapman & Ward, 2007; Cooper, et al., 2005; Flyvbjerg, et al., 2003; Hillson & Murray-Webster, 2007; Hillson & Simon, 2012; A. Johansen, Eik-Andresen, et al., 2014), and in more generic project management textbooks (Artto K., 2011; Mikkelsen & Riis, 2011; Rolstadås, 2008). (Cooper, et al., 2005) state:

all project and procurement involve at least two stakeholders; the procuring entity (the buyers) and the supplier of goods and services (the seller). In most projects, though, there is a wider set of stakeholders as well, whose desired outcomes must be considered when planning a project.

The authors also claim that stakeholder analysis is usually undertaken at an early stage of planning and that stakeholder analysis is an important part of the risk assessment activities. (Hillson & Simon, 2012) define stakeholders as 'Any person or party with an interest in the outcome of the project and/or an ability to exert influence'. This corresponds to Artto & Kujala's definition of stakeholders as individuals, groups, or organizations that the project may affect or that can affect the project ((Artto K., 2011). Artto and Kujala say that stakeholders can have a direct or indirect connection to the project, or to the resulting product. The connection can be based upon a possibility to affect the result of the project directly or indirectly. In addition, stakeholders include the groups that the project affects but that do not necessarily have the opportunity to affect the result of the project.



These groups can nevertheless have an indirect connection to the business; for example, they can affect the company image formed in the market. Artto and Kujala provide a list of the most common stakeholders in projects: project manager, project organization, project team, people participating in the project, the organization unit of the company making the project, customers, users, buyers, sponsor or project owner, suppliers and service providers, officials and authorities, financiers, the media, other target groups, competitors, and society in broader sense. The authors also make it clear that a complete list of stakeholders is impossible to provide.

Several authors have discussed how stakeholders are related to project uncertainty. Cooper et al. (2005), (C. Chapman & Ward, 2007), (Hillson, 2002), Johansen et al. (2012b), (Klakegg, et al., 2009), and (Flyvbjerg, et al., 2003) have discussed how stakeholders are connected to project uncertainty. In the next session I elaborate on some of the issues that show how stakeholder management is related to uncertainty, and how stakeholders' personalities and roles in the project organization may make a difference when interpreting uncertainty.

## 6.6 Stakeholder management and uncertainty

Chapman and Ward (2007) emphasize the importance of the link between stakeholder and risk, and say that an active approach to the stakeholder is based on the analysis of project risk. (Cooper, et al., 2005) state: 'Stakeholder analysis is important in risk assessment for most activities.' (Krane, Rolstadås, & Olsson, 2012), p. 5) claim that 'successful stakeholder management relies on effective communication with all stakeholder groups. And quite often, good communication with critical stakeholders will become a crucial element in keeping the project uncertainty at an acceptable level.' (Klakegg, et al., 2009) state:

On an individual level a person's psychology and attitudes towards risk and uncertainty are important – people think differently about similar issues and they assess risks differently. This has implications for how uncertainty is approached in analysis: how a question is asked matters. People's ability to imagine the future is limited and the level of precision in judgment and communication about uncertainty is low (Teigen & Brun, 1995).'

The perception of stakeholder management and uncertainty also depends on how clearly the stakeholders understand the process that will lead towards the objective (i.e. how the project will evolve). How uncertainty is assessed in a project is influenced by individual events that the project organization experiences. However, it is also affected by how the various members of the organization interpret events happening within and outside the project, and by the conditions and/or elements that the project owner and society emphasize while the project is being carried out. (Cooper, et al., 2005) suggest that dealing with uncertainty should be linked to the management level in the project. The bigger the threat or opportunity, the higher in the leadership hierarchy it should be analysed and decided upon. Further, Cooper et al. (2005) suggest that:

- Extreme threats or opportunities should involve senior-level management
- High-level threats or opportunities should involve senior executive levels
- Medium-level threats or opportunities should be managed by specific response procedures
- Low-level threats or opportunities should be managed by routine procedures without specific applications of resources

The list at p156 indicates that extreme and high-level threats or opportunities are linked to how they affect the project objectives, and therefore there is a need for focus from the project management team and the project owner. A stakeholder analysis covering 'all' actors who may have opinions or requirements regarding the project's goals and future effects and/or benefits, will in most projects be impossible to set up. One must therefore accept that 'all' stakeholders are not covered and that there must be more or less stereotypical assessments. One must also live with the fact that it is not possible to identify fully the stakeholder requirements and expectations, and that stakeholders might evolve during the progression of the project. This means that new needs may arise, the stakeholders may come up with new demands, and new goals may be set while the project is under development. This will contribute to creating uncertainty with respect to project deliverables.

#### 6.7 Contribution to research

Research on organizations and projects has shifted from developing tools and techniques too focusing more on understanding human behaviour (Smyth & Morris, 2007). Accordingly, project management scholars acknowledge that that context and the persons involved matter, and that they need to understand the organizational culture and the process in use for developing and changing organizations.

I suggest that if a company wants to develop in uncertainty management, it needs to understand human behaviour, the culture in the company, the project owners' role, and how stakeholders interact with the process. If projects should be efficient in dealing with uncertainty, then they need to understand, interpret, and handle uncertainty both within and outside the project. Projects must understand their circumstances and the impact of the efforts that they have initiated. If there is no focus on learning and knowledge creation as projects progress, the process of managing uncertainty will not be efficient. The mother organization, which is responsible for training and developing new methods, needs a strong focus on learning and knowledge sharing so that the new methods, tools, and techniques are actually applied in 'all' projects.

## 7 Opportunity management

In the context of projects, 'opportunity' can have several interpretations. One interpretation is that the project itself is the opportunity and that the desired change or effect for the stakeholder should be regarded as an opportunity. Another interpretation is that opportunities are all factors, or variations, or events that make the project's objective better than originally planned. It could also be argued that it is possible to talk about opportunities as some solutions are not seen at the beginning, or something that has just occurred, or something positive that could not be foreseen, or something that is more or less beyond our control but still positive or favourable or better compared to the original plan and or concept. Bringing an opportunity into the project means that the project must allow instability for a short period, and a project sponsor or manager with the power, ability, and willingness to change the plan or concept if they anticipate that the opportunity will give a better result is also needed.

Some authors suggest that dealing with opportunities is more or less the same as dealing with threats, and that there is no need for separate processes (Cooper, et al., 2005; Hillson & Simon, 2012). If the uncertainty is beneficial or positive for the objectives of the project, the risk will become synonymous with opportunity and be handled in the same process or model, namely the Active Threat and Opportunity Model (ATOM). Cooper et al. support this idea and claims that 'the general risk management process applies equally well to opportunities, requiring only minor adjustment' (Cooper et al., 2005, p. 125). They also support the idea that identifying opportunities is similar to identifying risks. However, is this really the case? I would argue that dealing with opportunities requires a different mindset and that most project managers still tend to spend most of their time on identifying and avoiding threats when focusing on uncertainty management.

Based on the literature I have reviewed and the empirical data presented in Papers 2, 4, 6, 7, 9, 12, and 13, I have deduced four characteristics of how opportunities are seen in most projects today:

1. When project starts, it has a high focus on opportunities and low focus on threats.
2. If nobody has a benefit, it is not a true opportunity.
3. Opportunities may happen if the project invested in them, and they will disappear or have no impact if the project does not change the plan or the way the project is executed.
4. Opportunities for the owner of a project are connected to the future benefits of the project, whereas opportunities for the project team are primarily connected to project planning and the execution phase of the project.

I suggest that opportunities and risk are fundamentally different concepts and need to be treated in separate processes. I also suggest that understanding who will benefit and who will benefit from the positive consequence of the opportunity is the key to understanding how to manage opportunities properly in projects. The management of opportunities needs to be linked to project goals and how the possible benefits will affect the different stakeholders of the project. Our empirical data show that exploiting opportunities is difficult and it is a different task compared to dealing with threats.

This chapter is based on the following papers:

- Paper 2 - 'Stakeholder benefit assessment - Project success through management of stakeholders'
- Paper 4 – 'Exploiting opportunities in the uncertainty management'
- Paper 6 – 'Opportunities in projects – what are they and do we really want them?'
- Paper 7 – 'Uncertainty management – Myths and realities'
- Paper 11 – 'Uncertainty management in projects – A new perspective'
- Paper 12 – 'Opportunities in projects and the role of project owners'
- Paper 13 – 'Opportunities in projects and innovative thinking'

### 7.1 Opportunities in projects – what are they and do we really want them?

Is it likely that risks are many and opportunities are few in all projects? The empirical data presented in Tables 19 and 20 in Chapter 5, show that only 7–9 opportunities were exploited and at least 100–110 threats had economic consequences for the five cases studied. We tested what would happen if we asked the participants in an uncertainty workshop to define opportunities, and then ask them to identify the threats, instead of asking about the uncertainty.

When we asked the participants to identify the project's uncertainty, we found a clear tendency for the mention of threats to come up in the discussion, typically at a ratio of 10:1 when comparing threats and opportunities. When the same question was asked in the execution phase of the project hardly any opportunities were mentioned. However, we observed some other rather interesting patterns. Participants in uncertainty workshops had more or less the same view of what were the threats and possible consequences and they related the threats to project objectives. When opportunities were discussed, the picture was far more inconclusive or foggy.

When opportunities were addressed, the participants tended to view them from their own role in the project. Identified 'opportunities', were not necessarily closely related to the project's objectives. Some of the participants often advised a change to solution, and typically saw new or better technology as an opportunity. Some stakeholders were of the opinion that there are no opportunities after the contract has been signed, some talked about opportunities that arise as a result of the project, and some talked about how good execution, new technology, and so forth can make the project better, faster, or cheaper. Furthermore, the stakeholders often tended to describe what they wished could be the benefit if the opportunity were to happen. Hence, when opportunities were discussed in workshops, typically there was a mixture of causes, uncertainty elements, possible effects, ideas, and strategies for managing an opportunity. Thus identifying and managing opportunity are closely related to understandings of what type of benefits the opportunity will bring to each actor in a project and when the opportunity will occur.

*Society, end users, and customers* benefit from the effect result of the project years after its completion. They have demands or requirements before the project start, such as for a new school, hospital, or road, and the expected benefit for them will typically be better education, better health care, and faster and/or safer travelling respectively. *The company* that starts and finishes the project will benefit financially when the project is executed, and after selling services or products that the project has delivered. At the same time, the company will also gain experience and skills that make it better prepared to delivered new projects. Furthermore, the delivery of a project would establish

and/or maintain the organization's justification for conducting the project, seen from the owner's point of view. *The project* will be interested in opportunities linked to the project objective, and opportunities for the project are thus linked to cost, time, and quality:

- Opportunities in terms of cost: The project can deliver more at the cost that was previously determined or with the predetermined quality at a lower cost.
- Opportunities in terms of time: The project can deliver a predetermined product or service quicker than planned, without increasing the cost, and with the predetermined quality.
- Opportunities in terms of quality: The project can deliver a concept that is better than the one originally agreed upon, within the same frame of time and cost. Operational solutions can also be considered in this regard. For example, a project can deliver a product or service according to the predetermined frame of time and cost, and the delivery will be more optimal to operate.

### Strategies for managing uncertainty

Several authors (e.g. PMBOK, 2000; Hillson, 2004; Piney, 2002) point out that there are at least six or seven strategies from which to choose as a response to uncertainty or as a way to manage uncertainty. Piney (2002) suggests 12 main strategies for dealing with project risk and he divides risk into opportunities and threats (Figure 49).

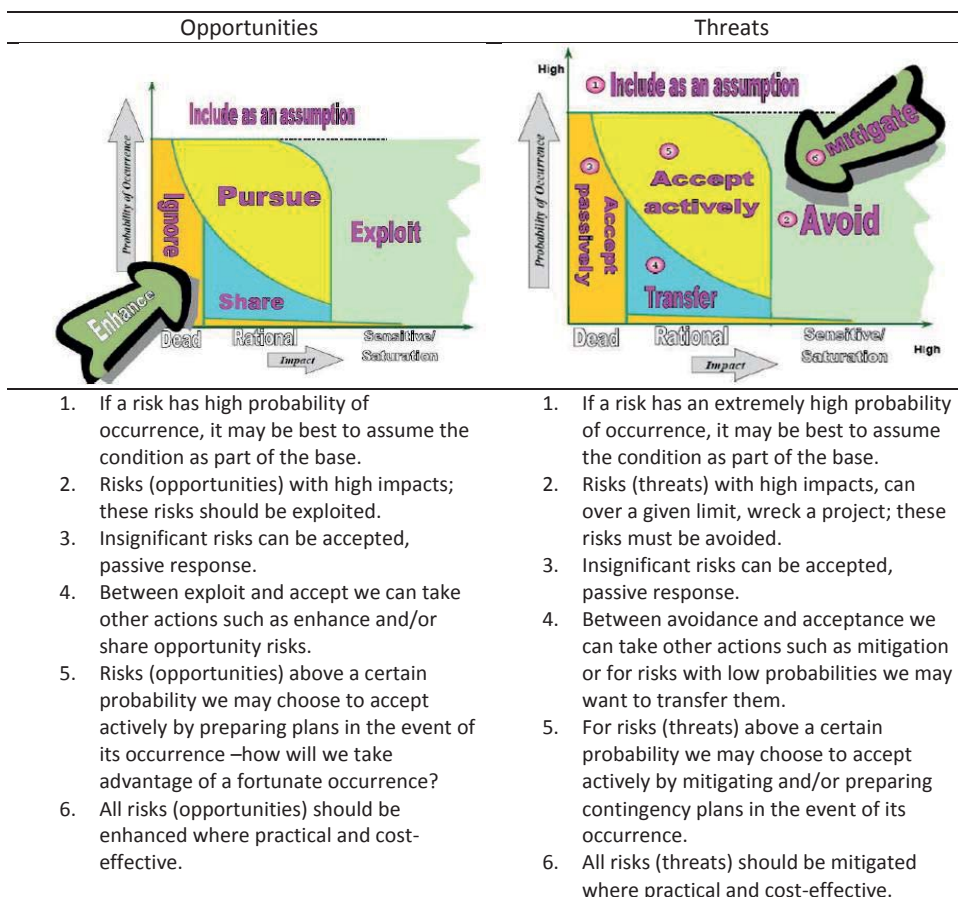


Figure 49 Risk response planning (Piney, 2002)

Other authors and publications such as PMBOK 2000) and Hillson (2004) suggest seven management strategies for dealing with uncertainty (Table 19).

Table 19 Strategies for uncertainty management response – opportunities and threats

Opportunities	Threats
Exploit	Avoid
Share	Transfer
Enhance	Mitigate
.....Accept.....	

According to the PMBOK (2000), the strategy Exploit is the opposite of Avoid, and is about ensuring a positive impact and striving to realize an opportunity. Hillson (2004) states that Exploit is the most aggressive of the response strategies and should be reserved for those ‘golden opportunities’ with high probability and impacts. In the PMBOK, sharing is considered a positive risk strategy that involves allocating ownership to a third party that is best able to capture the opportunity for the benefit of the project. Furthermore, according to PMBOK, Enhance is a strategy that the project will choose in order to modify the ‘size’ of an opportunity by increasing probability and/or impact. The fourth and final strategy, Accept, assumes or accepts that some threats or opportunities are not possible to eliminate or they are so small that the effort of doing anything about them would not be worthwhile.

The seven management strategies are well-known, but it must be questioned whether it is sufficient to have knowledge about them if a project should obtain full benefit of uncertainty management.

Findings from the PUS research project clearly indicate that project teams intended to focus on both opportunities and threats. However, their degree of focus varied (Amdahl et al., 2008 (A. Johansen, Langlo 2013). In a Norwegian survey of large project organizations (A. Johansen, Langlo 2013), in response to a question regarding the focus on uncertainty management in their projects, 76% responded that it was ‘mainly on risks (threats), but also on opportunities’, 15% said they had ‘equal focus on threats and opportunities’, and just 7% responded that they ‘only focused on risks (threats)’. However, the responses do not seem to reflect the contents of the projects’ risk registers. In another study done in the PUS project, to analyse the risk registers of several large projects, it was revealed that 81% of the risk elements could be categorized as threats, 3% as opportunities, and 16% as both threats and opportunities (Krane, et al., 2010). However, we cannot ignore the importance of having adequate focus on opportunities when it comes to managing uncertainty in projects.

## 7.2 Stakeholder and opportunities

Some authors (e.g. Hillson & Simon, 2012; Cooper et al., 2005) suggest that dealing with opportunities is more or less the same as dealing with threats and that there is no need for separate processes. According to (Hillson & Simon, 2012), ‘A risk is any uncertainty that, if it occurs, would have an effect on achievement of one or more objectives’. If the uncertainty is beneficial or positive for the objective, the risk will become synonymous with opportunity and handled in the same process or model (i.e. ATOM). ATOM is scalable and applicable to all projects. (Cooper, et al., 2005) support this idea and state that ‘the general risk management process applies equally well to opportunities, requiring only minor adjustment.’ They support the suggestion that identifying opportunities is similar to identifying risks.

As consultants and in the PUS project cases, we observed the same patterns, threats, and opportunities handled in the same process. We also saw that opportunities were few and often not exploited, often 70–100 threats compared to 5–10 opportunities. Why are there so few opportunities? Is it likely that risks are many and opportunities are few in all projects? There are at least eight reasons to rethink the way we deal with opportunities in projects:

1. There is a lot more focus on threats or risk than opportunities in a typical uncertainty analyses process – considerably more time and focus is spent on the threats than on opportunities.
2. If stakeholders are asked about risks, they readily list their worries – the stakeholders have no problem relating the risk or threat to the project objective.
3. If a stakeholder is asked to identify opportunities, they often will have trouble identifying what could be considered an opportunity.
4. Opportunities are often linked to the consequences or benefits that projects should deliver to the owner or society, and not to project objectives.
5. ‘As planned’ is considered as the best outcome that the project manager can hope for – faster, cheaper, or higher quality than planned and at the same price is considered ‘unrealistic’ from the project manager’s perspective
6. The risk registers normally have a lot more threats than opportunities in most projects, less than 20% of the identified uncertainties are opportunities.
7. Reporting ‘top ten’ threats or risk is normal practice – opportunities are sometimes, but not always, reported in the ‘top ten’ list. Studies of project practices show that projects only to a small extent actively seeking opportunities in the execution phase (i.e. after the contracts with the main contractors have been signed).
8. The context may change and the project team may as the project progresses, hence it is likely that new opportunities will emerge.

Findings from the PUS research project clearly indicate that the project teams intended to focus on both opportunities and threats. In a Norwegian survey of large project organizations ((A. Johansen, Langlo 2013), in response to a question regarding the focus on uncertainty management in their projects, 76% responded that it was ‘mainly on risks, but also on opportunities’, 15% said they had ‘equal focus on threats and opportunities’, and just 7% responded that they ‘only focused on risks’. However, the intentions reflected in the survey results do not seem to have been reflected in the contents of the projects’ risk registers.

Since 2008, I have tested what happens in uncertainty workshops if we ask the participants what their opportunities are and then ask them to identify the threats, instead of asking what the uncertainty is. When we ask participants to identify their project’s uncertainty, we found a clear tendency for the mention of threats to come up in the discussion, typically at a ratio of 10:1, when comparing threats and opportunities. When the same question was asked in the execution phase of the project, hardly any opportunities were brought up. We therefore started to test what would happen if we started the uncertainty analysis process by identifying the opportunities first and then the threats.

We changed the lead question to the following:

*Please write down all the opportunities that this project should exploit during the project that makes the project better, cheaper, or faster, or opportunities that may arise after the project has been delivered/finished (as a positive effect of the project), and then please write down individually all threats that we should avoid or control.*

The adjustment of the process (i.e. asking for opportunities to be identified first), contributed to the identification of more opportunities or potential ideas that could improve the project deliverables or effect. Instead of 5–10 opportunities, there were 20–40 possible ideas that could be potential opportunities. However, we also observed some other rather interesting patterns. Participants in the uncertainty workshops had more or less the same view on what the threats and possible consequences were and they related the threats to objectives. When opportunities were discussed the picture was far more inconclusive or foggy.

When opportunities are addressed, the participants viewed them from their own roles. Ideas that were identified were not necessarily closely related to their project's objectives. Stakeholders often advised a change to solution, and typically they see new or better technology as an opportunity. Some stakeholders said there was no opportunity left after the contract had been signed, some talked about opportunities that were expected to arise as a result of the project, and some talked about how good execution, new technology, and so forth could make their project better, faster, or cheaper. Furthermore, stakeholders often had a tendency to describe what they wished for an opportunity were to occur. Typically, we could expect to find a mix of causes uncertainty elements, possible effects, ideas, and strategies for managing opportunities. It is therefore necessary to re-examine the different ideas to analyse and clean the data.

I observed that identifying and dealing with opportunities were closely linked to which stakeholders would gain or lose. This was a question of who would benefit from the project and who would benefit from the opportunity that a member of the group had identified. In the case of threats, it is often easy to see who will gain if the threats happen. However, it is often unclear as to when opportunities are debated and discussed in projects.

Exploiting opportunities often requires the project owner and the project management team to accept changes and to have the will and the power to change the solutions or deliverables described in the plans and in project management documentation. This is often a difficult task: to motivate change, the opportunity must be significantly better than planned solutions, because implementing an opportunity means that the project must use money and time to change plans or, in the worst case, the whole concept. Opportunities and change are closely related. It is not possible to secure an opportunity for the project without the willingness to change what was originally planned and signed for. This means getting an opportunity into the project demands willingness and authority from the project sponsor and project management, since both must disregard something that earlier in the process they had agreed upon as the best option or solution. This suggests that an opportunity has to be extremely interesting to be considered, because:

- the project must be willing to change contracts, concepts, and plans to exploit a possible opportunity
- the project must abandon something it had earlier accepted as the best solution



- the project must use time and money on exploiting something that is uncertain – it cannot be sure whether the effect will be positive or give benefits

Opportunities ought to be treated in a separate process. There are a lot of challenges involved in dealing with opportunities. The following questions may be helpful when attempting to understand why some stakeholders consider the project or change as an opportunity:

- Who will benefit when the project is executed?
- Who will benefit if the project objectives are delivered?
- Who will benefit if the market conditions become more favourable in the execution period?
- Who will benefit if the political climate becomes better or more favourable in the execution period?
- Who will benefit if the project changes goals or objectives?
- Who will benefit if the project becomes bigger (and costs more)?
- Who will benefit if the technical concept is changed?
- Who will benefit if new technology becomes available?
- Who will benefit if the local condition becomes more favourable?
- Who will benefit if the project gets better and needs more resources?

I also think that the techniques for identifying uncertainty and the tools for calculating and reporting uncertainty are fine in most projects, but the uncertainty management process needs to create more value for the stakeholder. This thinking corresponds with Cooper et al.'s ideas of using value engineering, which often has the effect that opportunities are identified and exploited (Cooper et al. (2005). We believe that exploiting opportunities is difficult and a different task compared to dealing with threats. We also believe that one of the keys to understanding opportunities lies in understanding how different stakeholders benefit from a change – What is considered as an opportunity for whom?

Analysing the chain of cause, uncertainty, and effect could be viewed as an easy task for an experienced project management team, but very often this is quite a difficult task. Different stakeholders can have different opinions on what constitutes the project objectives. To make the situation worse, some stakeholders will change their mind or acquire new ideas when the project is executed, and some stakeholders will be absent at the beginning of the project. We suggest that it could be smart to try to analyse how opportunities are linked to project goals and how this would affect the different stakeholders of the project, as shown in Table 20 who get the benefit and maybe who have to carry the responsibility for lack of goal attainment.

Table 20 Goals, causes, uncertainties (threats and opportunities), and possible effects (A Johansen, et al., 2012)

Goal project objectives	Cause Situation and possible consequence	Opportunities	Effect – Project’s view, project owner’s view, society’s view
<p>Who pays for the project (i.e. taking financial risk)?</p> <p>Who determines whether project objectives are accomplished?</p> <p>Which stakeholders get positive benefit from the project?</p> <p>Which stakeholders are likely to have a positive effect if the project is implemented as planned?</p>	<p>What positive effects occur for the project if the opportunity occurs?</p> <p>Which stakeholders get benefit if the opportunity occurs?</p>	<p>Improved solution: How can the measure be solved and what are the time and cost implications of the measure required?</p> <p>Adjusted solution: How can we avoid the threats and what will the measure costs us?</p> <p>How large is the probability that opportunity will occur if the measures we put in work as expected?</p>	<p>Society’s view</p> <p>What is the benefit for the society if the opportunity occurs?</p> <p>Project owner’s view</p> <p>What is the benefit for the owner in the production phase if the opportunity occurs?</p> <p>Project’s view</p> <p>What is the benefit to the project if the opportunity occurs? (i.e. how much time is saved, how much cost savings can the project anticipate that it is possible to achieve? Alternatively, how much better quality can we achieve at the same cost if the measure succeeds?)</p>

### 7.3 Opportunities and systems thinking

A project can be seen as a system. A system is basically unstable and flexible at the start of the project, and it tries to achieve stability and order through establishing objectives, sub-objectives and plans. This will reduce uncertainty in the system, and the system will gradually become more stable and controllable. Although the system will become more controllable when it passes from the early phase to the execution phase, it will also become more rigid, and the flexibility with respect to changes and adopting new opportunities in later phases of the project will therefore tend to diminish.

However, new opportunities can emerge at any time in a dynamic work environment. There can be new internal conditions (e.g. higher levels of competence, and effective resources and/or work methods) and new external conditions that the project did not consider when objectives and plans

were established (e.g. cooperation with new projects in the nearby area, which can lead to the project saving money by, for example, common procurement of new products in the market, which in turn can lead to the project simplifying its technical solutions). If these conditions are exploited effectively, the project can deliver the product or service with the predetermined quality at a lower cost, or quicker than previously expected. Active involvement, knowledge, and authority are required from the management in order to materialize the benefits of opportunities.

The understanding of how threats and opportunities are interpreted can be linked to benefit the different stakeholders receive during the project's life cycle. Different stakeholder will normally receive different benefit and the consequences (wanted and unwanted) of a project can also be seen in several dimensions. (Ekambaram A, 2013a) argues that projects can be seen three dimension related to the consequences.

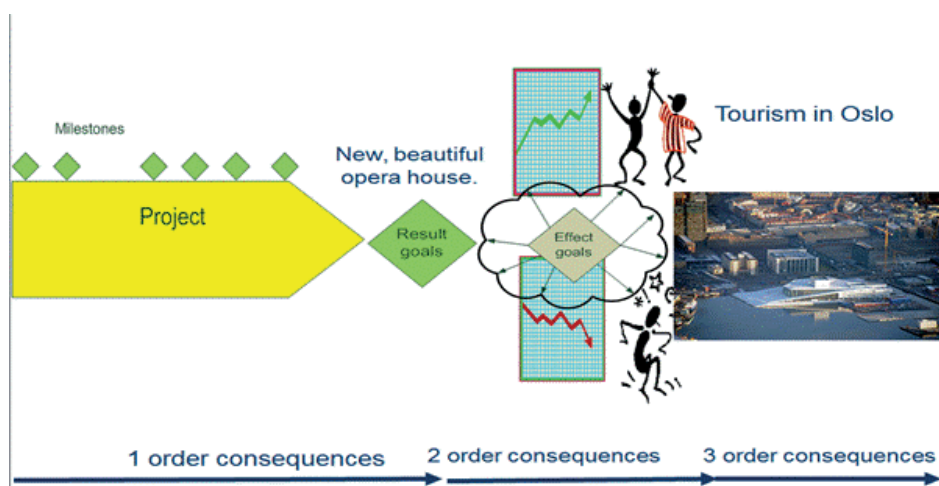


Figure 50 First, second, and third order consequences

Opportunities can be looked at with respect to different levels of consequences (see Figure 50). In addition, opportunities can produce effects and benefits for the stakeholders of a project. How an opportunity is viewed is dependent on the stakeholders; for example, a consequence of a project can be seen as positive by a stakeholder, while another stakeholder will view the same consequence negatively. The first order consequences emerge within the framework of the execution of a project and deliverance of the project's result objective, which focuses on time, cost, and quality. In this respect, opportunities are connected to achieving the project's result objective.

The second order consequences are the effects that emerge after the project is completed. These effects include benefits to the organizations that have been involved in the project, namely access to new markets and technology, developments in new knowledge, and increased competence within the respective organizations.

The third order consequences are the broader effects of the project on society. In this regard, opportunities encompass the establishment of new organizations and services as the result of the completion of the project.

In order to classify and describe opportunities in projects further, the following is a presentation of a classification of risks described by (Wideman, 1992). This classification is presented in Table 21.

Table 21 Wideman's classification of risk (Wideman, 1992)

<b>External Unpredictable</b> (and uncontrollable)	<ul style="list-style-type: none"> <li>A. Regulatory, i.e., unanticipated government intervention in:</li> <li>B. Natural Hazards, i.e., as a result of natural elements:</li> <li>C. Postulated Events, i.e., as a result of deliberate intent:</li> <li>D. Indirect Effects, i.e., occurring as a result of the project:</li> <li>E. Completion, i.e., failure to complete the project on account of one of the following:               <ul style="list-style-type: none"> <li>✓ Failure of the supporting infrastructure as a result of others</li> <li>✓ Failure of design, execution or supply contracts due to bankruptcy or receivership, etc.</li> <li>✓ Failure to provide financial support to the end of the project</li> <li>✓ Inappropriate project concept or configuration</li> <li>✓ Political unrest</li> <li>✓ Lack of final acceptance</li> </ul> </li> </ul>
<b>External Predictable</b> (but uncontrollable)	<ul style="list-style-type: none"> <li>A. Market Risks</li> <li>B. Operational (i.e., after project completion)</li> <li>C. Environmental Impacts</li> <li>D. Social Impacts</li> <li>E. Currency Changes</li> <li>F. Inflation</li> <li>G. Taxation</li> </ul>
<b>Internal -Non-Technical</b> (but generally controllable)	<ul style="list-style-type: none"> <li>A. Management, i.e., difficulties due to:</li> <li>B. Schedule, i.e., delays and time overrun due to:</li> <li>C. Cost, i.e., overruns due to:</li> <li>D. Cash Flow</li> <li>E. Loss of Potential, i.e., removal of:               <ul style="list-style-type: none"> <li>✓ Benefit</li> <li>✓ Profit</li> </ul> </li> </ul>
<b>Internal Technical</b> (and generally controllable)	<ul style="list-style-type: none"> <li>A. Changes in Technology</li> <li>B. Performance</li> <li>C. Risks Specific to Project's Technology</li> <li>D. Design</li> <li>E. Sheer size or complexity of project</li> <li>F. Legal (generally controllable)</li> </ul>

Difficulties arising from any of the following:

- G. Licenses
  - H. Patent Rights
  - I. Contractual i.e., difficulties due to:
    - ✓ Misinterpretation
    - ✓ Misunderstanding
    - ✓ Inappropriate contracting strategy/contract type
    - ✓ Failure
  - J. Outsider Suit
  - K. Insider Suit
  - L. Force Majeure
- 

The risk classification in Table 21 characterizes negative events or outcomes of the project. The use of terms such as difficulties, loss of potential, and natural hazards indicate that risks are unwanted negative outcomes and threats to the project. However, this classification appears to provide a framework that can also be used with respect to opportunities (both external and internal opportunities) in projects (A. Johansen et al., 2012b). Table 22 shows some examples of opportunities that can occur in the project period. These examples can be seen as first order consequences. Table 23 presents some examples of opportunities that arise after the project is delivered and/or finished. The list of factors has been developed based on a literature review and on an analyses of opportunities that have been identified in uncertainty analyses in the PUS project companies.

Table 22 First order consequences – opportunities in the execution of the project (A Johansen, et al., 2012)

Factors	From project start-up to project completion (delivering the result)
External factor: Market	New actors in the market – lower price in the bids than expected
External factor: Resources	More and better resources than planned <ul style="list-style-type: none"> <li>• Unexpected access to new resources</li> <li>• A big project ends in the mother organization</li> <li>• '58+': company's retired and/or older staff members</li> <li>•</li> </ul>
External factor: Owner priority	Easier access to key resources
External factor: Strategic alliance	Access to new methods or technology
External factor: Technology	New product with better performance New technology in the market Better management performance (than usual)
Internal factor: Management	Good planning process – decision-making Good execution More or better resources than planned or expected
Internal factor: Team performance	Better team performance <ul style="list-style-type: none"> <li>• More work done in less time</li> <li>• More/higher productivity than expected</li> </ul>
Internal factor: Design	More robust design that fits together with other solutions that the company has chosen
Internal factor: Technology	New product with better performance New technology in the market
Internal factor: Time	Less rework Faster execution than planned (better performance than expected) Faster deliveries of products than planned Faster deliveries of services
Internal factor: Cost	More money than expected from the owner Lower prices from the bidders Cheaper material – price of the material goes down Currency – cheaper than expected Inflation and taxation – more favourable than expected
Internal factor: Quality	Less mistakes (than usual) Less rework Fewer change orders (than usual)

Table 23 Second and third order consequences (A Johansen, et al., 2012)

Project owner/company: Opportunities as second order consequences – effect and functionality with respect to the company	Society effects: Opportunities as third order consequences
<p>Strategic</p> <ul style="list-style-type: none"> <li>• Strategic alliances with new companies</li> <li>• Open up new market areas</li> </ul> <p>Better performance</p> <p>Better functionality than expected</p> <p>Higher volume</p> <ul style="list-style-type: none"> <li>• more gas or oil for a longer period</li> </ul> <p>Longer duration of the end product than expected</p> <p>More robust technical solutions</p> <ul style="list-style-type: none"> <li>• fewer maintenance costs</li> <li>• easier to fix</li> </ul>	<p>New jobs in the area</p> <p>More tourists</p> <p>Less pollution</p> <p>Lower carbon footprint</p> <p>Less traffic in the area</p> <p>Less noise</p> <p>Better service (medical)</p> <p>Fewer accidents (traffic)</p> <p>Shorter travelling time (traffic)</p>

Data from the PUS project suggest that the role and position of the participants in the uncertainty analysis process had a huge impact on which opportunities were identified, on which opportunities their project considered for exploitation, and on which opportunities their project actually exploited.

The project owner’s perspective (which also incorporates the views of the project manager, who primarily focuses on cost, time, and quality of the project) provides a broader understanding of managing uncertainty in projects through the cooperation between the project manager and project owner. This perspective can be helpful to understand important aspects that influence a project (including aspects that lie outside the realm of traditional project management), as well as interrelations between the aspects. Thus, this understanding can pave the way to identify and make use of opportunities in projects in a more effective manner.

However, in many projects it can prove quite difficult in practice to exploit opportunities as the project progresses. At the beginning of projects, both the project owner and the project manager will have high degree of focus on opportunities and a low degree of focus on threats. A project itself can be seen as an effort to materialize one or more opportunities. However, at the later stage, the project manager tends to focus highly on threats and little on opportunities. At the later stage, the project owner is expected to have a high degree of focus on both opportunities and threats. However, in common with project managers, some project owners will focus highly on threats and little on opportunities at the later stage. This condition will create a ‘blind spot’, which indicates potential opportunities have been missed (Johansen et al., 2012a). To be aware of this ‘blind spot’ and deal with it effectively will improve the efforts towards managing opportunities as well as uncertainty.

There is a clear connection between creativity and/or innovation and the topic of opportunities in projects. It can be said that creative and innovative thinking can promote the identification and creation of opportunities in projects. In this regard, it is relevant to consider Hillson’s statement:

techniques designed to stimulate or support creativity and innovation are well suited to encouraging organizations to think positively, see opportunities, and develop strategies to capture benefits. (Hillson, 2004, p. 256)

Brainstorming, scenario thinking, and creation of artificial crises are some of the methods that can be used to promote creative thinking to identify and create opportunities in projects. These methods were applied by the organizations involved in our research study of uncertainty in projects (Agnar Johansen, et al., 2012; A. Johansen, Langlo 2013).

Innovative and creative thinking in organizations can also be encouraged by identifying and creating opportunities, materializing them, and harvesting the benefits of them (Ekambaram, Johansen, Jermstad, & Økland, 2010). Further, the topic of opportunity in projects can contribute to the wider management field. The focus on opportunities can influence the creation of an organizational culture that promotes innovation and creativity. Uncertainty can thus be seen as a potential source for generating opportunities, not as a condition that exclusively deals with threats. The lessons and experiences of how uncertainty is managed in projects can be transferred and/or transformed in order to generate positive effects in wider organizational settings.

#### 7.4 Cooperation between project managers and project owners

Having a broader perspective on managing opportunities in projects is both beneficial and necessary. The broader perspective can be developed by establishing good cooperation between project managers and project owners, with a strong degree of involvement from project owners.

The project manager focuses on achieving the result objective of the project, in accordance with the predefined time, cost, and quality (first order consequences), whereas the project owner focuses on ensuring the effect objective as well as the society objective (second and third order consequences).

Project managers and project owners traditionally deal with two types of information: project managers deal with detailed information (mainly projects' internal conditions, i.e. operational aspects), whereas project owners deal with general and/or high-level information (mainly projects' external conditions, i.e. tactical and strategic aspects). Establishment of a common understanding by combining and studying these two types of information could lead the involved parties to identify and/or create opportunities effectively in projects. However, cooperation between the project owner and the project manager is not always a problem-free affair. The project owner and the project manager can have differing understandings of opportunities, with regard to what opportunities are and how they can be used in order to improve the result objective, effect objective, and society-objective.

Although there are challenges with respect to communication and attitudes, companies take certain measures in order to tackle such challenges. A study conducted in the Norwegian telecommunication sector (conducted by the PUS project) revealed that training programmes exist in which project owners and project managers learn about their roles, their responsibilities, and what they can expect from each other. After the training programmes, the studied project managers seemed to notice improvements in project owners' behaviour and in the collaboration within the project team. Such training programmes can be seen as arenas for reflecting on action and making sense of various situations.



7.5 How good is the theory and how good are projects at identifying and managing uncertainty in practice?

Current practice shows that many of the challenges found from studying state-of-the-art literature have just partly been met in Norwegian projects. In most of the projects that I have studied since 2006, only the challenge of avoiding risk or threats has been well met in. The literature review conducted as part of research for this thesis revealed that risk management has been in focus for many years and that many uncertainty theories have been developed since the 1950s. Risk is covered in several project management standards and many generic and specialized textbooks provide guidelines for uncertainty analyses and risk management, yet uncertainty management is not as well defined in the PM standards and literature.

Hillson and Simon (2012), who developed the ATOM framework, as well as Chapman (1997) suggest that that risk management should deal with opportunities and threats, and were later supported by (Hillson, 2002; Husby, et al., 1999). The Norwegian approach to uncertainty analysis and managing uncertainty is illustrated in Figure 52.

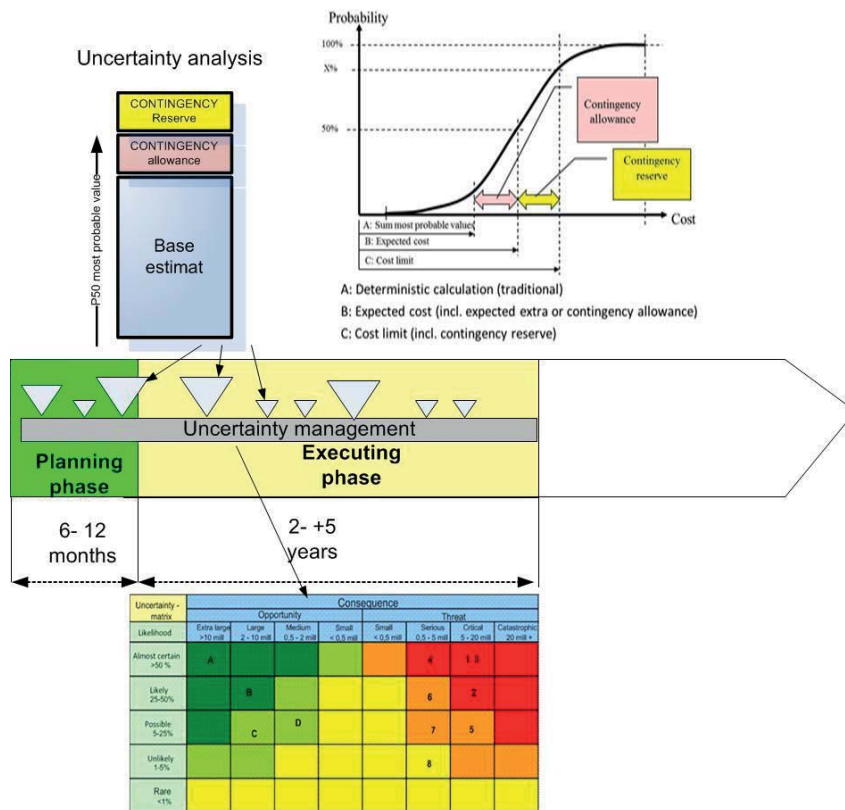


Figure 51 The Norwegian approach to uncertainty analyses and management of uncertainty

Our data from the PUS companies show that most of the companies did two or three cost analyses during the planning phase, and the last uncertainty analysis was closely connected to setting the project budget and cost target for the project. In the execution phase, the uncertainty was normally

followed up by annual analyses, and all of the PUS companies had some type of shorter, monthly updates of the uncertainty, and all five out of the six companies had some type of register for following up the uncertainty.

Our study findings show that the private sector and public sector cases had more or less the same focus on threats. They also show that the private sector projects we studied were not better at exploiting opportunities than the public sector projects. Opportunities and change are closely related. It is not possible to get an opportunity into the project without the willingness to change what was originally planned and signed for. This means getting an opportunity into the project in the project team demands willingness and authority from the project sponsor and project management, since both must disregard something that earlier in the process they had agreed upon as the best option or solution. This suggests that an opportunity has to be extremely interesting to be considered, because:

- The project must be willing to change contracts, concepts and plans to exploit a possible opportunity
- The project must abandon something they earlier accepted as the best solution
- The project must use time and money on exploiting something that is uncertain – it cannot be sure whether the effect will be positive or give benefits.

Our empirical data shows that exploiting opportunities often requires the project owner and the project management team to accept changes and have the will and power to change the solutions or deliverables described in the plans and in project management documentation. It is often a difficult task to motivate changes of plans in projects. The opportunities must be significantly better than planned solutions, because implementing an opportunity means that the project must use money and time to change its plans or, in the worst case, the whole concept. Our data indicate that many projects are conservative to new ideas and change, and that most projects do not seek new opportunities in the execution phase. In the uncertainty processes and projects that we have been a part of, we have observed a low degree of willingness to do something about identified opportunities.

Some authors suggest that dealing with opportunities is more or less the same as dealing with threats, and that there is no need for a separate process (e.g. Cooper et al., 2005; Hillson & Simon, 2012). We have argued that dealing with opportunities requires a different mindset and that most project managers still tend to spend most of their time on identifying and avoiding threats when managing uncertainties (Ekambaram, 2013; Johansen et al., 2014). In the following, short discussion scenarios are introduced to explain why so many projects tend to neglect opportunities.

Different stakeholders will normally receive different benefits from a project, and the consequences (wanted and unwanted) of the project may be considered in several dimensions. A benefit could be defined as a positive attribute that stakeholders acquire during or after the project is delivered and that is not related to value. For example, a society might benefit from a new road on which fewer accidents occur or the transportation of people and goods is improved due to fewer queues. However, the road could also create value in terms of road tax, whereby all road use would have to pay a certain amount of money to the owner.

Value, too, can be connected to the process of building of the new road. For example, if a project can choose between two types of bridges, both of which satisfy the objective, the one with the lowest price will normally be considered the one with the highest value seen from a project owner's perspective. We would argue that some of the difficulties related to securing opportunities in a project are related to the fact that project owner and the project manager have different opinions on what is the value and what is the benefit for the stakeholders.

Identifying new opportunities, deciding on which opportunities are is worth analysing, and/or which opportunities to exploit are not easy tasks. We have created a small framework for analysing uncertainty, considering opportunities from three different views:

- Project view: What is the value to the project if the opportunity occurs (i.e. how much time is saved, how large are the cost savings likely to be, and what degree of quality may be achieved at the same cost if the measure were to succeed?)
- Project owner view: What is the value and benefit for the owner in the production phase if the opportunity occurs?
- Society view: What is the value and benefit for society if the opportunity occurs?

Value and benefit have to be balanced against the economic consequences in terms of the time and resources that need to be spent in order to exploit the opportunity (see Figure 52).

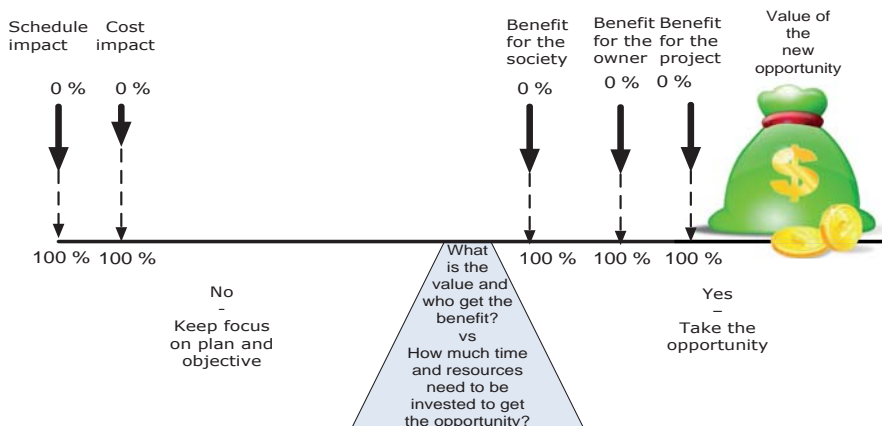


Figure 52 What is the value and who benefits?

Opportunities and change are closely related. It is not possible to exploit an opportunity without willingness to change the original plan. This means that bringing an opportunity into the project requires willingness and authority from the project sponsor and project management, since both must disregard something that earlier was agreed upon as the best solution. This suggests that an opportunity has to be extremely interesting to be considered, because:

- The project must be willing to change contracts, concepts, and plans to exploit a possible opportunity.
- The project must abandon something it had earlier accepted as the best solution.

In cases where the project cannot be sure whether an effect will be positive or beneficial, it will have to spend time and money on exploiting something that is uncertain.

The starting point for exploiting an opportunity is a decision-making scenario where a new idea emerges that requires, at least to some extent, abandoning an investment in time and money. How much better must the new idea be, in terms of risk and opportunity, in order for it to be likely that the project will pursue it? (See Figure 53)

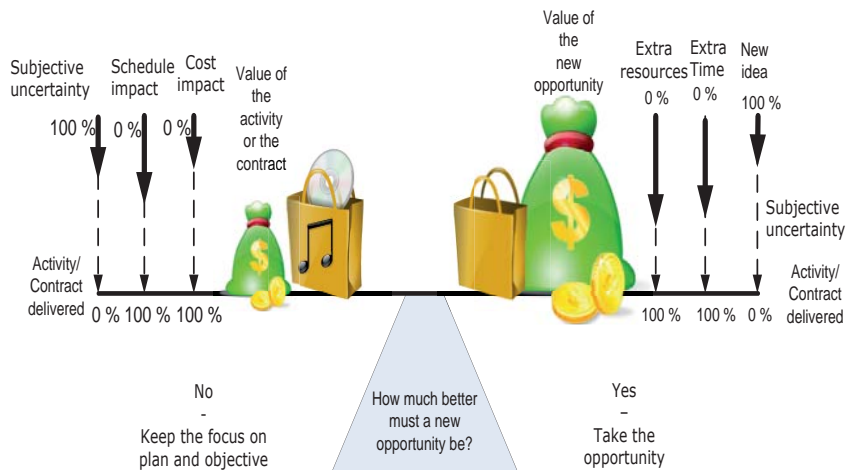


Figure 53 How much better must a new opportunity be?

While it is of course impossible to determine exactly how much better must a new opportunity be in order for it to be likely that the project will pursue it, we think the threshold is quite high because:

1. Losses from work already done must be abandoned ('sunk costs')
2. Effort is required to determine the value of the opportunity
3. Effort is required to replan the work to the same level of detail as the existing plan (without exploiting the opportunity)
4. There will be uncertainty as to whether the new opportunity will succeed, and who will share the additional benefit.

#### Decision scenario example

In a hypothetical project with an assumed value (for the owner) of USD 10 million, the project is one month into planning, and has spent USD 10,000, and the uncertainty of the cost estimate is 90% (i.e. there is a minimum value for the owner of USD 9 million). During an uncertainty workshop, an idea that looks like an opportunity arises that some believe could provide an additional 50% in value for the owner over the current concept. This would change the assumed value to USD 15 million if it were to succeed (and assuming that both the estimation of the original value and estimation of the opportunity value are correct).

The following decision scenario is from the project manager's point of view:

1. Loss of 1 month of planning work at a cost of USD 10,000
2. Some work in order to determine the value of the opportunity and replan. In the worst case estimated to 1 month of replanning (i.e. it requires a complete replan to reach the same level of detail as the original plan), at a similar cost of USD 10,000.
3. If the probability of success is estimated to 50% (i.e. the classic estimation from a risk register), the new value (P50) based on probability  $\times$  consequence will be USD 7.5 million (P50%  $\times$  the new value of USD 15 million).

The conclusion will be a sunk cost of USD 10,000 for the original plan (1), additional cost of USD 10,000 (2), and a new expected value of USD 7.5 million (3), which is USD 2.5 million lower than the original plan. No rational project manager would recommend such a change. The probability of success would need to be in excess of 60% before a change would be beneficial for the project managers. Alternatively, the additional value would have to be 80%+ under 50% uncertainty, if both the project manager and/or owner accepts a cost of USD 20,000 for pursuing the opportunity. Again, this highlights that the evaluation of opportunities solely from a single project management perspective requires quite significant rewards and a high degree of confidence in order to be exploited.

It is not an easy task to assess how the different stakeholders will interpret opportunities. It is therefore necessary to be aware of how their role, experience, and personality will affect assessments of opportunities. The stakeholder's responses are often linked to the reward system and how participants will be held accountable. Hence, in order to find and exploit opportunities in the project, our recommendation is to separate the opportunity process from traditional risk management process. Our suggested solution is presented in Paper 3 'Uncertainty management – A methodological framework beyond 'the six Ws' (A. Johansen, Halvorsen, et al., 2014), and in Chapter 8 of this thesis.

#### 7.6 Contribution to research

Findings from the PUS research project (which studied uncertainty management in projects) clearly indicate that the studied project teams intended to focus on both opportunities and threats. However, the degree of focus varied (Hald et al., 2008). In a survey conducted in 2010 as a part of the PUS project, in response to a question regarding the focus on uncertainty management in their projects, 76% responded that it was 'mainly on risks (threats), but also on opportunities', 15% said they had 'equal focus on threats and opportunities', and just 7% responded that they 'only focused on risks (threats)' (A. Johansen, Langlo 2013)

Our empirical data show that exploiting opportunities often requires the project owner and the project management team to accept changes and have the will and the power to change the solutions or deliverables described in the plans and in project management documentation. It is often a difficult task to motivate project managers to make changes in project; the opportunity must be significantly better than the planned solutions, because implementing an opportunity means that the project must use money and time to change plans or, in the worst case, the whole concept.

Many projects are conservative to new ideas and change, and do not seek new opportunities. Opportunities will normally be identified in an uncertainty analysis workshop, but that does not

mean that the participants will actually utilize the opportunities after the workshop is over. Rather, little willingness to actually do something with identified opportunities has been observed.

Many projects do not want to consider new opportunities. They may consider the list of opportunities as a gamble, because it means that they need to change the process or concept, and it may be a gamble because the project management team will not receive payment or will not benefit from the changes. Opportunities and change are closely related. It is not possible to get an opportunity into the project without some willingness from the project manager or the project owner to change what was originally planned and signed for. Getting an opportunity into the project demands willingness and authority from the project sponsor and project management, since both must disregard something that earlier in the process they had agreed upon as the best option or solution.

This suggests that an opportunity has to be extremely interesting in order to be considered, because:

- The project must be willing to change contracts, concepts, and plans to exploit a possible opportunity
- The project must abandon something it had earlier accepted as the best solution
- The project must use time and money on exploiting something that is uncertain – it cannot be sure whether the effect will be positive or give benefits.

Ideally, opportunities should be treated in a separate process or at least be the first step or process in the uncertainty analysis work shop.

The techniques for identifying uncertainty and the tools for calculating and reporting uncertainty are starting to become quite sophisticated. However, the uncertainty management process needs to create more value for the stakeholders. Securing benefit from the opportunities is closely linked to the understanding that it benefits the different stakeholders. This also corresponds with (Cooper, et al., 2005) ideas of using value engineering, which often has a similar effect to the effect of identifying and exploiting opportunities.

## 8 Practical uncertainty management – nine-step framework for identifying, analysing, and managing uncertainty

Uncertainty management in projects has primarily been based on isolated uncertainty analyses. The analyses have been carried out sequentially, where analyses and follow-up are done, but there are often quite long time intervals between the analyses. The questions based on ‘the six Ws’ have been central in uncertainty management. The drawback of using this method to manage uncertainty is that it only gives individual snapshots in time for the project.

In this chapter I present the practical uncertainty management nine-step framework for identifying, analysing, and managing uncertainty during the project’s different phases.

This chapter is based on the following papers:

- Paper 1 – ‘Uncertainty analysis – 5 challenges with today’s practice’
- Paper 2 – ‘Stakeholder benefit assessment – Project success through management of stakeholders’
- Paper 3 – ‘Uncertainty management – A methodological framework beyond ‘the six Ws’’
- Paper 8 – ‘Improving uncertainty management in projects by collaborating in an inter-organizational research project’

### 8.1 Nine-step framework for identifying, analysing, and managing uncertainty

A project will normally deal with different types of decisions with different types of uncertainty during the planning phase and execution phase. At the beginning the focus is on selecting the best concept and clarifying the project objectives. When this is sorted out the focus shifts to how to deliver the chosen concept according to specification or contract. This means that project members or project consultants hired to deal with uncertainty management in the project need to understand where the project is in the execution process and to focus the process on the specific uncertainties in the process that are relevant for next three to six months of the project execution period. We (Johansen et al., 2014b) therefore suggest that a project needs to deal with uncertainty in all phases and we believe that most projects need to deal with different types of uncertainty in their different phases (See Figure 54).

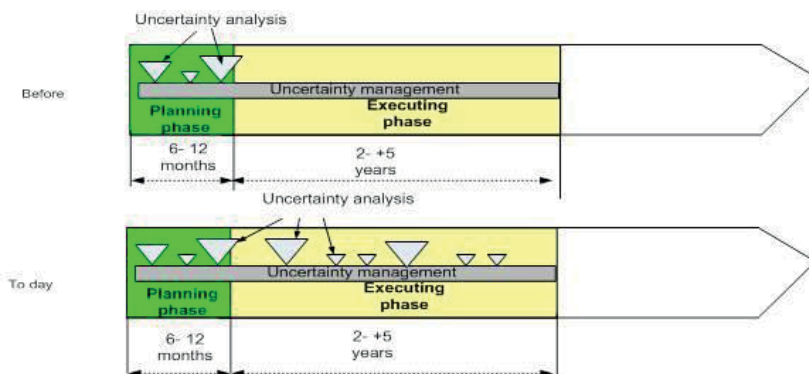


Figure 54 Uncertainty analyses (UAs) during the project life cycle (A. Johansen, Halvorsen, et al., 2014)

I have suggest a 9-step framework for identifying, analysing, and following up project uncertainty: Steps 1 and 2 are for preparing the process, Steps 3–7 are for group processes (workshops) for identifying, analysing, and developing measures for exploiting or controlling the uncertainty, and the final steps, Steps 8–9, are for following up the uncertainty during the project life cycle.

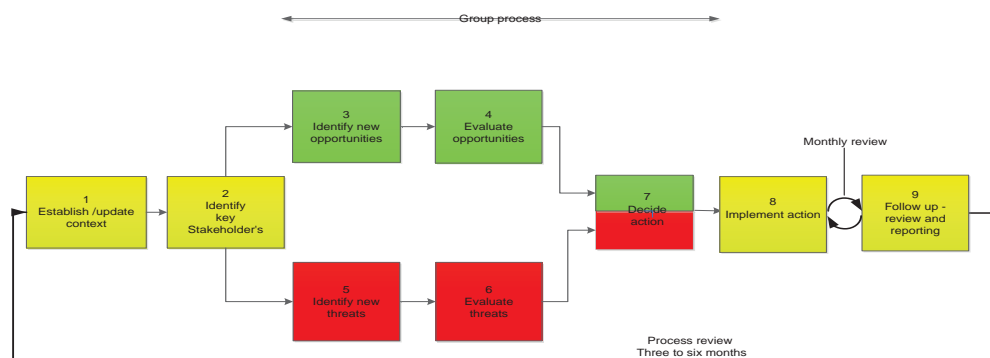


Figure 55 Practical uncertainty management – 9 step framework (A.Johansen, Halvorsen et al.,2014)

The purpose of the processes is fourfold: establish and update the project objectives and key stakeholders that ‘own the objectives’:

1. Identify – evaluate and decide action on the opportunities
2. Identify – evaluate and decide action on the threats
3. Implement and follow-up the actions from the UA workshop.
4. Decide when the process should be executed?

In a 3–5 year project, we recommend at least that between five and eight uncertainty workshops are held during the project duration. The duration of the workshop will typically vary between two and four hours to two days, depending on the size of the project and the subject or topic to be analysed in the process. I suggest that the UA process needs to focus on uncertainty for the next three to six months ahead, as well as on the more overall uncertainty connected to the project objectives and benefits for the project owner (second order consequences) and the society effects (third order consequences). I also suggest that follow-up and reporting should be done every month and a more overall assessment of the uncertainty should be done at least once or twice per year.

Typically, stakeholders that would participate in the UA workshop would be: the project owner or sponsor, the project manager and his or her team, and the project consultants, and in some rare cases, the contractor and representatives of the end user will participate. For a large or more complex project this process would often be led by a facilitator team, consisting of a facilitator that would ‘lead’ the process and a colleague who would take care of the documentation of the process. The persons responsible for following up and controlling the effect of the action between the UA workshops would normally be the project management team and the project owner’s representatives.



## 8.2 Practical uncertainty management – step by step

The nine-step framework for identifying, analysing, and following up the project uncertainty is illustrated in Figure 47. Steps 1–2 prepare the process, Steps 3–7 identify and analyse the uncertainties, and decide on actions, and the final two steps (8 and 9) follow up the uncertainties during the project life cycle.

### **Establishing the context: project objectives – key deliverables (Step 1)**

In most projects, people aim to decide on clear and unambiguous objectives in the planning phase. The reason for this is simple: ‘you need to know where you will end (i.e. your destination) before you start your journey towards your destination’. However, it is important to understand that the objectives are less neutral and explicit when a project is started. The objectives will typically implicitly contain the intentions of what the project owner or society wants to achieve through the project within the time and cost limitation set by the owner. What specifically will be delivered in terms of result-oriented goals or objectives will often have limited levels of detail, and usually will be further refined and developed over quite a long period lasting into the planning phase. In addition, the objectives will often be perceived differently depending on the point of view regarding the project. The project owner will often tend to be more concerned about the effect-oriented goals and how well the project results can fit with a (carefully defined) business case. By contrast, the project manager and the project team members will focus more on the result-oriented goal and the key deliverables. Finally, future users will typically represent parts of the social perspective, and be concerned about whether the project delivers the parts of the functionality that they have requested. In addition, project participant’s interpretation and assessment of the actual formulation of the objectives clearly varies according to whether the participant was involved in the development of the objectives. There is no contradiction between aiming for good and clear goals and acknowledging that the goals can be adjusted or changed during the course of a project. Project goals are uncertain, yet how one chooses to deal with uncertainties is a central issue when it comes to a project’s esteem and to its success.

### **Stakeholder analysis – step by step (Step 2)**

Several authors (e.g. Cooper et al., 2005; Torp & Johansen, 2004) have suggested that stakeholders should be analysed in the project start-up. Cooper et al. (2005) stress that a stakeholder analysis should provide a document profile of the most important stakeholders’ needs and concerns, and that involves considering the objectives of each stakeholder in relation to the requirement. (Hillson & Simon, 2012) state that stakeholder analysis is a process of determining the degree of interest, influence, and attitude that stakeholders have towards a particular project. Johansen & Torp Nordnett (2004) suggest a five-step approach to analysing project stakeholders:

1. Identification – who are stakeholders or customers of the project deliverables?
2. Group stakeholders into primary and secondary stakeholders – Who is most important?
3. Role clarification – What type of role do the stakeholders have in the project?
4. Effect of the project – What effect does the project have on the stakeholders?
5. Evaluation – How does the analysis impact further development in the project?

(Artto K., 2011) describe dealing with stakeholders as a more ongoing process and emphasizes that managing stakeholder relationship lasts from the beginning to the end of the project. Managing

stakeholder relationships can be seen as a continuous and repetitive development that consists of, among others, the following subtasks:

1. Identifying stakeholders
2. Collecting information on stakeholders
3. Identifying the tasks and roles of stakeholders
4. Understanding the strengths and weaknesses of stakeholders
5. Determining a stakeholder strategy.

(Hillson, 2004) recommends a process that identifies three dimensions of each stakeholder:

- Their attitude toward the project – either supportive or resistant
- Their power to influence the project for better or worse
- Their level of interest in the project and its success or failure.

#### **Identifying the relevant opportunities and threats (Steps 3–6)**

In projects, opportunity can have several interpretations. One possible interpretation is that the project itself is the opportunity and the desired change or effect for the stakeholder is what we should consider an opportunity. Another way to look at opportunities is as factors, variations, or events that make the project objective better than originally planned. It could be said that it is possible to talk about opportunities as some solutions that were not seen at the beginning, as something that just occurred, as something positive that could be foreseen, or as something that is more or less beyond our control but is still positive, or favourable, or better compared to the original plan and or concept. For most people, the term threats is easier to understand and relate to, and can be defined as factors, variations, and events that may lead to undesired changes to the project objective, scope, resources, or frame conditions, that in turn make the project cost more, spend more time, or deliver lower quality than what was agreed upon at the beginning of the project. When an uncertainty analysis session is about threats, it is normally quite easy to persuade the participants to come up with events or factors that could go wrong or say what they are worried about.

We therefore suggest that opportunities need special attention and that the process should always start with identifying and analysing the opportunities, and then deal with the potential threats. To identify the opportunities and threats, brainstorming is a suitable technique. Also other techniques, such as checklist of typical uncertainties, interviews held with experts (the Delphi method), and situation maps could be used in the first identifying round. The purpose of the exercise is to bring all the opportunities and threats to the table so that they can be discussed and managed by the project. The second round of the workshop is about determining the potential positive or negative consequences for the owner of the project if the opportunities pay off or the threats occur. In this part of the UA workshop, the participants should try to estimate briefly the potential positive or negative effect for the owner or for the project in the execution phase: What is the potential saving or acceleration effect if the opportunity happens? What is the potential negative effect if the threat happens, in terms of cost consequences or delay? Then, the participants should estimate the likelihood that the potential opportunities or threats will occur, in terms of ranges of likelihood: 'almost certainly' > 50%, 'likely' 25–50%, 'possible' 5–25%, 'unlikely' 1–5%, and 'rare' < 1%. In the process, we recommend that the participants should spend as little time as possible debating

likelihood and consequence of the potential opportunities and threats. The whole idea behind the exercises is to identify the opportunities and threats that will matter most in terms of project success, which means finding the opportunities and threats with highest consequences and highest likelihoods and then spending time together to decide on actions to ensure that the most important uncertainties are dealt with in an effective way.

**Implement action: uncertainty matrix and focus list – examples of tools for managing uncertainty (Step 8)**

The end result of the process is a ‘top ten’ list of the most important quantitative and qualitative uncertainties. The list should include the 3–5 best opportunities and 5–8 most important threats for the upcoming 2–6 months. The basis for the list is found by multiplying probabilities and consequences. The uncertainty with the highest number would be at the top of the list. These opportunities and threats should be placed in an uncertainty matrix, as shown in Figure 56 , to illustrate which uncertainties need special focus. We recommend letters for opportunities and numbers for threats, to distinguish them easily. The reason for this is that more than 29 opportunities are rare, but in large projects more than 50 threats are quite common.

Uncertainty - matrix	Consequence							
	Opportunity				Threat			
Likelihood	Extra large >10 mill	Large 2 - 10 mill	Medium 0.5 - 2 mill	Small < 0.5 mill	Small < 0.5 mill	Serious 0.5 - 5 mill	Critical 5 - 20 mill	Catastrophic 20 mill +
Almost certain >50 %	A					4	1, 3	
Likely 25-50%		B				6	2	
Possible 5-25%		C	D			7	5	
Unlikely 1-5%						8		
Rare <1%								

Figure 56 Uncertainty matrix

The last part of the uncertainty workshop is about deciding what type of strategies should be used to deal with the opportunities and threats. Several literature sources (e.g. PMBOK, 2000; Hillson, 2004) point out that there are at least six or seven strategies could be chosen for managing uncertainty. The possible strategies are listed in Table 24.

Table 24 Strategies for uncertainty management response – opportunities and threats

Opportunities	Threats
Exploit	Avoid
Share	Transfer
Enhance	Mitigate
Accept	

When the strategy is chosen, the action that is agreed upon should be specific in terms of who is responsible and when should the action take place, and when and how the effect should be controlled.

**Follow up – review and reporting (Step 9)**

Dealing with uncertainty means implementing the chosen strategies in the project and dealing with the opportunities and threats that project faces in the next two to six months. We suggest that the project should follow up the uncertainty on a monthly basis. After one month, the project management team should ask the following 10 questions:

1. Which of the opportunities and threats no longer have any value (delete them from the matrix)
2. Which of the opportunities are still possible?
3. Have there been any new opportunities since the last update of the matrix?
4. What is the possible value and likelihood of the new opportunities? (introduce them into the matrix)
5. How should we deal with the new opportunities? (find new actions and assign responsibilities, and agree on the control date for the new opportunities)
6. Check existing opportunities – Has the action made them more likely or given them a new value? (change their position in the uncertainty matrix)
7. Have there been any new threats since the last update of the matrix?
8. What is the possible value and likelihood of the new threats? (introduce them to the matrix)
9. Check existing threats– Has the action made them more likely or given them a new value? (change position in the uncertainty matrix)
10. How should the new threats be dealt with? (find new actions and assign responsibilities, and agree on the control date for the new threats).

The last part of the process is to maintain the focus list and the uncertainty matrix. After a second round of the process, the revised uncertainty matrix may appear like the one shown in Figure 57.

Uncertainty - matrix	Consequence							
	Opportunity				Threat			
Likelihood	Extra large >10 mill	Large 2 - 10 mill	Medium 0.5 - 2 mill	Small < 0,5 mill	Small < 0,5 mill	Serious 0,5 - 5 mill	Critical 5 - 20 mill	Catastrophic 20 mill +
Almost certain >50 %	<del>A</del>	E				(4)	<del>1</del>	
Likely 25-50%		B	C		4	<del>6</del>	2,10,11	
Possible 5-25%		(C)	D			7	5, 9	
Unlikely 1-5%						8		
Rare <1%								

Figure 57 Revised uncertainty matrix – one month later in the project

### 8.3 How should the changes in the matrix be interpreted?

In the situation shown in Figure 56, Opportunity A and Threats 3 and 6 are no longer considered important. This may be because the project has checked them in more detail and found that it is not possible to take the opportunity. The project may also have taken such actions that it no longer considers that Threats 3 and 6 will happen. However, it could also mean that the effect has occurred and the project has already benefitted or that the negative effect has occurred: it is no longer an uncertainty, but a fact, and the project knows that it has to spend time or money on the event. New opportunities or threats, such as Opportunity E and Threats 9, 10, and 11 will be introduced into the matrix for the first time, and these are illustrated with a different colour to make it clear to everyone which ones are new this month. Opportunity C and Threat 4 have a changed status in the matrix. The project has carried out actions to reduce the uncertainty, and it now believes that the status should be changed to a different position in the matrix. This means that, according to the project staff, Opportunity C and Threat 4 are less likely to happen. If C pays out, the project might save more money, and if 4 occurs, it might lose less money.

### 8.4 Discussion – from uncertainty analysis to uncertainty management

I have presented a framework for projects that have a high level of uncertainty during the project's life cycle. The suggested framework for uncertainty management consists of two steps for preparing the process, a five-step group process for identifying, analysing, and developing measures for exploiting or controlling the uncertainty, and two steps for following up the uncertainty during the project life cycle. There are three elements of particular importance if a project wants to implement practical uncertainty management: the human factor, models and tools, and method or methods.

The *human factor* is an important part of the practical uncertainty management method. The right people need to be involved in the process and a cross-functionality is very often a 'must' for understanding and dealing with uncertainty. If an organization has good methods and models for managing uncertainty, it will not work properly without key actors that know how to manage uncertainty in projects. The organization culture needs to have actors who believe in the processes, which means actors with competence, experience, and certain attitudes towards uncertainty management. Such actors are not just internal project workers, but also external stakeholders of the projects that need to be enrolled in the processes.

The organization needs an overall *model and tools* for uncertainty management. It is also important that the organization is open regarding the processes. Uncertainty should be considered in all project phases, and dealing with uncertainty must be an ongoing process and have a different focus during the project life cycle. The model has to include both operational uncertainty and contextual uncertainty.

Figure 58 shows a framework for living uncertainty. It consists of nine steps with different types of tools to assess and analyse uncertainty. We believe that *methods and models* should be as simple as possible, and that the action matters – simple spreadsheets and flipcharts are often enough for identifying, analysing, and dealing with the uncertainty in most projects.

A project will normally deal with different types of decisions with different types of uncertainty during the planning phase and execution phase. At the beginning, the focus is on selecting the best concept and clarifying the project objectives. When this is decided, the focus shifts to how to deliver the chosen concept according to specification or contract. This means that project members or

project consultants hired to deal with uncertainty management in the project need to understand where the project is in the execution process and focus the process on the specific uncertainties in the process that are relevant for the next three to six months of the project execution period. We therefore propose that a project needs to deal with uncertainty in all phases and that most projects need to deal with different types of uncertainty in the different phases.

#### 8.5 What are the steps if a company wants to implement 'living uncertainty management?' in their projects?

In response to the above question, my recommendation would be the following seven steps.

##### **Step 1: Start by defining models and method**

Most of the guidelines with models and methods on uncertainty management need some adjustments to the context and the company-specific requirements. The organization of uncertainty management in a multimillion project as opposed to a small project with a few stakeholders can be two completely different tasks. Guidelines are good practices that fit many project or they are standardized company-specific recommendation, orders, or demands from the top management of a company. However, it is important to recognize that guidelines are just 'guidelines' and they are not laws that should be followed blindly. Adapting generic guidelines without knowing the background of the recommended practice or the background to the demands is not a necessarily a very good idea. Spending some time defining the needs in the company and then adjusting generic models or, even better, developing a company-specific model and method are therefore recommendable. Most companies need to discuss what types of uncertainty analyses are needed based on the project type (i.e. runners, repeaters, or strangers), typical duration, complexity, and size of the projects in the project portfolio. The company should conclude how many uncertainty analyses a typical project needs and how often they should be updated in different types of projects. It should also define how the results of the analyses should be documented, and discuss how they should be followed up by the project and the project owner.

##### **Step 2: Identify and choose the right tools**

Many descriptions of practical tools and how they should be used have been developed (see for example, [www.prosjektnorge.no/index.php?subsite=pus&pageId=427](http://www.prosjektnorge.no/index.php?subsite=pus&pageId=427)). By starting with the use of simple tools, the project management team will be able update the uncertainty. I would argue that in most projects a simple tool is better than one that can only be understood and used by an expert.

##### **Step 3: Define roles and responsibility in the organization and in the project**

Defining clear responsibility and roles in the company and in the project are an important part of what is necessary to succeed with 'living uncertainty management'. The company must decide the following:

- Who will train the project manager and the uncertainty manager?
- Who will guide and help the project management team in starting up the uncertainty management?
- Who will give support on the use of the tools?
- Who will check whether the tools and process are used as expected and recommended?

**Step 4: Hold two short introductory training sessions or courses – one on how to do uncertainty analysis and one on how to do uncertainty management**

Two introductory training sessions or courses should be mandatory for all project managers and all persons with the role of uncertainty managers in projects.

**Step 5: Start following up all project regarding opportunities and threats**

A project progress report that also reports on uncertainty should be made. Start to demand that project should identify and follow up on opportunities and threats every month. The project should be made responsible for identifying and exploiting opportunities that could be of interest to the owner as well as to the project. When the project starts reporting on unknown threats the project owner should be fair and give credit to those that come up with opportunities. Correct reporting of uncertainty is difficult, due to uncertainties and lack of clear knowledge about the effect or the likelihood of experience. If the company 'shoots the messenger' or the bearer of bad news, the consequence may be that project stops reporting them. The effect can be that the threats, which could have been avoided or mitigated if they had been reported and dealt with, will go under the radar and the project owner or the company will not know about them until they occur. Also, opportunities that the project owner or the company may have wanted would be left out of the project.

**Step 6: Benchmarking and continuous improvement of the method and process**

When the methods and the process have been used for some time, it is recommendable to check how good they are against other companies, against literature, and the most recent research in the field. This can be done by benchmarking the method against other companies' methods or by being part of collaborative research projects with a focus on uncertainty management.

**Step 7: Learn more about uncertainty analysis and management**

There are many good books and research papers that can provide additional more insights into uncertainty analyses and uncertainty management. There are also possibilities to learn more in different Special Interest Groups (SIGs) on risk management, quality management, and cost estimation. The SIG community on risk and uncertainty is an active group and new researchers, scholars, and practitioners are always welcome. Last, but not least, there are many good courses at universities in Norway, Europe, and the USA that can give project managers more insights and knowledge.

**8.6 Contribution to research**

In this chapter, a nine-step framework for uncertainty management has been presented. The framework was developed in two steps. In 2006, a Norwegian model for handling uncertainty was developed as one of the first deliveries in the PUS project, and in 2013 a new and modified version was developed in English. The latter version has similarities to the ATOM framework developed by (Hillson & Simon, 2012) but was developed without cross-border cooperation. This framework explains in a practical way how to identify, analyse, and manage uncertainty in projects. It shows how an uncertainty matrix can be used as a management tool, and it explains the steps needed for using the tool.

## **9 Conclusion: project uncertainty management and the need for a new approach – the ‘lost opportunities’**

How good are projects at identifying and managing uncertainty in practice? How good are the theories and the guidelines provided to project managers and project owners today? Do projects deal with uncertainty in a professional way? Has the long-term focus on uncertainty analysis and uncertainty management in Norway had any impact on how projects in Norway deal with uncertainty today?

I started this thesis with four research questions:

*Q1 How do projects identify and manage uncertainty in practice?*

*Q2 How do the different roles of project owner and project manager affect or influence a project’s capability to identify and deal with opportunities and threats?*

*Q3 Are today’s project management and uncertainty management theories adequate in terms of dealing with opportunities and threats in projects?*

*Q4 Do project management and uncertainty management theories provide the right tools and concepts to enable projects to manage opportunities and threats in practice?*

In this chapter I give a short summary of my hypotheses and main findings relating to each of the four research questions addressed in this thesis, and then reflect on the research questions. I discuss what areas need to be developed further if we are to achieve ‘living uncertainty management’ in our projects today. I also look at what part of the concept is well developed and what needs to be developed in the years to come. This chapter ends with reflections on the journey that I have undergone while preparing this thesis (Section 9.4).

### **9.1 Most important findings relating to uncertainty management in practice**

In my research, I have tried to find out whether today’s project management and uncertainty management theories are adequate in terms of dealing with opportunities and threats in projects, and whether the theories provide the right tools and concepts to enable projects to manage opportunities and threats in practice.

#### ***Q1 How do projects identify and manage uncertainty in practice?***

Scholars and consultants have worked with cost and time uncertainty since the early 1980s. Steen Lichtenberg’s Successive Principle was adopted by the Norwegian project management researchers at NTH, and from the early 1990s uncertainty analysis was used when projects wanted to find expected costs or time. In the same time period, the step-by-step approach (the Norwegian evolution from the successive principle) and triple estimates were introduced and adopted by consultants and practitioners. Today, the step-by-step approach and uncertainty analysis are established as the dominant concepts in Norway, and the methods are used for estimating expected cost and time and for finding the uncertainty factors that could affect the project objectives in a positive (opportunities) or negative (threats) way.

However, there are also challenges relating to uncertainty analyses in Norway: (A. Johansen, Sandvin, Torp, Økland, 2014)



1. The expected value/the base case challenge
2. The detail challenge
3. Realistic standard deviation in all phases of the project challenge
4. The human/team challenge
5. The lost opportunity challenge

I have presented empirical data that prove that many projects still do not deal with threats and opportunities in a balanced way. The empirical data from the studies show more or less the same pattern: there are many more threats than opportunities in the uncertainty registers. I have also shown that opportunities identified in the execution phase of studied projects were few and often not exploited at all. The two case studies show that the private sector and public sector had more or less the same focus on threats, and that private sector projects are not better at exploiting opportunities than projects from the public sector. All of the projects seemed to be quite conservative towards new ideas and change, and were not seeking new opportunities in their execution phase. Some opportunities were identified late in the projects, in uncertainty analysis workshops, but the identification of new opportunities did not mean that the projects subsequently utilized the opportunities. Project managers still do not fully understand the uncertainty picture they have to face. The studied projects clearly overestimated the potential influence of some factors and underestimated the influence of other factors. The research revealed that many projects lacked the ability to unveil and utilize opportunities. Many projects had what I have called a 'blind spot' in their uncertainty register. Many projects had either none or few opportunities in the register and they did not spend time or effort on identifying and analysing new opportunities when entered the execution phase. In most of the analysed projects, uncertainty management focused on the opportunities and threats or risks in the planning phase, and only on threats or risks in the execution phase.

***Q2 How do the different roles of project owner and project manager affect or influence a project's capability to identify and deal with opportunities and threats?***

The project owner's perspective provides a broader understanding of managing uncertainty in projects, than the project management team's perspective. This perspective can be helpful for understanding important aspects that influence a project (including aspects that lie outside of the realm of traditional project management), as well as interrelations between the aspects. This understanding, which can be achieved through co-operation between the project manager and the project owner, can enable uncertainty in projects to be dealt with effectively. Good co-operation between a project manager and a project owner can produce a holistic understanding of the project, which can in turn help to identify and/or create opportunities in the project.

Increased active involvement by project owners in uncertainty management was observed in the studied projects. In the mid-2000s, the project owner role was not very common and not well defined in most of the companies in the PUS project, but the situation has clearly changed since then. All of the studied PUS companies had a project owner role that contributed significantly to managing uncertainty in their projects.

Project owners and project managers may have differing views on what are considered to be threats and opportunities. Six dilemmas facing project and project owners were identified in 2006.

Some uncertainties can be treated as threats by the project organization, while the same uncertainties can be treated as opportunities by the project owner. While a line organization often initiates a project to master a more complex environment or situation than normal, the project organization often uses a closeout strategy to minimize the threat. This strategy often results in less potential for including new opportunities and managing changes during project execution than expected by line organization. Contextual demands in complex and long-term projects usually develop considerably during project execution, leading to increased uncertainty. The project often finds itself in a situation where it cannot report this uncertainty without the probability of receiving a stop order. This often leads to the project overrating the accuracy and quality of its available information and underrating the tangible uncertainty reported to the line organization at decision gates. In order to maximize the chances of being perceived as successful, a project in the early phases will often actively work to widen its financial frames and to obscure its goals, thus hiding an increased total cost for the line organization. If the project owner intervenes or participates in the project uncertainty management process, there is a potential risk that the responsibility will become unclear and that the project owner, either completely or partially, will take over something that is the project manager's responsibility.

The findings from the PUS project clearly indicate that project teams intend to focus on both opportunities and threats in the uncertainty management process. However, the intentions expressed during the survey did not seem to reflect the contents of the projects' risk registers. Studies of project practices show that projects only to a small extent actively seek opportunities in the execution phase. This does not mean that such opportunities do not exist there, but rather that many projects miss opportunities because they lack focus on this issue when it comes to managing uncertainty. The participants in uncertainty workshops had more or less the same view on what constituted threats and their possible consequences, and they related the threats to objectives. When opportunities were discussed with the participants, the picture became far more inconclusive or foggy.

When opportunities were addressed, the participants viewed them from their own role. Identified ideas were not necessarily closely related to the projects' objectives. Some stakeholders often advised changes. Typically, they saw new or better technology as an opportunity. Some stakeholders believed that there are no opportunities left once the contract has been signed. Some stakeholders talked about the opportunities that would arise as a result of their project, while others talked about how good execution, new technology, and so forth could make projects better, faster, or cheaper. Stakeholders also tended to describe new opportunities as positive effects or as wishes that would be realized if an opportunity resulted in faster, cheaper, or better solutions than were planned or that were more effective. Thus, typically there will be a mix of causes, uncertainty elements, possible effects, ideas, and strategies for managing opportunities when they are discussed in the context of the uncertainty management process. It is therefore often necessary to go through the different ideas in a second round in order to analyse and clean the data before the strategies are chosen.

Identifying and dealing with opportunities seems to be closely linked to who will receive positive benefits or negative effects if a given opportunity or threat occurs. In the case of threats, it is often easy to see who will lose if the threats happen, but it often seems less clear who will benefit from the opportunities and this is based on one stakeholder role in the project.

***Q3 Are today's project management and uncertainty management theories adequate in terms of dealing with opportunities and threats in projects?***

The project management and uncertainty management theories are well known among Norwegian practitioners and also adequately used in an appropriate manner. However, there are still challenges regarding how many project managers deal with opportunities in projects today.

Many papers, textbooks, and standards on risk and uncertainty management have been developed internationally as well as in Norway since the mid-1980s, and the development is still ongoing. Norwegian scholars have played an important role in development of the field since the early 1990s. There has been high degree of focus on uncertainty analysis and uncertainty management, and the Concept research programme and the PUS project have contributed to the development of better uncertainty management in Norway and also internationally.

The literature review revealed that the topic 'uncertainty' has been in focus for many years and that there are many different papers related to risk and uncertainty management have been published since the 1950s. Uncertainty management is covered in several PM standards. Also, many generic and specialized textbooks have been published since the first one appeared in 1981 (Rolstadås, 1981). The PRAM framework, developed in 1997, suggests that that risk management should deal with opportunities and threats. Norwegian research on uncertainty started in the early 1990s and was strongly influenced by Steen Lichtenberg's methods for calculating the cost of major projects (the Successive Principle of cost estimation). In the same time period, the step-by-step approach (the Norwegian evolution from the Successive Principle) and triple estimates were introduced and adopted by consultants and practitioners. In Norway today, the step-by-step approach, triple estimates, and Monte Carlo simulation are established as the dominant methods for estimating expected cost and time and for finding the uncertainty factors that could affect the project objectives in a positive (opportunities) or negative (threat) way.

Much of the literature within the field of risk and uncertainty management is concerned with uncertainty and risk analysis, and does not focus on the management aspects of risk and uncertainty management. Recent Norwegian research initiatives, such as PS 2000 and the Concept research programme have focused more on uncertainty and risk analysis, and less on how to manage opportunities.

Stephen J. Simister (2004) developed a generic risk management model based on publications from national standards associations, professional institutions , Project Management Institute (2008), and Association of Project Management), and government departments ). His risk model presents the basic idea of having a continuous, repetitive, and iterative process, and that risk management is more than isolated exercises and analyses. Stephen J. Simister (2004) underlines the importance of undertaking risk management as a structured formal process aligned with the overall project management approach.

**Project literature is inconsistent in the use of the terms uncertainty and uncertainty management, and Norwegian companies are not consistent how they use the term uncertainty.**

In some literature the term risk is treated having neutral meanings and in other literature it is treated as having as negative meanings. However, I have argued that the term is mostly understood as a

combination of the probability and consequences of an unwanted event. I have suggested that projects need to do risk analyses and uncertainty analyses and that they are different concepts that require different methods and tools.

Chapman (1977(C. Chapman, 1997; C. B. Chapman & Ward, 1997; Hillson & Simon, 2012) all suggest that 'risk' can consist of two parts: threats and opportunities. This thinking has strong similarities to the way that scholars belonging to the uncertainty school in Norway have defined uncertainty. However, if the view is adopted in Norway, the distinction between risk as a concept and uncertainty as a concept will be lost.

I have proven that term uncertainty has several meanings. Some authors regard uncertainty as indicative of lack of knowledge, some refer to potential outcomes and causal forces that may happen in the future, and some point to the positive or negative effects that uncertainty will have on a project objective. Uncertainty or lack of certainty are about variability in relation to performance measures such as cost, duration, and quality. They are also about the ambiguity associated with lack of clarity due to the behaviour of relevant project players, lack of data, lack of detail, lack of structure to consider issues, working and framing assumptions being used to consider the issues, known and unknown sources of bias, and ignorance about how much effort it is worth expending to clarify the situation. I have suggested that the linking of 'probability' to the term 'uncertainty' may reflect different understandings and a lack of consistency in the use of the terminology in textbooks and articles on uncertainty management.

Further, I have suggested that uncertainty can be defined as two possible future outcomes – threats and opportunities – both of which consist of controllable and non-controllable factors that may occur, and variation and foreseeable events that may occur during a project execution and that have a significant impact on the project objective.

Uncertainty in single projects can be linked to the traditional performance criteria time, cost, and quality, but project managers and project owners also need to consider the tactical and the contextual uncertainty in the uncertainty management process. The main purpose of the uncertainty management process is to create as much value and benefit as possible for the owner and for society.

***Q4 Do project management and uncertainty management theories provide the right tools and concepts to enable projects to manage opportunities and threats in practice?***

Although tools and concept for handling uncertainty in projects exist, the process is insufficient when it comes to dealing with opportunities. Tools and methods for handling uncertainty are available and in use in many projects. However, finding and exploiting or utilizing opportunities are still a problem in many projects. The tools seem to be standardized in most of the studied companies and the majority of the respondents were more or less satisfied with the tools their company provided for uncertainty management. However, there are still many types of potential opportunities that have not been investigated and exploited in Norwegian projects.

The two case studies conducted as part of the PUS project revealed more or less the same results. The study conducted in 2009 by Krane et al. revealed that 81% of the risk elements could be categorized as threats, 3% as opportunities, and 16% could turn out as both threats and

opportunities(Krane, et al., 2010). The follow-up study in 2013 revealed that only 7–9 opportunities was exploited in average and 100–110 threats had had economic consequences(Krane, et al., 2014). Some of the companies had system that made identification and following up on opportunities possible, and the findings revealed clearly that threats were in focus in most of the project most of the time. It did not matter whether the companies had tools that supported threats and opportunities if the project team did not see the benefit of those opportunities, or if the project owners did not request opportunities and following them up in the same way as threats.

Since the mid-2000s, projects in Norway have become been better at hitting their cost target, and there have been fewer cost overruns in big public projects compared with before the year 2000. However, there are also some potential negative impacts of the system implemented in large public projects in Norway. For example, it is easier for such projects to keep within their budget if the costs are overestimated. In the first years of the quality assurance regime, a certain increase in the budgets was detected, and almost all of the external reviews resulted in increases in budget, both in the base estimate, but more frequently in the uncertainty allowances. This could have been a result of previous underestimation of the cost of uncertainty, but it is also likely that all parties benefited from increasing the budgets: the project, because it would be easier to ensure success; the politicians, since they would not have to answer for cost overruns to the opposition, and the external reviewers, since they would not like to be blamed for cost overruns and so forth. However, it became apparent that this development could have two major disadvantages: (1) tax payers would have to pay more for the services provided by the public as the projects became more expensive, and (2) the large allocation of funds to meet potential threats from all the projects combined could actually reduce the total number of projects to be sanctioned in a given period.

## 9.2 Most important findings and contribution – uncertainty management in practice

### **The project uncertainty management maturity has increased as a result of the focused improvement efforts in Norway**

In my research, I found evidence that long-term improvements in efforts within project uncertainty management in Norway has had an effect in several areas. The project maturity increased in all six studied organizations. Evidence to support this conclusion was in the form of new systems, the development of support and training, and the concepts of uncertainty analysis and management. In addition, there was improved performance in how uncertainty was analysed and managed in the investigated cases in the PUS project and in the Concept research programme study.

Joint efforts to focus on uncertainty management had improved the level of maturity in uncertainty management in the participating companies in the PUS project. However, this did not guarantee success in all projects, and higher levels of maturity in uncertainty management did not necessarily mean that all projects in the participating companies would be efficient in their planning and execution.

It is still not known whether project managers have become better at estimating uncertainty and whether their estimations are more realistic now than in the year 2000, or whether project managers simply have become better at raising their budgets. Moreover, it is not known how many uncertainties that are identified in the early uncertainty analyses become certainties.

Project managers responsible for big uncertain projects should not be blamed for wanting to have a time and cost buffer for handling the uncertainty. Furthermore, it should not come as a surprise that project managers try to avoid changes of the scope in the execution phase. However, such changes will have a severe effect on the handling of opportunities. Avoiding changes means avoiding opportunities, and it means that for many projects uncertainty management is still the same as risk management and that many projects spend most of their time on managing the threats.

In almost all of the organizations involved in the PUS project there was an increase in maturity regarding their handling of uncertainty. However, there was no evidence to suggest that this improvement was due to the PUS project alone.

### **The context matters and the focus of the analyses will differ if the project owners participate in the process**

Project management scholars acknowledge that that context and the humans involved in the uncertainty management process matter. If a company wants to develop in uncertainty management, it will need to understand human behaviour, the culture within the company, the project owner's role, and how the stakeholders interact with the process. In order for projects to become efficient in dealing with uncertainty, they need to understand, interpret, and handle uncertainty both within and outside the project. Projects must understand their circumstances and the impact of the efforts that they have initiated. If there is no focus on learning and knowledge creation as projects progress, the process of managing uncertainty will not be efficient. The mother-organization, which is responsible for training and developing new methods, needs to have a strong focus on learning and knowledge sharing so that the new methods, tools, and techniques are applied in 'all' projects.

### **A new and improved uncertainty management process has been developed**

In 2006, the first uncertainty management process was developed as one of the first deliverables in the PUS project. It started with a process consisting of five different steps (see Figure 47). This process was tested and developed further into a nine-step uncertainty management process (see Figure 48). Steps 1–2 prepare the process, Steps 3–7 identify and analyse the uncertainties and decide on actions, and the final two steps (8 and 9) follow up the uncertainties during the project life cycle.

### **Tool for uncertainty management**

An uncertainty matrix was developed in 2006 together with PUS companies, with a focus list that can be used by practitioners in the uncertainty management process in projects, and guidelines were prepared to point out how and when to use the approach.

### **Five characteristics of uncertainty and four characteristics of opportunities have been developed**

Based on the literature review and the study of how the PUS companies related to uncertainty in their practices, the following five characteristics of uncertainty and four characteristics of opportunities have been suggested. These characteristics have been developed based on a step-by-step deductive approach. They represent an end result of this thesis work, rather than hypotheses or research questions that typically would be the starting point for this type of research.

1. A project with fixed goals, budget, and time schedules is only possible if the project team can control everything within it (the operational uncertainty is zero from the start of the project) and it can be totally isolated from the outside world (the contextual uncertainty is zero).

Projects are fundamentally uncertain – goals budgets and time schedules must be considered as best guesses and nothing more. Zero contextual and operational uncertainty is impossible if the project is truly unique and with different stakeholders involved in the process.

2. No deviation or change in a projects goals and plan is unrealistic

Threats and opportunities may happen through projects. New technology and new methods will be developed. The project will acquire more information and learn during its execution. That means that the project's operational uncertainty will decline, but it does not mean that contextual uncertainty will follow the same pattern.

3. Zero uncertainty means that 'as planned' is the best the project owner can hope for

This means that the project has exploited all opportunities at the beginning and that better than planned is not option. It also means that all projects must have a schedule and a budget with a 'buffer' that makes it 'certain' that the project will succeed if a threat occurs.

4. Avoiding uncertainty comes at a cost – uncertainty can be avoided and transferred, but it has an impact on cost, time, and the potential benefits obtained from the project

Reducing the uncertainty level has an impact on cost, schedule, and the potential benefits from the project. It makes cost overruns less likely, if the project succeeds in handling of the threats. It also means that increased benefits for the owner and society will be less likely, since the opportunities will not be explored.

5. A project should have as low level of uncertainty as possible when it starts and should avoid variations in and changes of plan at all cost

Seen from a project's perspective the level of uncertainty should be as low as possible when it starts and the project should avoid any variations and changes of plan at all cost. From the owner's perspective uncertainty is seen differently – uncertainty is to a certain extent desirable, as it gives the owner more flexibility and opportunities. Seen from the project perspective, threats are negative future events that might happen and that would have negative consequence or impacts, and opportunities should be avoided too because exploiting them would mean that the plan would have to be changed and opportunities might turn out to be a threat for the project's time, cost, and quality objectives in the execution phase.

#### **Four characteristics of opportunities in projects**

1. When a project starts, it will have a high degree of focus on opportunities and a low degree of focus on threats.

All projects start by exploiting the opportunities and coming up with ideas or concepts that will maximize the benefits or effect for the stakeholders. When projects have established their objectives they automatically shift focus to dealing with threats that could cause the project to fail. All projects are started in response to a need or demand for positive change.

2. If nobody has a benefit, then it is not a true opportunity

A true opportunity will give at least one stakeholder a benefit that is worth more than the investment in the project needed to for the opportunity to occur. No projects would be started if they did not give at least one stakeholder an 'opportunity' that they would consider a positive change. However, that does not mean that such changes or opportunities would be considered positive for all of the stakeholders influenced by the project.

3. Opportunities might happen if the project invests in them and they will disappear or have no impact if the project does not change its plan or its execution

Opportunities identified during later stages of a project will not give any benefit if the project manager or the owner does not accept any changes to the project plan.

4. Opportunities for the owner of a project are connected to the future benefits of the project, whereas opportunities for the project team are primarily connected to project planning and the execution phase of the project.

True opportunities for the project will be changes that enable the project to deliver the project deliverables at a lower price, faster than expected, or of a higher quality than described within cost target. Furthermore, the investment must at least balance the economic consequences and the time and resources that need to be spent so that opportunities can be exploited. For the owner, true opportunities are ones that give a return on their investment in a project life-cycle perspective.

New opportunities that have impacts on the future effect or benefits for the owner are often less interesting for the project than opportunities that will have an impact on the project objective. Opportunities can be connected to the process of delivering something faster, better, or cheaper in the project, but they will always have a cost dimension for the existing plan too. The project manager team must investigate the new idea and the need to abandon the current concept that so far has been considered as the best one. For the owner, new opportunities may jeopardize the project plan since the project will have to use more money or spend more time on planning or changing the project scope, and they will therefore become threats. Seen from the project view, such opportunities should be avoided so that the plan is not jeopardized.



### 9.3 Further research – Where do we need to create new knowledge in uncertainty management?

Based on the finding from research, it can be concluded that many further developments in methods, theories, and techniques are needed in order for projects to be able to identify and handle the uncertainty, which in fact is a natural part of the journey, without adding extreme time and cost buffers. Projects need to be able to live with uncertainties, and they need to be professional in handling threats and opportunities, so that they can deliver maximum benefit to the project owners and society.

I have argued that the concept of living uncertainty consists of three pillars – human, models, and techniques. Further, I have concluded that all three elements need to be developed if living uncertainty management is to be achieved in projects.

**What needs to be developed in order to succeed with ‘living uncertainty management’ in future projects?**

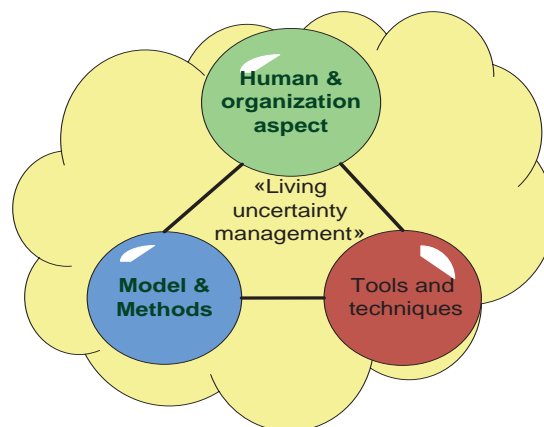


Figure 58 Living uncertainty management (Hald, Johansen et al., 2008)

**What types of issues are included in ‘living uncertainty management’ and which of them need to be developed further in the years to come?**

I suggest that future developments of the concept of living uncertainty management should focus on the following aspects.

**Humans and organizations aspects.** These include aspects connected to the project team members’ personalities and attitudes towards uncertainty, the understanding of behaviourism, and how decision-making and benefit may influence how stakeholders value the uncertainty. These aspects concern understanding team members’ experiences, knowledge, and ability to manage uncertainty. In addition, they are about organizations and roles (i.e. owners, project managers, consultants, and contractors) and their impact on how projects identify and value uncertainty during their execution.

**Models and methods.** These concern focusing on developing good and practical concepts for identification, calculating, developing actions and systematic monitoring of uncertainty in projects.

They are also about describing the steps in the recommended methods and models, and the steps needed for the implementation of uncertainty management in projects.

**Tools and techniques.** These concern the challenges related to the identification of techniques, and to analytical and visualizations methods for managing uncertainty in projects. They are also about the support systems (ICT tools) needed to calculate and monitor uncertainty in projects and portfolios. I suggest that the development good and clear theories that satisfy Thomas S. Kuhn's five characteristics has still not been fully done in the management of uncertainty in single-project environments.

In my research I have tried to find out whether today's project management and uncertainty management theories are adequate in terms of dealing with opportunities and threats in projects, and whether the theories provide the right tools and concepts to enable projects to manage opportunities and threats in practice.

#### **What needs to be developed further?**

**Tools and techniques.** Based on the findings presented in this thesis, I suggest that we need to develop more insights into all three elements of 'living uncertainty management'. The findings indicate that many techniques and tools are available and that the users are more or less satisfied with them. However, there is also clear evidence to suggest that the tools and techniques are 'made by experts for experts' and that many projects struggle with using them in their daily handling of uncertainty without support from base organizations or from external uncertainty management consultants. This suggests that we need to focus on the following developments:

- Develop better and simpler techniques for identifying opportunities and threats in single projects.
- Develop tools that are 'good enough and simple enough' so that 'ordinary' project teams can use them by themselves without the need for an expert to come in and instruct them on their use
- Develop more advanced tools that experts can use and offer as support when handling uncertainty in more complex projects
- Develop tools that communicate uncertainty clearly in the organizational hierarchy
- Developing cost analysis methods that reflect operational, strategic, and contextual uncertainty
- Develop more practical tools for time estimation under uncertainty linked to the cost analysis tools.

**Models and methods.** Developing good and practical concepts for identification and calculation, developing actions and systematic monitoring of uncertainty in projects, and developing the steps in the recommended methods and models are all elements of the models and methods in the 'living uncertainty management' concept. Research findings indicate that the management of risk should cover risks and opportunities (C. Chapman, 1997; C. Chapman & Ward, 2011; Cooper, et al., 2005; Hillson, 2002; Rolstadås, et al., 2011; Rolstadås & Johansen, 2008), and most of the theoretical concepts suggest that these should be handled in the same risk management process.

The findings from the studies on which this thesis is based indicate that projects focus mainly on risk, and that often opportunities are not identified or exploited (i.e. opportunities have a 'blind spot'). However, there is still a need for more research before it can be concluded whether unclear methods, lack of methods or models, or project managers' competence in the application of existing theories or models are cause of projects' failure to deal with opportunities. The findings suggest that the uncertainty arising from the different cost analyses expressed in standard deviations is significantly lower than the international cost standards suggest, and significantly lower than projects experience. In conclusion, there are five challenges relating to how uncertainty analyses are used in the late stage of the planning process. Moreover, the uncertainty analysis in the front end is more about identifying the 'right project' than finding the right expected value. This means that mutual relations between different concepts of uncertainty and expected value are often more important than estimating the true expected value of the different concepts in the early stage of the process. It also means that a project that is chosen as the 'best project' does not necessarily have the true and correct end cost in its first two or three uncertainty analyses.

The uncertainty analysis method used in Norway was designed to be a top-down approach for the early phase of the project life cycle. The method was designed to find the expected value and expected time based on limited information in the early stage of a project life cycle. Ideally, the process should focus on the big picture and not all the details. It should focus on the most important items, namely uncertainty factors or contracts with the largest levels of uncertainty and activities that are most important for achieving the project objectives. I have observed that many uncertainty analyses have drifted away from the original concept.

In this thesis I have drawn the conclusion that a part of the terminology problem is the use of the term 'risk' in project management standards and textbooks, and that we could avoid some of the identified weaknesses by using the term 'threat' instead of risk when uncertainty is discussed in projects. I have suggested that uncertainty management should focus on threats and opportunities, and that projects need also risk analysis and risk management and that this should focus on identifying risks that can be defined as combinations of probability and consequences of unwanted events ((Rausand & Utne, 2009). These suggestions highlight the need for the following aspects to be developed further in the future:

- Better insights into separating opportunities from threats affects how many opportunities a project will exploit
- More knowledge about what 'type' of uncertainty typically appear in the planning and execution phases of different types of projects
- More insights into the 'size' of threats in the planning and execution phases
- More insights into what changes are linked to opportunities and threats
- Development and testing of decision-making models for opportunities
- Better and simpler techniques for identifying opportunities and threats in single projects
- More insights into how uncertainty can be managed in the different phases of a project
- More insights into the use of value management principles to find the most valuable solution for project owners
- More insights into how option theory can be used together with opportunity management
- More insights into how opportunities can be used as early signals of upcoming opportunities
- More insights into how threats can be used as early warning signals of potential loss.

**Humans and organizations aspects.** When uncertainty is discussed in projects, there is a tendency for project owners and managers to think that it is done more or less objectively and that uncertainty is interpreted more or less in the same way by all participants in the process. However, this is not necessarily the case. Hillson and Murray-Webster (Hillson & Murray-Webster, 2007) state that people's chosen state of mind, mental view, or disposition with regard to facts or states will matter when attempts are made to interpret uncertainty. The authors label this 'risk attitude'. People's risk attitudes drive project members' behaviour, which means that if an uncertain event is observed or presented in an uncertainty analysis process, different participants will understand the situation as favourable or unfavourable, or even hostile, depending on their personal attitude towards risk. There is also evidence that situational factors such as training, role, and how accountable the different participants are in relation to the end results will all have an influence on the project members' attitudes towards risk (Flyvbjerg, et al., 2003).

There are also some pitfalls when analysing uncertainty in group sessions. (Hillson & Murray-Webster, 2007) talk about group risk attitudes and heuristics, and list five common heuristics in groups working with identifying risk: group thinking, the Moses factor, cultural conformity, risk shift, and cautious shift. They also point out that each of these group heuristics often does not occur alone or in isolation, and they reinforce causal relationships between them, potentially resulting in the effects of the above-mentioned factors becoming even more severe in the uncertainty analysis process. A group will offer more insights and experience than an individual, and this explains why groups are very often used when uncertainty is discussed (Klakegg, 1994). Individual heuristic and group thinking may affect how well the group performs in an uncertainty analysis process. This means that the results of the process are dependent on the skills and attitudes of the individuals who participate in the process; hence, the result will not be objective. The participants in an uncertainty analysis will often be held accountable for the cost estimates they provide. There is therefore an obvious risk that those who provide estimates actively will add a 'buffer' to their cost estimate or add unrealistically high uncertainty factors so that the end result of the process will give a 'high enough' expected value.

Although all participants in uncertainty analyses are asked to prepare basic estimates based on a cost breakdown structure without allowance, and although they are informed that the use of triple estimates and uncertainty factors will address the uncertainty in the estimates, the reported study findings reveal that buffers are constantly added when cost estimates are discussed. Hence, the following aspects need to be developed further in the future:

- More and better knowledge relating to how the different roles in the project may affect the identification of uncertainty
- More knowledge about how the organization of the uncertainty process affects the identification and management of threats and opportunities,
- More knowledge around the decision process involved in dealing with uncertainty in the different phases of the project – how to identify and exploit opportunities and how to deal with threats
- More knowledge relating to individual personalities and how attitudes towards uncertainty affect the uncertainty management process
- More and better knowledge relating to how the different roles in the project may affect the identification of uncertainty and management of uncertainty

- More knowledge relating to what is needed in terms of support to the project teams, to enable them to implement 'living uncertainty management'
- More insights into what skills and knowledge are needed for the uncertainty management role.

In this thesis, I have focused on single projects. The main focus has been on the project manager's role as seen from the client's side in public and private sector projects. I have also focused on the project owner's side and how the two groups of actors (project owners and project managers) deal with uncertainty in the planning and executing phase of their projects. Consequently, two important parts or areas have not been covered in this thesis, the front end of the project and the contractor side of the project.

Although it possible to start early in the project life cycle and develop more insights into how the different roles deal with the high numbers of uncertainties that are inevitable at the front end, it is also possible to cover more roles in the project organizational hierarchy than the two roles in focus in this thesis. Despite acknowledging that these two areas are important, my decision not to focus on them was conscious, primarily for three reasons:

1. The front end was not the main focus in the PUS project
2. The organization that I covered in my research had a client role – it 'owned the projects'
3. Other research initiatives in Norway (e.g. the Concept research programme) had been covering the front end for some time when the PUS project was launched.

Recently, I have been working with several contractors and have discussed uncertainty management from their perspective. It has become clear to me that they have another way of thinking about threats and opportunities in projects. It could therefore be interesting to conduct more systematic research into how they deal with threats and opportunities, seen from the contractor's view.

#### 9.4 Epilogue – ‘having new eyes’

When I started working with the PUS project in 2005, I thought that I had relatively good knowledge about earlier research on project management, and on uncertainty analysis and uncertainty management. I am truly surprised by how much I learned and discovered during the work with the PUS project and more recently in connection with this thesis. After having acquired more than 15 years of experience in the project management and uncertainty management business, I still feel that there are still a lot of areas to investigate, discover, and understand on the topic of managing uncertainty in projects.

I am truly grateful for all the help and inspiring comments I received from all of my colleagues, my co-authors, and other scholars and practitioners that I have met in the process of developing this thesis. I have learned from all of them and without the benefit of their comments and suggestion this work would never been developed. I have been very fortunate to have been a part of generous research communities at SINTEF and NTNU for more than 10 years. Without the support from SINTEF and NTNU and the time and space provided by my colleagues to enable me to focus on this work, this research would never have succeeded.

It has been a true privilege for me to work on a subject that I believe is important and interesting for the project community. In order to succeed with work such as this, a certain amount of talent is needed but most of all there is a need to be stubborn and a willingness to work hard for many years. In addition to being a great learning experience for me, the journey taken during my research has been interesting and it has been fun. I hope that this journey has made me a better and more reflective researcher and that in the future I will be able to bring to and share some of my knowledge with my future students, my colleagues, other researchers, and projects in which that I participate in. Doing this research has given me ‘better and new eyes’.

The real voyage of discovery begins not in seeking new landscapes but in having new eyes

(Marcel Proust)

## Appendix I                      Published Paper

No.	Paper title	Contribution/role in preparing the paper
1	Johansen A, Sandvind B, Torp O, Økland A Uncertainty analysis – 5 challenges with today's practice <i>Social and Behavioral Sciences</i> (2014), pp. 591–600 information Double blind review	First author Collecting the data, leading the discussions, and drawing up the conclusions from the work
2	Johansen A, Andresen PE, Ekambaram A Stakeholder benefit assessment – Project success through management of stakeholders <i>Procedia – Social and Behavioral Sciences</i> (2014), pp. 581–590 Double blind review	First author Collecting the data, leading the discussions, and drawing up the conclusions from the work together with my fellow researchers
3	Johansen A, Halvorsen SB, Haddadic A, Langlo, JA Uncertainty management – A methodological framework beyond 'the six Ws' <i>Procedia – Social and Behavioral Sciences</i> (2014), pp. 566–575 Double blind review	First author collecting the data, leading the discussions, and drawing up the conclusions from the work together with my fellow researchers
4	Krane H, Johansen A, Aalstad R Exploiting opportunities in the uncertainty management <i>Procedia – Social and Behavioral Sciences</i> (2014), pp. 615–624 Double blind review	Second author Responsible for data collection from five cases and the analyses, and for drawing up the conclusions from the work together with my fellow researchers
5	Johansen A, Langlo JA Effects of long-term improvement efforts within project uncertainty management Egos 2013 Conference proceedings Double blind review	First author collecting the data, leading the discussions, and drawing up the conclusions from the work together with my fellow researchers
6	Johansen A, Ekambaram A, Hald LC Opportunities in projects – What are they and do we really want them? IPMA, 2012 Conference proceedings Double blind review	First author collecting the data, leading the discussions, and drawing up the conclusions from the work together with my fellow researchers
7	Johansen A, Ekambaram A, Krane HP, Steiro T Uncertainty management – Myths and realities EURAM 2012 Conference proceedings Double blind review	First author Collecting the data, leading the discussions, and drawing up the conclusions from the work together with my fellow researchers
8	Johansen A, Ekambaram A, Hald LC Improving uncertainty management in projects by collaborating in an inter-organizational research project EURAM 2012 Conference proceedings Double blind review	First author Collecting the data, leading the discussions, and drawing up the conclusions from the work together with my fellow researchers

No.	Paper title	Contribution/role in preparing the paper
9	<p>Johansen A, Ekambaram A, Krane HP, Steiro T  Exploring uncertainty and flexibility in projects: Towards a more dynamic framework?  Egos 2012  Conference proceedings  Double blind review</p>	<p>First author  Collecting the data, leading the discussions, and drawing up the conclusions from the work together with my fellow researchers</p>
10	<p>Johansen A, Ekambaram A, Hald LC  Living uncertainty management – An approach to learning and improvement in project-based organizations  ECKM 2012  Conference proceedings  Double blind review  Sonning Common, UK: Academic Publishing International</p>	<p>First author  Collecting the data, leading the discussions, and drawing up the conclusions from the work together with my fellow researchers</p>
11	<p>Ekambaram A, Johansen A  Uncertainty management in projects – A new perspective  IPMA World Congress, 2011, Brisbane  Conference proceedings  Published in <i>Project Perspectives</i> 2013, pp. 68–73</p>	<p>Second author  Development of the idea of the paper and leading the discussions together with my fellow researcher</p>
12	<p>Ekambaram A, Johansen A, Jermstad, O  Opportunities in projects and the role of project owners  IPMA World Congress, 2010  Conference proceedings</p>	<p>Second author  Development of the idea of the paper, leading the discussions, and drawing up the conclusions from the work together with my fellow researchers</p>
13	<p>Ekambaram A, Johansen A, Økland A  Opportunities in projects and innovative thinking  ECIE, 2010  Conference proceedings  Double blind review</p>	<p>Second author  Development of the idea of the paper, leading the discussions, and drawing up the conclusions from the work together with my fellow researchers</p>
14	<p>Rolstadås A, Johansen A  From protective to offensive project management  PMI EMEA Congress, 2008  Conference proceedings</p>	<p>Second author  Responsible for data collection from two cases and for the analyses, and drawing up the conclusions from the work together with my fellow researcher</p>
15	<p>Olsson, NOE, Johansen, A, Langlo, JA, Torp O  Who owns a project?  EURAM – 2007 (extended version)  Double blind review  Nordnett 2007 Reykjavik  <i>Measuring Business Excellence</i> (2008) 12:1, 39–46</p>	<p>Second author  I was part of the team that developed the idea, contributed with data, and I drew up the conclusions from the work together with my fellow researchers</p>



**Nr 1 Uncertainty analysis – 5 challenges with today's practice**

## Uncertainty analysis – 5 challenges with today's practice

**Abstract** As pointed out by Venkataraman and Pinto (2010), the importance of estimating project costs arises as the estimates become the benchmarks of which future costs are compared and evaluated. Although estimates become more accurate as decisions are made and uncertainties resolved, they are also chief means for assessing project feasibility, as a comparison of cost estimates with estimates of revenues and other benefits that are crucial in determining whether the project is worthwhile to carry out or not. In this paper we will discuss whether or not the uncertainty analysis is a reliable tool for supporting the cost estimation process. We present 5 challenges in connection with the way uncertainty analyses of cost estimates are done today and present findings that indicate a need to rethink the uncertainty analyses of the projects that have a high degree of uncertainty. This paper is a product of collective reflection, experience and the knowledge of the authors. It is of a qualitative nature as we do not present any quantitative or statistical evidence or methods in our approach. It is understood, due to the diverse contextual backgrounds of the projects involved, that the explanations for differences may be equally diverse. The paper is divided into five parts; The introduction – explaining the importance of the topic; part two provides a short introduction to the applied research methods; part three explain what we mean by cost estimation under uncertainty; part four presents the five identified challenges in cost estimation under uncertainty; part five presents a conclusion and proposes potential areas of further research.

*Keywords:* Mega project; Uncertainty analysis; Cost estimation

### **Part I: Uncertainty analysis – tool for finding the right project and a tool for managing the uncertainty**

As pointed out by Venkataraman and Pinto (2010), the importance of estimating project costs arises as the estimates become the benchmarks of which future costs are compared and evaluated. In this paper we address the following two research questions: (1) Is the uncertainty analysis a reliable tool for supporting the cost estimation process of projects? (2) Do the result from the uncertainty analysis reflect the end cost of the project, and are the results of the uncertainty analyses trustworthy in the various phases of the project?

### **Part II: Research methods and limitations**

The paper is inspired by the experiences gained by the authors in working with uncertainty management over the last 15 years. The authors have worked in two large research projects with special focus on uncertainty analysis and uncertainty management; CONCEPT project "Uncertainty analyses" (2003 -2005) and "Practical uncertainty management in the project owner perspective" (the PUS-project, 2005-2010). In both projects, we did extensive literature reviews on uncertainty analysis theory and uncertainty management theory. And in both projects, ideas and concepts were developed and tested in case projects together with industry partners. The authors have been responsible for uncertainty analysis and/or the documentation of more than 100 analyses in total - We have led the 11 concept selection studies for Oslo Municipality, 2 concept studies on major road systems (Ferjefri E39). The authors have worked with health institutions (hospitals), public buildings, power companies, and road and railway constructors in Norway. The basis for this writing process is the discussions and analysis of the authors' joint experiences and interpretations of our findings. The paper is a product of collective reflection on the experiences and knowledge. The methodological approach is qualitative in the sense that we do not use any quantitative or statistical evidence or methods in our approach. It is understood, due to the diverse contextual backgrounds of the projects involved that the explanations for differences may be equally diverse. Therefore, it is aimed at analysing possible explanations and present and discuss them in a manner which could be meaningful on a level superior to that of the single project

### **Part III: Uncertainty analysis in Projects – threats and opportunities**

In the project management domain, uncertainty is currently understood as lack of information but uncertainty could also be understood as lack of certainty. Rolstadås, et al, (2011) state that uncertainty in projects may take on a number of very different forms, and

propose a structure for categorization of uncertainty into controllable and non-controllable factors Hetland, (2003). Rolstadås, et al, (2011) suggest that uncertainty could be negative and positive for a project. Negative implications of uncertainty are labeled as risk factors. Positive implications of uncertainty are labelled as opportunity factors. Both may have consequences if they occur. They refer to risk as the consequence of an unwanted event multiplied by the probability of the event, and opportunity as the opposite of risk, ie. events with positive consequences. Projects have traditionally strived towards predictability and to keep all critical factors under control. However, for large and complex projects, such predictability does not exist in reality (Rolstadås, et al, 2011). Major uncertainties play a large role in important areas. And especially under such conditions, it may not be a good strategy to strive for maximum predictability, but rather to choose a strategy of flexibility in the project, in order to be able to face changes in a better way (Olsson, 2006). In this paper, we adopt the term uncertainty to include both the positive effects (opportunities) and the negative effects (threats) in the execution of projects. We define uncertainty as follows: Project uncertainty is defined as controllable and non-controllable factors that may occur, and variation and foreseeable events that occur during a project execution, and that have a significant impact on the project objective Johansen et al 2012 (1) We define threats as factors, variations and events that may lead to undesired changes to objective, scope, resources, frame conditions that make the project cost more, spend more time or delivers less quality than was agreed up on in the beginning of the project. Opportunities are factors, variations and events that may lead to changes that make the project able to deliver the same quality in less time or to lower price than was agreed upon in the beginning of the project. And all such factors, variations and events that cause changes can make the project to deliver higher functionality or lead to positive NPV after the project is delivered.

#### **What do we mean by uncertainty analysis in this paper**

The GAO Cost Estimating and Assessment Guide presents 12 key steps that are essential to producing high quality cost estimates:

1. Define the estimate's purpose
2. Develop an estimating plan
3. Define the Project (or Program) characteristics
4. Determine the estimating structure [e.g., Work Breakdown Structure (WBS)]
5. Identify ground rules and assumptions
6. Obtain data
7. Develop a point estimate and compare to an independent cost estimate
8. Conduct sensitivity analysis
9. Conduct risk and uncertainty analysis
10. Document the estimate
11. Present the estimate for management approval
12. Update the estimate to reflect actual costs and changes

The Cost estimating guide also state that "most cost estimates have common characteristics, regardless of whether the technical scope is traditional (capital funded, construction, equipment purchases, etc.) or nontraditional (expense funded, research and development, operations, etc.). The most common characteristics are levels of definition, requirements (end usage/purpose), and techniques used. These characteristic levels are generally grouped into cost estimate classifications. Typically, as a project evolves, it becomes more definitive. Determination of cost estimate classifications helps ensure that the cost estimate quality is appropriately considered. Classifications may also help determine the appropriate application of contingency, escalation, use of direct/indirect costs (as determined by cost estimate techniques), etc." Standards of Cost estimation processes for projects (IAACE) describes a cost estimation process where you build up a detailed base estimate with a bottom-up approach. The project should start with determine the estimating structure (WBS) and develop a point estimate and compare it to an independent cost estimate, and in the end follow this up with by an uncertainty analysis of the estimate, often with a top-down approach. The purpose for the uncertainty analysis is to identify the confidence level (e.g., 80 or 85 percent), identify

uncertainties and develop an allowance to mitigate cost effects of the uncertainties.

In the early 1970s Lichtenberg S, together with researcher from Stanford University and MIT in U.S.A. Universities in Lough-borough, UK, Gothenburg, Sweden and the Technical University of Norway in Trondheim (NTH) developed a new approach for calculating the cost of big projects called the successive principle of cost estimation (Lichtenberg 2006). Lichtenberg used the term uncertainty, and it was from the beginning a neutral concept and it should have a broader view than risk concept that was dealing only with the down side – for instance, unexpected delays and higher cost. For him, uncertainty just meant that something could go faster or the project could cost less than planned, or it could take longer time or cost more than planned. This concept was adapted by the Norwegian project management researchers from NTH - and from early 90ies uncertainty analysis was used as the concept to find the expected cost or expected time for projects and the variability of cost/time, given by the standard deviation. The step by step approach (the Norwegian evolution from the successive principle) and stochastic estimation were introduced and were spread together with the uncertainty analysis concept among consultants and practitioners in the same time period. Today the step by step approach and the term uncertainty analysis is established as the concept to be used in Norway for uncertainty analyses of project cost estimates to calculate expected cost/time and find the uncertainty factors that could affect the project objectives in a positive (opportunities) or negative (threat) way. And the term uncertainty management is used in identifying the positive and negative events or activities that may or may not happens, quantifying the expected effect, prioritizing, planning response, implementing the response and following them up. The Nordic tradition in uncertainty analysis is typically a group process lead by a facilitator who is expert on uncertainty analysis and a resource group of experts within the areas of the project Klakegg, O.J (1994). Typically ten to twenty experts are involved in the process, and it goes on for 1 to 4 days. It is a top down approach and typically a kind of Monte Carlo simulation tool is used, where the time or cost model can be made out of the input from the resource group that is involved in the process. The model can be complex or simple depending on the purpose. But if a simple model does the job and if the results are reliable enough for the purpose, a simple model is preferred. The uncertainty analyses process can be divided in three phases – The uncertainty analyses process can be divided in three phases – Phase 1, Purpose of analysis – address the six Ws of the risk management process Ward &Chapman, (2004). Phase 2 Uncertainty analyses and phase 3 - Documentation of the result of the process. Torp et al (2008), Klakegg et al (2009), Klakegg, O. J. (1994), Simister, S. J. (2004).

Table 1 The uncertainty analyses – step by step approach

<b>Phases</b>	<b>What</b>	<b>Technique</b>
<b>Purpose of analysis</b>	1. Defining the objective for UA	
	2. Defining what should be calculated	
	3. Defining a cost structure for the base alternative	
	4. Establishing the UA model in a cost estimation tool	Crystal ball or similar tools
<b>Uncertainty analyse</b>	5. Identifying the opportunities and threats	Successive principal
	6. Estimation of the cost for all elements,	
	7. Low Cost- most likely Cost and High cost	Triple estimate
	8. Estimation of the uncertainty all elements impact	Monte Carlo
	9. Finding expected value E(P) and Varian's Var (X) for cost elements, factors and for the total project	probabilitet-curve
	10. Develop uncertainty response to the "Top	Tornado diagram

	ten uncertainty's"	
<b>Documentation</b>	11. Report – documentation of the process and its premises presenting most likely cost for the project (P50 estimate) and continece	Uncertainty matrix Uncertainty log
	12. Top ten list – most important opportunities and threats	
	13. Cuts – list over elements that can be taken out of the scope	

The end result from this process is a picture that describes which cost items or uncertainty factors that are most uncertain and a probability distribution of the cost or time estimate for the project with expected costs and the uncertainty measured as standard deviation.

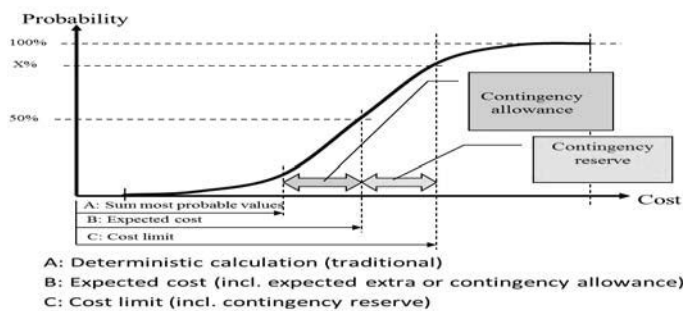


Fig. 1 Probability distribution of the cost estimate for a project  
This method for uncertainty analysis was typically used in the early phase of the project and it is closely related to the thinking of Stage gate models Johansen et al 2012(3). A stage-gate model used in Norwegian public project is illustrated in fig. 2



Fig. 2 Stage gate model

"The logic in the stage gate model is based on the principle that one starts with different alternatives (concepts) and develops them up to a stage gate, where the project owner decides which concept that should go over to the next stage. " Johansen et al (2012). (3) This correspond to the thinking that is described in the cost estimation guide and the AACE International Estimation classification. The uncertainty analysis is therefore an important tool in term of picking the right project at decision gate 1 and 2, and in term of establishing the budget that the project should stick to after passed decision gate 3, where budget are authorized and controlled. The American standard suggest that accuracy range at DG 3 should be between - 10 /-20 (low), and +10/+ 30 (high). In Norway it seems like uncertainty analyses provide result that is significantly more precise, the result from the analyses are typically in the range of - 10 to +10 % on a class 3 estimate. In 2006-2007, 56 large public projects were investigated in Norway. The average standard deviation is shown in table 2 for different types of projects. The average in total was calculated as 10,5 %. For single projects it varied from 4 % to 21%. See table 2.

Table 2. Cost uncertainty and standard deviation

Type of project	Cost uncertainty, standard deviation (%)Effect
Roads	11,4 %
Public buildings	9,8 %
Defence procurement	8,5 %
Railway	14 %
ICT	7 %
Other	12 %

Still, the question remains; can we really trust the results from this process, and is this a realistic picture of the uncertainty? And are we able to calculate a realistic expected value, compared to the final costs of the project?

#### PART IV: Five challenges with - Uncertainty analysis

We have identified five challenges that influence the result from the uncertainty analyses.

They are:

1. The expected value / the base case challenge
2. The detail challenge
3. Realistic Standard deviation in all phases of the project challenge
4. The human/team challenge
5. The lost opportunity Challenge

**The expected value / the base case challenge** - In Norway, we use uncertainty analyses in the early stage of the project screening to find the expected value of the different concepts that are analyzed. The purposes of the process is more about identifying the "right project" then finding the right expected value. This means that mutual relations between different concepts of uncertainty and expected value are often more important than estimating the true expected value of the different concepts in the early stage of the process. This means that a project that is chosen as the "best project" doesn't necessarily signal the true and correct end cost in the two or three first uncertainty analyses that is conducted in the project. In fig. 3, we illustrate this challenge by showing the result from 7 uncertainty analyses from a building project ending up with 7 different answers to the question what is the expected value of the project, and increasing the value of the project all the way during the project process.

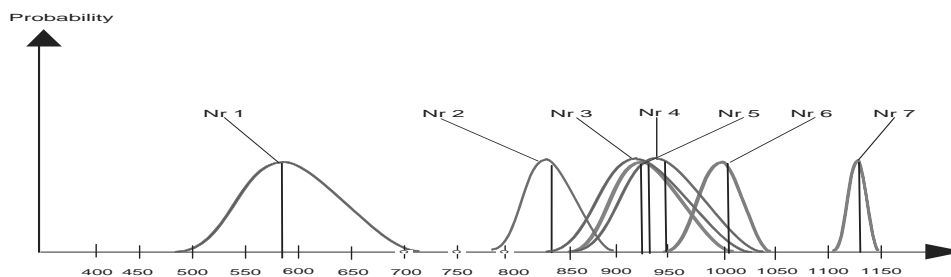


Fig. 3 Seven analysis – 1- 5 planning phase 6- 7 in the execution phase

This building project may illustrate how uncertain projects really are and how poorly some projects perform in term of "guessing" the expected end value of the project. But, it also points out that what we plan for in the early stage of the project will not necessarily be the same at the completion of the project. We will suggest that in many cases what we estimate in the uncertainty analysis is the base case – that means what we believe at the current stage of the process that will be delivered at the end of the project. And, we estimate this as accurate as possible at the current stage. Estimating the cost of project without really knowing what

the end result is going to be will mean delivering estimates with high uncertainty. Still, to get project approval, we need estimates with relatively low uncertainty. Based on our experience we suggest that projects in most of the cases give estimates that are as good as you can expect based on the available information. The uncertainty analysis can send out two sets of wrong signals – they give poor signals to the owner in term of expected end cost and they underestimate the uncertainty. The uncertainty analyses number 2 in the fig 3. estimate the costs to about 840 mill NOK with a relative standard deviation of +/- 5,2 % . The real uncertainty when compared to the end result reveals that uncertainty at that given stage in reality was much higher. A more realistic range of uncertainty seems to be to be 840 + 30%. Uncertainty in that range however, would be considered unacceptable. In the building case, we saw that the project delivery in term of m<sup>2</sup> increased by 25% and that the end time was adjusted by two years between analysis 3 and 4 – the two analyses carried out by a 6 months interval and both analyses had low level of uncertainty. But, the reality shows that the first four analyses were based on the wrong assumptions in term of size and capacity compared with what the project ended up building - all four analyses fall short in predicting the project's final cost, although they appeared to be secure of the result. It seems like nobody really questions if the base case was realistic and correct compared to what the project should deliver. In other words, you are very sure about something that you are very unsure of delivering.

**The detail problem-** The uncertainty analysis method that we discuss in this paper was designed to be a top down approach for the early phase of the project lifecycle. The method was designed for finding the expected value and expected time based on limited information in the early stage of a project life cycle. Ideally the process should focus on the big picture and not all the details. It should focus on the most important items – uncertainty factors or contracts with largest uncertainty and activities that are most important for achieving the project objectives. Based on our experience, we have observed that a lot of the uncertainty analyses that have been conducted have drifted away from the original concept. Today we see two trends:

1. The uncertainty analyses are used at later stages of the process with more details available. This means that project can bring more elements and more details into the uncertainty analyses.
2. The project size is increasing. This means more subprojects and in turn more activities appear in the process.

But unfortunately both trends also mean that the uncertainty may be lost in the calculation and estimation of the details. In 1995 - 2005, 500 mill NOK was considered as a cost that characterizes a big project by Norwegian standards, and the uncertainty analyses had typically 20 – 35 elements that was estimated in the process. Today, the average project size in public sector is often higher than 1 billion NOK and average numbers of elements has increased to + 50 elements. Seen from the project perspective, the details are necessary to give a realistic estimate in the process, and they will be skeptical to the result, if the uncertainty analyses are to aggregate the uncertainties. From an uncertainty analytical perspective, we know that too detailed models will mean that uncertainty will be "calculated away". Today, we see a trend that projects intend to combine the better of the two mind-sets - by allowing detail structures with a lot of elements and discussing factors and overall conditions in the same process. The process for identification of uncertainty is good for the project team, and they feel that results are realistic and reliable. The resulting uncertainty is unfortunately often unrealistically small in the vast majority of cases that we have seen using this approach. If the goal is to avoid calculating away the uncertainty, we must either keep the analysis at a high level – that means less details in the analyses and using uncertainty factors that maintains contextual variables, or create highly sophisticated models where correlation between items and factors are maintained.

**Realistic Standard deviation in all phase of the project challenge** -Textbooks and company standards operate with uncertainty expressed in standard deviation that typically should be +/- 50 % in the beginning before passing DG 1 , +/- 25 % between DG 1 and DG 2 and typically +/- 10% when the project passing DG 3 and from there it will decline to nought when the project is handle over. The AACE International Estimation classification states that

concept screening and feasibility studies estimates typically should have variation from -30% to + 50 % and -20 to + 30 % at budget authorization and control. Studies of more than 100 Uncertainty analyses done in the last 10 years – conducted by the authors of this paper show a different pattern - the standard deviation in % is normally considerably lower than suggest in the AACC standard. US . dep of energy - Cost estimating guide (2011)

Table 3 Concept screening analyses feasibility studies and planning phase budget authorization and control – check estimate bid/tender

	Type of project	Total nr of projects/analysis	Standard deviation in %
<b>Concept screening analyses</b>	Public buildings	34 project – Schools	From 13,7 % to 21 % average 16,1 %
	Road project	16 tunnel /bridge 15 tunnel /bridge	From 12 % to 24 % average 20,56%, From 11-% to 26% average – 19,26
<b>Feasibility studies and planning</b>	Public buildings (schools theatre etc)	6 project	From 6 % to 12% average 8 %
	Hospital	20 +	
	Road	15+	
	Railroad	15+	
	Road project	3	
<b>Check estimate bid/tender</b>	Public buildings (schools theatre etc)	10	From 1% to 3% average – 2%

Based on our experience we observe that recommended uncertainty level according to AACC standard is rare in the Norwegian analyses and that the uncertainty analyses often give a considerable more accurate result than the standard suggest. In table 3, we summarized the range we have observed in uncertainty analyses the past 15 years.

Table 4 Theoretical and empiric level of standards deviation in 5 phases

Analyse phase	(Standard deviation) Opportunity		(Standard deviation ) Threat	
	Theoretical	Empiric	Theoretical	Empiric
1 Concept screening	-40%	<b>-20%</b>	+ 50%	<b>+30 %</b>
2 Study or feasibility	-25%	<b>-15%</b>	+30%	<b>+20%</b>
3 Budget authorization	-20%	<b>-10 %</b>	+25%	<b>12%</b>
4 Control or bid/tender	-10%	<b>-5%</b>	+15%	<b>8%</b>
5 Check estimate	-5%	<b>0</b>	+5%	<b>5%</b>

This indicates that a high share of the uncertainty analyses from Norwegian projects shows an unrealistic low uncertainty – and we suggest that this has to do with the challenges mentioned earlier.



**The human/team challenge**-When uncertainty is discussed in projects, we tend to think that we do it more or less objectively and that uncertainty is interpreted more or less in the same way by all the participants in the process. But this is not necessarily the case. Hillson et al. (2005) states that people's chosen state of mind, mental view or disposition with regard to fact or state matter when people interpret uncertainty. The authors label this "risk attitude". People's risk attitude drive project members' behavior – that means that if an uncertain event is observed or presented in an uncertainty analysis process, different participants understand the situation as favorable or as unfavorable or even hostile depending on their individual attitude towards risk. There is also evidence that propose situational factors such as training, role and how accountable the different participants are in relation to the end results Flyvebjerg et al.,(2003) have influence on the project members preferred attitude towards risk. There are also some pitfalls when analysing uncertainty in groups sessions. Hillson et al (2005) talk about group risk attitudes and heuristics, and they list up 5 common heuristic in groups working with identifying risk: Group thinking, the Moses factor, Cultural conformity, Risk shift and Cautious shift. They also point out that this group heuristic often does not occur alone or in isolation, and they are reinforcing causal relationship between them, potentially resulting in the effects of the above mentioned factors becoming even more severe in the uncertainty analysis process. A group offers more insight and experience than a single person can possess – which explains why groups very often are used when uncertainty is discussed Klakegg O, J (1994). Individual heuristic and group thinking may affect how good the group performs in an uncertainty analysis process. This means that the results of the process are depending on the skills and attitudes of the individuals who participate in the process, and the result of the process is therefore clearly not objective. The participants in an uncertainty analysis will often be held accountable for the cost estimates they provide. It is therefore an obvious danger that those who provide estimates actively will add "buffer" to the cost estimate or add unrealistic high uncertainty factors so that the end result of the process will give a "high enough" expected value. Although all participants in the analysis are asked to prepare basic estimates based on a cost break down structure without allowance, and although we tell them that use of triple estimate and uncertainty factors will address the uncertainty in the estimates, we find constantly that buffer is added when cost estimates is discussed. To deal with this challenge, the project management team must have great insight in the price structure on every component of the cost estimate, and very often this is almost an impossible task in large projects. To check if the result of the process is fair, they can use independent expert. Or, they can use benchmarking to control if the estimate is reliable on higher level. Still the challenge remain unsolved - which of the estimates can the project team trust, how big buffer is in the estimates and how much the different stakeholders' expertise, experiences and type of personalities influence the estimation of the uncertainty?

**The lost opportunity challenge – the blind spot of uncertainty** - From our experience as consultants and our experience in the PUS project, we saw the same pattern, when threats and opportunities were handled in the same process – much less opportunities then threats were identified and discussed in the process. Often 70 or 100 threats were discussed compared to 5 to 10 opportunities. We did a follow up study on five of the case that was a part of the PUS projects in spring 2013. We counted threats and opportunities in planning and execution phases and asked the projects how they did in the end – How many opportunities was exploited and what was the effect for the project, and which threats did materialize and what was the consequence for the project in the end?

Case 1: 17 opportunities were identified and 2 were exploited, 40 threats identified and 22 of them had economic consequences – increased cost + 180 to 200 mill

Case 2: 3 opportunities were identified and 0 was exploited, +50 threats were identified and +30 of them had economic consequences – project delays and increased cost + 40 mill.

Case 3: 6 opportunities were identified and 3 were exploited, reduced cost 10 -15 mill., +50 threats identified and 18 of them had economic consequences – project delays and increased cost + 75 -100 mill.

Case 4: 10 opportunities were identified and 2 were exploited, reduced cost 15 -30 mill., 33 threats identified and 8 of them had economic consequences – increased cost + 30-50 mill.

Case 5: 0 opportunities were identified and 0 was exploited, 28 threats identified and 3-5 of them had economic consequences –increased cost + 15- 25 mill.

Total number of opportunities exploited –7, total numbers of threats that had economic consequences 100 - 110. The pattern is more or less similar in all the five cases that we have been looking in to – Why are there so few opportunities in projects? Is it likely that threats are many and opportunities are few in all projects? And, why is so few opportunities exploited in the end?

#### **Part V Conclusion Uncertain analyses -problem and limitation**

The use of uncertainty analyses for establishing cost estimates is more or less mandatory in Norwegian public companies today. The method is well established and the results have big impacts on establishing the cost estimates and budgets in this type of projects. The trend of using uncertainty analyses as a tool in the execution phase makes it even more of a pity that the method is giving the wrong signals to the project management team. Uncertainty analysis is meant to give the project valuable insight in the most important areas that the project management team should pay attention to. We have argued that today's practice have five challenges that must be dealt with if uncertainty analyses should be a useful strategic decision support tool in project in the future. **The expected value / the base case challenge** – Uncertainty analyses often fall short in predicting the project's final cost and even though they appear to produce accurate estimates – the uncertainty is in most cases underestimated in the base case being analyzed. Additionally, we have seen that in many cases nobody really questions whether the base case estimates represent a realistic picture of the end cost.

**The detail challenge** -the calculated uncertainty disappears during the cost estimation process. As details are added to the cost estimates, the results seem to indicate more and more precision, even if in reality nothing has changed. **Realistic Standard deviation in all phase of the project challenge** – the uncertainty analyses fails to give a realistic picture of the uncertainty involved in big projects. **The human/team challenge** –when the participants in an uncertainty analysis learn that the uncertainty associated with cost estimation of the project has a direct impact and learn that they will be held accountable for the cost estimates they provide, then it results in an obvious danger that those who provide estimates actively will add "buffers" to the cost estimate or add unrealistic high uncertainty factors so that end result of the process provides a "high enough" expected value. The consequence will often be a higher expected value with unrealistically low uncertainty. **The lost opportunities** - Exploiting opportunities often requires that project owner and project management team accept changes and have the will and the power to alter the solutions or deliverables described in the plans and in the project management documentation. This is often a difficult task, to motivate to change; the opportunity must be significantly better than solutions that are planned, because implementing an opportunity means that the project must spend money and time to change plans or in worst case; change the whole concept. We see that many projects are conservative to new ideas and change, and that they are not seeking new opportunities. Some opportunities will normally be identified in an uncertainty analysis workshop, but this doesn't mean that the participants actually utilize the opportunities after the workshop is over. What we observe in the uncertainty processes and projects that we have been involved with, is a low willingness to actually do something with the identified opportunities. We believe that uncertainty analyses should be a highly valued tool, and when used properly it could contribute significantly to add value to the projects. But, we also think that today's practice are faced with challenges that must be overcome to avoid project management teams starting to disbelieve in the result from the analyses. If the uncertainty analysis is not giving signals about the end cost and fail to give signals about which cost item or factors that are important to manage, then there is not much point left in doing the analysis.

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**Nr 2 Stakeholder benefit assessment - Project success through management of stakeholders.**

# Stakeholder benefit assessment – Project success through management of stakeholders

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## Abstract

This paper discusses how a project should deal with its internal and external stakeholders who are associated with determining the project's objectives and uncertainty issues. Our experiences during 15 years of uncertainty assessment in many different sectors show that stakeholders are subjective and influenced by the objectives or effects of the project more than expected. This paper focuses on the relationship between the stakeholders and opportunities. We conclude that projects to a little extent find opportunities because risk and opportunities processes not are separated. From our point of view, projects can find and exploit opportunities and benefits to a greater extent if they use a defined opportunity management process. This paper has four parts. Firstly, rationality and methodology are presented. The method that we adopt is of qualitative nature. In the second part, relevant theories are described. Part three presents our ideas about the connection between stakeholders and uncertainty. And finally, conclusion and a description of further research wind up the whole discussion.

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*Keywords:* Mega project; Uncertainty; Opportunity management; Stakeholder management

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## 1. Method and research design

Working with research, project management and as consultants in the field of uncertainty management over the last 15 years we have observed that opportunities are drowned in the focus on risk. Only to a small extent do projects identify opportunities and exploit them. Some authors, for instance, Hillson et al (2012) Cooper et al (2005) suggest that dealing with opportunities are more or less the same as dealing with risk and that there is no need for separate processes. This view is also supported by the risk standards on the market (market?). This does not correspond with what we have observed in practice. Our observation is that projects have a focus on uncertainty management which in theory should consist of the dual focus; risk and opportunities management. Our observation is that projects only do risk management, opportunities are seldom identified and if they are identified, they are rarely exploited. This phenomenon has been the same over many years and none of us can recollect any deviation from this observation. Our conclusion is that we need to rethink how we manage uncertainty if we really want to utilize the opportunities.

Uncertainty is often said to have its root cause in the lack of available information, available knowledge or competence (Kolltveit & Reve, 2002; Christensen & Kreiner, 1991). In a project context, uncertainty management has traditionally been synonymous with risk management (Hillson, 2007). Uncertainty can be positive or negative; positive as opportunities and negative as threats (Loch, De Meyer, & Pich, 2006; Perminova, Gustafsson, & Wikström, 2008). Some use the term risk management to denote exclusively managing

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threats, and some others consider risk management as an umbrella term for describing the management of both threats and opportunities (Hillson, 2004). Traditionally, both project literature and project practice have focused much on identifying, evaluating and managing threats – or, as some call it, risks (e.g. Simister (2004) or Ward and Chapman (2004)). Over the last decade, there has gradually been a stronger focus on how to manage the opportunities facing the project. Ward and Chapman (2004) introduced the term uncertainty management to be used in preference to the terms of risk management and opportunity management. Supported by Hillson (2004), they promoted the idea of focusing on exploiting opportunities as well as mitigating risks. In this paper, we use the term uncertainty to include both the positive effects (opportunities) and the negative effects (risk). When our discussion touches upon others' definitions, then we use the term that the corresponding authors adopt.

This paper concentrates on identifying explanations for differences, i.e. qualitative descriptions of why and how stakeholders are connected to and have influence on uncertainty in general and on dealing with opportunities in particular.

All three authors have been part of large research projects that have special focus on uncertainty analysis and uncertainty management called "Practical uncertainty management in the project owner perspective" – in short, the PUS-project (2005-2010) [www.nsp.ntnu.no/PUS](http://www.nsp.ntnu.no/PUS). The ideas behind this paper have grown from developing methods and testing new ways to deal with uncertainty together with participants in this project.

The basis for the writing process was the discussions and analysis of the joint experiences and individual interpretations of our findings. This paper is a product of collective reflection of our experience and knowledge. It is qualitative in the sense that we do not use any quantitative or statistical evidence or methods in our approach in this paper.

## **2. Stakeholder – Uncertainty and opportunities in projects**

A project stakeholder can be defined in many different ways. The PM standards in project management define stakeholders as: "Persons and organizations such as customers, sponsors, the performing organization, and the public that are actively involved in the project, or whose interests may be positively or negatively affected by the execution or completion of the project" (p. 246) PMBOK, PMI (2008) or "People or groups, who are interested in the performance and or success of the project, or who are constrained by the project" (p. 42) ICB, IPMA (2006) or Any individual, group or organization that can affect, be affected by, or perceives itself to be affected by an initiative program, project, activity, risk" (p. 313) PRINCE2 (2009).

Stakeholders are also discussed in project management literature focusing on uncertainty/risk for instance, Cooper et al (2005) Hillson (2012), Flyvebjerg et al 2003) and in more generic project management texts books Arto et al (2011) Rolstadås (2008) Mikkelsen and Riis (2003). Cooper et al 2005 says; "all project and procurement involve at least two stakeholders; the procuring entity (the buyers) and the supplier of goods and services (the seller). In most projects, though, there is a wider set of stakeholders as well, whose desired outcomes must be consider when planning a project." The authors also say that stakeholder analysis is usually undertaken at an early stage of planning and that stakeholder analysis is an important part of the risk assessment activities. Hillson and Simon (2012) say that stakeholders are "Any person or party with an interest in the outcome of the project and/or an ability to exert influence. This correspond to Arto et al (2011) definition that stakeholder's are individuals, groups, or organizations that the project may affect or that can affect the project. The authors say that stakeholders can have a direct or indirect connection to the project, or to the resulting product. The connection can be based upon a possibility to affect the result of the project directly or indirectly. Stakeholders also include the groups that the project affects but that do not necessarily have the opportunity to affect the result of the project. These groups can nevertheless have an indirect connection to the business; they can, for example affect the company image formed in the market. And, they also provide a list over the most common stakeholders in projects,

Project manager, project organization, project team, people participating in the project, organization unit of the company making the project, customer, user, buyer, sponsor or project owner, suppliers and service providers, officials and authorities, financiers, media, other target

groups, competitors, society in a broader sense. And they of course make it clear that a complete list of stakeholders is impossible to provide.

There are several authors that have discussed how stakeholders are related to project uncertainty. Cooper et al (2005) Ward & Shapman (2008), Hillson et al and Johansen et al Klakegg et al Flyvebjerg et al (2010) have discussed how stakeholders are connected to the project's uncertainty. In the next session will we elaborate on some of the issues that, in our view, show how stakeholder management is related to uncertainty, and how stakeholder personality and role in the project organization may make difference in interpreting uncertainty.

### *2.1 Stakeholder management and Uncertainty*

Ward & Chapman (2008) emphasize the importance of the link between stakeholder and risk, and say that an active approach to the stakeholder is based on the analysis of project risk. Cooper et al. (2005) says that "Stakeholder analysis is important in risk assessment for most activities." Krane et al (2012) (p5) says "that successful stakeholder management relies on effective communication with all stakeholder groups. And quite often, good communication with critical stakeholders will become a crucial element in keeping the project uncertainty at an acceptable level".

Klakegg et al 2009 says that (p4) "On an individual level a person's psychology and attitudes towards risk and uncertainty are important – people think differently about similar issues and they assess risks differently. This has implications for how uncertainty is approached in analysis: how a question is asked matters (Jørgensen 2004). People's ability to imagine the future is limited and the level of precision in judgment and communication about uncertainty is low (Teigen 2006)."

The perception also depends on how clear an understanding the stakeholders have about the process that will lead towards the objective - i.e.; how the project will evolve. How uncertainty is assessed in a project is influenced by individual events that the project organization experiences. But it is also affected by how the various members in the organization interpret events happening inside and outside the project, and by the conditions / elements that the project owner and the society emphasize while the project is carried out.

Cooper et al (2005) suggest that dealing with uncertainty should be linked to the management level in the project. The bigger the threat or opportunity are the higher in the leadership hierarchy should it be analyzed and decide.

They suggest that:

- Extreme threats or opportunities' - should involve senior level management
- High level threats or opportunities' - should involve senior executive levels
- Medium level threats or opportunities' - managed by specific response procedures
- Low level threats or opportunities' - managed by routine procedures without specific application of resources

This description points out that extreme and high level threats or opportunities are linked to how they affect the project objectives, and therefore there is a need for focus from the project management team and the project owner.

### *2.2 What do we mean by opportunity in projects?*

The word opportunity in projects can have several interpretations. One possible interpretation is that the project itself is the opportunity and that the desired change or effect for the stakeholder is what we should consider as opportunity. Another way to look at it is that opportunities are all factors or variations or events that make the project's objective better than originally planned. One could also say it is possible to talk about opportunities as some solutions that we didn't see in the beginning, something that just occurred, something positive that we could not foresee or something that is more or less out of our control but still positive or favorable or better compared to the original plan and or concept. Bringing an opportunity into the project means that the project must allow instability for a short time period, and you need a project sponsor or manager that has the power, ability and willingness to change the

plan or concept if they believe that the opportunity may give a better result. If uncertainty is defined as controllable and non-controllable factors that may occur, and variation and foreseeable events that occur during a project execution, and that have a significant impact on the project objective.

Threats can be defined as factors, variations and events that may lead to undesired changes to project objective, scope, resources, frame conditions; that make the project cost more, spend more time, or deliver less quality than agreed upon. Opportunities can be defined as factors that may lead the project to deliver the same quality in less time or at a lower price than agreed upon at the beginning of the project.

### 2.3 Uncertainty – objective facts or subjective believes?

When uncertainty is discussed in projects, we tend to think that we do it more or less objectively and that uncertainty is interpreted more or less in the same way by all the participants in the process. But, this is not necessarily the case. Hillson et al (2005) says that the mental view regarding facts when people interpret uncertainties is not objective, the authors identify this as risk attitude.

People's risk attitude affect project members behavior, different participants can understand the situation as favorable or as unfavorable or even hostile depending on their individual attitude towards risk. Situational factors, such as knowledge, role and how accountable the different participants in the project are to the end result have influence on the project members preferred attitude towards risk (Flyvebjerg et al., 2003). Hillson et al. (2005) list 6 situational factors that have influence on how people in a project react on a given uncertainty:

1. Level of relevant skills, knowledge or expertise - prior knowledge or not, skills or not?
2. Perception of probability and frequency of occurrence – unlikely or not?
3. Perception of impact magnitude, either severity of negative threats or size of positive opportunities – high or low perceived positive or negative impact
4. Degree of perceived control or choice in the situation (manageability)- manageability high or low?
5. Closeness of the risk in time – near future or further away in time?
6. Potential for direct consequences – impact on the group or others?

It is therefore likely that the results from uncertainty analysis processes are subjective results. Hillson et al. (2005) add what they call heuristic factors in order to understand the behavior towards risk. Heuristic factors are underlying psychological factors that operate on the subconscious level, and are therefore less controllable. (2005) Typical underlying heuristics are:

1. Availability -more memorable more significant
2. Representativeness - using similarities and stereo types
3. Anchoring and adjustment starting point and variation around it
4. Conformation trap -seeking and weighting "evidence" ignoring contrary data

The heuristics have something in common. They help to simplify the decision making process and reduce the amount of data to be considered and lead the individual more rapidly to a decision. Heuristic factors can explain individual errors in identifying and analyzing uncertainties. Understanding heuristics can therefore make us aware of pitfalls that may occur in the uncertainty process.

There are also some pitfalls in analyzing uncertainty in groups. Hillson et al. (2005) talk about group risk attitudes and heuristics and list 5 common heuristics.

1. Group thinking  
Member of cohesive group prefer unanimity and suppress dissent
2. The Moses factor  
It Influences person's risk attitudes is adapted against the personal preferences of group members.
3. Cultural conformity



- Making decisions that match or follow the group or organizational norm
- 4. Risk shift
  - More risk seeking than its constituents individuals
- 5. Cautious shift
  - More risk averse than its individual members

They also point out that this group heuristic often does not occur alone or in isolation, and they are reinforcing causal relationship between them. This can give severe biases in the uncertainty analysis process.

### 3. Stakeholder and opportunities

Uncertainty is said to be a two sided coin – threats and opportunities. However, in practice, there is a significant focus on dealing with threats when it comes to managing uncertainty in projects, and less focus on the opportunities.

Some authors, Hillson et al. (2012) Cooper et al. (2005) suggest that dealing with opportunities are more or less the same as dealing with threats and that there is no need for separate processes. According to Hillson "A risk is any uncertainty that, if it occurs, would have an effect on achievement of one or more objectives". If the uncertainty is beneficial or positive for the objective, then the risk becomes synonymous with opportunity and handled in the same process/model, The Active Threat and Opportunity Model (ATOM). This model is scalable and applicable to all projects. Cooper et al. support this idea and say that "the general risk management process applies equally well to opportunities, requiring only minor adjustment". They support identifying opportunities is similar to identifying risks.

From our experience as consultants and in the PUS project, we saw the same pattern, threats and opportunities were handled in the same process. We also saw that opportunities were few and often not exploited, often 70 or 100 threats compared to 5 to 10 opportunities. Why are there so few opportunities? Is it likely that risks are many and opportunities are few?

We think there are at least eight reasons to rethink the way we deal with opportunities in projects.

1. There is a lot more focus on threats or risk than opportunities in a typical uncertainty analyses process –
  - More time and focus are spent on the threats than opportunities
2. If you ask stakeholders about risks, they easily list their worries -
  - The participants have no problem relating the threat to objective
3. If you ask a stakeholder to identify opportunities -
  - They often have trouble identifying what could be considered an opportunity
  - Opportunities are often linked to consequences of the project and not to project objectives
4. "As planned" is considered as the best the project can hope for
  - faster, cheaper or higher quality to the same price is considered as "unrealistic"
5. The risk registers - has normally a lot more threats than opportunities
  - Less than 20% of the identified uncertainties are opportunities
6. Reporting
  - top ten threats or risk are normally reported, opportunities are sometime reported and sometime not
7. Studies on project practices show that projects, only to a small extent, are actively seeking opportunities in the execution phase (after the contracts with the main contractors are signed).
8. The context changes and the project team learns it's therefore likely that opportunities will emerge.

Johansen et al. (2012) Findings from the PUS research project clearly indicate that project teams have the intention to focus on both opportunities and threats. In a Norwegian survey of large project organizations (Hald & Langlo, (2011), a response to a question regarding the focus on uncertainty management in their projects, 76% responded that it was "mainly on risks, but also on opportunities", 15% said they did "equally focus on threats and

opportunities”, and just 7% responded that they “only focused on risks”. However, those intentions expressed through the survey do not seem to be reflected by the contents of the projects’ risk registers. In another study done in the PUS project (Krane, Rolstadås, & Olsson, 2009), analyzing the risk registers of 7 large projects, it was revealed that 81% of the risk elements could be categorized as threats, 3% as opportunities and 16% could turn out as both threats and opportunities. Johansen et al. (2012) p 32 - Studies on project practices show that projects, only to a small extent, are actively seeking opportunities in the execution phase (Krane, et al., 2010; Johansen et al., 2013). It does not mean that such opportunities do not exist there; it only means that many projects miss opportunities because they lack focus on this issue, when it comes to managing uncertainty.

We have in the past five years tested what happens in uncertainty workshops if we ask the participants what the opportunities are and then ask them to identify the threats, instead of asking what the uncertainty is. If we ask the participants to identify the project's uncertainty, then we see a clear tendency that it is the threats that come up in the discussion, typically at a ratio of 10 to 1, comparing threats and opportunities. If you ask the same question in the execution phase of the project, then hardly any opportunities are brought up. We therefore started to test what would happen if we started the uncertainty analysis process by identifying the opportunities and then the threats.

We changed the lead question and asked in the following way:

*“Please write down all the opportunities that this project should exploit during the project that makes the project better, cheaper, faster or opportunities that may arise after the project is delivered / finished (as a positive effect of the project), and then please write down individually all threats that we should avoid or control.”*

The adjustment of the process, asking for opportunities first, contributed to identifying more opportunities or potential ideas that could improve the project deliverables or effect. Instead of 5 to 10 opportunities, there were 20 to 40 possible ideas that could be potential opportunities. But, we observed some other rather interesting pattern as well. Participants in uncertainty workshops have more or less the same view on what the threats and possible consequences are and they relate the threats to objectives. When opportunities are discussed the picture is far more inconclusive or foggy.

When opportunities are addressed the participants view them from their own role. Ideas which are identified are not necessarily closely related to the project's objectives. Stakeholders often advice a change to solution, typically they see new or better technology as an opportunity. Some stakeholders say there is no opportunity left when the contract is signed (project contractors), some talk about opportunities that will arise as a result of the project and some talk about how good execution, new technology and so forth can make the project better, faster or cheaper (for project management team). Another tendency is that stakeholders often describe what they wish if the opportunity happens. This means that we typically will get a mixture of cause, uncertainty elements, possible effect, ideas and strategy for managing the opportunity. It is therefore necessary to go through the different ideas in a second round to analyze and clean the data.

A fourth aspect that we see is that identifying and dealing with opportunities are closely linked to who will gain or lose. Who will benefit from the project and who will benefit from the opportunity that someone in the group has identified? For threats it is often easy to see who will gain if the threats happen, but that it is often unclear when opportunities are debated and discussed.

Exploiting opportunities often requires that the project owner and the project management team accept changes and that have the will and the power to change the solutions or deliverables described in the plans and in project management documentation. This is often a difficult task, to motivate change, the opportunity must be significantly better than solutions which are planned, because implementing an opportunity means that the project must use money and time to change plans or in worst case, the whole concept.

We see that many projects are conservative to new ideas and change, and that they are not seeking new opportunities. Some opportunities will normally be identified in an uncertainty analysis work shop, but that doesn't mean that the participants actually utilize the opportunities after the workshop is over. What we observe in the uncertainty processes and

projects that we have been a part of, is a low willingness to actually do something with identified opportunities.

If a project management team believes that they have enough money and time to deliver what has been agreed upon together with the project owner, then their interest for new opportunities is normally limited. Our observation is that many projects don't want to consider new opportunities. They may consider the list of opportunities as a gamble, because it means that they need to change the process or concept, and it may be a gamble that the project management team don't get paid for or have any benefit of.

Opportunities and change are closely related. It is not possible to get an opportunity into the project without the willingness to change what's originally planned and signed for. This means getting an opportunity into the project demands willingness and authority from the project sponsor and project management, since both must disregard something that they earlier in the process have agreed upon as the best.

This suggests that an opportunity has to be extremely interesting to be considered, because:

- The project must be willing to change contracts, concepts and plans to exploit a possible opportunity
- The project must abandon something they earlier accepted as the best solution
- The project must use time and money on exploiting something that is uncertain – they can't be sure of the effect will be positive or give them benefit

We think opportunities must be treated in a separate process. There are a lot of challenges involved in dealing with opportunities. As part of understanding who the stakeholders are, the following questions can be helpful to understand why some stakeholders consider the project or change as an opportunity:

- Who will benefit when the project is executed?
- Who will benefit if then project objectives are delivered?
- Who will benefit if the market conditions become more favorable in the execution period?
- Who will benefit if the political climate becomes better or more favorable in the execution period?
- Who will benefit if the project changes goals/objectives?
- Who will benefit if the project becomes bigger (cost more)?
- Who will benefit if the technical concept is changed?
- Who will benefit if new technology becomes available?
- Who will benefit if the local condition becomes more favorable?
- Who will benefit if the project gets better and more resources?

We think that the techniques for identifying uncertainty and tools for calculating and reporting uncertainty are fine, but they need to create more value for the stakeholder if opportunities are to be taken into consideration. This corresponds with Cooper et al. ideas of using value engineering that often have the effect that opportunities are identified and exploited. We believe that exploiting opportunities are difficult and a different task than dealing with threats. We believe that one of the keys to understand opportunities lies in understanding how different stakeholders benefit from change, what is considered as an opportunity for whom? Analyzing the chain of cause, uncertainty and effect could be viewed as an easy task for an experienced project management team, but very often this is actually quite a difficult task. Different stakeholders can have different opinions on what the project objectives are. And to make the situation worse, some of the stakeholders will change their mind or get new ideas when the project is executed, and some stakeholders will be absent in the beginning of the project. We suggest that it could be smart to try to analyze how opportunities are linked to project goals and how this will affect the different stakeholders of the project.

This is shown in table 1 Goal – cause- uncertainty (threats and opportunity) and possible effect. Table 1. Goal – cause- uncertainty (threats and opportunity) and possible effect

Goal	Cause	Opportunities	Effect –
project objectives	Situation and possible consequence		Project view Project owner view Society view
Who pays for the project (i.e., taking financial risk)	What positive effects occur for the project if the opportunity occurs?	Improved solution-How can the measure be solved and what is the time and cost implications, the measure required?	Society view What's the benefit for the society if the opportunity occurs?
Who determines whether project objectives are accomplished	Which stakeholders get benefit if the opportunity occurs?	Adjusted solution-how can we avoid the threats and what will the measure costs us?	Project owner view What's the benefit for the owner in the production phase if the opportunity occurs?
Which stakeholders get positive benefit of the project's		How large is the probability that opportunity will occur if the measures we put in work as expected?	Project view What is the benefit to the project if the opportunity occurs? – i.e., how much time is saved, how much cost savings can the project anticipate that it is possible to achieve? Or, how much / better quality can we achieve at the same cost if the measure succeed?

Such an approach could help the project to get an overview of the stakeholders- who get the benefit and maybe who have to carry the responsibility for lack of goal attainment.

#### 4. Discussion and conclusion

Johansen et al 2012 (IMPA) discussed strategies that are involved in dealing with opportunities and threats. It's not an easy task to find which opportunities are worth analyzing or exploit. In table 4, we proposed some ideas that can make it easier to analyze how the project, the project owner and the society may benefit from opportunity.

Project view: What is the benefit to the project if the opportunity occurs – i.e, how much time is saved how much cost savings can the project anticipate that it is possible to achieve. Or how much / better quality can we achieve at the same cost if the measure succeed?

- Project owner view: What's the benefit for the owner in the production phase if the opportunity occurs?
- Society view: What's the benefit for the society if the opportunity occurs?

We suggest that that the management team, the owner and the society might have different views and get different benefit of and change and it therefor important to understand this when opportunities are discussed. Seen from the project view, opportunities are about the benefits that a project can get if the project changes something, how much time will be saved, how much cost savings can the project anticipate or how much / better quality can we achieve at the same cost if the measures succeed? Seen from the project owner view the interesting opportunities are the ones that give project owners a higher profit or some other strategic long-term benefits (2nd order consequences). Seen from the society view, opportunities that

increase the positive effect for the society or decrease the negative effects are the interesting opportunities (3rd order consequences). We have observed that the three different stakeholders often have three different views about what are "good" opportunities for them, and this is highly value motivated. This suggests that "good opportunity" is highly subjective and very often based on how they believe they will be "rewarded" and how they "interpret" and "estimate" the future uncertain effect. We think that understanding the values for different stakeholders is equally as important as understanding the attitude to uncertainty, underlying heuristic and group attitude.

Another observation that points in this direction is the work done by Flyvbjerg et al. (2010). They say that it seems like the willingness to gamble or taking opportunities into the project would increase if the project is not held accountable for cost overrun or delays. In organizations where the project management team is held accountable for the budget and company profit, there will be less willingness to exploit opportunities that might jeopardize the budget or the profit margin. This suggests that as in the same way as distance to the uncertainty matters it also seems like the distance to the uncertain reward plays an important role when it comes exploiting the opportunities or not. We believe that the mixed interest and different interpretations of value are key issues to understanding why an opportunity is preferred compared to another. We suggest that understanding the value for the different stakeholders may also explain why so few opportunities are exploited in many projects.

We support the view that the closeness to the threat (i.e., it will affect us more or less personally), what kind of personality we have and that you can be held accountable for the negative consequences play a significant role in the determination to manage and live with threats.

But we also believe managing opportunities is difficult because it often means changes and the top management's attention. We believe that the project owner has to start to ask how the project can optimize its deliverables and get more out of the money and time that is spent on this project if they really want to utilize the opportunities. We will also argue that dealing with opportunities in an effective way may require a separate process or at least special attention in the ordinary uncertainty analysis process.

It is not easy to assess how stakeholders will interpret opportunities. It is therefore necessary to be aware of how their role, experience and personality affect assessing opportunities. And, that stakeholders response often is linked to the reward system and how participants will be held accountable. In order to find and exploit opportunities in the project our recommendation is therefore to separate the opportunity process from traditional risk management process.

A stakeholder analysis covering "all" actors, who may have opinions or requirements regarding the project's goals and future effects / benefits, will in most projects be impossible to set up. One must therefore accept that "all" stakeholders are not covered and that there must be more or less stereotypical assessments. One must also live with the fact that the stakeholder requirements and expectations at the individual level are not possible to identify to its full extent and that stakeholders might evolve over the progression of the project. This means that new needs may come up, the stakeholders may come up with new demands and new goals may occur while the project is under development. This will contribute to creating uncertainty with respect to project deliverables.

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**Nr 3 Uncertainty Management - A Methodological  
Framework Beyond "The Six W's"**



# Uncertainty Management – A Methodological Framework Beyond "The Six W's"

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## **Abstract**

Many projects have to live with high uncertainty because of stakeholders with different demands to the project objectives, project owners who change their mind in the middle of the execution phase and changes in the market or in regulations from the government. Dealing with uncertainty must therefore be an ongoing process and will require a change in focus during the project life cycle. The traditional approach of looking towards the project objective and stick to the plan will be difficult for projects with long timespan and high uncertainty. We will present a framework for projects that have high uncertainty over the project's life cycle. We suggest a framework for uncertainty management consisting of 2 steps for preparing the process, a 5 step group process for identifying, analysing and developing measures for exploiting or controlling the uncertainty and 2 steps for follow up the uncertainty over the project life cycle. This paper has four parts. Firstly, rationality and methodology are presented. In the second part we outline some of the theory, in part three is the nine step framework for identifying, analysing and managing uncertainty described (how). And finally, we present our conclusion and wind up the main ideas that we have presented.

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*Keywords:* Mega project; Uncertainty; Stakeholder management; Opportunity management; Threat management; Risk management

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## **1. Introduction**

Uncertainty management in projects has primarily been based on isolated uncertainty analyses. The analyses have been carried out sequentially, where analyses and follow up are done, but there are often quite a long time between the analyses. The questions based on "The Six W's" have been central in uncertainty management. The drawback by using this method to manage uncertainty is that it gives you only individual snapshots in time for the project. The authors see a need for an overall method for uncertainty management throughout a project's life cycle. Many years of research on this topic have made the authors able to present a nine step framework for uncertainty management, beyond "The Six W's" Chapman&Ward (2003), presented in this paper. Uncertainty is said to be a two sided coin – threats and opportunities. However, when it comes to uncertainty in practice, there is a significant focus on dealing with threats and less focus on the opportunities. We believe that it's almost impossible to foresee or imagine all potential uncertainties (threats and opportunities) that may occur in a project with a long time span (more than 3 year). This means that a project needs to repeat the uncertainty analyzing processes two to three times annually if they want to have proper control of the uncertainty.

## **2. Method and research design**

The framework and methods outlined in this paper has been developed as a part of a big research project that has special focus on uncertainty analysis and uncertainty management "Practical uncertainty management in the project owner perspective" – in short, the PUS-project (2005-2010). The framework that we present correspond to a certain extent to the ATOM framework developed by Hillson and Simon (2012) in UK. When we started the PUS project we didn't know about Hillsons et al. work on developing the ATOM model, and we had no cross-border cooperation with them when we developed our model. In the PUS project different research approaches were used. Literature studies have been conducted covering different areas of relevance (see for instance (Torp&Johansen, 2002) and (Torp, Karlsen, & Johansen, 2008)), there have been several surveys, action research has been carried out in a number of projects, trailing research in others, and also in-depth interviews and discussions with experts. Some of the case studies are also of a longitudinal and qualitative nature, where the authors have been involved as researchers and process contributors repeatedly in all the cases, and in a large number of other industrial and governmental projects. The above description points out that this research endeavor includes quantitative, qualitative and mixed methods. This compound research basis means that we do not refer to just one dataset as the basis for our results and conclusions. Because of the page limitation conference format calls for we will limit the paper to a short introduction of the framework and some of the tools that plays a key role in analyzing and managing uncertainty in big and complex projects. For more detailed papers on uncertainty analysis and uncertainty management we recommend the PUS projects homepage ([www.nsp.ntnu.no/PUS](http://www.nsp.ntnu.no/PUS)).

Developing and testing of the methods presented in this paper was done together with participants from the PUS project and the research approach was an action research approach. The researchers took an active role in the development and testing of the methods, tools and techniques that was developed. The basis for the writing process of this paper has been discussions and analysis of the joint experiences and individual findings in developing the framework that we present in this paper. This paper is therefore a product of a collective reflection of our experience and knowledge. The research is qualitative in the sense that we do not use any quantitative or statistical evidence or methods in our approach in this paper.

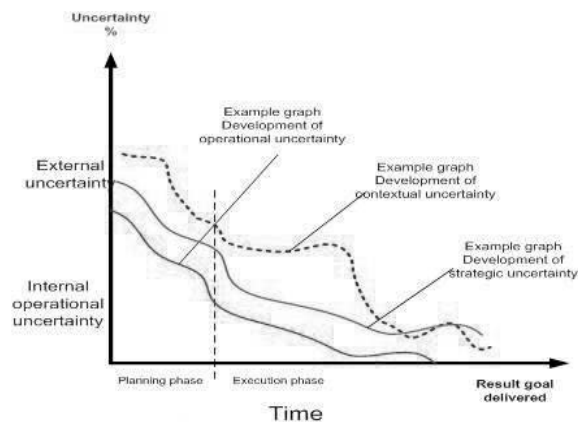
## **3. Uncertainty in projects**

Uncertainty is often said to have its root cause in lack of available information, available knowledge or competence ((Christensen & Kreiner, 1991)). In a project context, uncertainty management has traditionally been synonymous with risk management (Hillson, 2012). Uncertainty can be positive or negative; positive as opportunities and negative as threats (Loch, De Meyer, & Pich, 2006; Perminova, Gustafsson, & Wikström, 2008). Some use the term risk management to denote exclusively managing threats, while others consider risk management as an umbrella term for describing the management of both threats and opportunities (Hillson, 2004). Traditionally, both project literature and project practice have focused considerably on identifying, evaluating and managing threats – or, as some call it,

risks (e.g. Simister (2004) or Ward and Chapman (2004)). Over the last decade, there has gradually been a stronger focus on how to manage the opportunities facing the project. Ward and Chapman (2004) introduced the term uncertainty management to be used in preference to the terms of risk management and opportunity management. Supported by Hillson (2004), they promoted the idea of focusing on exploiting opportunities as well as mitigating risks. In this paper, we adopt the term uncertainty to include both the positive effects (opportunities) and the negative effects (threats). When our discussion touches upon others' definitions, we will use the term that the corresponding authors adopt. Projects have traditionally strived towards predictability and to keep all critical factors under control. However, for large, complex projects such predictability is not the reality (Rolstadås, Hetland, Jergeas, & Westney, 2011). Major uncertainties play a large role in important areas. And especially under such conditions, it will not be a good strategy to strive for maximum predictability, but rather to choose a strategy of flexibility in the project, in order to be able to face changes (Olsson, 2007). Rolstadås et al. (2011) point out that it is a dilemma for decision makers that they have to make decisions based on very little information that is available in the early stage of the project. This dilemma is also described by Arto et al. (2011), and by Alessandri et al. (2004). In this regard, Rolstadås et al. (2011) describe the dilemmas of Capital Expenditure (CAPEX) predictability. The dilemma of CAPEX predictability consists of two important decisions:

- On one hand, CAPEX decision-makers require (inter alia) a certain level of confidence in the prediction of how much the proposed production asset will cost as well as how long it will take to achieve the expected revenue stream.
- On the other hand, CAPEX decision-makers must acknowledge the hard truth that, when all risks related to a project's outcome are considered, this desired level of confidence may simply be unattainable. (Rolstadås, et al., 2011, pp. 2-3)

This dilemma highlights the nature of uncertainty that project managers come across. In order to cope with this dilemma, they suggest that capital projects need a new concept to understand, embrace and exploit project risk, and they suggest what they call a new framework for risk management – “The Extended Project Risk Navigator”. Rolstadås et al. (2011) state that conventional project risk management may increase the predictability of project outcomes, but it tends to ignore the business value that may be added through the project execution phase. And, because of this weakness they claim that risk navigation should also be addressed at an executive level; in fact they claim that the risk management is an executive level responsibility, and that you cannot deal with this only at the project level (one project at a time) in the organization. According to Simister (2004) the risk management process should be commenced as early as possible in a project life cycle, and the process has to be undertaken on an iterative basis since each assessment is a snapshot in time. This view is supported by (Rolstadås & Johansen, 2008), (Johansen et al. 2012) and they suggest that the uncertainty found in a project can be of three different types Operational uncertainty (internal uncertainty), Strategic uncertainty (external uncertainty) and Contextual uncertainty (external uncertainty) and that the uncertainty can increase and decrease throughout the course of the project due to external uncertainties, see Fig. 1

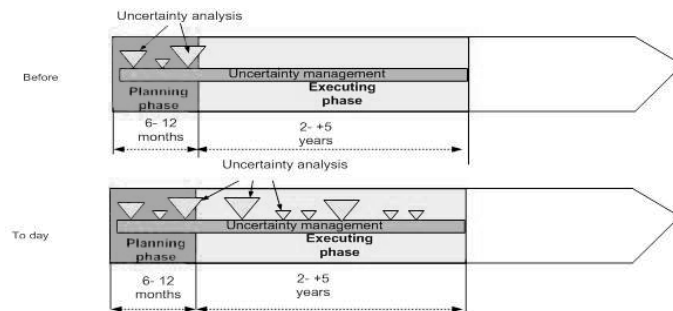


**Fig. 1. Uncertainty during the course of projects - internal and external uncertainty**

For example, competing projects in the market, market fluctuations and economic conditions could give rise to this “type 3” kind of uncertainty. Likewise, choice of social values such as those against counter-cyclical measures that were initiated by the governments in some countries during the financial crisis in late 2008 and 2009 can be a source of such uncertainty - both positive and negative, in terms of opportunities and threats. The uncertainty can increase and decrease throughout the course of the project due to external uncertainties, see Fig. 1. The uncertainty may rise and fall through the entire course of the project. When the project management makes its choices and clarifications, then they will experience that the uncertainty is reduced. But, since the project is a part of a larger whole, many projects experience that uncertainty may increase again if the parent organization makes new choices and priorities. It may also be a result from the society evolving and changing during project execution. Projects that have a long duration – i.e. three years or more– may experience that the conditions and requirements may change several times during the course of the project. The real uncertainty that the project has to deal with does not necessarily decline in a linear manner. And, it is not sufficient to handle only internal uncertainty, if the project wants to achieve success for the key stakeholders..

#### **4. Practical uncertainty management – nine step framework for identifying, analyzing and managing uncertainty**

A project will normally deal with different types of decisions with different type of uncertainty over the planning phase and execution phase. In the beginning the focus is on selecting the best concept and clarifying the project objectives. When this is sorted out the focus shifts to how to deliver the chosen concept according to specification or contract. This means that project members or project consultants that is hired to deal with uncertainty management in the project needs to understand where the project are in the execution process and focusing the process on the specific uncertainties that is relevant for next 3 to 6 months of the project execution period. We therefore propose that a project needs to deal with uncertainty in all phase and we believe that most projects need to deal with different types of uncertainty in the different phases of project – se Fig. 2.



**Fig. 2. Uncertainty analyses (UA) over the project lifecycle**

Based on this we suggest a 9 step framework for identifying, analyzing and follow up the project uncertainty – step 1 and 2 for preparing the process, step 3-7 is a group process (workshop) for identifying, analyzing and developing measures for exploiting or controlling the uncertainty and the final steps 8-9 for follow up the uncertainty over the project life cycle. The purpose with the processes is four divided:

1. Establish and update the project objectives and key stakeholders that "owns the objectives"
2. Identify – evaluate and decide action on the opportunities
3. Identify – evaluate and decide action on the threats
4. Implement and follow-up the actions from the UA work shop.

**5. When should the process be done?**

In a 3 to 5 year project we will recommend at least 5 to 8 uncertainty workshops over the project duration. The duration of the workshop will typically vary between 2 – 4 hours to 2 days depending on the size of the project and the subject/topic to be analyzed in the process. We suggest that the UA process needs to focus on uncertainty for the next 3 to 6 months ahead as well as the more overall uncertainty that is connected to the project objectives and benefit for the project owner (2<sup>th</sup> order consequences) and the society effects (3<sup>th</sup> order consequences) in this workshops. We suggest that follow up and reporting should be done every month and a more overall assessment of the uncertainty should be done at least once or twice per year.

**5.1. Who should participate in the group process?**

The typical stakeholders that participate in this UA workshop are: the project owner/sponsor, the project manager and his team, and the project consultants, and in some rear cases does the contractor and representatives for the end user participate as well. In large or more complex project this process is often led by a facilitator team consisting of a facilitator that "leads" the process and a person that takes care of the documentation of the process. The persons responsible for following up and control the effect of the action between the UA workshops are normally the project management team and the project owner representatives.

**5.2. Practical uncertainty management – step by step?**

The aforementioned nine step framework for identifying, analyzing and follow up the project uncertainty is illustrated in Fig. 4. Steps 1-2 prepares the process, steps 3-7 identify and analyzes the uncertainties as well as decide on action. The final two steps are following up the uncertainties over the project life cycle.

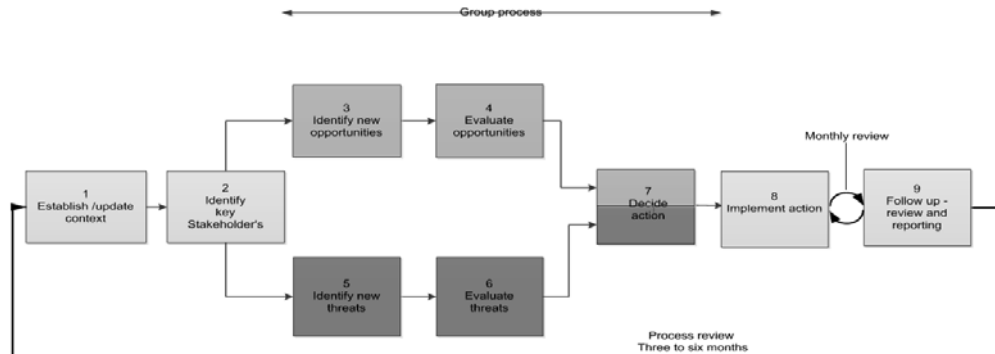


Fig. 3. Practical uncertainty management – 9 step framework

### 5.3. Establishing the context – project objectives – key deliverables (Step 1)

In most projects, people aim at making clear and unambiguous objectives in the planning phase. The reason for this is simple: you need to know where you shall end (your destination) before you start your journey towards your destination. However, it is important to understand that the objectives are less neutral and explicit when a project is started. The objectives will typically implicitly contain the intentions of what the project owner or society wants to achieve through the project within the time and cost limitation set by the owner. What specifically will be delivered in terms of result oriented goals or objectives will often have limited levels of detail, and are usually further refined and developed quite a long period into the planning phase. In addition, we often find that the objectives are perceived differently depending on the point of view that one has of the project. The project owner will often tend to be more concerned about the effect oriented goals and how well the project results can fit with a (carefully defined) business case. The project manager and the project team members, however, will focus more on the result oriented goal and the key deliverables. And finally, future users will typically represent parts of the social perspective, and be concerned about whether the project delivers the parts of the functionality that they have requested. In addition, it appears that a project participant's interpretation and assessment of the actual formulation of the objectives clearly vary with whether the participant was involved in the development of the objectives or not. There is no contradiction between aiming for good and clear goals and acknowledging that the goals can be adjusted or changed over the course of a project. Project goals are uncertain; however, how one chooses to deal with uncertainties is a central issue when it comes to a project's esteem and to its success.

### 5.4. Stakeholder analysis – step by step (step 2)

Several authors (Cooper et al (2005), Torp & Johansen (2004)) have suggested that stakeholders should be analyzed in the project startup. Cooper et al. (2005) stress that a stakeholder analysis should provide a document profile of the most important stakeholder's needs and concerns. "It involves considering the objectives of each stakeholder in relation to the requirement." Hillson and Simon (2012) says that stakeholder analysis is the process of determine the degree of interest, influence, and attitude stakeholders have toward a particular project. (Johansen&Torp Nordnett(2004) suggest at 5 step approach for analyzing the project stakeholders .

1. Identification – who are stakeholders/customer of the project deliverables?
2. Grouping stakeholders in primary and secondary stakeholders – Who is most important?
3. Role clarification – what sort of role do the stakeholder have in the project?
4. Effect of the project – what effect does the project have on the stakeholder?
5. Evaluation – How does the analysis impact further development in the project?

Artto et al. (2011) describes dealing with stakeholders as a more ongoing process and emphasize managing stakeholder relationship as something that will go on from the beginning to the end of the project. Managing stakeholder relationships can be seen as a continuous and repetitive development that consists of, among others, the following subtasks:

1. Identifying stakeholders
2. Collecting information on stakeholders
3. Identifying tasks and roles of stakeholders
4. Understanding strengths and weaknesses of stakeholders
5. Determining a stakeholder strategy
6. Managing stakeholders - predicting the actions of stakeholders; and taking practical measures to manage stakeholders by affecting their attitudes and activities, and dealing directly or indirectly with the implications of their activities by, for example, communicating and using power in relations with them, adapting to their demands, negotiating and compromising with them, ignoring or buffering their demands, and building distance from or closer collaboration with them.

#### **5.5. Identifying the right opportunities and threats (steps 3-6)**

The word opportunity in projects can have several interpretations. One possible interpretation is that the project itself is the opportunity and the desired change or effect for the stakeholder is what we should consider an opportunity. Another way to look at it is that opportunities are all factors, variations or events that make the project objective better than originally planned. One could also say it's possible to talk about opportunities as some solutions that we didn't see in the beginning, something that just occurred, something positive that we could not foresee or something that is more or less out of our control but still positive or favourable or better compared to the original plan and or concept. The term threats is for most people easier to understand and relate to and it can be defined as factors, variations and events that may lead to undesired changes to the project objective, scope, resources, or frame conditions, that make the project cost more, spend more time or delivers Lower quality than that was agreed upon in the beginning of the project. When the uncertainty analyse session is about threats it is normally quite easy to get the participants too come up with events or factors that could go wrong or what they are worried about.

Based on this we suggest that opportunities need specially attention and suggest that the process always should start with identifying and analysing the opportunities and then deal with the potential threats. To identify the opportunities and threats, brainstorming is a suitable technique. Other techniques as checklist of typical uncertainties, interviews of experts (Delphi method) and situation map are also possible to use in the first identifying round. The purpose of the exercise is to bring all the opportunities and threats up on the table so that they can be discussed and managed by the project. Round two of the workshop is about determining the potential positive or negative consequences for the owner of the project if the opportunities pay off or the threats occur/happen. In this part of the UA workshop the participants should try to briefly estimate the potential positive or negative effect for the owner or for the project in the execution phase. What is the potential saving or acceleration effect if the opportunity happens? What is the potential negative effect if the threat happens – cost consequence or delay? Then the participants should estimate the likelihood that the potential opportunity/threats will occur, in terms of ranges of likelihood– almost certain > 50 % , likely from 25 -50%, possible 5- 25% , unlikely 1– 5 % , and rare <1 % . In the process we recommend that the participants should spend as little time as possible debating likelihood and consequence of the potential opportunities and threats. The whole idea behind the exercises is to find the opportunities and threats that matter most in term of project success – this means finding the opportunities and threats with highest consequence and highest likelihood and then spends time together to find actions so that the most important uncertainties are dealt with in an effective way.

#### **5.6. Implement action – Uncertainty matrix and focus list – example's tools for managing uncertainty (Step 8)**

The end result of the process is a "top ten"-list of the most important quantitative and qualitative uncertainties. "Top ten" should have the 3 to 5 best opportunities and 5 to 8 most important threats for the upcoming 2 to 6 months. The basis for the list appears by

multiplying probabilities and consequences. The uncertainty with the highest number would be on top of the list. These opportunities and threats should be placed in an uncertainty matrix, as shown in Fig. 4, to illustrate which uncertainties needs special focus. We recommend letters for opportunities and numbers for threats to easily distinguish them. More than 29 opportunities are rare, but in large projects more than 50 threats are quite common.

Uncertainty - matrix	Consequence							
	Opportunity				Threat			
	Extra large >10 mill	Large 2 - 10 mill	Medium 0.5 - 2 mill	Small < 0.5 mill	Small < 0.5 mill	Serious 0.5 - 5 mill	Critical 5 - 20 mill	Catastrophic 20 mill +
Almost certain >50 %	A					4	1, 3	
Likely 25-50%		B				6	2	
Possible 5-25%		C	D			7	5	
Unlikely 1-5%						8		
Rare <1%								

Fig. 4. Uncertainty matrix

The last part of the workshop is about deciding what type of strategies that should be used to deal with the opportunities and threats. Several literature sources (PMBOK; Hillson, 2004) point out that there are at least 6 or 7 strategies that could be chosen as a response to manage uncertainty, possible strategies are found in Table 1.

Table 1. Strategies for uncertainty management response - opportunities and threats

Opportunities	Threats
Exploit	Avoid
Share	Transfer
Enhance	Mitigate
Accept	

When the strategy is chosen the action that is agreed upon should be specific in terms of who is responsible and when should the action take part and when should we control the effect.

### 5.7. Follow up – review and reporting (Step 9)

Dealing with uncertainty means implementing the chosen strategies in the project and deal with the opportunities and threats that project face in the next 2 to 6 months. We suggest that the project should follow up the uncertainty on a monthly basis. After one month the project management team should ask the following 10 questions:

1. Which of the opportunities and threats is not valuable any longer (delete them from the matrix)
2. Which of the opportunities is still possible to take?
3. Any new opportunities since the last update of the matrix?
4. What is the possible value and likelihood of the new opportunities? (introduce them to the matrix)
5. How should we deal with the new opportunities ?- Find new actions and assign responsibilities and agree the control date on the new opportunities
6. Check of existing opportunities – has the action made them more likely or given them a new value? (change position in the uncertainty matrix)
7. Any new threats since the last update of the matrix?
8. What is the possible value and likelihood of the new threats? (introduce them to the matrix)



9. Check of existing threats– has the action made them more likely or given them a new value (change position in the uncertainty matrix)
10. How should we deal with the new threats? Find new actions and assign responsibilities and agree the control date on the new threats.

The last part of the process is maintaining the focus list and the uncertainty matrix. After a second round of the process the revised uncertainty matrix can for example look like this, see Fig. 5.

Uncertainty - matrix	Consequence							
	Opportunity				Threat			
Likelihood	Extra large >10 mill	Large 2 - 10 mill	Medium 0.5 - 2 mill	Small < 0,5 mill	Small < 0,5 mill	Serious 0.5 - 5 mill	Critical 5 - 20 mill	Catastrophic 20 mill +
Almost certain >80 %	<del>A</del>	E				(4)	<del>1</del>	
Likely 25-50%		B	C		4	<del>6</del>	2,10,11	
Possible 5-25%		(C)	D			7	5,9	
Unlikely 1-5%						8		
Rare <1%								

Figure. 5. Revised uncertainty matrix - one month later in the project

### 5.8. How should the changes in the matrix be interpreted?

Opportunity A and threat 3 and 6 are no longer considered important. This may be because the project have checked them out in more detail and found out that it is not possible to take the opportunity. The project may also have made actions so that they consider threats 3 and 6 can't happen anymore. But on the other hand it can also mean that the effect has occurred and the project already has got the benefit or that the negative effect has taken place, it is no longer an uncertainty, it is a fact and the project knows they have to spend time or money on the event. New opportunities or threats, such as opportunity E and threats 9, 10 and 11, are introduced in the matrix for the first time, and these are illustrated with and different color to make clear for everyone which ones are new this month. Opportunity C and threat 4 has a changed status in the matrix. The project has carried out actions to reduce the uncertainty, and they now believe that status should be changed to a different position in the matrix. This means C and 4 are according to the project staff less likely to happen. If C pays out they can save more money, and if 4 occur they may lose less money.

## 6. Discussion -from uncertainty analysis to uncertainty management

We have in this paper presented a framework for projects that have high uncertainty over the project's life cycle. We suggest a framework for uncertainty management consisting of 2 steps for preparing the process, a 5 step group process for identifying, analysing and developing measures for exploiting or controlling the uncertainty and 2 steps for follow up the uncertainty over the project life cycle. There are three elements of particular importance if a project wants to implement practical uncertainty management. **Human factor** – is an important part of the Practical uncertainty management method. You need to involve the right people in the process and a cross functionality is very often a "must" for understanding and deal with uncertainty. If an organization has good methods and models for how to manage uncertainty, it will not work properly without key actors that know how to manage uncertainty in projects. The organization culture needs to have actors which believe in the processes. This means actors with competence, experience, and attitude towards uncertainty management. These actors are not just internal project workers, but also external stakeholders of the projects that need to be enrolled in the processes. **Models and tools** – The organization need an overall model for uncertainty management. It is also important that the organization is open regarding the processes. One need to think uncertainty in all of the projects phases

Dealing with uncertainty must be an on-going process and it will have to have different focus over the project life cycle. The model has to include both operational uncertainty and contextual uncertainty. **Method – or methods.** Figure 3 shows a framework for living uncertainty. It consists of 9 steps with different types of tools to assess and analyse uncertainty. We believe that methods and models should be as simple as possible, it's the action that matters – A simple spreadsheets and flipchart is often enough for identifying, analyzing and dealing with the uncertainty in most projects.

## 7. Conclusions

A project will normally deal with different types of decisions with different type of uncertainty over the planning phase and execution phase. In the beginning the focus is on selecting the best concept and clarifying the project objectives. When this is sorted out the focus shifts to how to deliver the chosen concept according to specification or contract. This means that project members or project consultants that is hired to deal with uncertainty management in the project needs to understand where the project are in the execution process and focusing the process on the specific uncertainties that is relevant for next 3 to 6 months of the project execution period. We therefore propose that a project needs to deal with uncertainty in all phase and we believe that most projects need to deal with different types of uncertainty in the different phases of project. We suggest a 9 step framework for identifying, analyzing and follow up the project uncertainty – step 1 and 2 for preparing the process, step 3-7 is a group process (workshop) for identifying, analyzing and developing measures for exploiting or controlling the uncertainty and the final steps 8-9 for follow up the uncertainty over the project life cycle. The purpose with the processes is four divided:

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We suggest that the UA process needs to focus on uncertainty for the next 3 to 6 months ahead as well as the more overall uncertainty that is connected to the project objectives and benefit for the project owner (2<sup>th</sup> order consequences) and the society effects (3<sup>th</sup> order consequences) in this workshops. We suggest that follow up and reporting should be done every month and a more overall assessment of the uncertainty should be done at least once or twice per year.

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#### **Nr 4 Exploiting opportunities in the uncertainty management**

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## Exploiting opportunities in the uncertainty management

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### Abstract

In uncertainty management - in Norway as in many other countries - uncertainty analyses are used to get answers to questions about expected total costs and expected final delivery date for a project. Uncertainty management should include both possible threats and opportunities - this is claimed to be the common view among both practitioners and academics. However, it is questioned whether uncertainty analyses and uncertainty management is still focusing mainly on threats, and too little seeking to exploit opportunities. If this is the case, then the projects will only to a small extent achieve the benefits they can achieve from those opportunities. In the paper we study how the projects are actually exploiting opportunities. This is done through two larger longitudinal case studies, each of them looking into six projects. Each of the case studies looked at the management of the projects' uncertainties over time - from concept development through design and execution to hand-over. In the studies we use combined qualitative/quantitative methods, with interviews and analyses of the projects' risk registers as two of the main elements. The results from those analyses are used to reflect on the current practice within uncertainty management, and some possible strategies for a better exploitation of the projects' opportunities are pointed out.

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*Keywords:* Mega project; Uncertainty; Stakeholder management; Opportunity management; Threat management; Risk management

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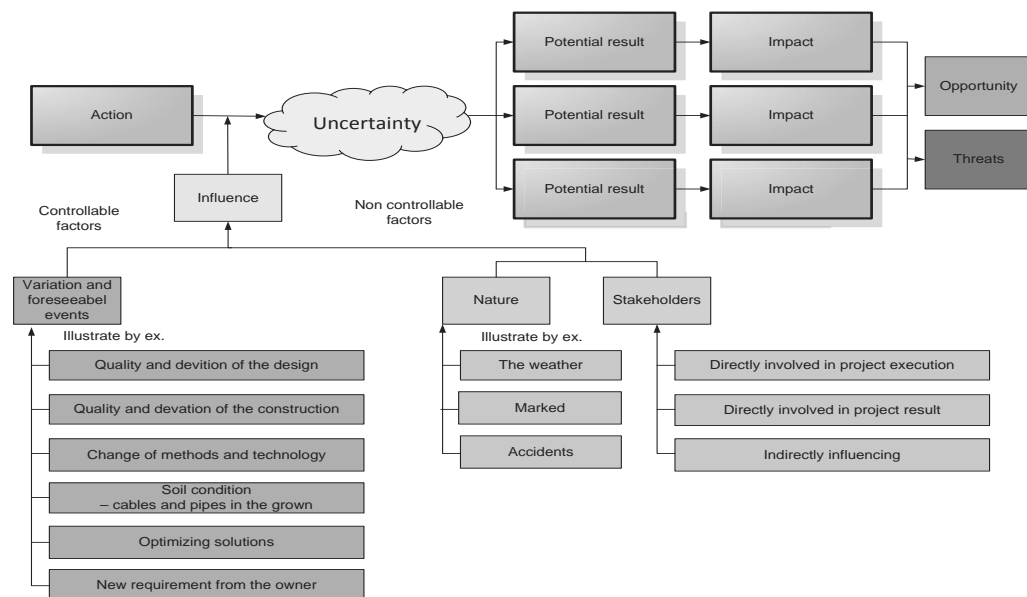
### ***Part I Theoretical framework – Uncertainty management***

In the project management domain, uncertainty is currently understood as lack of information. But uncertainty could also be understood as lack of certainty. Rolstadås et al. (2011) state that uncertainty in projects may take on a number of very different forms, and they propose a structure for categorization of uncertainty into controllable and non-controllable factors. Rolstadås et al. suggest that uncertainty could be negative and positive for a project. Negative implications of uncertainty are labelled risk factors. Positive implications of uncertainty are labelled opportunity factors. Both may have a consequence if

they occur. They refer to risk as the consequence of an unwanted event multiplied by the probability of the event, and opportunity as the opposite of risk, i.e. events with positive consequences. Projects have traditionally strived towards predictability and to keep all critical factors under control. However, for large and complex projects, such predictability does not exist in reality (Rolstadås et al., 2011). Uncertainties play a large role in important areas, as developing the right concept, manage multi cultured organisations estimating the cost and time, defining the project objectives, manage new demands from stakeholders, manage multiple ownership. Especially under such conditions, it may not be a good strategy to strive for maximum predictability, but rather to choose a strategy of flexibility in the project, in order to be able to face changes in a better way (Olsson, 2006). In this paper, we adopt the term uncertainty to include both the positive effects (opportunities) and the negative effects (threats) in the execution of projects.

We define uncertainty as follows:

project uncertainty is defined as controllable and non-controllable factors that may occur, and variation and foreseeable events that occur during a project execution, and that have a significant impact on the project objective (Johansen, Ekambaram, Krane, & Steiro, 2012).



**Fig 1 Uncertainty – opportunities and threats (Johansen, Ekambaram, Krane, & Steiro, 2012)**

We define threats as factors, variations and events that may lead to undesired changes to objective, scope, resources, frame conditions, that make the project cost more, spend more time or delivers less quality than was agreed upon in the beginning of the project.

Opportunities are factors, variations and events that may lead to changes that make the project able to deliver the same quality in less time or to lower price than was agreed upon in the beginning of the project. It is also all such factors, variations and events that will cause changes who can make the project deliver higher functionality or lead to positive NPV after the project is delivered.

Findings from the PUS research project, which studied uncertainty management of projects, clearly indicate that the project teams that were studied had the intention to focus on both opportunities and threats. But, the degree of focus varies (Hald et al., 2008; Ward &

Chapman, 2003). In a Norwegian survey in large project organizations (Hald & Langlo, 2011), the response to a question regarding the focus on uncertainty management in their projects, 76% responded that it was “mainly on risks (threats), but also on opportunities”, 15% said they did “equally focus on threats and opportunities”, and just 7% responded that they “only focused on risks (threats)”.

Some authors (Hillson & Simon, 2012; Cooper, 2005) suggest that dealing with opportunities is more or less the same as dealing with threats, and that there is no need for separate processes. If the uncertainty is beneficial or positive for the objectives of the project, then the risk becomes synonymous with opportunity and handled in the same process/model, The Active Threat and Opportunity Modell (ATOM). Cooper supports this idea and says that “the general risk management process applies equally well to opportunities, requiring only minor adjustment” (p. 125). They support the idea that identifying opportunities is similar to identifying risks. If this is true, a study of risk/uncertainty registers in projects will provide evidence in this direction. We therefore formulated the following research question for this work.

*Is the uncertainty register ‘balanced’ – i.e. are there more or less the same number of threats and opportunities in the register and – do the projects follow up threats and opportunities in the same way?*

## **Part II Research methods and limitations**

For this study a combined approach was chosen, using both qualitative and quantitative data collection methods (Creswell, 2003; Flyvbjerg, 2006). An introductory interview in each project gave a first insight into their differences and similarities. Data were collected from the risk registers of seven projects in a private company in the energy sector over a period of 6 months, and from five projects from public sector over a time span of 4 – 5 years. For quality assurance, initial results from the study were shared with persons with insight in the projects, in follow-up interviews. These follow-up interviews gave better insight into certain aspects that were brought to light through the data analysis. After the follow-up interviews, a summary of used methodology and preliminary results were presented to an expert panel from the companies for feedback and comments. The main data source for this article has been the reports with data extracted from the project risk registers. This has been supplemented (to some extent) with information from the interviews with key persons from the projects.

For the first part of the study in the energy sector, all identified uncertainties were categorised according to their possible impact to the project's – and the organisation's – objective levels: Operational, short-term strategic or long-term strategic. A criteria set had been established, making it possible to categorise risks based on info in the risk register. These criteria was developed based on a study of the literature dealing with project objectives with long- and short-term perspectives. There has also been made a categorisation into opportunities and threats – also called positive and negative risks (Krane et al., 2009).

The data from the public sector project were collected in the spring 2013, and also here uncertainty registers from the projects were the main data sources for the study. For the public sector project we collected data from the risk registers at four different data points. – The first collection was when the register was established, then when the budget was established, then half way in the execution, and finally at the end of the project. We counted threats and opportunities in the planning and execution phases and asked the projects how they did it in the end – How many opportunities were exploited, and what was the effect for the project. We also looked for which threats did materialise, and what the consequences were for the project at the end? It is understood, due to the diverse contextual backgrounds of the projects involved, that the explanations for differences may be equally diverse. Therefore, we aimed to analyse possible explanations and present and discuss them in a manner which could be meaningful above the level of the single project.



### ***Part III Result of uncertainty management in energy sector company - and public sector companies***

The first part of the study was performed in seven projects in organisations in the energy sector. The projects studied may all be characterised as engineering and construction projects, and they were all large projects (i.e.; projects with total costs of 100 Mill Euro (M€) or more). They were selected to represent a broad range of projects – regarding size, project phase and project culture. The projects studied were in different project phases – varying from one that had not yet made all conceptual decisions to one that was close to takeover and start-up of production. The other ones were at different stages between these. Regarding their organisational relations, most of the projects were quite complicated, both because ownership of the project results will be split, and because suppliers/ contractors to the projects were many and diverse. For the first research question – regarding when the risks are identified - the projects' identification of risks as opportunities ('positive risks') vs. threats ('negative risks') were examined. The results are given in table 1 (the energy sector projects) and table 2 (public sector).

Table 1 - Distribution of identified uncertainties , threat/opportunity categories

	Phase I			Phase II			Phase III			TOTAL
	Opportun.	Threats	Oppo./thre.	Opportun.	Threats	Oppo./thre.	Opportun.	Threats	Oppo./thre.	
Proj A	0	0	0	4	92	14	0	0	0	110
	0 %	0 %	0 %	4 %	84 %	13 %	0 %	0 %	0 %	100 %
Proj B	0	0	0	0	4	1	0	39	5	49
	0 %	0 %	0 %	0 %	8 %	2 %	0 %	80 %	10 %	100 %
Proj C	5	0	11	0	0	0	0	35	2	53
	9 %	0 %	21 %	0 %	0 %	0 %	0 %	66 %	4 %	100 %
Proj D	0	0	0	0	35	0	0	261	3	299
	0 %	0 %	0 %	0 %	12 %	0 %	0 %	87 %	1 %	100 %
Proj E	3	29	28	1	41	23	1	31	4	161
	2 %	18 %	17 %	1 %	25 %	14 %	1 %	19 %	2 %	100 %
Proj F	0	0	0	15	75	37	12	245	82	466
	0 %	0 %	0 %	3 %	16 %	8 %	3 %	53 %	18 %	100 %
Proj G	0	0	0	0	25	0	0	166	5	196
	0 %	0 %	0 %	0 %	13 %	0 %	0 %	85 %	3 %	100 %
TOTAL	8	29	39	20	272	75	13	777	101	1334
	1 %	2 %	3 %	1 %	20 %	6 %	1 %	58 %	8 %	100 %

In the table data are given for each project phase: Phase I – ‘Concept development’, Phase II – ‘Design’ and Phase III – ‘Detail design, construction and test’. For each of the projects the first line gives the number of risk elements. The second line gives the percentage of the total of risks for that project.

Table 2 - Threats and opportunities planning and execution phase Public sector projects

		Opportunities		Threats	
		Number	Consequence	Number	Consequence
Case 1	Planning 2005- 2009	11	50- 70 Mill	14	+160 – 190 mill
	Execution 2009 -2012	5	30-50 mill	26	+190-200 mill
	Actual outcome:	2	20-30 mill	22+	+ 180- 200 mill
Case 2	Planning 2001- 2006	2	1 mill	21	Delays and 25– 35 mill
	Execution 2007 -2010	1	> 0,100 mill	31	25– 35 mill
	Actual outcome:	0	0	30+	+40 mill
Case 3	Planning 2001- 2011	2	15- 20 mill	52	Delays and 12– 16 mill
	Execution 2011 -2014	4	14- 16 mill	23	Delays and 30– 40 mill
	Actual outcome:	3	10- 15 mill	18	Delays 3 month +75-100 mill
Case 4	Planning 1999- 2007	8	30- 40 mill	7	20 – 30 mill
	Execution 2007 -2010	2	Effect not clear	26	Delays and 20 – 60 mill
	Actual outcome:	4	15-30 mill	8	30-50 mill
Case 5	Planning 2001- 2006	0	0	12	20- 40 mill
	Execution 2006 -2011	0	0	14	20- 40 mill
	Actual outcome:	0	0	4	15-25 mill

The result in table 2 shows that only 9 opportunities were exploited and at least 82 threats had economic consequences for the five cases that we studied.

The pattern is more or less similar in all the five cases in the public sector study that we have been looking into – they all had much focus on threats and still a lot of them turned into reality – the projects were not capable of taking measures so that the threats were avoided. There were substantially less opportunities and in the end even fewer that projects follow up and actually exploited in the end.

The data from the two different studies show more or less the same pattern – there are much more threats than opportunities in the uncertainty registers. We also see that opportunities that were identified in the execution phase were few and often not exploited at all. Our case shows that the private sector and public sector cases had more or less the same focus on threats. And that private projects are not better at exploiting opportunities than public projects.

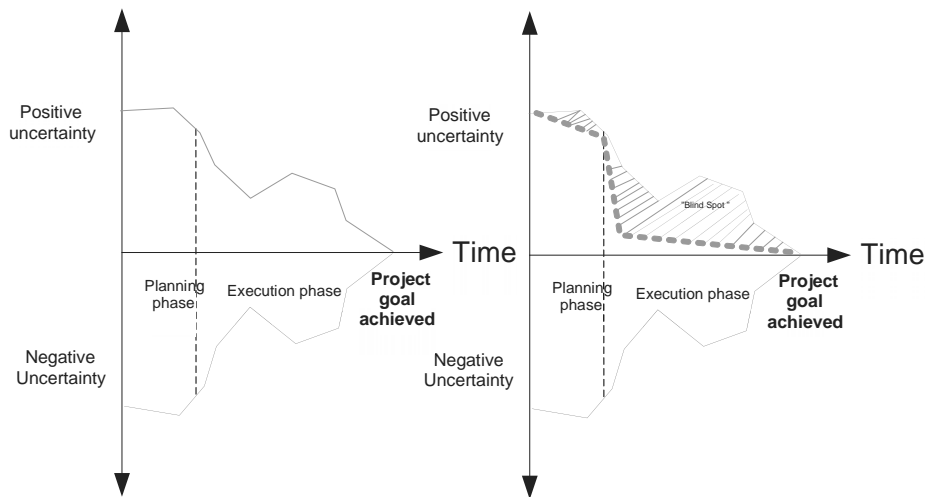
All of our projects seem to be quite conservative to new ideas and change, and they are not seeking new opportunities in the execution phase of the project. Some opportunities were identified late in the project in uncertainty analysis workshops, but identifying new opportunities doesn't mean that the project actually utilize the opportunities, after the workshops are over.

If a project management team believes that they have enough money and time to deliver what has been agreed upon with the project owner, then their motivation and interest for new opportunities will normally be limited. They may consider the list of opportunities as a gamble, because it means that they need to change part of the process or concept, and this may be a gamble where the project management team doesn't get paid for those changes or have any benefit from them.

On the other hand, if a project believes that the budget is too small or tight, then they will start seeking for opportunities and more actively exploit new ideas. they will then also be willing to make changes to the concept, so that they will deliver according to budget. Case 1, 3 and 4 in the public sector all had tight budgets, and this made them all exploit opportunities more actively than in the other cases.

Our studies on project practices indicate that projects only to a small extent are actively seeking opportunities in the execution phase. This does not mean that such opportunities do not exist there; it only means that quite many projects miss out possible opportunities because they are lacking focus on this issue, when it comes to managing uncertainty.

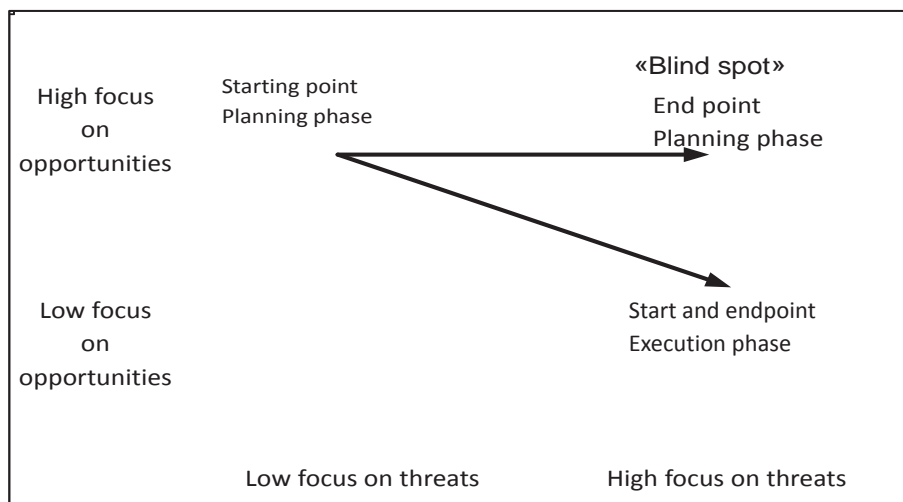
This research has also revealed a phenomenon that might be called "the blind spot" of uncertainty management. In short, the blind spot is the missing ability to unveil and to utilize the opportunities in a project. Fig 1 below illustrates how the number of opportunities and threats is evolving during the project planning and execution phases. In the left part of the figure, the development regarding opportunities and threats is symmetrical, reflecting an assumption that they are equal in numbers. The graph also shows the common observation that there is an overall, though uneven dropping trend towards delivery. In the right part of the figure, the set of lost (i.e. unexploited) opportunities – due to a low opportunity focus – is marked as the area called the "blind spot".



**Fig.2** Number of opportunities and threats during project planning and execution phases

From the findings of the PUS research project referred to in the first part of this article, we may get the impression that most project managers and project owners have realized that there is an opportunity side of uncertainty, and further on that those opportunities are pursued and utilized in most projects today. However, the fact is that the projects are preoccupied with the threats, thus losing sight of the opportunities.

The matrix in fig 3 is another way of illustrating the “blind spot” in uncertainty management. The figure is intended to give a principal illustration of how the project owner (PO) and project manager (PM) is focusing (i.e., having high or low focus) on threats and on opportunities, and how this is typically developing through the project. At project start the main focus of both actors is on opportunities – and typically on the opportunities that the project will or can bring. At later stages; in fact already when the project is detail planned and organized, the PM’s focus will turn from "high on opportunities and low on threats" into a "high focus on threats and low on opportunities". The project owner, being responsible for achieving benefits from the project, will still be highly focused on project opportunities, but will at later project stages usually also have a higher focus on threats.



**Fig. 3 Focus on threats and opportunities**

However, for some POs we observe that they assume the PM’s attitude to uncertainties and get a high focus on threats and low on opportunities. The gap regarding opportunity focus between the two types of owners that we here illustrate will represent a potentially large number of lost opportunities, i.e.; opportunities that may remain unidentified and very rarely will be utilized. This area or set of lost opportunities may then be called the project’s “blind spot”.

**Part IV Conclusion – Exploiting opportunities in the uncertainty management**

Uncertainty is said to be a two sided coin – threats and opportunities. This is implicitly to indicate that the two sides have equal weight. However, in practice, there is a significant focus on dealing with threats when it comes to managing uncertainty in projects, and less focus on the opportunities. Our data suggest that uncertainty management still is more about dealing with threats and that most projects seem to be paying little or no attention to the opportunities in the execution phase of the project. Only if the project believes that budget is too small or tight will they start seeking for opportunities and be more active in exploiting new ideas and possible changes to the concept. The 5 public projects also suggest that identifying the threats in the early stage of the project doesn't necessarily mean that it is possible to avoid the consequence on later stage of the project. In fact many of the threats still become a reality, although the project identified them and tried to make action so the effect could be avoided. 4 out our 5 public project did underestimate possible consequences and was too optimistic in terms of estimating the effect of the opportunities that were identified at an early stage of the project. This shows that getting positive effects of an opportunity is not necessarily that easy

and that controlling and avoiding consequence of threats also can be quite difficult in many projects. It also indicates that in many projects there is a lot more that can go wrong or not according to plans and that uncertainty management therefore is more about identifying and dealing with threats than exploiting new opportunities.

In (Johansen, Ekambaram & Hald, 2012 and Johansen et al., 2013) it is discussed more in detail the challenges involved in identifying and exploiting opportunities. They suggest that identifying and managing opportunity is closely related to understanding what type of benefit that the opportunity will bring to each actor in a project, and also to when the benefit may occur. The project or project management team will be interested in opportunities that are linked to the project objective, and opportunities for the project are thus linked to cost/time/quality. The company or project owner that both initiates and ends the project will have a particular focus on their financial benefit after the project has been executed, and after selling services or products that the project has delivered. At the same time, the company also gains experience and skills that make them better prepared to execute new projects. Furthermore, the execution of a project would establish / maintain the organization's justification for conducting the project, seen from the owner point of view. The society / end user / customers get the effect result of the project, years after the project is completed. They have requirements before the project starts; for instance, a new school, hospital, road, etc., and for them the expected benefit will typically be better education, better healthcare, faster / safer travelling respectively.

Johansen and Langlo (2013) suggest that the key to understanding why some stakeholder may be interested in exploiting opportunities will be to see how the different stakeholders may benefit if an opportunity occurs. Another observation pointing in the same direction can be found the work done by Flyvbjerg et al. (2002). They say that it seems like the willingness to gamble or taking opportunities into the project would increase if the project would not be held accountable for cost overruns or delays. This suggests that – in the same way as closeness/involvement to the uncertainty matter – it also seems like the closeness/involvement to the uncertain reward plays an important role when it comes to exploiting the opportunities or not. We believe that the mixed interests and different interpretations of value is a key issue to understand why one opportunity is preferred compared to another.

#### **Acknowledgement**

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**NR5 Effects of long-term improvement efforts within  
project uncertainty management**

Effects of long-term improvement efforts within  
project uncertainty management

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**Abstract**

Managing the uncertainty (threats and opportunities) is one of the main activities in large scale capital projects. In Norway, project uncertainty management has been in focus for research and continuous structured development since the 1990s. The main question after all these years is: Have these efforts had any results or effects? This paper will address this question and show some of the possible effects the efforts have had on cost estimation and budgeting in six large organizations' in Norwegian. In addition, we will take a closer look at how organizational maturity and individual maturity within project uncertainty management have evolved as a result of the long-term improvement efforts in these organizations. The research is based on a longitudinal investigation of investment projects in Norwegian public sector from year 2000 until present. Approximately 100 projects from a sequence of projects planned and executed under a common framework for project improvement have been included in this investigation. In addition, a case study has been carried out in six large project organisations comparing uncertainty management practice and experience in 2006 and in 2011. This longitudinal study is used to see whether uncertainty management in the organisations have matured in this period. The research has shown that cost estimates normally increase over time. However, the increase from sanction to delivery is modest and normally within acceptable risk contingencies. We have seen that the accuracy of cost estimates has increased from 2000 up until present. The reasons for this development are multifaceted and divergent, which will be elaborated in this paper. The research has also confirmed that organisational maturity in the uncertainty management area and individual maturity have evolved from 2006 to 2011. Potential reasons for this evolvment will be presented.

*Keywords:* Uncertainty management, project management, research, organisational uncertainty management maturity

## **1 Introduction – from cost estimation tool to management tool**

In Norway, uncertainty management has been in continuous focus for research and structured development for the last three decades, since the early 1980s. This paper will present recent research that has addressed and evaluated how this focus has impacted the practice in and execution of projects, and what long term effects these efforts have had.

The purpose of this paper is twofold: First of all, we would like to present the findings from our investigation on the effect of the long-term improvement effort on project uncertainty management in Norway. Secondly, we would like to underline the importance of managing both threats and opportunities on equal terms throughout the project life cycle, and that this should be a structured and continuous process.

Uncertainty management has become an inherent part of managing projects, and a project manager seldom starts executing his project without making sure he has control over potential threats, and sometimes he also has made sure that he is able to utilize potential opportunities as they may appear. The risk for cost overruns and delays has traditionally been the primary focus; how to manage them, mitigate them, avoid them or simply accepting them. In the recent years, the interest for how to manage opportunities (upside risks) in projects have increased. Hence, the term uncertainty management has been introduced in order to emphasize that the upside should be more protruding in risk management in projects. This development is closely connected to the advancement of active project ownership.

Uncertainty is often said to have its root cause in lack of available information, available knowledge or competence (e.g. Kolltveit & Reve, 2002, Christensen & Kreiner, 1991). In a project context, uncertainty management has traditionally been synonymous with risk management (Hillson, 2007). Some authors suggest that Risk can be positive or negative; positive as opportunities and negative as threats (Loch, De Meyer, & Pich, 2006; Perminova, Gustafsson, & Wikström, 2008, Johansen et al 2012). Some use the term risk management to denote exclusively managing threats, and some others consider risk management as an umbrella term for describing the management of both threats and opportunities (Hillson, 2004). According to Hillson arises risk from uncertainty, and risk is about the impact that uncertain events or circumstances could have on the achievements of goals. This leads to a definition that combines two elements, uncertainty and objectives, and Hillson suggests that "A risk is any uncertainty that, if it occurs, would have an effect on achievement of one or more objectives". He also point out risk has been considering synonymous with threat, but this is not the only perspective to day. If the uncertainty is beneficial, positive or welcome for the objective then the risk becomes synonymous with opportunity. According to Hillson, the practitioners are divided in to three "camps" in accordance with their use of terminology (see figure 1).

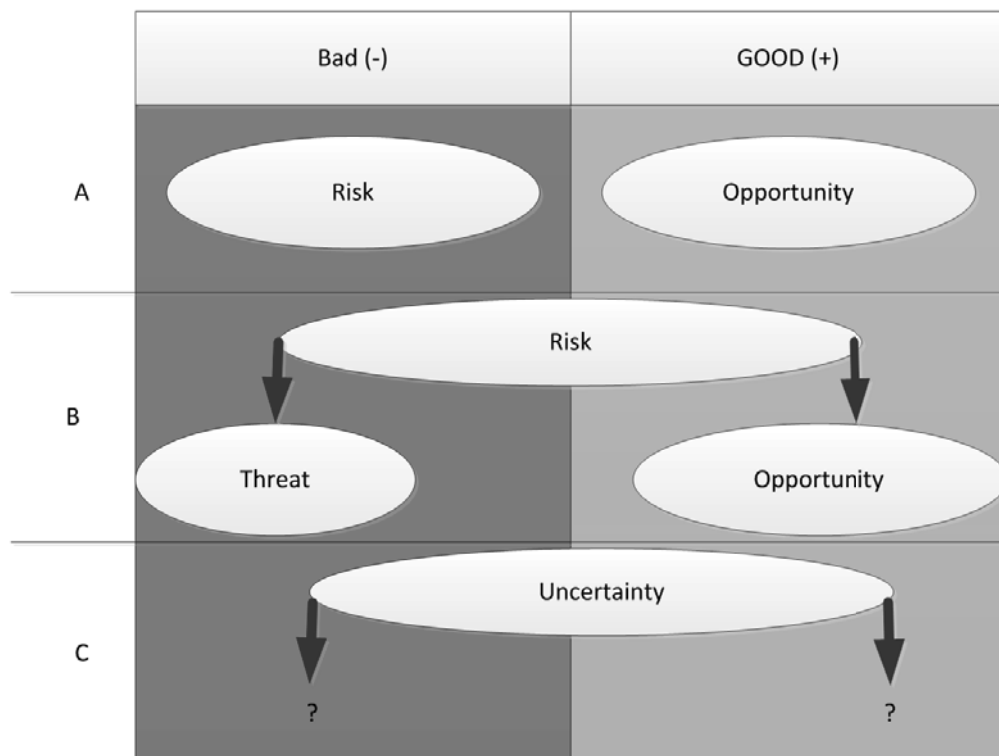


Figure 1 Risk - The definition debate (based on Hillson, 2004)

Group A insists that the "traditional approach" must be upheld, reserving the risk for bad things that happen and opportunities for the good things that should be treated differently using a distinct process.

Group B believes that there are benefits from treating threats and opportunities together and that scope of the risk management should be handling both in the same process.

Group C seems unconcerned about definitions and jargons and are more focused on doing the job. This group emphasizes the need to deal with all types of uncertainty without worrying about which labels to use.

These three "camps" show that the perception of what should be in focus in risk management varies, and this has subsequently resulted in differences in theoretical textbooks as well as in governing documentation and practice in project organizations. Many organizations still mainly focus on threats in their risk management processes. Hillson also point out that, today, majority of risk standards and guidelines use a broadened definition of risk, including both upside opportunities and downside threats.

For this paper, it is important also to have a better insight into how the balance between "threats" and "opportunities" has evolved over the years in the Norwegian professional project environment. In Norway it has also been a debate among the academics whether risk or uncertainty is the "right" terminology. In the 1980s and the early 1990s two "schools" were developed in Norway: The Risk School and the Uncertainty school. These schools have had

considerable impact on how threats and opportunities have been managed in practice, and below we will present them both in more detail.

### **The Risk School**

1991 was the Norwegian stand NS 5814 Requirement to Risk analysis published and that was also a starting point for the " Risk School " at Norwegian technical University (NTH). Marvin Rausand published (1991) the "Risk Analysis: Guidance on NS 5814" and this work was followed up by "Risk Analysis: Theory and methods" (2009) and "Risk assessment – theory methods and applications" (2011).

The Risk School are dealing with risk related technical and sociotechnical system which

- Events may occur in the future
- Have unwanted consequence to assets that we want to protect

They also state that they do not cover all aspects of the term risk – the main focus is on accident that may give negative outcome (some kind of loss or damage). From this school perspective is risk analysis a proactive approach that uses available information to identify hazards and to estimate the risk to individuals, property and the environment. And when risk analysis and risk evolution are carried out in a joint process they use the term risk assessment. The term Risk management is used on the total concept involving the three steps: Risk analysis, Risk evolution, and Risk control. Risk management is defined as a continuous management process with the objective to identify analyze and assess potential hazards and introduce risk control measures to eliminate or reduce potential harms to people, the environment or other assets

In other words, in "Risk school" risk is equal to BAD or UNWANTED because RISK is a about unwanted consequences. Positive risks or opportunities had no place in this school. The Risk School had considerable impact due to a considerable attention on HES (health, environment and safety) in the Norwegian offshore industry in the 1980s and 1990s. The Norwegian Government presented their zero casualty vision for the industry, and they embraced the Risk School as a tool to reach this vision.

### **The Uncertainty school**

The Uncertainty school was established a little bit earlier than the risk school and it was researchers from the project management and construction field at NTH that adapted uncertainty concept that original was introduced by Steen Lichtenberg. Lichtenberg developed his methods for calculating the cost of major projects (the successive principal of cost estimation) in the 1970s and 1980s together with researchers from Stanford University and MIT in USA., Universities in Loughborough, UK, Gothenburg, Sweden, and not least the Technical University of Norway in Trondheim (NTH). The essence of the "Successive principal" according to Lichtenberg is:

"The Successive Principle can handle the uncertainty or contingency in projects, budgets and plans in a controlled, efficient and scientifically based manner. Using a consistent top down procedure you in successive steps clarify the many uncertain factors. In this manner it – besides other valuable benefits - has documented an ability to largely eliminate unplanned budget overruns and delays. "

He also states that that the research behind the "Successive principle" is based on the new scientific paradigm which accepts and deals with uncertain and fuzzy issues. The aim of the research into the Successive Principle has been to allow professionals to calculate the projected total actual cost or duration of new projects or ventures in a more realistic and controlled manner – more focused on the relevant future uncertainties. Lichtenberg used the term uncertainty and it was from the beginning a neutral concept and it should have a broader view than the risk concept, as that was only dealing with the downside. For him uncertainty just meant that something could go faster or activities or the project could cost less than planned, or it could take longer time or cost more than planned. This concept was adapted of the Norwegian project management researchers from NTH, and from early 1990s uncertainty analysis was used as term when a project wanted to find the expected cost or time. The step by step approach (the Norwegian evolution from the successive principal) and triple estimates was introduced and was adopted as by consultants and practitioners in the same time period. Today, the "step by step approach" and the uncertainty analysis are established as the dominating concept in Norway used for estimating expected cost/time and finding the uncertainty factors that could affect the project objectives in a positive (opportunities) or negative (threat) way. The term uncertainty management is used on the set of processes of identifying the positive and negative events or activities that may or may not happens, quantifying the expected effect, prioritizing, planning response, implementation of response and following up.

The differences between the schools of risk management and uncertainty management in Norway have influenced the way projects have managed threats and opportunities for more than three decades. The result of this conflict is discussed in more detail in chapter 3 and 4. But before we present the research design and our findings, we would like to present some of the theoretical models we have based our research on in order to measure the effects of the improvement efforts within project uncertainty management.

## **2 Important elements in a continuous uncertainty management process**

In this paper, we have no ambition of presenting a complete and exhaustive model for uncertainty management. We are just mentioning the steps in what we consider as more or less generic uncertainty management process so that reader of this paper can understand what type of proses we have analyzed the maturity of. Several authors have covered the subject uncertainty management process the last years (Hillson (2012), Johansen et.al. (2012, 2013), Simister (2004), and Torp et al (2008)) The findings from these authors can be summarized in the following Generic Uncertainty Management Process (table 1)

Table 1 Generic Uncertainty management process

Step	Step description
Initiation - Establishing the context	Define objectives for the uncertainty management process <ul style="list-style-type: none"> <li>- Some standard/text books use the term <b>initiate</b> or <b>identify the context</b></li> <li>- Some make a link between objectives and stakeholders</li> </ul>
Identification key stakeholders	Identifying key stakeholders
Identification and assessment	Identify relevant uncertainties Quantify the probability and the possible impact on the projects objectives
Evaluate and prioritize	Finding the "top ten" opportunities and threats
Planning response	Develop response; allocate responsibility and time frame for execution of the response.
Implementation response	Execution of agreed response <ul style="list-style-type: none"> <li>- Exploit, share or enhance the opportunities- take advantage of opportunities that will benefit the owner, his customers or the project itself.</li> <li>- Avoid transfer or mitigate on the threats - reduce the likely hood or the impact of negative events that if they occur will have negative effect on the objective, scope, resources, frame conditions, etc</li> </ul>
Review	Control – did the response have the desired effect?
Follow –up and reporting	Updating the Uncertainty register (UR) <ul style="list-style-type: none"> <li>- Assessments of the uncertainties in the uncertainty register</li> <li>- Take out opportunities and threats that is not valued any more</li> <li>- Identify new opportunities and threats</li> <li>- Plan and execution of new response</li> </ul>

This generic process describes 9 steps that should be included in a continuous and iterative uncertainty management process. Figure 2 illustrates the different steps.

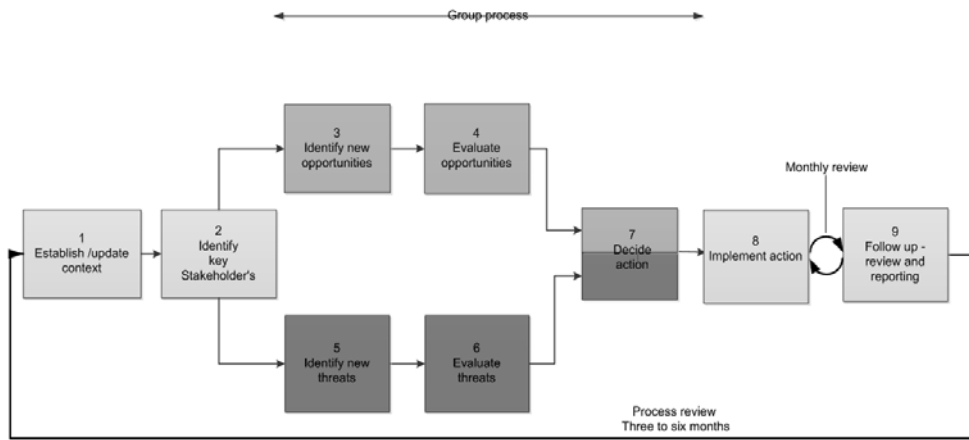


Figure 2 Practical uncertainty management (Johansen et al 2013)

The basis for and the main elements in this process are briefly presented in the following.

Simister (2004) has developed a generic risk management model based on publications from national standards associations (British Standards Institute, Canada Standards Association, and Standards Australia), professional institutions (Institution of Civil Engineers (ICE, 1998), Japan Project Management Forum (2002), Project Management Institute (2008), and Association of Project Management), and government departments (U.S. DoD (2003), and the UK OGC (2002)). His risk model presents the basic idea of having a continuous, repetitive and iterative process; the idea that risk management is more than isolated exercises and analyses. Simisters modell is presented in Figure 3

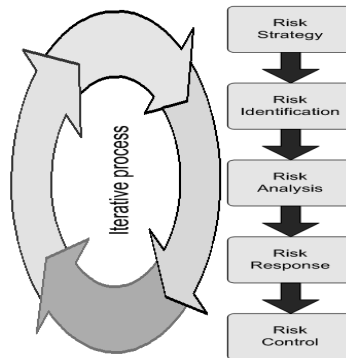


Figure 3 Risk management process (Simister, 2004)

Simister (2004) underlines the importance of undertaking risk management as a structured, formal process aligned with the overall project management approach. The Norwegian research project "Practical uncertainty management in a project owner's perspective" proposes a similar model and the project also suggests that opportunities and threats should be analyzed and managed through the whole project lifecycle (see Figure 4)



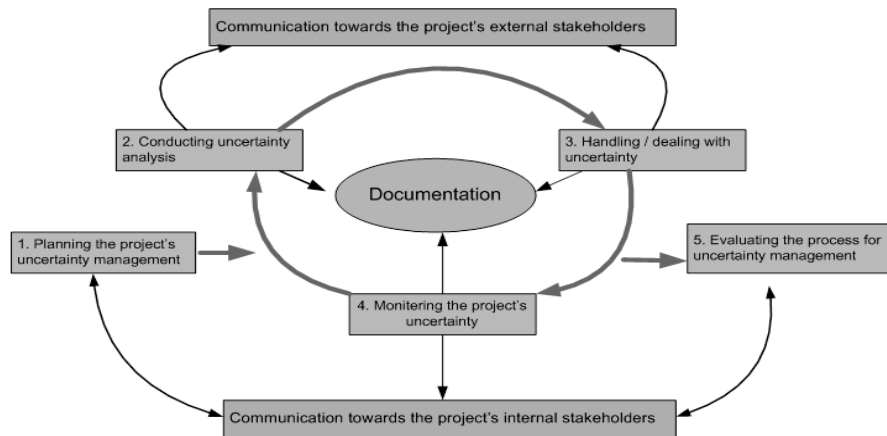


Figure 4 Practical Uncertainty Management process

The third aspect that we used in to in our research was the utilization of tools and techniques involved in uncertainty management for analyzing, estimating and structuring the response and follow-up of each uncertainty element. Examples of what we consider as techniques are: brainstorming, checklists, interviews, delphi methods, expert opinion etc. Examples of what we consider as tools are: cost estimation tools, risk scoring matrix, maturity models, situation map, risk cubes and Boston charts, just to mention a few. In Figure 5 we have presented a typical uncertainty matrix as an example of a tool actively used in uncertainty management in organizations involved in the PUS research project.

Uncertainty - matrix	Consequence							
	Opportunity				Threat			
Likelihood	Extra large >10 mill	Large 2 - 10 mill	Medium 0,5 - 2 mill	Small < 0,5 mill	Small < 0,5 mill	Serious 0,5 - 5 mill	Critical 5 - 20 mill	Catastrophic 20 mill +
Almost certain >50 %	<del>A</del>	E				(4)	<del>1, 3</del>	
Likely 25-50%		B	C		4	<del>6</del>	2,10,11	
Possible 5-25%		(C)	D			7	5, 9	
Unlikely 1-5%						8		
Rare <1%								

Figure 5 Example tool -Uncertainty matrix

The matrix is used to illustrate both threats and opportunities in the same view. Notice that the consequence scale is different from threats and opportunities. This is due to the fact that opportunities normally have less impact than potential threats. Using the same scale would seemingly present the opportunities as less attractive. The matrix can also illustrate how

uncertainty elements change as a consequence of responses taking effect, changes in context, or simply time passing by.

### **3 Measuring maturity in project uncertainty management**

In order to see if the long-term efforts have had any impact, we need to be able to measure if there have been any changes or development over the time which our research results spanned. We had close contact with six major organizations in Norway through the PUS project, providing us with a vast amount of data. To help us narrow down the scope, we have used the following four elements in our analyses of the organizations maturity level:

- The use of the term "Uncertainty" should include both opportunity and threat on equal terms, and both aspects should be exploited and visible in the projects and in the management of the projects from the organization view.
- There should be a clearly structured process; in other words the organizations should have established: what to do, when should it be done and who is responsible?
- There should be a clear recommendation of tools and techniques that project should apply in their daily management.
- There should be a clear structure on support, training and further development of uncertainty management process in the projects and in the line organization.

We believe that all four aspects should be covered if they should be considered as mature organization in uncertainty management. We believe that an organization with high maturity on uncertainty has clear process that includes opportunity and threat, and that both aspects are exploited and visible in the management of the projects from the organization.

#### **Research methods and limitations**

The normal way of assessing the effect of improved uncertainty management is to see if there is an increase in the number of projects being completed on time, within budget and at the agreed quality level. But this measure could be misleading, if the uncertainty management process in the mean time has resulted in increased budgets and increased schedule. It is therefore always of interest to keep a keen and critical eye on how the uncertainty management process is developing. This research offers another perspective for analyzing the uncertainty management process, as we have addressed and assessed how the project uncertainty management process and organizational project uncertainty management maturity levels have developed in the organizations involved in the long-term improvement efforts. These findings will be of interest for future improvement efforts, as well as contributing to published knowledge on organizational learning in temporary organizations.

The research presented in this paper is part of a larger research work. The main body of research is based on data from (a) a major research project on uncertainty management of projects – PUS<sup>2</sup>, and (b) a research program on large public sector projects - Concept<sup>3</sup>.

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<sup>2</sup> PUS = Norwegian acronym for "Practical uncertainty management in a project owner's perspective" (see (PUS, 2011))

The PUS project on uncertainty management had duration of approximately 5 years and involved 6 major Norwegian public and private 'project intensive' companies/organisations. Together those 6 have a total yearly project portfolio of approximately €10 billion. The PUS project, with a total budget of more than €4 million, was one of the largest research projects on project management for the last decade.

The Concept program has carried out trailing research on the management and governance of - in principle - all larger Norwegian public sector projects (i.e. with total costs of more than €70 million) since 2002. This means that it has examined and evaluated approximately 130 large public projects, and holds records of those projects in its database.

Our results are based on a multitude of techniques and methodologies. There have been literature studies into the different areas of relevance (see for instance (Torp, 2002) and (Torp, Karlsen, & Johansen, 2008)), there have been several surveys, action research has been done in a number of projects, trailing research in others, and also in-depth interviews and discussions with experts. We refer to the individual research efforts to find further details on the research design applied in each case.

The results presented here are also based on a number of case studies of projects. Some of the case studies are also of a longitudinal and qualitative nature, where the authors have been involved as researchers and process contributors repeatedly in all the cases. The research have been carried out in both industrial and governmental projects. The above description points out that this research endeavour includes quantitative, qualitative and a combination of these methods. This compound research basis means that we do not refer to just one dataset as the basis for our results and conclusions. Below we elaborate on some methods that were applied in the research.

When it comes to conducting interviews, the interviews were based on interview guides prepared by the researchers in all of the studies. These questions and the following response and discussion can be considered as semi-structured, and there were both individual and group interviews. The organisations that took part in the interviews belonged to sectors such as telecommunication, construction, offshore and defence.

The majority of the studies based on interviews must be characterized as qualitative studies (Yin, 2003). There have been made a number of such studies in the work that this paper is based upon, especially in the PUS research project. In some of the case studies in the PUS research project, the researchers applied action research. Here, several sessions of uncertainty analysis were carried out in various projects. One of the authors of this paper participated actively in and led/facilitated the sessions. In a typical uncertainty analysis session, approximately 20 members from the respective organisation would take part. The participants would belong to several professions/positions; for instance, project manager, assistant project manager and construction manager. Experience from these analyses was reflected upon in connection with the topic of uncertainty in projects, and this is used in this paper. These analyses can therefore be regarded as action research, at least to a certain extent.

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<sup>3</sup> Concept is doing trailing research on all large Norwegian public investment projects (over 70 million Euro, and is funded by the Norwegian Ministry of Finance (see (Concept, 2010))

Some of the studies were also based on trailing research (Finne, Levin, & Nilssen, 1995), thus combining on one hand pragmatic on going evaluation activities with on the other hand utilizing the opportunity of doing more thorough analyses and reflections around the results.

Two surveys regarding the uncertainty management of the projects were conducted in a number of the projects that were studied in the PUS research project. Questionnaires were distributed to a representative selection of participants related to the projects. Using both electronic and paper-based questionnaires, they were distributed to a total of 2701 persons, and overall there was a response rate of 29.7%. The questionnaires used in both instances of the longitudinal survey were not identical. This means that the results from the first survey had to be manually processed in order to be compared. The sample was unique for each survey, and the respondents were identified by representatives for each research partner.

Some of the quantitative studies, which were done in the PUS research project, were based on data extracted from the risk registers of seven large projects in the energy sector. Also, longitudinal quantitative economical analyses have been made in the Concept program.

Studies applying mixed methods (Creswell, 2003; Flyvbjerg, 2006; Tashakkori & Teddlie, 1998) include a majority of the research that was based on a combination of surveys and interviews. There have also been made a number of this type of studies, both in PUS and in the Concept program. Those studies are to a large extent used to underpin what is presented in this paper. The projects covered here are basically construction, infrastructure and oil and gas projects, and mainly medium large to large (more than €50 million), and they mainly had a duration of over two to four years.

### **Limitations**

It is, of course, unacceptable from a research perspective to imply that it was only the investigated research activities that have contributed to the development of uncertainty management in projects the recent two decades. It is neither our intention to claim this. We know that it is all the small contributions as a result of a focused effort that provide the overall result. The purpose of this paper is to describe the different improvement efforts, assess current practice within uncertainty management, and evaluate how the project uncertainty management maturity has developed over the last two decades. The combination of the different research initiatives give us a unique opportunity to see how uncertainty management practice has developed and also to evaluate how it has influenced project execution and the effects of implementing the project results.

## **4 The historical evolution of uncertainty management in Norway**

Project uncertainty management has been in focus and under scrutiny in Norwegian industry and public sector for nearly two decades. It has been a consistent, yet fragmented, development consisting of several initiatives; a combination of joint research efforts, intra-company competence developments, and governmental regulations. Among these efforts we find the research program Project 2000, the research program Norwegian center for project management, the research project Practical uncertainty management in a project owner

perspective (PUS), the Quality Assurance regime established by the Norwegian Ministry of Finance, and the research program Concept. This paper will draw on results and experiences from all these efforts to evaluate how practice has evolved as a result of these efforts.

#### **Uncertainty Management in the research program Project 2000 (PS 2000)**

In the 1980s and 1990s major public investment projects experienced lack of success and repeated failures. Several major investment projects in the energy sector also experienced cost overruns and delays. There was a growing concern that more competence on risk management in projects had to be developed.

In 1993, Project 2000 (PS 2000) was established as a joint research program by Norwegian industrial partners and partners in Norwegian public sector. The main goal was to ensure and further advance the competitiveness of Norwegian industry and public sector by developing and implementing competence on identification, evaluation, planning and execution of projects. The PS 2000 revealed the need for increased attention on the early phase of projects. The need for new evaluation schemes for projects arose based on these challenges.

PS 2000 was concluded by the end of 1999, and the results were comprehensive and addressed many of the different knowledge areas. Uncertainty management was a research topic for all the six consecutive years of the research program, thus being the single most important topic in the program. In the final summary report (Andersen et.al., 1999), uncertainty management was identified as an important issue for project success in the future, and it was identified as especially important to utilise the full potential of opportunities in projects.

#### **Uncertainty Management in Norwegian Centre for Project Management (NSP)**

Norwegian Centre for Project Management (NSP) was the realisation of the third main goal of PS 2000; a permanent competence centre for project management where practitioners and academics could meet and develop future project management competence. NSP was established in November 1999, and has now operated for 13 consecutive years.

Uncertainty management was once again put high on the agenda. In 2005 Norwegian centre of project management together with 6 partners launched the research project " Practical uncertainty management in a project owner's perspective", in short the "PUS project". The PUS project had duration of approximately 5 years and involved 6 major Norwegian public and private 'project intensive' companies/organisations. The main focus of the project was to develop knowledge and insight on how uncertainty management should be executed throughout project execution to take advantage of opportunities and managing all the threats in an appropriate manner. The mantra in the project was to ensure that the project owner was actively involved in the uncertainty management. As a result of the PUS project, all six organisations had revised and developed their procedures and processes for uncertainty management in their project organisations. We will come back to more of the results from this project in the next chapter.

## The Quality Assurance regime of the Norwegian Ministry of Finance and the Concept research program

The Norwegian government introduced in 2000 a quality assurance scheme performing an external review for all public investment projects with expected budget above NOK 500 million before they are authorized for execution (Concept 2012). For the research presented in this paper, the documentation from this scheme has provided an opportunity to look into predictions of costs in a stream of projects planned and executed under a common framework for project improvement and how these costs have developed during project execution. The research program Concept was established in 2000 in order to carry out trailing research on the quality assurance scheme and all the actors that undertook the scheme.

As for a more detailed description of the project approval process, its theoretical underpinnings, embedded principles, and how it is carried out in practice, it is referred to Magnussen and Samset [3] and Magnussen and Olsson [1]. A short description of the quality assurance follows, with its basis in Figure 6.

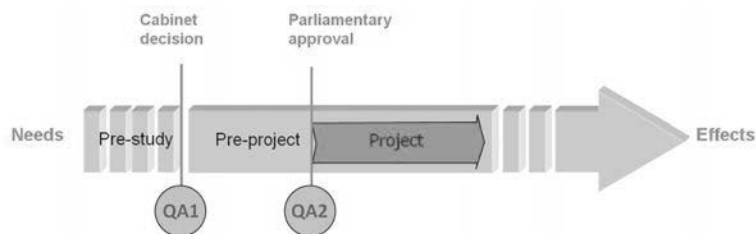


Figure 6 Illustration of the Norwegian Quality Assurance scheme

The project approval process was implemented in 2000 by the Norwegian Department of Finance. The first exercise put in place was mandatory quality assurance and uncertainty analysis of projects, the so-called Quality Assurance 2 (QA2). These analyses were carried out by external consultants on behalf of the responsible ministry before the project is brought before parliament to be authorised for execution. The aim of the QA2 was to evaluate the professional quality of the basis for the chosen alternative. The more particular focus regarding revision of cost estimates and identifying major risks should be seen in light of the specific goal for the quality assurance. It is a tool for evaluating the quality of information and for providing new information on the basis of which the decision makers can judge the project.

In 2005 the government introduced an exercise to be carried out at the end of the pre-study phase, just prior to Government's decision whether pre-planning should be carried out or not, the quality assurance 1 (QA1). The purpose of QA1 is to ensure a rational and realistic choice of concept. In conformity with QA2 the QA1 is mandatory and consists of external review to judge the project. QA1 also supplements the existing exercise. It aims to ensure that realistic and informative analyses are made available at an early stage and that the initiation process and choice of the project as conceptualised is subject to actual political steering.

The Norwegian QA scheme and the Concept research program have been running since 2000. In 2005, the Concept research program launched several projects where they asked whether up-front assessment and quality assurance guard against underestimation of cost. To carry out

this assessment, the cost estimates from the early stages of definition to completion in transportation infrastructure projects were analysed. While previous studies in this area have compared budgeted costs (costs at the time of decision to build) with actual outcomes, often on the basis of unsystematic selections of diverse, although large, samples of projects, this study is concerned with investigating the cost development from the early stages of definition to completion in a stream of projects planned and executed under a common framework for project improvement. In 2006 did Magnussen and Olsson (2006) the first attempt to analyse the development of cost estimates in the early stages of projects subjected to up-front assessment and quality assurance. This paper concentrates on identifying explanations for differences, i.e. qualitative descriptions of why estimates differ. It is understood, due to the diverse contextual backgrounds of the projects involved that the explanations for differences may be equally diverse. Therefore, it is aimed to analyse possible explanations and present and discuss them in a manner which could be meaningful above the level of the single project.

As pointed out by Venkataraman and Pinto [2], the importance of estimating project costs originate from that estimates become standards against which future costs are compared. Although estimates become more accurate as decisions are made and uncertainties resolved, they are also chief means for assessing project feasibility, in the sense that a comparison of cost estimates with estimates of revenues is crucial in determining whether the project is worthwhile to carry out or not. The decision to finance and execute the project is based on estimates, and estimates are influenced by historical data. Therefore, among the factors that influence project success is the cost estimation. In 2010, the Concept project concluded the study of more than 100 projects that gone through the QA scheme and they did sum up how emphasis on review of cost in the front-end of major projects may contribute to more consistent achievement of project success.

## **5 What is the status? Do we really manage uncertainty in our projects?**

In this section, we will briefly present the findings and main contributions of the research. The research has found evidence of the effect of the long-term improvement efforts within project uncertainty management in several areas. The main findings are as follows:

1. An indication that project uncertainty management maturity has increased as a result of the focused improvement efforts.
2. Increased ability to meet cost targets
3. Increased active involvement of project owner in project risk management

The research has also shown that there still is considerable room for improvement:

4. Increased estimates due to too much contingencies
5. Projects do still not fully understand the uncertainty picture
6. The blind spot of project risk management

### **Finding 1: Increased project uncertainty management maturity**

The research has shown that almost all organisations involved in the research have increased their organisational project uncertainty management maturity level. The figure presented below will illustrate this conclusion (see Figure 7).

ID	Project	Project owner involv.	Plans and estimates	Goal achievement	Management and org.	Project control	Contract management	Uncertainty management
1	E6 Skjerdingsstad – Jaktøyen	█	█	█	█	█	█	●
2	E6 Riksgrens. – Svingensk.	△	█	█	█	△	█	●
3	E6 Klemetsrud – Assurtjern	█	△	█	█	█	█	●
4	Rv 653 Eiksundsambandet	△	█	█	△	█	█	●
5	E18 Høvik – Frydenhaug	█	█	█	█	█	█	█
6	Ringvei Nord, Tønsberg	●	△	△	△	█	●	△
7	E10 Lofast	△	△	△	█	△	█	●
8	E18 Kopstad – Gulli	△	△	█	█	█	█	█
9	Rv 2 Kløfta – Nybakk	△	△	█	△	△	█	△
10	E6 Åsgård – Halmstad	△	●	█	█	█	█	█
11	E6 Svingenskogen – Åsgård	△	█	△	█	█	△	█
12	E18 Momarken – Sekkelsten	△	●	●	△	△	△	●
13	Dobbeltspor Sandvika-Asker	●	△	█	█	█	█	█
14	GSM-R samband for jernbanen	△	△	█	█	█	█	█
15	Nytt operahus	△	△	█	█	█	█	█
16	Høgskolen i Østfold	△	█	█	△	█	█	△
17	Nybygg Svalbard forskningsp.	█	█	█	█	█	█	█
18	Tollområde Svinesund	█	█	█	█	█	█	█
19	ISL-prosjektet (nybygg FD)	█	△	△	█	█	●	█
20	FIS Basis	△	█	█	█	█	●	█
21	GOLF, leveranseprosjekt 1	█	█	█	█	█	█	█
22	LOS ØP (økonomiprojektet)	█	△	△	△	█	△	█
23	NAV-IKT	█	█	█	█	█	█	█

Figure 7 Evaluation of 23 capital projects in Norway –Concept study(presented by Klakegg in 2010)

Figure 7 is based on the evaluation of the governing documents in the first 23 capital projects in the Norwegian QA scheme. The projects are listed in chronological order (from top to bottom), and each column indicates how well the governing documents in each project have addressed this topic. As we can see for uncertainty management (the right column) there has been a definitive improvement from the first projects (with red circles indicating that these elements are insufficiently described) to the last projects (with green boxes indicating that the description is acceptable). In the last column (marked Uncertainty management) we see that none of the project had established acceptable procedures for uncertainty management. As time progressed, we can see that they gradually move from red circle, via yellow triangles to green squares. This means that the projects got a better hold of uncertainty management after a slow start. In addition, we see that the project owner involvement has increased, and there has been a general improvement in all columns. However, there are still room for improvement.

In the longitudinal study carried out in the PUS project, one of the questions asked to respondents to explain what they base their execution of uncertainty management on. The results from the 2011 survey are presented in



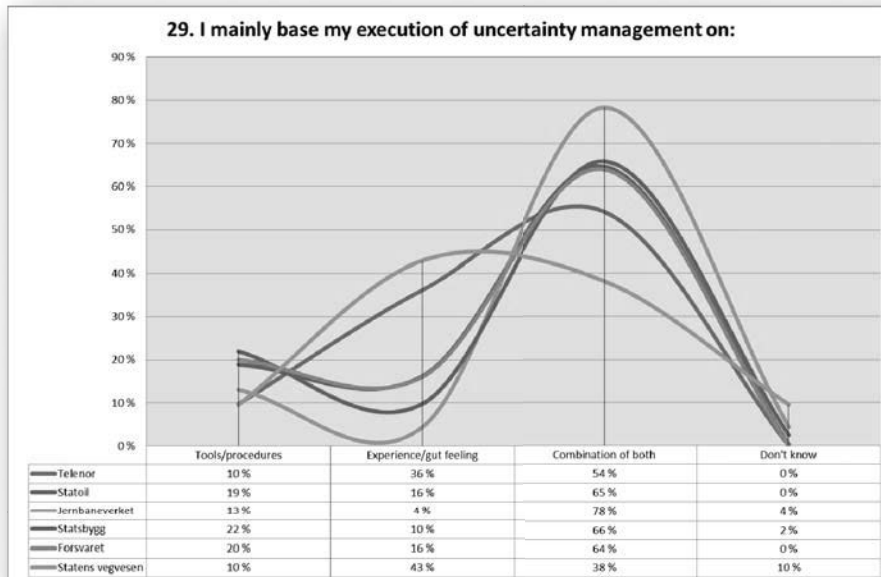


Figure 8 The basis for execution of uncertainty management, responses from survey in 2011.

Figure 8 is based on a survey of all the partners in the PUS project. The figure shows that projects utilize gut feeling in combination with tools and routines. This is a good indication of maturity with reference to the fact that both tools and gut feeling is used as equal Early Warning Signs in projects. (Klakegg, Williams, Walker, Andersen, & Magnussen, 2010). We can also see that two of the investigated organizations score a bit different from the others, which is natural as they all are at different maturity levels. The fact that some of the organizations have non-conclusive results on which of the three alternatives they use, is also an indication of less maturity. Potential reasons for this is lack of training, no common tools for uncertainty management, wanting involvement of project owner, lacking procedures for uncertainty management, just to mention a few. The figure shows a snapshot in time, and clearly shows that there are differences between the evaluated organizations. It does, however, not provide any clue as to how this situation has evolved from 2006 to 2011. This is illustrated in the next figure.

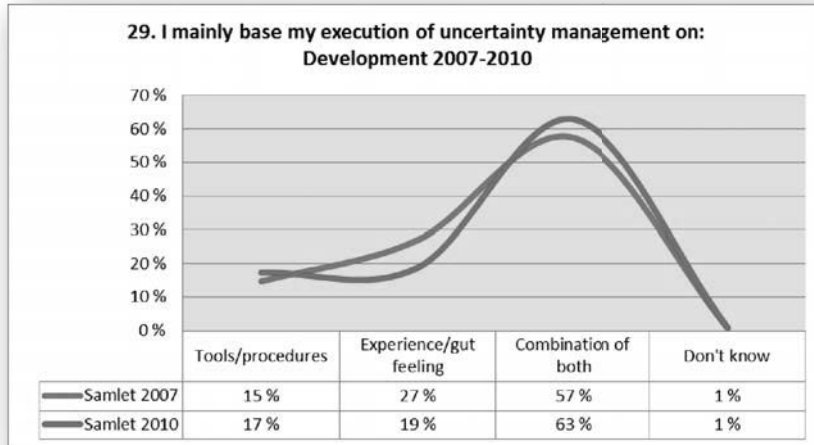


Figure 9 The basis for execution of uncertainty management, development from 2006 to 2011

Figure 9 shows how the score for the same question has changed from 2006 to 2011. This is the average score for all organizations. We can see that the single use of gut feeling has decreased, and that there is an increase in the combined use of tools and gut feeling. This is a small indication that the average project uncertainty management maturity has increased from 2006 to 2011. The figure does not show the development for each organization, but we can see from our detailed results, that all organizations have improved. Some more than other, but all have improved.

In order to investigate the maturity further, we asked the respondents if it was accepted that they expressed their concerns and uncertainty. Figure 10 below shows how the attitude towards this question changed from 2006/2007 to 2010/2011.

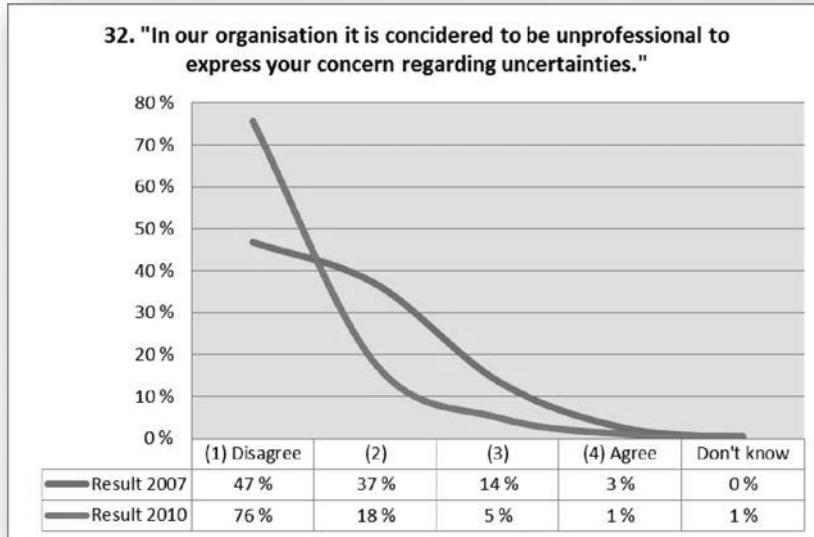


Figure 10 The changes in attitude towards expressing uncertainty

Figure 10 illustrates that all organizations to a larger degree accept and endorse that project team members express their concern. The change is significant, as the score in (2) is reduced from 37 % to 18 %, while the score in (1) has increased from 47 % to 76 %. This indicates that uncertainty management maturity has increased in all organizations. However, we also see that there still is room for further improvement. And again, this is the combined result of all the organizations, and the detailed results shows that some organizations have more improvement than others. Still, there was improvement in all organizations.

**Finding 2: Increased ability to meet cost targets**

Another main finding is documented through an evaluation by the Norwegian Ministry of Finance in 2012. The evaluation indicates that recent Norwegian public projects to a larger extent have been able to meet their cost and time targets. And since the estimates have some variance, the Ministry was interested in measuring how much variation they could find in the final cost compared to the control estimate. Figure 11 below was presented by the Ministry showing the cost deviation for 35 most recent investment projects.

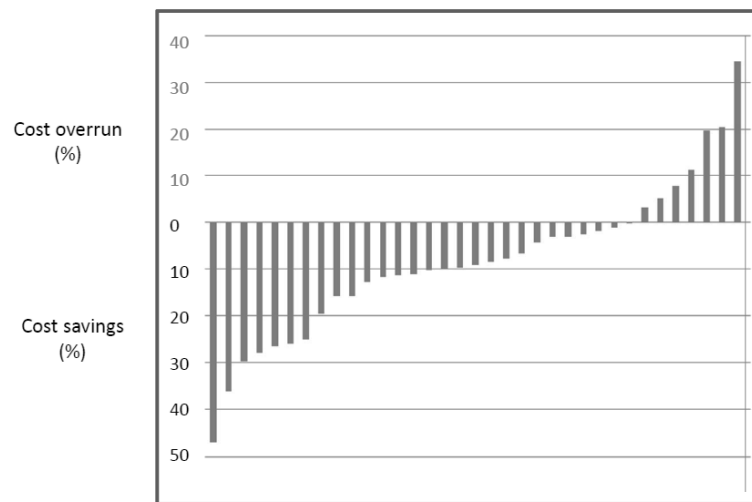


Figure 11 Cost deviation relative to P85 estimates (presented at Concept Symposium 2012)

It is interesting to observe that the distribution of the 35 projects is nearly exactly identical to a P85 distribution. The standard in Norwegian public projects is to use P85 estimates as the total budget, and we can see that approximately 85 % of the projects are spending less than their budget. When comparing with the P50 estimates, we could see the same situation; approximately 50 % of the projects were spending less than their budget. This indicates that the public projects in Norway have succeeded in their estimation and project control, and that their uncertainty management processes have been successful. We also see that most of the projects actually are returning 5-30 % (or more) of their budget. This could indicate that they are over-estimated, but it could also indicate that they are looking for opportunities and actively exploiting them, thus returning money to the government. Public project does not have any natural incentives to reduce cost, as the project does not benefit from this itself. The results presented by the Ministry of Finance are therefore a strong indication that there has been a shift in the mindset of public projects, and that uncertainty management is placed higher on the agenda. It is also an indication that the public agencies are taking a clearer lead in the improvement effort and that they are succeeding in completing projects within budget and within time.

**Finding 3: Increased active involvement of project owner in uncertainty management**

The research has also documented that project owners now are more actively involved in managing the uncertainty in the projects. This is important to make sure the project can utilize the opportunities discovered in course of project execution. We have also seen that the project owners involved in the PUS project have improved their processes, procedures and tools for project uncertainty management. Some of the project owners have actively developed and offered internal training in uncertainty management, both formal (together with academic institutions) and informal (in-house). We have also registered that there is more

communication between the project and the project owner than before, and that the project owner is taking more part in following up the project.

However, it is important that the project owner is "hands on" and not "hands in". There is a balance to be maintained, and if the project owner is too involved in the project, he/she will undermine the position of the project manager. On the other hand, the project owner has to be involved and have close relation to the project manager and the project if opportunities should be exploited and when measures on major threats should be developed and implemented. Both cases normally mean that the scope has to be changed, that funds should be redistributed, or that the cost will increase. All these changes require accept from the project owner, and project owner involvement ensures project success. It is therefore with great enthusiasm we have registered that project owners in the last years have taken more actively part in the projects and are "playing" their role better than before.

#### **Finding 4: Potential negative impacts**

The research has also unveiled some unintended and potential negative impacts of the improvement efforts, which may have resulted in more expensive projects and less innovation.

As mentioned previously, it is easier to meet a budget if the cost is overestimated. In the first years of the quality assurance regime, we could detect a certain increase in the budget, and almost all the external reviews resulted in increases in budget, both in the base estimate, but more frequently in the uncertainty allowances. This could be a result of previous underestimation of the cost of uncertainty, but it is also likely that all parties benefited from increasing the budgets: the project because it would be easier to ensure success, the politicians since they would not have to answer for cost overruns to the opposition, the external reviewers since they would not like to be blamed for cost overruns, and so forth. It became apparent though, that this development could have two major disadvantages: 1) the tax payers would have to pay more for the services provided by the public as the projects got more expensive, and 2) the large allocation of funds to meet potential threats from all the projects combined could actually reduce the total number of projects to be sanctioned in a given time period.

In spite of the positive indications, we think that these potential negative impacts still have to be watched closely the coming years, and it should always be a part of the responsibility for the project owner to make sure that the funds are appropriate for the project objectives. We will continue to investigate this closely in our research in the years to come.

#### **Finding 5: Still room for improvement**

Our research has shown that there still is room for improvement. Figure 12 below illustrates the score of important factors at the time of cost estimation (to the left in blue) and the real score at project completion (to the right in orange). We can clearly see that the projects overestimate the potential influence on the project from some factors, while others are underestimated.

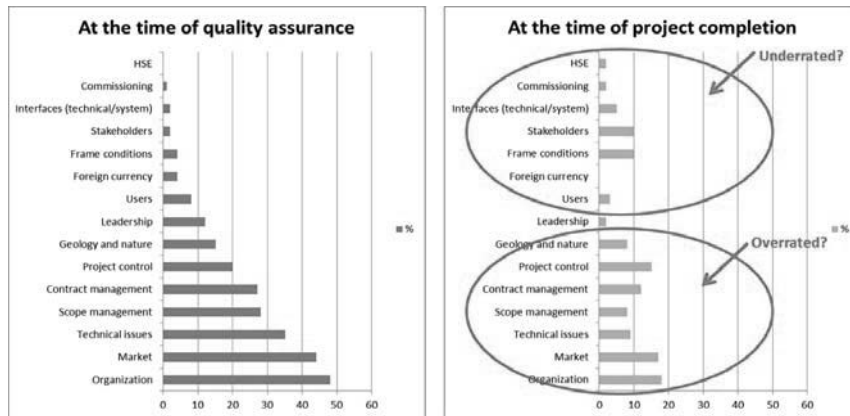


Figure 12 Important factors influencing the project, anticipated vs real

Over the years, we know that organization and market situation always come out on the top priority at the time of quality assurance before project sanction. It was therefore interesting to see that they still came out on top, but at a much lower impact than anticipated. It seems that the actual most influential factors are overrated, and that the factors coming out as less important at the time of quality assurance are underrated. In other words, there is a clear room for improvement. This indicates that the uncertainty analysis systematically delivers results that take too much headroom for the most frequent factors, and too little headroom for the apparently less frequent factors. This finding is supported by the line of thinking related to the concept of "black swans". These findings will certainly foster more research on uncertainty management.

**Finding 6: Blind spot of uncertainty management**

The research has also revealed something which could be called "the blind spot" of uncertainty management. In short, the blind spot is the missing ability to unveil and to utilize the opportunities in a project.

Figure 13 below illustrates the development in number of opportunities and threats during project planning and execution phases. In the left part of the figure, the development regarding opportunities and threats is symmetrical, but with an overall, though uneven dropping trend towards delivery. In the right part of the figure, the set of lost (i.e. unexploited) opportunities due to a low opportunity focus is marked as the area called "blind spot".

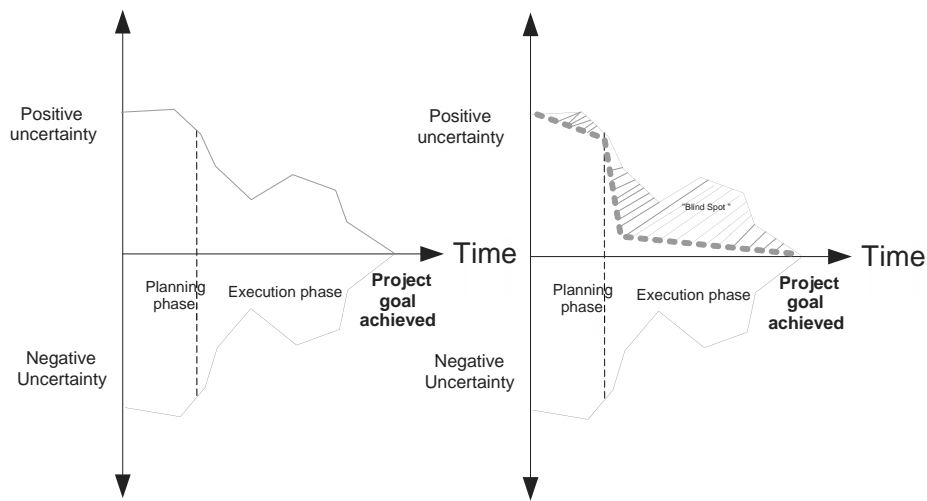


Figure 13 Number of opportunities and threats during project planning and execution phases

From this, we may get the impression that most project managers and project owners have realized that there is an opportunity side of uncertainty, and further on that those opportunities are pursued and utilized in most projects today. The fact is that the projects are preoccupied with the threats, thus losing sight of the opportunities.

The matrix in Figure 14 is another way of illustrating the blind spot in uncertainty management. The figure is intended to give a principal illustration of how the project owner (PO) and project manager (PM) is focusing (i.e., having high or low focus) on threats and on opportunities, and how this is typically developing through the project. At project start the main focus of both actors is on opportunities – and typically on the opportunities that the project will or can bring. At later stages; in fact already when the project is detail planned and organized, the PM's focus will turn from "high on opportunities and low on threats" into a "high focus on threats and low on opportunities". The project owner, being responsible for achieving benefits from the project, will still be highly focused on project opportunities, but will at later project stages usually also have a higher focus on threats.

High focus on opportunities		"Blind spot"
Low focus on opportunities		
	Low focus on threats	High focus on threats

Figure 14 Focus on threats and opportunities

However, for some POs we observe that they assume the PM's attitude to uncertainties and get a high focus on threats and low on opportunities. The gap regarding opportunity focus between the two types of owners that we here illustrate will represent a potentially large number of lost opportunities, i.e.; opportunities that may remain unidentified and very rarely will be utilized. This area or set of lost opportunities may then be called as the project's "blind spot".

In a Norwegian survey in large project organizations (Hald & Langlo, 2011), the response to a question regarding the focus on uncertainty management in their projects, 76% responded that it was "mainly on risks, but also on opportunities", 15% said they did "equally focus on threats and opportunities", and just 7% responded that they "only focused on risks". However, those intentions expressed through the survey do not seem to be reflected by the contents of the projects' risk registers. In another study done in the PUS project (Krane, Rolstadås, & Olsson, 2009), analyzing the risk registers of 7 large projects, it was revealed that 81% of the risk elements could be categorized as threats, 3% as opportunities and 16% could turn out as both threats and opportunities. These results underline the finding that the blind spot is present and highly influential on project execution. This will also be subject for further research.

## 6 Some further assessments on project uncertainty management maturity

We would also like to elaborate some more on how the organizations involved in the PUS project developed and how they matured within project uncertainty management during the time they were involved in the PUS project. Kerzner (2009) describes a maturity model (cf Figure 15 ) in connection with project management. This model can be used to look at the levels through which an organization learns and develops itself.



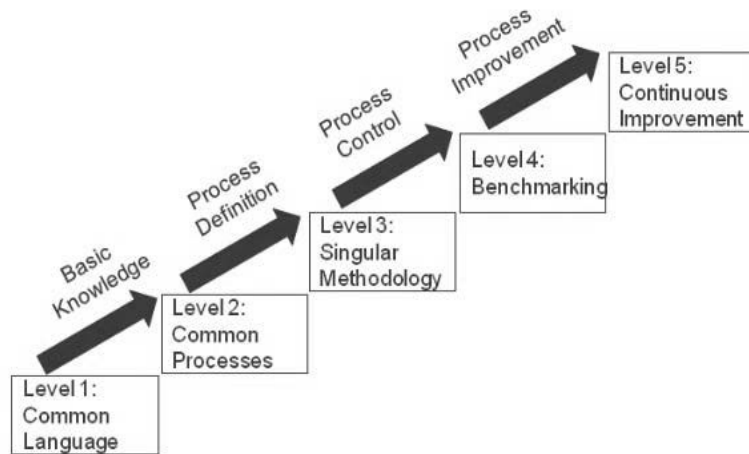


Figure 15 The five levels of maturity (Kerzner, 2009)

Based on this maturity model, we have tried to make a subjective evaluation of the maturity levels in the organizations involved in the PUS project. We have followed these organizations closely for several years, and feel confident in trying to illustrate their maturity level in this manner. Table 2 shows the maturity level of the involved organizations (when it comes to managing uncertainty in projects) at the beginning of the PUS-project in 2006 (denoted by a small x), and the maturity level of the organizations (when it comes to managing uncertainty in projects) at the end of the project in 2010 (denoted by a large X).

Table 2: Subjective evaluation of maturity level in 2006 and in 2010 on uncertainty management.

Company	Level of maturity				
	1	2	3	4	5
Statoil (private)					xX
Telenor (Private)			x	X	
Norwegian Directorate of Public Construction and Property Management (Statsbygg)		x		X	
Norwegian Armed Forces (Forsvaret)			xX		
Norwegian Public Roads Administration (Statens vegvesen)			x	X	
Norwegian National Rail Administration (Jernbaneverket)		x		X	

As we can see in Table 2, Statoil was already a matured organization in the beginning of the PUS-project, when it comes to uncertainty management. They had a clear understanding of the importance of uncertainty management in their projects. They made systematic efforts to develop their work-force (humans), the models and techniques. They are at a level where they

perform "living uncertainty management", that is, they are constantly working to improve their knowledge, skills, attitudes, processes and tools in order to enhance their uncertainty management process.

When it comes to Norwegian armed forces, there has been no noticeable impact of the PUS-project. This can be due to the recurring restructuring processes that would take away or reduce the needed attention and energy to work with managing uncertainty in projects.

Norwegian Directorate of public construction and property management improved its ability to manage uncertainty in its projects through its participation in the PUS-project. The organization established new roles (such as uncertainty coordinators), conducted courses for its employees to improve their knowledge and competence, developed their model for dealing with uncertainty management, and started to apply systematic techniques to improve uncertainty management. And, the organization's participation in the PUS-project and the good results were notified in a high profile manner in the organization by awarding innovation prize for its representatives in 2011.

Norwegian public road administration made its development in managing uncertainty. Conducting / arranging courses for own employees, developing and applying models and techniques (tools for analysis, etc.) were prominent focal points that the organization started to adopt in order to manage uncertainty effectively. This description also points out the role of "living" uncertainty management in the organizational setting.

The improvement that Telenor and Norwegian national rail administration experienced can also be considered with respect to the "living" uncertainty management. The focus on humans, models and techniques and on the interplay between these three elements could contribute to create a positive culture that promotes effective management of uncertainty. The wish and intention of creating a positive culture for uncertainty management was mentioned by the organizations that were participated in the PUS-project – for instance, by Telenor.

This chapter illustrates that there have been an increase in maturity for almost all organizations involved in the PUS project. However, there is no evidence to support that this improvement is due to the PUS project alone, and this research does not claim so either. We are satisfied that we have documented that the combined effort over long time actually has improved the way uncertainty management is carried out, and that this increase in maturity also may result in better project execution.

## **7 Conclusions and suggestions for further research**

Based on our study, we have illustrated some of the effects of long-term improvement efforts within project uncertainty management. We have shown that there is an increased ability to meet cost targets, and that the project owners are taking a more active role in project uncertainty management. We have also presented some indications that the maturity within project uncertainty management has increased in the involved organizations. This research demonstrates that long-term improvement efforts in uncertainty management in Norway have had positive effects, and are still producing more positive effects.

There are still room for improvement, and this paper suggests that further work should be carried out in order to improve the techniques used in the uncertainty processes. It is important to utilise the knowledge and experience of the participants in the best possible

way. It is especially important to investigate how we can improve the processes for identifying and describing opportunities, and how we best can involve the project owner in these processes.

There are three elements of particular importance if a project wants to implement practical uncertainty management. Human factor – is an important part of the “Practical uncertainty management method. You need to involve the right people in the process and a cross functionality is very often a "must" for understanding and deal with uncertainty. Even though an organization has good methods and models for how to manage uncertainty, it will not work properly without key actors that know how to manage uncertainty in projects. The organization culture needs to have actors which believe in the processes. This means actors with competence, experience, and attitude towards uncertainty management. These actors are not just internal project workers, but also external stakeholders of the projects that need to be enrolled in the processes. Model – The organization need an overall model for uncertainty management. It is also important that the organization is open regarding the processes. One need to think uncertainty in all of the projects phases. Dealing with uncertainty must be an on-going process and it's focus will change over the project life cycle. The model has to include both operational uncertainty and contextual uncertainty. Method – or methods. Figure shows a framework for living uncertainty. It consists of 9 steps with different types of tools to assess and analyse uncertainty. We believe that methods and models should be as simple as possible; it's the action that matters. A simple spreadsheets and flipchart is often enough for identifying, analyzing and dealing with the uncertainty in most projects.

### **Acknowledgement**

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**Nr 6 Opportunities in projects – what are they and do we really want them**

## Opportunities in projects – what are they and do we really want them?

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### Abstract

Project literature says that uncertainty can manifest itself in two forms: opportunities and threats. However, in practice, there is a significant focus on dealing with threats, when it comes to managing uncertainty in projects. Traditional way of managing uncertainty falls within the iron triangle of cost, time and quality that are associated with the project, and focuses mainly on threats rather than on opportunities. This traditional approach has its limitations, especially when it comes to creating or ensuring a wider effect that is to be produced by the project when it is completed. A project may be completed according to a predefined frame of cost, time and quality. But, the very purpose of the project (the intended effect of the project) may not be achieved. This paper discusses what opportunities are, and how to explore and exploit opportunities actively during the project. In this regard, this paper characterizes opportunities as first, second and third order consequences, and provides relevant examples. It also presents strategies to deal with opportunities and threats. In addition, this paper briefly describes the roles of project owner and project manager with respect to dealing with opportunities and threats. Although project uncertainty management has gained a lot of attention both from academics and practitioners, there is still a considerable potential for development in the field. This paper emphasizes the need to focus on opportunities in managing uncertainty in projects.

*Keywords:* Project management; Uncertainty; Opportunity; Risk; Project owner

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### 1. Introduction

Uncertainty is often said to have its root cause in lack of available information, available knowledge or competence (e.g. (Kolltveit & Reve, 2002), (Christensen & Kreiner, 1991)). In a project context, uncertainty management has traditionally been synonymous with risk management (Hillson, 2007). Some author's suggest that uncertainty can be positive or negative; positive as opportunities and negative as threats (Loch, De Meyer, & Pich, 2006; Perminova, Gustafsson, & Wikström, 2008). In this paper, we adopt the term uncertainty to include both the positive effects (opportunities) and the negative effects (threats) in the execution of projects.

We, the authors of this paper, worked in a research project called "Practical uncertainty management in the project owner perspective – in short, the PUS-project (2005-2010). This paper is based on experience and knowledge that were gained through the PUS-project. And, this paper is a product of collective reflection of that experience and knowledge. In this regard, we present research methods, which were applied in the PUS-project that inspired this paper, in the following section.

This paper contains five parts. They are:

- Introduction
- Research methods and limitations

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- Theoretical framework – Uncertainty management
- Opportunities – first, second and third order consequences
- Reflections and Concluding remarks

## 2. Research methods and limitations

The research presented in this paper is part of a larger research work. The main body of research is based on data from the PUS-project. The PUS-project involved 6 major Norwegian public and private project intensive companies / organisations. The research method connected to this paper is of a combination of qualitative and quantitative nature. Our results are based on a multitude of techniques and methodologies - there have been literature studies into the different areas of relevance (see for instance (Torp, Karlsen, & Johansen, 2008)), there have been several surveys, action research, in-depth interviews and discussions with experts. The results presented here are also based on a number of case studies of projects. Some of the case studies are also of a longitudinal and qualitative nature, where the authors have been involved as researchers and process contributors repeatedly in the case studies. The above description points out that this research endeavour includes quantitative, qualitative and mixed methods. This compound research basis means that we do not refer to just one dataset as the basis for our results and conclusions. This condition can be considered as a limitation of this paper.

## 3. Theoretical framework – Uncertainty management

Some author's suggest that uncertainty can be positive or negative; positive as opportunities and negative as threats (Loch, De Meyer, & Pich, 2006; Perminova, Gustafsson, & Wikström, 2008). Johansen et al. (2012) define project uncertainty as:

*Project uncertainty is defined as controllable and non controllable factors that may occur, and variation and foreseeable events that occur during a project execution, and that have a significant impact on the project objective.*

We define threats as factors, variations and events that may lead to undesired changes to project objective, scope, resources, frame conditions, that make the project cost more, spend more time or delivers less quality than that was agreed upon in the beginning of the project. Opportunities are factors, variations and events that may lead to changes; that may make the project to deliver the same quality in less time or to lower price than that was agreed upon in the beginning of the project. And all such factors, variations and events, which cause changes, can make the project to deliver higher functionality or lead to positive NPV after the project is completed. Several authors (PMBOK; Hillson, 2004; Piney, 2002) point out that there are at least 6 or 7 strategies that one could choose from as a response / way to manage uncertainty. Piney (2002) suggests 12 main strategies for dealing with project risk and he divides risk into opportunities and threats (see Table 1).

Table 1. Risk response planning

Opportunities	Threats
<ol style="list-style-type: none"> <li>1. If a risk has high probability of occurrence, it may be best to assume the condition as part of the base.</li> <li>2. Risks (opportunities) with high impacts; these risks should be exploited.</li> <li>3. Insignificant risks can be accepted, passive response.</li> <li>4. Between exploit and accept we can take other actions such as enhance and/or share opportunity risks.</li> <li>5. Risks (opportunities) above a certain probability we may choose to accept actively by preparing plans in the event of its occurrence –how will we take advantage of a fortunate occurrence?</li> <li>6. All risks (opportunities) should be enhanced where practical and cost-effective.</li> </ol>	<ol style="list-style-type: none"> <li>1. If a risk has an extremely high probability of occurrence, it may be best to assume the condition as part of the base.</li> <li>2. Risks (threats) with high impacts, can over a given limit, wreck a project; these risks must be avoided.</li> <li>3. Insignificant risks can be accepted, passive response.</li> <li>4. Between avoidance and acceptance we can take other actions such as mitigation or for risks with low probabilities we may want to transfer them.</li> <li>5. For risks (threats) above a certain probability we may choose to accept actively by mitigating and/or preparing contingency plans in the event of its occurrence.</li> <li>6. All risks (threats) should be mitigated where practical and cost-effective.</li> </ol>

Other authors such as PMBOK and Hillson (2004) suggest 7 management strategies for dealing with uncertainty (see Table 2).

Table 2. Strategies for uncertainty management response – opportunities and threats

Opportunities	Threats
Exploit	Avoid
Share	Transfer
Enhance	Mitigate
.....Accept.....	

According to PMBOK, the strategy Exploit is the opposite of Avoid – this strategy is about insuring a positive impact, striving for to realize an opportunity. Hillson (2004) states that Exploit is the most aggressive of the response strategies and should be reserved for those

“golden opportunities” with high probability and impacts. According to PMBOK, Sharing is a positive risk strategy that involves allocating ownership to a third party who is best able to capture the opportunity for the benefit of the project. According to PMBOK, Enhance is a strategy that the project will choose for modifying the “size” of an opportunity by increasing probability and/or impact. The last strategy, Accept assumes/accepts that some threats or opportunities are not possible to eliminate, or they are so small that the effort to do anything is not worthwhile.

These 7 management strategies are well-known – but it must be asked whether it is sufficient to have knowledge about them if a project should obtain full benefit of uncertainty management?

Findings from the PUS research project clearly indicate that project teams had intention to focus on both opportunities and threats. But, the degree of focus varies (Amdahl, et al., 2008; Ward et al., 2003). In a Norwegian survey in large project organizations (Hald & Langlo, 2011), the response to a question regarding the focus on uncertainty management in their projects, 76% responded that it was “mainly on risks (threats), but also on opportunities”, 15% said they did “equally focus on threats and opportunities”, and just 7% responded that they “only focused on risks (threats)”. However, the responses expressed through the survey do not seem to reflect the contents of the projects’ risk registers: In another study done in the PUS project (Krane, Rolstadås, & Olsson, 2009), analysing the risk registers of 7 large projects, it was revealed that 81% of the risk elements could be categorized as threats, 3% as opportunities and 16% could turn out as both threats and opportunities. However, we cannot ignore giving adequate focus on opportunities when it comes to managing uncertainty in projects. So far in this paper, we have seen ways to deal with opportunities (and threats). Now we shall look closely at opportunities: What are opportunities?

#### **4. Opportunity – first, second and third order consequence.**

Ekambaram et al. (2010) discussed project as a system and how opportunities differ over the project life cycle. They say that a project can be seen as a system and that this system is basically instable and flexible at the start of the project. And, it tries to achieve stability and order by the help of establishing objectives, sub-objectives and plans. This will reduce uncertainty of the system. And, the system becomes gradually more stable and controllable. Though the system becomes more controllable when it goes from the early phase to the execution phase, it becomes more rigid, and the flexibility with respect to changes and adopting new opportunities in later phases of the project therefore tends to diminish.

However, new opportunities can emerge at any time in a dynamic work environment. There can be new internal conditions (such as, higher level of competence, effective resources / work methods) and new external conditions (such as cooperation with new projects in the nearby area, which can lead the project to save money by, for instance, common procurement; new products in the market, which can lead the project to simplify its technical solutions) that the project did not consider when objectives and plans were established. If these conditions are exploited effectively, then the project can deliver the product / service with the predetermined quality at a lower cost, or quicker than previously expected. Active involvement, knowledge and authority are required from the management in order to materialize the benefits of opportunities.

Opportunities can be looked at with respect to different levels of consequences. The first order consequences emerge within the framework of the execution of a project and deliverance of the project’s *result-objectives*. (Result-objectives focuses on time, cost and quality). Opportunities are in this respect connected to achieving project’s result-objective efficiently:

The second order consequences are the effects that emerge after the project is completed (*effect-objectives*). These effects include benefits to the organisations that have been involved in the project, *i.e.*, access to new markets and technology, development of new knowledge and competence within the respective organisations.

The third order consequences are broader effects of the project on the society (*society-objectives*). Opportunities in this regard encompass establishment of new organisations and services as the result of the completion of the project. An example in this regard is a construction project called Snow-white project in the Finnmark region, Norway. When the construction project was completed and operations were begun, then the surrounding environment / society started to obtain benefited from it; for instance, there were new work opportunity for the local people, day care facilities for children, and schools. In order to classify / describe opportunities in projects further, we shall first present a classification of risk described by Wideman (1992). This classification is presented in Table 3.

Table 3. Classification of risk

<b>External Unpredictable</b> (and uncontrollable)	<ul style="list-style-type: none"> <li>A. Regulatory, i.e., unanticipated government intervention in:</li> <li>B. Natural Hazards, i.e., as a result of natural elements:</li> <li>C. Postulated Events, i.e., as a result of deliberate intent:</li> <li>D. Indirect Effects, i.e., occurring as a result of the project:</li> <li>E. Completion, i.e., failure to complete the project on account of one of the following:               <ul style="list-style-type: none"> <li>✓ Failure of the supporting infrastructure as a result of others</li> <li>✓ Failure of design, execution or supply contracts due to bankruptcy or receivership, etc.</li> <li>✓ Failure to provide financial support to the end of the project</li> <li>✓ Inappropriate project concept or configuration</li> <li>✓ Political unrest</li> <li>✓ Lack of final acceptance</li> </ul> </li> </ul>
<b>External Predictable</b> (but uncontrollable)	<ul style="list-style-type: none"> <li>A. Market Risks</li> <li>B. Operational (i.e., after project completion)</li> <li>C. Environmental Impacts</li> <li>D. Social Impacts</li> <li>E. Currency Changes</li> <li>F. Inflation</li> <li>G. Taxation</li> </ul>
<b>Internal Non-Technical</b> (but generally controllable)	<ul style="list-style-type: none"> <li>A. Management, i.e., difficulties due to:</li> <li>B. Schedule, i.e., delays and time overrun due to:</li> <li>C. Cost, i.e., overruns due to:</li> <li>D. Cash Flow</li> <li>E. Loss of Potential, i.e., removal of:               <ul style="list-style-type: none"> <li>✓ Benefit</li> <li>✓ Profit</li> </ul> </li> </ul>
<b>Internal Technical</b> (and generally controllable)	<ul style="list-style-type: none"> <li>A. Changes in Technology</li> <li>B. Performance</li> <li>C. Risks Specific to Project's Technology</li> <li>D. Design</li> <li>E. Sheer size or complexity of project</li> <li>F. Legal (generally controllable)</li> <li>Difficulties arising from any of the following:</li> <li>G. Licenses</li> <li>H. Patent Rights</li> <li>I. Contractual i.e., difficulties due to:               <ul style="list-style-type: none"> <li>✓ Misinterpretation</li> <li>✓ Misunderstanding</li> <li>✓ Inappropriate contracting strategy/contract type</li> <li>✓ Failure</li> </ul> </li> <li>J. Outsider Suit</li> <li>K. Insider Suit</li> <li>L. Force Majeure</li> </ul>

The risk classification in table 3 characterizes negative events or outcome for the project – the use of terms like *difficulties*, *Loss*, *Natural*, *Hazards* and so forth indicate that risks are unwanted negative outcome and threats to the project. However, we think that this classification provides a framework that can also be used with respect to opportunities in project (external and internal opportunities). Table 4 shows some examples of opportunities

that can occur in the project period. These examples can be seen as 1<sup>st</sup> order consequences. Table 5 presents some examples of opportunities that arise after the project is delivered / finished. These opportunities can be seen as 2<sup>nd</sup> and 3<sup>rd</sup> consequences.

Table 4. First order consequences – opportunities in the execution of the project

Factors	"From project start-up to project completion (delivering the result)"
External factor: Market	New actors in the marked – lower price in the bids than expected
External factor: Resources	More and better resources Unexpected access <ul style="list-style-type: none"> <li>• A big project ends in the mother organization</li> <li>• "58 +": company's retired / older staff members</li> </ul>
External factor: Owner priority	More resources Easier access to key resources
External factor: Strategic alliance	Access to new methods or technology
External factor: Technology	New product with better performance New technology in the marked Better management performance (than usually)
Internal factor: Management	<ul style="list-style-type: none"> <li>• Good planning process – decision making</li> <li>• Good execution</li> </ul> More or better resources than planned or expected
Internal factor: Team performance	Better team performance <ul style="list-style-type: none"> <li>• More work done in less time</li> <li>• More productive</li> </ul>
Internal factor: Design	More robust design that fits together with other solutions that the company has chosen
Internal factor: Technology	New product with better performance New technology in the marked
Internal factor: Time	Less rework Faster execution than planned (better performance than expected) Faster deliveries of products than planned Faster deliveries of services
Internal factor: Cost	More money than expected from the owner Lower prices from the bidders Cheaper material – price of the material goes down Currency – cheaper than expected Inflation and taxation – more favourable than expected
Internal factor: Quality	Less mistakes (than usually) Less rework Less change orders (than usually)

Table 5. Second and third order consequences

Project owner /company: Opportunities as second order consequences - "Effect and functionality with respect to the company"	Society effects: Opportunities as third order consequences
Strategic <ul style="list-style-type: none"> <li>• Strategic alliances with new companies</li> <li>• Open up new marked areas</li> </ul> Better performance Better functionality than expected Higher volume <ul style="list-style-type: none"> <li>• more gas or oil</li> <li>• in a longer period</li> </ul> Longer duration of the end product than expected More robust technical solutions <ul style="list-style-type: none"> <li>• less maintaining cost</li> <li>• easier to fix</li> </ul>	New jobs in the area More tourists Less pollution <ul style="list-style-type: none"> <li>• Lower carbon foot print</li> <li>• Less traffic in the area</li> <li>• Less noise</li> </ul> Better service (medical) Less accidents (traffic) Shorter travelling time (traffic)

## 5. Reflection and concluding remarks

Data from the PUS-project suggests that role and position of the participants in the uncertainty analysis process have a huge impact on which opportunities that are identified, which opportunities that the project considers for exploitation and finally which opportunities that they actually exploit.

Identifying and managing opportunity are closely related to understanding what type of benefit that the opportunity will bring to each actor in a project and when the opportunity will occur.

*The society / end user / customers* get the effect result of the project, years after the project is completed. They have a demand / requirement before the project starts; for instance, a new school, hospital, road, etc., and the expected benefit for them will typically be better education, better healthcare, faster / safer travelling respectively.

*The company* that starts and finishes the project will benefit financially when the project is executed, and after selling services or products that the project has delivered. At the same time, the company also gains experience and skills that make them better prepared to delivered new projects. Furthermore, delivery of a project would establish / maintain the organization's justification for conducting the project, seen from the owner point of view.

*The project* will be interested in opportunities that are linked to the project objective, and opportunities for the project are thus linked to cost/time/quality:

- Opportunities in terms of cost: The project can deliver more at the cost that was previously determined, or with the predetermined quality at a lower cost.
- Opportunities in terms of time: The project can deliver a predetermined product / service quicker than planned, without increasing the cost and with the predetermined quality.
- Opportunities in terms of quality: The project can deliver a concept that is better than the one which was originally agreed upon, within the same frame of time and cost. Operational solutions can also be considered here; for example, a project can deliver a product / service according to the predetermined frame of time and cost, and the delivery is more optimal to operate.

The project owner perspective (which also incorporates views of the project manager who primarily focuses on cost, time and quality of the project) provides a broader understanding of managing uncertainty in projects through cooperation between project manager and project owner. This perspective can be helpful to understand important aspects that influence a

project (including aspects that lie outside of the realm of traditional project management) as well as interrelation between the aspects. Thus, this understanding can pave the way to identify and make use of opportunities in projects in a more effective manner.

However, there can be a challenge. At the beginning of projects, both the project owner and the project manager will have high focus on opportunities and low focus on threats. A project itself can be seen as an effort to materialize one or more opportunities. But at the later stage, the project manager tends to focus high on threats and low on opportunities. The project owner, at the later stage, is expected to have high focus on both opportunities and threats. However, some project owners will focus high on threats and low on opportunities at the later stage as the project managers. This condition will create a "blind spot" that indicates potential opportunities are missed (Johansen et al., 2012). To be aware of this "blind spot" and deal with it effectively will improve the efforts towards managing opportunities as well as uncertainty.

We would also like to point out our discussion on opportunities can be compared with SWOT-analysis. SWOT-analysis looks at strengths, weaknesses, opportunities and threats that an organization has in order to formulate and implement its strategy (Hax & Majluf, 1984; Stacey 2003). However, as SWOT-analysis seems to focus primarily on stakeholders (Rolstadås, 2008), our discussion has objectives and consequence of projects as the major focal point.



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**Nr 7    Uncertainty Management - Myths and Realities**

## **Uncertainty Management – Myths and Realities**

### **Abstract**

This paper addresses the need for using a project owner perspective in projects in order to handle uncertainty management processes more thoroughly. Traditionally, literature and actual practice have focused on risk mitigation. Recent published knowledge reflects a change in attitude, as it acknowledges that uncertainty has both an upside and a downside. Most literature, however, is still using a too narrow project perspective when analyzing and describing uncertainty management processes. But more alarming was the lack of focus on opportunities that we saw when we followed project in six different companies over a four year period. This is also evident when it comes to thinking in terms of lifecycle.

The aim of this paper is to discuss a set of often-claimed viewpoints on project uncertainty. We have organized the ideas into what we denote “three myths about project uncertainty”. In this paper, we will first present the research methods that were applied in the work on which this paper is based. We then describe relevant theories as a background and a framework for describing the three myths. Finally, an overall discussion and concluding remarks will wind up the paper. In this paper the following myths are presented and examined 1) Uncertainty is reduced to zero towards the end of the execution phase, 2) There are substantial amounts of both opportunities and threats at the start of a project, 3) Uncertainty is understood in the same manner by all the main actors within and outside the project (everyone has same understanding of the uncertainty that is associated with the project). A traditional way of dealing with uncertainty has been to mitigate the risk. Project owners should demand results and negotiate cost and time buffers. In our opinion, front-end loading is necessary, but not sufficient for managing projects. We argue that project managers still need traditional skills in managing uncertainty. However, we see that project managers face more demands, many of which are of non-traditional nature. Project managers will hence need more training in managing uncertainty. Equally important is to raise the consciousness of uncertainty not only as a limiting factor, but also an enabling factor both for project managers and project owners.

## **1. Introduction**

Uncertainty is often said to have its root cause in lack of available information, available knowledge or competence (e.g. (Kolltveit & Reve, 2002), (Christensen & Kreiner, 1991)). In a project context, uncertainty management has traditionally been synonymous with risk management (Hillson, 2007). Uncertainty can be positive or negative; positive as opportunities and negative as threats (Loch, De Meyer, & Pich, 2006; Perminova, Gustafsson, & Wikström, 2008). Some use the term risk management to denote exclusively managing threats, and some others consider risk management as an umbrella term for describing the management of both threats and opportunities (Hillson, 2004). Traditionally, both project literature and project practice have focused much on identifying, evaluating and managing threats – or, as some call it, risks (e.g. Simister (2004) or Ward and Chapman (2004)). Over the last decade, there has gradually been a stronger focus on how to manage the opportunities facing the project. Ward and Chapman (2004) introduced the term uncertainty management to be used in preference to the terms of risk management and opportunity management. Supported by Hillson (2004), they promoted the idea of focusing on exploiting opportunities as well as mitigating risks. Taking advantage of the opportunities has in recent years been an important issue for practitioners, at least at an executive level. In this paper, we adopt the term uncertainty to include both the positive effects (opportunities) and the negative effects (threats). When our discussion touches upon others' definitions, then we use the term that the corresponding authors adopt. Projects have traditionally strived towards predictability and to keep all critical factors under control. However, for large, complex projects such predictability is not the reality (Rolstadås, Hetland, Jergeas, & Westney, 2011). Major uncertainties play a large role in important areas. And especially under such conditions, it will not be a good strategy to strive for maximum predictability, but rather to choose a strategy of flexibility in the project, in order to be able to face changes (Olsson, 2006).

The aim of this paper is to discuss a set of often-claimed viewpoints on project uncertainty. We have organized the ideas into what we denote “three myths about project uncertainty”. In this paper, we will first present the research methods that were applied in the work on which this paper is based. We then describe relevant theories as a background and a framework for describing the three myths. Finally, an overall discussion and concluding remarks will wind up the paper.

## **2. Research methods and limitations**

The research presented in this paper is part of a larger research work. The main body of research is based on data from (a) a major research project on uncertainty management of projects – PUS. The PUS project on uncertainty management had duration of approximately five years and involved six major Norwegian public and private ‘project intensive’ companies/organisations. Together those six have a total yearly project portfolio of approximately ten billion Euros. The PUS project, with a total budget of more than four million Euros, was one of the largest research projects on project management for the last decade. Our results are based on a multitude of techniques and methodologies - there have been literature studies into the different areas of relevance (see for instance (Torp, 2002) and (Torp, Karlsen, & Johansen, 2008)), there have been several surveys, action research has been done in a number of projects, trailing research in others, and also in-depth interviews and discussions with experts. The results presented here are also based on a number of case studies of projects. Some of the case studies are also of a longitudinal and qualitative nature,

where the authors have been involved as researchers and process contributors repeatedly in all the cases, and in a large number of other industrial and governmental projects. The above description points out that this research endeavor includes quantitative, qualitative and mixed methods. This compound research basis means that we do not refer to just one dataset as the basis for our results and conclusions. We shall elaborate some methods that were applied in the research. When it comes to conducting interviews, the interviews were based on interview guides prepared by the researchers in all of the studies. These questions and the following response and discussion can be considered as semi-structured, and there were both individual and group interviews. The organisations that took part in the interviews belonged to sectors such as telecommunication, construction, offshore and defence. The majority of the studies based on interviews must be characterized as qualitative studies (Yin, 2003). There have been made a number of such studies in the work that this paper is based upon, especially in the PUS research project. In some of the case studies in the PUS research project, the researchers applied action research. Here, several sessions of uncertainty analysis were carried out in various projects. One of the authors of this paper participated actively in and led / facilitated the sessions. In a typical uncertainty analysis session, approximately 20 members from the respective organisation would take part. The participants would belong to several professions / positions; for instance, project manager, assistant project manager and construction manager. Experience from these analyses was reflected upon in connection with the topic of uncertainty in projects, and this is used in this paper. The uncertainty analyses were led / facilitated by this author in order to improve the situation that the involved organisations encountered in connection with managing their projects. These analyses can therefore be regarded as action research, at least to a certain extent. Some of the studies were also based on trailing research (Finne, Levin, & Nilssen, 1995), thus combining on one hand pragmatic on going evaluation activities with on the other hand utilizing the opportunity of doing more thorough analyses and reflections around the results. Two surveys regarding the uncertainty management of the projects were conducted in a number of the projects that were studied in the PUS research project. Questionnaires were distributed to a representative selection of participants related to the projects. Using both electronic and paper-based questionnaires, they were distributed to a total of 2701 persons, and overall there was a response rate of 29.7%. Some of the quantitative studies, which were done in the PUS research project, were based on data extracted from the risk registers of seven large projects in the energy sector. Studies applying mixed methods (Creswell, 2003; Flyvbjerg, 2006; Tashakkori & Teddlie, 1998) include a majority of the research that was based on a combination of surveys and interviews. There have also been made a number of this type of studies in the PUS project. Those studies are to a large extent used to underpin what is presented in this paper. The projects covered are basically construction and infrastructure projects, and mainly medium large to large (more than 50 million Euro), and they mainly had a duration of over two years.

Within the field of project management research there has – among other trends – been a move from viewing projects as instrumental processes to seeing them as social processes (Winter, 2006), and there has been defined a number of ‘Project management schools’ that have evolved during the last decades (Söderlund, 2011). This also discussed in the article "Two Schools of Risk Analysis: A Review of past Research on Project risk (Zhang, 2010). He conclude that research articles can be divide in too Risk is essentially something objective (Fact) or in too Risk is essentially something subjective (Construction).

We will here focus on what we call a traditional view on projects regarding uncertainty management, and against that view we will present what we regard as a more mature and holistic view.

### 3. Uncertainty management in projects

There are several definitions of uncertainty. We will start by discussing some of them and then look at the process of uncertainty management in projects. We proceed to a description of the role of project owner, and finally discuss the concept of front-end loading and flexibility.

Christensen and Kreiner (1991) define uncertainty as the difference between currently available information and required information when making a decision. They also provide two strategies for reducing uncertainty; 1) to reduce the necessary information (e.g. by preferring a known solution), and 2) to increase the existing information basis (e.g. by gathering more information, bringing in more competence, or gather more experience by launching a test pilot). Figure 1 illustrates the strategies.

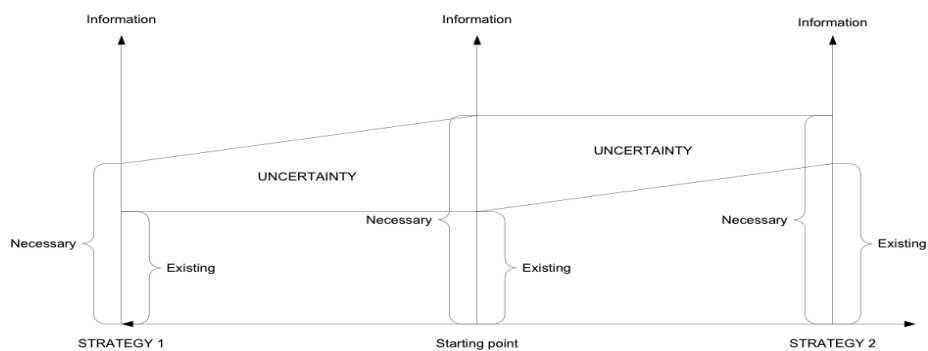


Figure 1 Strategies for reducing uncertainty (Christensen & Kreiner, 1991)

Rolstadås et al. (2011) look at uncertainty as a measure of a range of likely values while risk is a potential event that has both a probability and an impact. They claim that risk is a term that has been dealt with for a long time and uncertainty is a relatively modern term. In the 1920s a distinction was made between risk and uncertainty (Knight, 1971); The distinction highlights a risk as a known and an uncertainty as an unknown. The term known means that, in the case of risk, the outcome of an event can be calculated. Rolstadås et al. (2011) discuss how the term risk should be understood, and claim that one of the most cited definition is "consequence x has a probability of occurrence". This means that risk equals consequence (impact) of an event multiplied by the probability of the occurrence of the consequence. They state that risk is very often thought of as something negative and that the definition, in essence, implies that risk is a weighted consequence of something being feared or unwanted if it materializes.

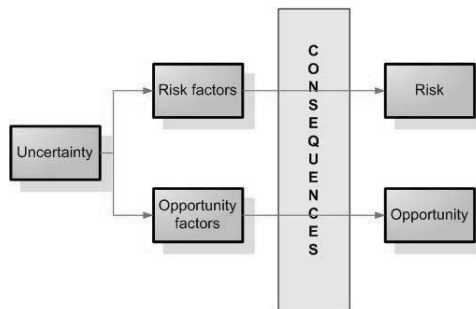


Figure 2 Relationship between uncertainty and risk (Rolstadås, et al., 2011)

Rolstadås et al. (2011) suggest that uncertainty could be negative and positive for a project. And, they refer to the negative implications of uncertainty as risk factors. And they refer to the positive implications of uncertainty as opportunity factors. Both may have a consequence if they occur. They refer to the consequence that is multiplied by its likelihood of occurrence as either risk (negative) or opportunity (positive). In the project management domain, uncertainty is currently understood as lack of information but uncertainty could also be understood as lack of certainty. Rolstadås et al. state that uncertainty in project may take on a number of very different forms, and therefore they offer a structure for categorization of uncertainty (Hetland, 2003). The two by two matrix combines two different stages of data (known or unknown) and two different states of the event from which the uncertainty originates (closed or open). In the matrix, four prime categories of uncertainty are identified:

- Known-closed (deterministic uncertainty)
- Known-open (volatility)
- Unknown-closed (lack of information)
- Unknown-open (undetermined uncertainty)

D A T A	Unknown	Lack of information Lack of predictability	Undetermined Uncertainty Lack of predictability
	Known	Deterministic Uncertainty The uncertainty is fully predictable	Volatility Lack of predictability
		Closed	Open

EVENT STATE

Figure 3 Two by two uncertainty matrix (based on Hetland (2003))  
 In the known-closed segment of the matrix the uncertainty is fully predictable. However, as executing a project is a unique event and it is not possible to predict every final outcome with certainty, a dilemma would arise. They call this dilemma “the flaw of averages”. The other three segments represent lack of predictability. According to Rolstadås et al. (2011) the following is categorizing each of the squares:

- The known-closed (deterministic uncertainty) category is similar to the spinning wheel of casinos. We recognize this as a zero sum closed game situation where all information about possible outcomes are fully known; i.e. the number of possible outcomes, their values and their probability of occurrence are all known.
- In the known-open segment, uncertainties are identifiable and expected. The known-open (volatility) category is recognized as the planners’ and schedulers’ dilemma. As the result of an event or a decision has not yet happened, the planner guesses possible outcomes; i.e. the number of possible outcomes, their values and their probability of occurrence are all based on historical observations and the application of subjective or inter-subjective probabilities.

In the unknown-closed segment, the information available to us is incomplete and ambiguous, hence quality decisions cannot be made. Typically, this kind of uncertainty occurs at defined project decision gates. The unknown-closed category is recognized as lack of information. Uncertainties in this category are rooted in missing pieces of information related to events that have taken place, hence may give a picture that is incomplete and ambiguous. The unknown-open (undetermined uncertainty) category is often referred to as unknown–unknown or complexity.



- The unknown-open (undetermined uncertainty) category embraces uncertainties that are unidentifiable and unknown at the time when particular project decisions of some significance are to be made. This categorization is an attempt by Rolstadås et al. (2011) to describe the nature of uncertainties in a structured manner. The categorization can be considered as a background when we discuss the process of uncertainty management.

**Process of uncertainty management** Simister (2004) has developed a generic risk management model based on publications from national standards associations (British Standards Institute, Canada Standards Association, and Standards Australia), professional institutions (Institution of Civil Engineers (ICE, 1998), Japan Project Management Forum (2002), Project Management Institute (2008), and Association of Project Management), and government departments (U.S. DoD (2003), and the UK OGC (2002)).

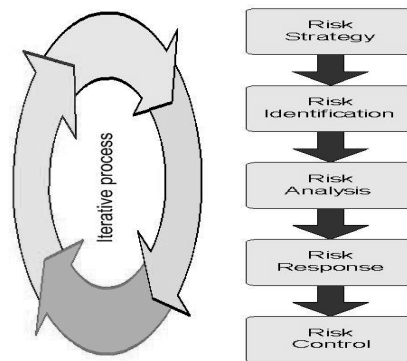


Figure 4 Risk management process (Simister, 2004)

Simister (2004) underlines the importance of undertaking risk management as a structured, formal process aligned with the overall project management approach. Simister says the risk management process should be commenced as early as possible in a project life cycle, and that the process has to be undertaken on an iterative basis since each assessment is a snapshot in time. Ward and Chapman (2004) elaborates on Simister's risk management process, and considers how risk management can be made more effective in a given project context. They divide project uncertainty into five areas (Chapman & Ward, 2003):

1. Variability associated with estimates.
2. Uncertainty about the basis of estimates.
3. Uncertainty about design and logistics.
4. Uncertainty about objectives and priorities.
5. Uncertainty about fundamental relationships between project parties.

All areas of uncertainty are important, according to Ward & Chapman, and generally they become more fundamentally important to project performance as they go down the list, and the areas effect on one another. In the context of this paper, we claim that project uncertainty in at least the last two areas in the list depend upon involvement of project owner and other stakeholders in the uncertainty management process.

### **The role of the project owner**

Traditional ways of managing uncertainty has been very much focused on project objectives, and also focuses mainly on threats rather than opportunities. This traditional approach has its limitations, especially when it comes to creating or ensuring a wider effect that is to be produced by the project when it is completed. A project may be completed according to a predefined frame of cost, time and quality. But, the very purpose of the project (the intended effect of the project) may not be achieved. Furthermore, the traditional approach tends to assume that the world is stable and predictable. The PUS-project acknowledged that the world in which projects are a part of is dynamic, unpredictable and complex, and proposed a broader perspective: the project owner perspective (Ekambaram & Johansen, 2011). A project owner has rights to and is responsible for the project. Olsson, Johansen, Langlo, & Torp (2007) say:

*"The beauty behind the concept of a project owner lies in the fact that a project owner has incentives for weighing costs against benefits for a project. Project owners are therefore expected to strive for project governance aimed at maximising the value from the project". (p. 7).*

The project owner perspective provides a broader understanding of managing uncertainty in projects. This perspective can be helpful to understand important aspects that influence a project (including aspects that lie outside of the realm of traditional project management) as well as interrelation between the aspects. This understanding, which can be achieved through cooperation between the project manager and the project owner, can help to deal effectively with uncertainty in projects. A good cooperation between a project manager and a project owner can produce a holistic understanding of the project, which can in turn help to identify / create opportunities in the project. Olsson (2007) also emphasizes the importance of having a holistic approach in projects in order to identify and materialize opportunities. As with the role of project owner, there is another issue that we would like to point out, which is the concept of front- end loading.

**Front-end loading (FEL)** on the rational and sequential approach to project management, beyond depending heavily on the fixed structures and plans.

Rolstadås et al. (2011) say that much of the body of knowledge of project management and project risk management is based on fixing and achieving project objectives. And, they point out that a predictable project objective is, in fact, destined to be an exercise in futility. They also claim that the conventional thinking about project risk has led to much attention on the concept of front Discussion on front-end loading can be seen in connection with the traditional project management approach that focuses on the iron triangle: time, cost and quality. This focus tends to overshadow the importance of the usability of the final outcome

of the project – the functionality of the project. Morris (1998) criticizes the dedicated focus on the iron triangle, since it cannot ensure obtaining potential commercial benefits of the project delivery. According to Anttila, Artto, and Wallén (1998), the final end result of the project that matters. When discussing the strategic view of front-end management of projects, Artto, Lehtonen, and Saranen (2001) say that the means to manage the functionality should incorporate experimenting with a dynamic environment that supports decision making and management of future outcomes, rather than just dictating activities for project implementation. The description mentioned above suggests that it is important to consider the final outcome of the project (its functionality and its benefits), rather than focusing solely on defining objectives and plans at the front-end of the project and following them strictly through the project execution. Front-end loading, in this regard, can contribute to efficiency (doing things right), but not to effectiveness (doing the right things). What are the right things that are to be done with respect to the purpose of a project can change over time, since the project is operated in a dynamic world. FEL can be viewed from the task perspective. The iron triangle – cost, time and quality – is closely connected to the task perspective (Andersen, 2008). Ekambaram, Johansen, Aalstad and Hansen (2010) say that the task perspective has an assumption that everything can be predicted and planned. According to this perspective "when one gains an understanding of the problem at hand and the stakeholders' needs at the beginning of a project, then one can take predictable measures to make sure that the intended product or service will be produced at the completion of the project. In other words, a detailed plan is made in an early phase of a project and then the project is carried out as best as possible according to the plan." The authors also point out that it is not desirable if a project delivers its result according to the predetermined time, cost and quality, while its intended benefits / effects are not materialized. Söderholm (2008) also emphasizes the need to look beyond focusing on the iron triangle, beyond relying -end loading (FEL) and that the main philosophy behind the FEL concept is to reduce the probability of cost and schedule deviations by fully defining the project (its objectives and plans) before execution begins. (See also (Crawford & Bryce, 2003)). They also argue that it is hard or even often impossible to predict the outcome of large capital project in the early stage, and that more front-end loading will to a little degree change this fact. This is also supported by Alessandri et al. (2004). Rolstadås et al. (2011) point out that it is a dilemma for decision makers that they have to make decisions based on very little information that is available in the early stage of the project. This dilemma is also described by Artto et al. (2001), and by Alessandri et al. (2004). In this regard, Rolstadås et al. (2011) describe the dilemmas of Capital Expenditure (CAPEX) predictability. The dilemma of CAPEX predictability consists of two important decisions:

- On one hand, CAPEX decision-makers require (inter alia) a certain level of confidence in the prediction of how much the proposed production asset will cost as well as how long it will take to achieve the expected revenue stream.
- On the other hand, CAPEX decision-makers must acknowledge the hard truth that, when all risks related to a project's outcome are considered, this desired level of confidence may simply be unattainable. (Rolstadås, et al., 2011, pp. 2-3) This dilemma highlights the nature of uncertainty that project managers come across. In order to cope with this dilemma, they suggest that capital projects need a new concept to understand, embrace and exploit project risk, and they suggest what they call a new framework for risk management – "The Extended Project Risk Navigator".

Rolstadås et al. (2011) state that conventional project risk management may increase the predictability of project outcomes, but it tends to ignore the business value that may be added through the project execution phase. And, because of this weakness they claim that risk navigation should also be addressed at an executive level; in fact they claim that the risk management is an executive level responsibility, and that you cannot deal with this only at the project level (one project at a time) in the organization. In this regard, it is relevant to look at the role of project owner, and the cooperation between the project owner and the project manager.

The discussion on the shortcomings of front-end loading points out the need to see uncertainty from a broader perspective, and consider various categories of uncertainty – specially, the unknown-closed and unknown-open categories that have been mentioned earlier in this paper (cf. Figure 3). To what extent front-end loading can take these categories into account – given the fact that there will be changes in the project level (operational uncertainty), organizational level (strategic uncertainty) and societal level (contextual uncertainty) – is a question that is worthy to reflect upon. This line of thought leads us to consider a concept in connection with managing uncertainty. That concept is flexibility within projects.

#### **4. Flexibility**

According to Husby et al. (1999), project flexibility is “the capability to adjust the project to prospective consequences of uncertain circumstances within the context of the project”. Flexibility is essential to tackle the changes and uncertainty that business environment (Olsson, 2006). Volberda (1998, p. 89) claims that “Flexibility can be considered as a new way to achieve some form of control in extremely turbulent environments”. And according to Birkinshaw (2000, p. 5), “Flexibility means an ability to adapt aspects of the organization rapidly in the face of new opportunities and threats in the environment”. This description reflects our discussion on opportunities and threats with respect to uncertainty. When it comes to managing a project successfully, we claim that uncertainty and flexibility are closely related to each other. It may even be expressed as uncertainty and flexibility being “two sides of a coin”. Flexibility is also necessary for innovation, but not alone sufficient to create it (Volberda, 1998). Burns and Stalker (1961) and Woodward (1965) argued that there is no guarantee that companies will find a necessary or sufficient organizational model for managing the environment in a flexible manner. Jensen, Johansson, and Löfström (2006, p. 8) say – as a proposition based on their model – that “projects that act in a trustful environment have low degree of uncertainty” In this regard, they discuss also the role of the project owner. We interpret their description and conclude that establishing trust between project owner and project manager can contribute to reduce uncertainty. We have mentioned earlier the benefit of establishing a good cooperation between the project owner and the project manager. This kind of cooperation will lead to establish or is based on trust between these two parties. Jensen et al. (2006, p. 10) also point out that “if trust between project owner and project improves, the image of the project will certainly also improve.” Similar descriptions of the importance of trust between project owner and project management may also be found in (Kadefors, 2004), (Diallo & Thuillier, 2005) and (Zaghoul & Hartman, 2003), among others. Jensen et al. (2006) suggest that a trustful environment,

where there is a good relationship between the project owner and the project, provides a "high degree of freedom of action". This freedom of action may also be regarded as a form of flexibility.

In this theoretical discussion, we have presented definitions and descriptions of uncertainty. Many authors (see for instance (Ward & Chapman, 2003), (PMI, 2008) and (Rolstadås, et al., 2011)) have pointed out that uncertainty has both positive and negative sides – opportunities and threats. We have then presented a model that illustrates a process of managing uncertainty in projects. In this regard, we have focused on 3 important issues, namely the role of project owner, front-end loading and flexibility. This theoretical discussion sets the base for continuing our discussion further in this paper. Both in the project management literature and among practitioners we have seen ideas about project uncertainty that not all are well rooted – neither empirically nor in project management theory. In general, we find them as ideas of how uncertainties occur and evolve, ideas of how different uncertainties should be handled under different conditions, and ideas about how the actors in and around a project experience the uncertainties and relate to them.

## **5. Myths about uncertainty – assumptions and limitations**

There are many myths and different explanatory models that are related to uncertainty in projects. In many projects, it is assumed that:

1. Uncertainty is reduced to zero towards the end of the execution phase
2. There are substantial amounts of both opportunities and threats at the start of a project
3. Uncertainty is understood in a same manner within and outside the project (everyone has the same understanding of the uncertainty that is associated with the project)

These myths are important as basic explanatory models. But, they also implicitly bring with them a range of challenges. These challenges should be considered seriously and in particular when one has to manage uncertainty in projects.

### **Myth-1: Uncertainty is reduced to zero towards the end of the execution phase**

The basis for this myth is that uncertainty (defined as "difference between currently available information and required information when making a decision" (Christensen & Kreiner, 1991)) is something that decreases over time. This can be justified by the common experience that we obtain more information as time passes, and also that we make choices and decisions throughout the project cycle. Regarding the latter, one may assume that uncertainty is closely linked with the flexibility that exists until one has taken certain decisions over the course of the project. This flexibility is normally quite large at the start of the project and gradually decreases as the project approaches the handover. If this assumption is right, then we could expect that the uncertainties will approximately be equal to zero at the handover of the project.

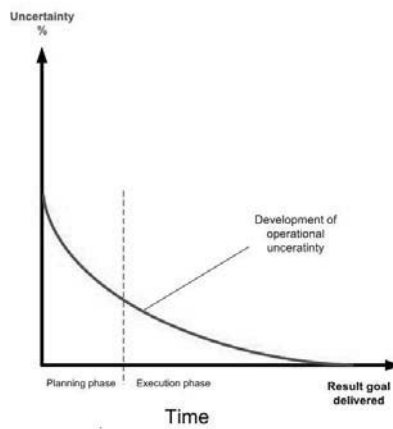


Figure 5 Myth-1: Uncertainty during the course of projects

For many projects, uncertainty and flexibility are related to each other to a certain degree (Olsson, 2006). We will here consider a case, as an example, where one has the options to choose between the concept of road and the concept of rail as a solution to a need for transport infrastructure. Then, the choice of one option automatically means that all uncertainty associated with the alternative option will simply disappear. This condition will also reduce the total uncertainty accordingly. But similarly, flexibility will also be reduced in the project, because one must choose one of these solutions (options). A simple model, which is often used for this declining uncertainty, is illustrated in Figure 5. (See for instance (Samset, 2003) and (Rolstadås, et al., 2011)). The model has two other aspects;

1. The uncertainty will decrease approximately linearly during a larger portion of the course of the project – It is highest in the planning phase and is decreasing in the execution phase
2. Risk management will primarily deal with reducing uncertainty that the project comes across with respect to its result oriented goals.

This model / figure legitimizes that the project is aiming at reducing the uncertainty associated with the result oriented goal, since this is the primary goal of the project management team. Risk management in the project will hence be primarily aimed at the result oriented goal, and will deal with (Krane, Rolstadås, & Olsson, 2010):

- Finding uncertain conditions that helps the project to achieve its result oriented goals faster, cheaper, or with the same quality at a lower cost (opportunities) or
- Preventing conditions that might make the project more expensive, lead it to take longer time or contribute to deviating from the goal

One may ask whether Figure 5 really reflects the experiences that many projects have, or whether it should be reconsidered. With projects carried out in interaction with a dynamic, evolving world, new uncertainties are likely to be introduced, also at late stages of the project. For instance this may be caused by political decisions or market developments. Many projects

experience that uncertainty varies over the course of the project, and that it is not reduced linearly in many parts of the project cycle, as Figure 5 shows (Rolstadås, et al., 2011). On the one hand, the uncertainty to some extent decreases with the choices that are made over the course of the project. On the other hand, new opportunities and threats may occur in the execution phase. It is therefore a myth that uncertainty almost vanishes towards the end of the execution phase, and that a project manager will be able to:

- Identify all relevant conditions of uncertainty in the planning phase of the project
- Consider how much impact the different uncertain condition will have on the project results
- Assess which of the uncertain conditions that actually happens and which are not.

The uncertainty found in a project can be of three different types (Rolstadås & Johansen, 2008):

1. Operational uncertainty (internal uncertainty). This can be related to the choice of concepts in the planning phase and technical uncertainties in the implementation phase.
2. Strategic uncertainty (external uncertainty). This can be related to the project owner's changing strategic considerations of the project. But, it is also related to how the owner perceives achieving the best possible business profile at the completion of the project.
3. Contextual uncertainty (external uncertainty). This is related to the external environment which the project is a part of.

For example, competing projects in the market, market fluctuations and economic conditions could give rise to this “type 3” kind of uncertainty. Likewise, choice of social values such as those against counter-cyclical measures that were initiated by the governments in some countries during the financial crisis in late 2008 and 2009 can be a source of such uncertainty - both positive and negative, in terms of opportunities and threats. This distinction implies that uncertainty will have a more fluctuating or pulsating course than what is outlined in Figure 5. In addition, the uncertainty can increase and decrease throughout the course of the project due to external uncertainties, see Figure 6.

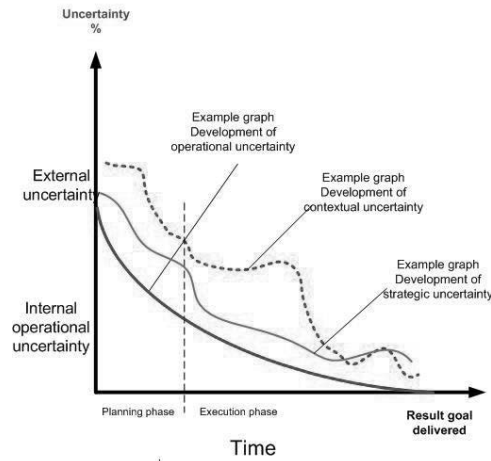


Figure 6 Uncertainty during the course of projects – internal and external uncertainty

The uncertainty may rise and fall through the entire course of the project. When the project management makes its choices and clarifications, then they will experience that the uncertainty is reduced. But, since the project is a part of a larger whole, many projects experience that uncertainty may increase again if the parent organization makes new choices and priorities. It may also be a result from the society evolving and changing during project execution. Midler does in (1995, p. 369) point out the non-linearity in the learning processes and the production processes of the project. This is illustrated by curves characterizes by numerous jumps during the execution of the project. Projects that have a long duration – i.e. two or more years – may experience that the conditions and requirements may change several times during the course of the project. The real uncertainty that the project has to deal with does not necessarily decline in a linear manner. And, it is not sufficient to handle only internal uncertainty, if the project wants to achieve success.

**Myth-2: There are substantial amounts of both opportunities and threats at the start of a project**

The nature of uncertainty is gradually better understood as the project goes through its development phases, and hence a better understanding of the consequences of uncertainty will emerge. Consequences of uncertainty are said to have an up-side (opportunities) and a down-side (threats) with respect to the project. Again, one can assume that these opportunities and threats will be reduced in the course of the project, based on active choices and conscious management of the project. While such an understanding of a "dualism" in the uncertainty has evolved, it is implicitly also taken for granted that negative and positive uncertainty has a "symmetrical" development – with a steady decrease during the course of the project, as



Figure 7 shows. In other words, when we have assumed that the uncertainties will decrease as the project work goes ahead, this means furthermore that the project's negative and positive uncertainties decrease equally during the course of the project, and that there should be equal amount of negative and positive uncertainties when the project is almost handed over. This assumption does not suit well with what most projects experience (Miller & Lessard, 2000).

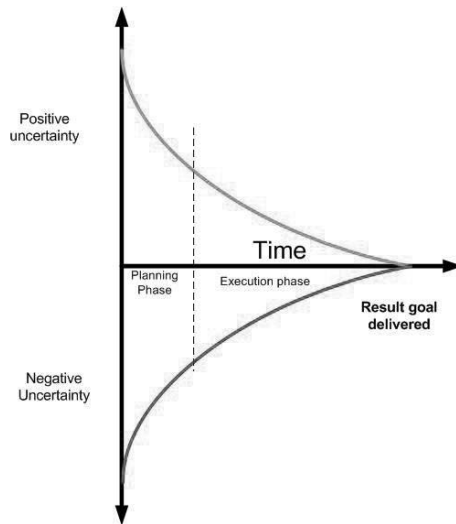


Figure 7 Myth-2: Positive and negative uncertainty decreases during the course of projects

We have previously argued that when an idea for a new project arises, then there are no negative or positive uncertainties. There is only a wish or an expectation from those who initiate the project that the project should create a positive change. This means that the project is, in itself, an opportunity to create a positive change for the project owner. The understanding of negative and positive uncertainty is only established at the planning phase of the project when the objectives and limits are set during the project startup. Therefore, there are strong indications that uncertainties do not have a symmetrical shape, and that positive and negative uncertainties will diminish in different ways (unequally) during the course of a project.

When a project is carried out, project members will typically experience that they have to choose among various concepts – concepts that have their positive and negative outcomes. If you choose, for example, to build a building on site A, all uncertainties that are related specifically to the site B will become irrelevant and disappear (i.e., both positive and negative uncertainties lapse.) This will also lead to that the project will subjectively assess the uncertainty as relatively much lower, which for instance means that the uncertainty is considered lower because project management expects that the final costs will be lower by constructing a building on site A instead of on site B. Further on, this means that it is the negative uncertainty that is diminished by the choice of site A, and the positive uncertainty in principle is the same after site A has been chosen. But, from Figure 7, one would assume that

the positive uncertainty should have been reduced accordingly. One may also think that the negative and positive uncertainties, presented in Figure 7 can say something about how much variation one may expect to what has been assumed in the project's plans and budget. By adopting such an approach, one will assume that it is possible and common to utilize positive and negative uncertainties throughout the entire course of the project. But, this is inconsistent with what one would see when ongoing as well as completed projects are studied. It turns out that (Miller & Lessard, 2000; Krane, Rolstadås, & Olsson, 2009):

- Uncertainty does only to a limited degree decrease symmetrically during the course of a project. Uncertainty varies based on the decisions that the project makes, the tactical choices that are made in the parent organization, and society's changing demands and expectations.
- Project management takes advantage of the positive uncertainty as early as possible in the project. However, such positive uncertainty is not sought after and it is not visible in the execution phase.
- Negative uncertainty is highest in the start phase, but it is not uncommon that negative uncertainty is high during periods of the project execution phase. Uncertainty management, seen from the project's point of view, deals largely with reducing the likelihood of adverse events or consequences of adverse events. This means that the project's uncertainty management is risk aversion by its nature (basically reluctance to take risks).
- The uncertainty management of the project has little focus on future benefits and functionality for the project owner.

The effects of this are illustrated at the right-hand side of figure 8. In the figure this is contrasted to – on the left-hand side – the 'ideal' reduction over time, earlier presented in figure 7 and discussed in connection with that.

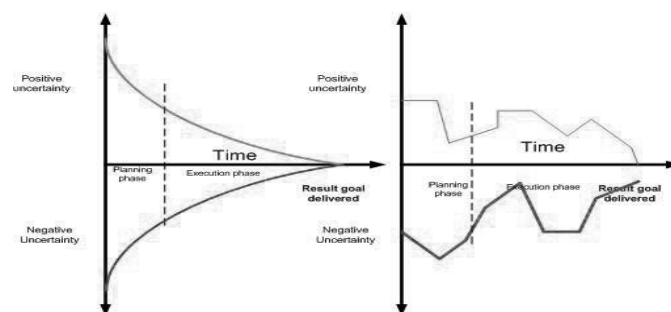


Figure 8 Positive and negative uncertainty, ideal and real

How uncertainties are assessed is related to how individuals or organizations are measured. Whether uncertainties are high or low, positive or negative is never assessed “in a vacuum” – such assessments must always be done in its right context. It is always about how individuals or groups are affected or held responsible for the choices they make during the project. Willingness to live with uncertainty to a large extent deals with whether one is negatively or positively affected by the uncertainty as an individual and group, and how much the project earns or loses on exploring uncertainty. At the initiating stages of a project, uncertainties rarely have any distinct character of threats or opportunities. When it’s initiated, the whole project will normally appear as an opportunity, or the implementation of one. It is not until the project and its course towards an implementation is defined (to a certain degree) that threats are defined. We will now for a moment go to the situation of an “ordinary” uncertainty/risk analysis during the implementation phase of a project – where the results of the analysis may be plotted in a grid as shown in figure 9.

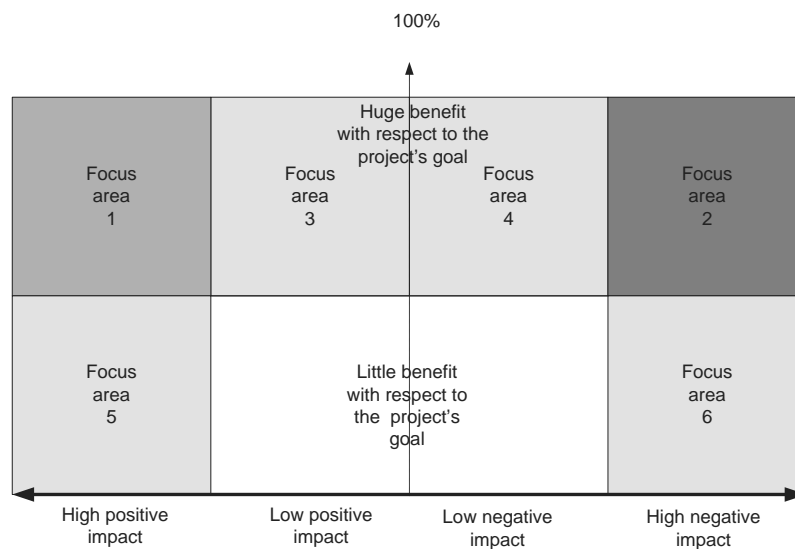


Figure 9 Focus areas based on benefits to the project

In Figure 9, we have tried to illustrate under what conditions that different issues will get different attention from the project management. Project management will initially focus on the issues that matter most to the project's success. This means that in a normal situation, the project management will work actively to exploit the positive uncertainty that gives the greatest benefits – this is evaluated with respect to the project-objectives (focus area 1 in Figure 9). Moreover, the project management will work actively to reduce the probability of experiencing the negative uncertainty, or to minimize the effects of the negative uncertain conditions (focus area 2). Then, one can prioritize uncertainties that lie in areas 3 and 4 in Figure 9, since these uncertainties provide the greatest benefit with respect to achieving the project's objectives. Finally, one may focus on the uncertainties that represent a large positive or negative uncertainty, but give less contribution to the project's objectives (focus area 5 and 6). The uncertainty that the project will actually experience will vary during the course of a project. Moreover, each stakeholder of the project understands the size of the uncertainty and

how it is assessed (i.e., whether the uncertainty is negative or positive) in his / her own way (Hillson & Murray-Webster, 2005). This understanding is also influenced by the objectives that each stakeholder focuses on. Studies on project practices show that projects, only to a small extent, are actively seeking opportunities in the execution phase (Hillson, 2002; Krane, et al., 2010). It does not mean that such opportunities do not exist there; it only means that quite many projects miss opportunities because they are lacking focus on this issue, when it comes to managing uncertainty.

**Myth-3: Uncertainty is understood in the same manner within and outside the project (everyone has same understanding of uncertainty that is associated with the project)**

When a project starts, there is uncertainty about the future need, hence there is also uncertainty regarding objectives and deliverables. Uncertainty is also linked to the execution of various activities, cost and time needed for the activities and whether the project will produce the intended deliverables with the quality that the project owner and the parent organization expect. Therefore, most of the choices and decisions that the project management has to consider that in principle, "all" decisions that are made will be based on more or less uncertain assumptions. The choices and decisions will also be based on some fundamental information that is a more or less correct at the point of decision making. Many projects deal with uncertainty as if it was something "objective", and that it is possible to identify and quantify uncertainty at the project startup. It is assumed that "everyone" related to the project have almost the same perception of what is uncertain. It is further assumed that there is a common understanding of how uncertainty can affect the project, either positively or negatively (Krane, et al., 2010). Studies of larger infrastructure projects suggest that this is not the case (Krane, Rolstadås, & Olsson, in print; Miller & Lessard, 2000). They say:

- Uncertainty is looked at and assessed subjectively by the project management, and threats or negative uncertainty dominates most presentations of identified uncertainties
- The project owner is less involved in the assessment of uncertainty
- Uncertainty management is largely based on the project management's framework and perspective

The stakeholders' experience and understanding of how much uncertainty the project actually faces as it progresses is largely subjective. This means that there are no exact measures regarding the uncertainties that the projects have to deal with during their course - i.e., how big or small those uncertainties are. How the stakeholders of a project perceive the uncertainty of the project and its context is closely related to what kind of experience and competence the stakeholders have. The perception also depends on how clear understanding the stakeholders have about the process that will lead towards the objective - i.e.; how the project will evolve. Thus, an experienced project owner or project manager will most likely understand and evaluate uncertainties of a project substantially different from one who comes straight from the academy (Langlo, Johansen, & Olsson, 2007; Rolstadås & Johansen, 2008). Similarly, an organization that has undertaken many complex projects consider uncertainty differently compared to a one-time project owner or a newly formed company. A challenge that they all have in common is that making an objective assessment of the uncertainties; in the best case, this sort of objective assessment can only first be done after the project is delivered. It has been claimed that the project's real uncertainty can seldom be estimated

objectively while the project is in progress, it can only be considered reasonably objectively and after the completion of the project (Christensen & Kreiner, 1991). How uncertainty is assessed in a project is influenced by individual events that the project organization experiences. But it is also affected by how the various members in the organization interpret events happening inside and outside the project, and by the conditions / elements that the project owner and the society emphasize while the project is carried out. Issues such as what attention uncertainty management gets and which areas receive attention are largely based on what individuals and groups are measured upon. The project owner and the project management have different roles and thus different assessment of to what issues in the project there is uncertainty related to (Olsson, et al., 2007). Langlo, Johansen, and Olsson discuss six dilemmas between the project owner and the project leader in (2007). This will also affect how the project's uncertainty is evaluated and presented. Both the project owner and the project manager have their subjective perceptions of the uncertainties that the project faces - and they will interpret differently the information-base that is available throughout the course of the project. It is up to the project owner and the project management to decide who will focus on which areas of uncertainty. It is up to the owner to decide whether the project management should look beyond the project objective and whether responsibility for functionality and for future needs should to be included in the mandate of the project management. Without guidance from the project owner in this matter, one can expect that the project will focus on uncertainty management towards the project's result oriented goals and not towards effect oriented goals or society oriented goals.

## **6. Overall discussion and conclusion**

In the discussions in this paper we have argued for a more nuanced and less mythicized view on uncertainty. We have also argued that flexibility is necessary in order to successfully navigate the project in a dynamic setting with large uncertainty. To be successful with this adaptation towards taking into account more uncertainty in projects, will largely depend on that senior management and projects owner interact. This interaction must mean that they together interpret and indicate the conditions they face in an appropriate manner and take appropriate measures. From the literature, top level commitment is identified as the key in implementing changes successfully (French & Bell, 1990). For instance, in order to achieve exploration of positive uncertainty in the execution phase of the project, in order to overcome risk aversion and to focus more on uncertainty management regarding future usefulness and functionality for the owner (Krane et. al, in print, 2009). We therefore argue that the focus on exploration of uncertainty has received too little attention, while the framework of project execution can be said to have seen more on exploitation of uncertainty in projects (March, 1991). We have also seen that too much of the focus in project has been on the project deliverables. The project owner should look more to his or her portfolio of projects and not focusing too narrowly on one project. It is also important that the evaluation of the projects is not limited to time and costs only. A traditionally way of dealing with uncertainty has been to allocate more money and time as buffer. This will of course make it easier to keep within time and cost limits within the projects (and hence have project management success), but for instance "Parkinson's law" claims that available time and resources will always be spent. Hence, this will overall give more costly projects with a longer duration. So project owners should negotiate such buffers because by building large buffers less projects overrides will appear. By looking at portfolio management, resources could be steered more effectively. The

project owner must ask for more exploration of opportunities and foster a dialogue with both stakeholders and project managers. The traditional front-end loading is still of importance, but from our perspective front end loading is necessary, but not sufficient. Project managers still need to master the traditional skills. However, we see that more aspects of the project managers must be added. Project managers will need more training in steering uncertainty. Equally important is to raise the consciousness of uncertainty not only as a limiting factor, but also an enabling factor. Project managers will interact in a dialogue with more competent owners. We do not argue that project managers should take on the role of project owner. In that case roles can be blurred and project managers can contribute to create artificial needs. In advance project managers should be expected to be evaluated on a broader level than today.

## **7. Further work and need for more research**

There is a need to reformulate some of the literature on project management, given the discussion presented in this paper. We have hopefully contributed to a more nuanced understanding of uncertainty and through our discussion of the three myths. We have further argued that uncertainty must be taken more into consideration when governing projects. However, criticism has been raised regarding a too narrow focus on contract deliverables, front-end loading and locking of project objectives too early in order to deal with uncertainty. We believe that the discussion must have implications in such areas within project management as contracts, management and understanding of roles. But we do not fully know what the alternatives would provide. Further studies should investigate more into the interaction of process, technology and governance. This should further address questions on how learning processes are performed during different phases of the project. Last, but not least, given the importance of the interplay between process, technology and governance, more knowledge should be attained in order to understand how to lead the processes. Further studies should investigate more into the interaction process between project owners and project managers. We need in particular research on the interaction between project owners and project managers as a means to handling both positive and negative aspects of uncertainty.

### **Acknowledgement**

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**Nr 8 Improving uncertainty management in projects by  
collaborating in an inter-organizational research project**

## **Nr 8 Improving uncertainty management in projects by collaborating in an inter-organizational research project**

### **Abstract**

Research projects play an increasingly important role in learning and knowledge creation in organizations. Inter-organizational collaborative research projects provide opportunities for organizations to collaborate with each other along with researchers, and contribute to finding ways to improve their work practices as well as the norms that guide their practices. This paper present how a collaborative research project on uncertainty management (called Practical uncertainty management in a project owner perspective – in short the PUS-project) contributed to produce positive results both in the theoretical and practical fronts. In this regard, this paper describes instances and achievements that demonstrate how the participating organizations developed their competence in managing uncertainty in projects. This paper is based on several studies that adopted various methods (qualitative and quantitative) in connection with the PUS-project.

*Key words: Inter-organizational collaborative project, project management, research, uncertainty management*

## **1. Challenges in producing desired effects of collaborative research projects**

In general, research projects deal with innovation in varying degrees. Innovation, we are often told, requires risk taking and the ability to change course mid-stream to take advantage of emerging new ideas and trends or acknowledge the failure of specific lines of enquiry. Publically funded research projects, although often initially responding to emerging trends, are frequently rigid and inflexible due to the need to control project outcomes and meet the requirements of funding agencies of agreed aims and objectives. A conflict can exist between the need for agility to respond to changes and the rigidity of project work plan. Management and decision making related to research projects are not only a question of rational logic and optimizing technological and economic solutions, but also about power and negotiation, networks and alliances.

Projects usually face complex issues. When it comes to inter-organizational research projects, there is an extra dimension to complexity; Distance and difference in organizational culture and the fact that several autonomous organizations are involved. The actors involved need to align the project with the research policy or needs of their respective organizations. Academics might have a stronger focus on long-term research and publishing opportunities, while participating industrial organizations might search for short-term solutions in order to improve their organizations. Researchers are struggling to develop a methodology for collaborative research efforts that reflects and incorporates expectations and aspirations from academia and industry. In academia, there is little tradition for rigorous project management of activities, and the result can be frequent delays, cost overruns, and adjusted or only partially achieved objectives. Collaborations between diverse organisations are difficult to manage and the cultural differences between academia and industry present particular difficulties (Wong et al., 2010). Some go as far as claiming research projects cannot be planned, since the results are risky and unknown.

In 2006, Norwegian Center of Project Management funded and started a research and development project in cooperation with 6 companies and 3 academic partners, co funded by the Norwegian Research Council. This project is called as “Practical uncertainty management in a project owner perspective” – in short, the PUS-project. The PUS project had duration of approximately 5 years and involved 6 major Norwegian public and private ‘project intensive’ companies/organizations. Together these 6 organizations have a total yearly project portfolio of approximately 10 billion Euros. The PUS project, with a total budget of more than 4 million Euros, was one of the largest research projects on project management for the last decade.

In this paper, we look into the effects of the collaborative research project PUS – its practical (industrial) contribution along with relevant elements of its theoretical contribution. This paper first presents research methods that were applied in the PUS-project, which also consequently contributed to the methodological aspects of this paper. Following the description of the research methods, theories that are relevant to this paper are presented. In this regard, the topics of research projects and uncertainty management are dealt with. And then, experiences from the PUS-project are presented. This presentation has 2 parts. The first part looks at the theoretical contribution of the research project and the second part describes the practical contribution (the industrial contribution). Finally, the concluding remarks wind up the whole discussion.

## **2. Research methods**

The research presented in this paper is part of a larger research work. Our results are based on a multitude of techniques and methodologies - there have been literature studies into the different areas of relevance (Torp, et al., 2008), there have been several surveys, action research, in-depth interviews and discussions with experts. The results presented here are also based on a number of case studies of projects. Some of the case studies are also of a longitudinal and qualitative nature, where the authors have been involved as researchers and process contributors in the cases, and in a number of other industrial and governmental projects. The above description points out that this research endeavor includes quantitative, qualitative and mixed methods. This compound research basis means that we do not refer to just one dataset as the basis for our results and conclusions. We shall elaborate some methods that were applied in the research.

When it comes to conducting interviews, the interviews were based on interview guides prepared by the researchers. The interview-guides were semi-structured, allowing and encouraging respondents to involve actively and comfortably during interviews. And, there were both individual and group interviews. The organisations that took part in the interviews belonged to sectors such as telecommunication, construction, offshore and defence. The majority of the studies based on interviews must be characterized as qualitative studies (Yin, 2003). There have been made a number of such studies in the PUS-project. In some of the case studies, the researchers applied action research. Here, several sessions of uncertainty analysis were carried out in various projects. One of the authors of this paper participated actively in and led / facilitated the sessions. In a typical uncertainty analysis session, approximately 20 members from the respective organisation would take part. The participants would belong to several professions / positions; for instance, project manager, assistant project manager and construction manager. Experiences from these analyses were reflected upon again in connection with this paper and used in this paper. As we have stated before, the uncertainty analyses were led / facilitated by this author in order to improve the situation that the involved organisations encountered in connection with managing their projects. These analyses can therefore be regarded as action research, at least to a certain extent. Two surveys regarding the uncertainty management of the projects were conducted in a number of projects that were studied in the PUS research project. Questionnaires were distributed to a representative selection of participants related to the projects. Using both electronic and paper-based formats, the questionnaires were distributed to a total of 2701 persons, and overall there was a response rate of 29.7%. Some of the quantitative studies, which were done in the PUS research project, were based on data extracted from the risk registers of seven large projects in the energy sector.

## **3. Collaborative research – Project management theory in practice**

Research projects play an increasingly important role for the innovation process at national and global level. Collaborative research provides opportunities for enterprises and technology providers to collaborate with leading scientists and contributes to knowledge-based innovation and innovation in industry and society (RCN, 2011). Collaborative research can create synergies like improvement of the economic and technological potential of partners that cooperate. (Mora-Valentin, Montoro-Sanchez, & Guerras-Martin, 2004). This requires a



close partnership between researchers and other stakeholders. The idea is to engage enterprises in the research process to enable sustainable research results. Research projects aim at creating new knowledge or finding applicable knowledge. When a research project is started, few know what the outcome of the project will be. This means that a research project can be rated highly successful even though the results of the project are different than originally planned. In many cases, collaborative research projects are initiated by a university partner, sometimes in co-operation with an industrial partner, who together may seek to identify other partners to fund and participate in the project (Barnes et al., 2006). Researchers are typically concerned with interesting scientific phenomena and fundamental technology breakthroughs, whereas the intended development must satisfy the demands of business units and impatient costumers. The context and surroundings are often uncertain, and it is hard to know what the outcome would be. In addition to answers and new business solutions, new problems and opportunities are welcome results of research projects (Artto, Martinsuo, and Kujala, 2011).

Project management of collaborative research projects needs to involve the support of dynamic processes, and flexible approaches to goals and project objectives. This means not only supporting the scientific methodology of the researchers, but also the nature of the work carried out by different stakeholders in the project. The processes and approaches include the primary research work such as conducting experiments and gathering and analyzing data; and supporting activities such as producing proposals, conducting quality reviews, and managing projects and all of its stakeholders. Finally, they also include implementation of the results as innovation in industry.

#### **4. Uncertainty management in projects**

In this paper, we adopt the term uncertainty to include both the positive effects (opportunities) and the negative effects (threats). When our discussion touches upon others' definitions, then we use the term that the corresponding authors adopt. Projects have traditionally strived towards predictability and to keep all critical factors under control. However, for large, complex projects such predictability is not the reality (Rolstadås, Hetland, Jergeas, and Westney, 2011). And especially under such conditions, it will not be a good strategy to strive for maximum predictability, but rather to choose a strategy of flexibility in the project in order to be able to face changes (Olsson, 2006).

Simister (2004) has developed a generic risk management model based on publications from national standards associations (British Standards Institute, Canada Standards Association, and Standards Australia), professional institutions (Institution of Civil Engineers (ICE, 1998), Japan Project Management Forum (2002), Project Management Institute (2008), and Association of Project Management), and government departments (U.S. DoD (2003), and the UK OGC (2002)).

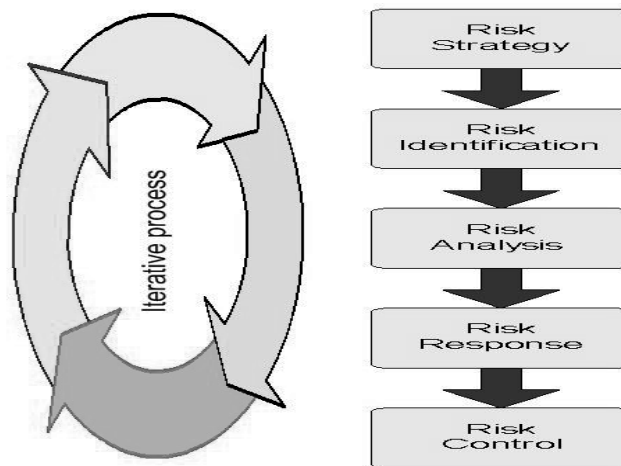


Figure 1: Risk management process (Simister, 2004)

Simister (2004) underlines the importance of undertaking risk management as a structured, formal process aligned with the overall project management approach. Simister says that the risk management process should be commenced as early as possible in a project life cycle, and that the process has to be undertaken on an iterative basis since each assessment is a snapshot in time.

Ward and Chapman (2004) elaborates on Simister's risk management process, and considers how risk management can be carried out more effective in a given project context. They divide project uncertainty into five areas (Chapman and Ward, 2003):

1. Variability associated with estimates.
2. Uncertainty about the basis of estimates.
3. Uncertainty about design and logistics.
4. Uncertainty about objectives and priorities.
5. Uncertainty about fundamental relationships between project parties.

All areas of uncertainty are important, according to Ward and Chapman (2004), and generally they become more fundamentally important to project performance as they go down the list, and the areas affect each other. In the context of this paper, we claim that project uncertainty in at least the last two areas in the list depends upon involvement of project owner and other stakeholders in the uncertainty management process.

More details around the theoretical framework of uncertainty management are presented in "Uncertainty Management – Myths and Realities" (Johansen et al. 2012).

## 5. Experiences from the PUS-project – Theoretical and practical contributions

The main industrial partners of the PUS-project were:

- Statoil (an international energy company with operations in 34 countries, headquartered in Norway),
- Norwegian Directorate of Public Construction and Property Management (Statsbygg),
- Telenor (one of the world's largest mobile operators with 33 200 employees worldwide, headquartered in Norway)
- Norwegian Armed Forces (Forsvaret)
- Norwegian Public Roads Administration (Statens vegvesen)
- Norwegian National Rail Administration (Jernbaneverket)

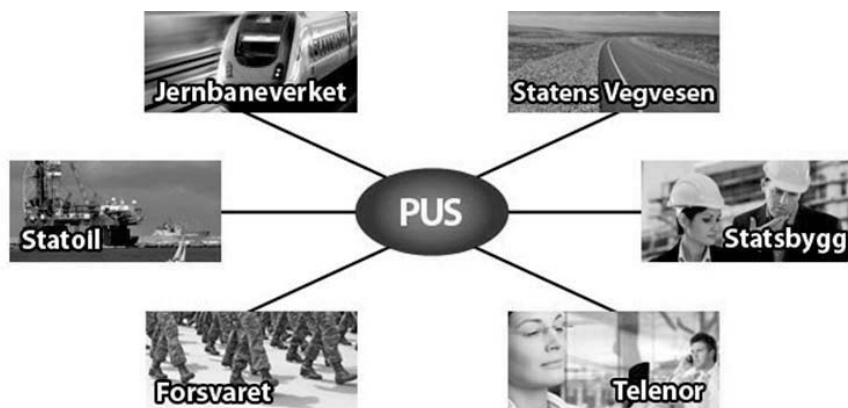


Figure 2: Major industrial partners of the PUS-project

The research project aimed to explore uncertainty management of projects in a broad and empirical perspective. In this regard, the project chose to focus on the project owner perspective. The way a project owner looks at his / her project is not limited to the iron triangle of time, cost and quality that a project manager normally focuses on. A project owner focuses also on effects or benefits of his / her project. The project owner perspective that the PUS-project has (in addition to its consideration on project managers) leads to develop a broader understanding of projects – a broader understanding of objectives, uncertainties (both opportunities and threats), and consequences that are associated with projects. A project owner has rights to and is responsible for the project. The project owner takes the risk connected to the project's cost and its future (Eikeland, 2001). Olsson *et al.* (2007, page 7) say:

“The beauty behind the concept of a project owner lies in the fact that a project owner has incentives for weighing costs against benefits for a project. Project owners are

therefore expected to strive for project governance aimed at maximising the value from the project.”

To get a complete picture of how to manage uncertainty in an owner's perspective, the project was divided into two equal main parts

- uncertainty management - theoretical view / contribution
- uncertainty management - the practical view / contribution

To examine and understand a phenomenon - uncertainty management - in a complex (or seemingly complex) environment with many factors that affect the outcome is a demanding task. In the PUS project, we tried to integrate researchers' ambition to deliver excellent and break through results in various development projects that were initiated in the participating organizations. Figure 3 shows the logic of the research project.

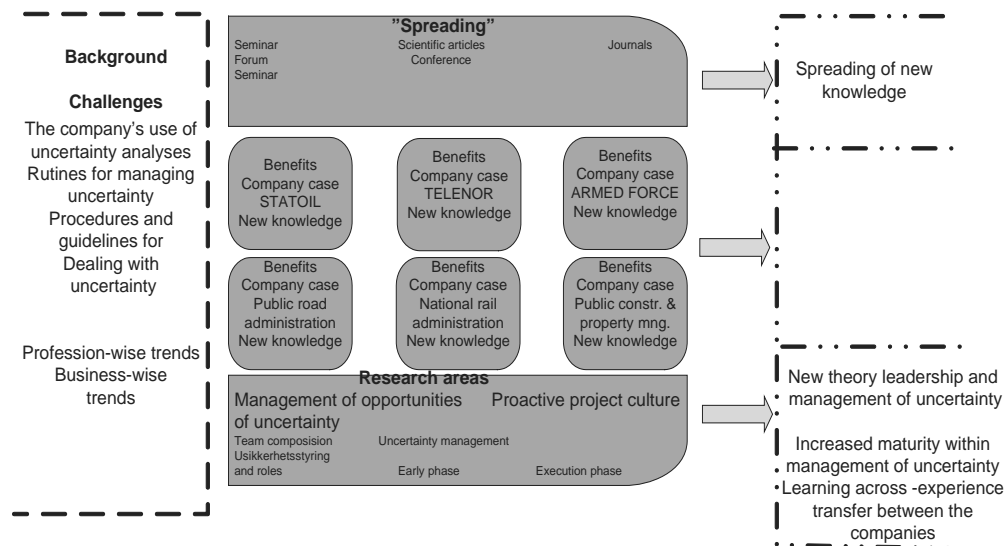


Figure 3: Methodological procedure

PUS-project had an ambition of focusing on leadership and culture connected to practical management of uncertainty in major public and private projects. The PUS-project had five objectives from the beginning:

1. Development of theory / knowledge base within uncertainty management leadership
2. Development of project-specific means for identifying and managing uncertainty in collaboration with the organizations that participate in the project
3. Testing the theoretical foundation and project-specific means in case projects from the project participants (participating companies)
4. Gathering experience based knowledge
5. Development of maturity model with concrete Key Performance Indicators (KPI) for managing uncertainty

Lot of work was done on the issue of uncertainty analysis both in Norway and abroad, and much of this kind of work was carried out in the early phase ("front end loading") of projects. But, there was less research on the issue of how to manage opportunities and threats in a project's life cycle in a practical manner. Further more, there was not much research on how and what the project owner role should be with respect to management of uncertainty; from the very start of the project to the phase where the intended benefits of the projects are realized. PUS had an ambition to shed light on the owner's role related to uncertainty management throughout the project life cycle. The project had a keen interest in influencing large organizations' thinking patterns and actions associated with identification and management of uncertainty elements in projects.

Uncertainty management is not something that must only be established at the project level. It is important that uncertainty management becomes a vital part of the organization's management philosophy. Although the current uncertainty management is to a large extent developed and implemented from the project's perspective, many organizations discuss the possibility of viewing uncertainty management from the project owner and senior executive perspective. The PUS-project, as its name suggests, looks at uncertainty management from the project owner perspective. In addition, it emphasizes giving adequate focus on opportunities in managing uncertainties in projects, and on contributing to create a positive culture that promotes effective and efficient uncertainty management in project organizations.

## **6. Theoretical contribution – Humans, models and techniques**

Having these viewpoints as its background, the PUS-project adopted an approach called, "living" uncertainty management – a sustained, active approach that the PUS-project developed in order for organizations to deal with uncertainties continuously, making timely and effective response to challenges emerging from the dynamic environment. The aim is to discuss how to integrate uncertainty as a part of project management. Living uncertainty management is described by three elements and their interaction with each other. These elements are:

- **Humans and organization aspects:** This aspect deals with what types of people gathered in a project team, what kind of ability that they have, what kind of impact that they make and who has what role and position in the project. These issues will influence identifying uncertainty elements and managing uncertainty.
- **Models and methods:** This aspect is about what the activities or steps are to be implemented in order to archive uncertainty in projects.
- **Tools and techniques:** This aspect is about which identifying-techniques and analyzing and visualizations methods are used in projects.

These elements had made the base to develop theories that were studied in connection with practice in the participating organizations. The practical contribution of the PUS-project – how the involved organizations improved their uncertainty management through collaborating in the project – reflects the theoretical views as well as theoretical contributions of the project. We shall now describe the practical contribution of the PUS-project, which is the core issue of this paper.

## **7. Practical contribution – Uncertainty management in public and private sectors**

Here, we shall summarize the practical view (effect) of the PUS-project by describing what the involved organizations (the 6 industrial partners) accomplished through the collaboration in the PUS-project.

### **International energy company – Statoil**

Risk management (uncertainty management) in Statoil is an important process in connection with project development. Statoil was involved in the PUS-project with an intention of implementing improvements in risk management (uncertainty management), and researching on selected topics in risk management. The following description presents Statoil's efforts to develop and improve risk management in its projects, in which the PUS-project played a notable role. This presentation does not specify the exact contribution of the PUS-project in detail, since the collaborative work was integrated with the improvement efforts that Statoil took in connection with risk management.

Over many years, Statoil has worked with the topic of risk in its projects. In the mid 1990's, Statoil developed its own risk registers on Lotus Notes platform, and developed procedures for managing risk in its projects. Today, Statoil has a well defined methodology with its own governing documents and its own tools for managing risk in projects. Statoil is therefore can be called as a "mature" organization in the field of risk management. Statoil has organized its work on risk management in a separate group that has resources to develop procedures and tools, and provide assistance in conducting seminars and support implementation (of tools, procedures, etc.) in projects in the organization. This group has its own website on Statoil's intranet - where the "governing documents" in the area of risk management are gathered and made available for the users. There is also a possibility for obtaining assistance from the central support unit. The web site also contains links to tools, presentations as well as detailed description on latest developments. Furthermore, the website also publish announcement on internal seminars that are to be held 2 to 3 times a year at various locations in Norway.

In 2001, Statoil's first version of a web based risk management system, called PIMS Web was introduced. The tool contains a risk matrix that handles all types of risks (Health, Safety, Environment, and Cost and Time) in projects. PIMS Web was fully integrated with the group's e-mail system, which made the group to assign actions to deal with the risk factors that have been identified in meetings. The tool also has its own report generator, so that a list of highest prioritized opportunities and threats (top 10 risks) at the project level and sub-project level can easily be made.

Since Statoil merged with parts of Hydro in January 2008, it was necessary to review and revise work instructions and procedures for risk management. Hence, a new working procedure for risk management in projects and a risk management module were developed. In addition, templates and tools were modified in order to reflect the two organizations' methodology in this area of risk management. Statoil's "new" methodology was launched in autumn 2008. The methodology is closely connected to the ISO 31000 risk management standard, and Statoil participated actively in the development of the standard.

In 2009, Statoil launched Risk Lite - a simplified version of PIMS Web and a corresponding training module. This Risk Lite module included all the key features of PIMS

Web in one screen / display, and thus simplified user interface between projects and subprojects.

In 2010, the PIMS version 3 (R3) of the risk management system was launched. R3 has an improved risk management module. It provides the possibility to monitor risks conditions over time. It also has a built-in module for transferring experience, and it provides information to Statoil's suppliers, so that the suppliers can use the same tool that Statoil itself uses.

Statoil continuously measures how many active users who utilize various tools offered by the organization in the area of risk management. Figure 4 shows the rising curve (graph-line) in connection with the number of risk management tools. The "name tags" in the figure (x-axis) specifies the time-line of some of the most important measures taken in IT support for uncertainty management in Statoil. The 3 boxes under the curve (graph-line) show 3 generations of Statoil's basic support tools for risk management in projects, while the boxes above the curve (graph-line) point out 11 key internal development projects (within risk management in projects in Statoil) during this time period.

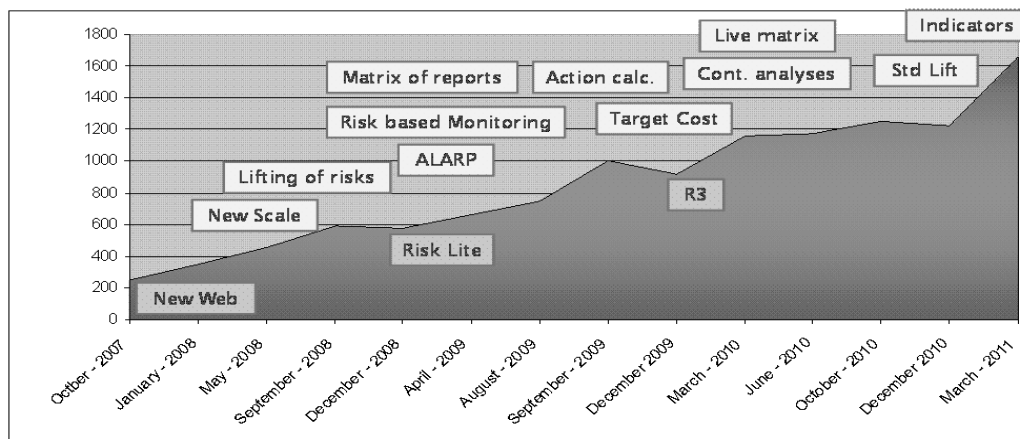


Figure 4: Development projects and increment of number of users in risk management in Statoil

Statoil, as with many large organizations, is in constant change. In 2011, the units Quality and Risk integrated into a common group within the project unit in Statoil. This group now has the responsibility for improving the governing documents and business processes. Risk management in Statoil is under continuous development. The continuous development is due to new user requirements or new demands from external stakeholders. Feedback from project participants is collected continuously and new features / functions will be tested continuously. Giving quick response to user requirements and providing adequate support to the above mentioned projects (see Figure 4) have been two key success factors in the introduction of "living" risk management in Statoil's projects.

## **Mobile operator -Telenor**

Telenor, through its participation in Norwegian Center for Project Management (NSP), has been one of the initiators of the PUS-project. Telenor made commitments to support the project with NOK 100,000 per year from 2007 to 2010, in addition to its own efforts with NOK 1.8 million (own man-hours). Telenor's collaboration with the PUS-project create two positive results in Telenor, including (1) getting help from academia and the participating companies to obtain quality assurance on its existing methodology and process for risk management, (2) obtaining suggestions for improvements and suggestions for how to "spread" a positive culture for better risk management in the whole organization in an effective manner. The purpose of the collaboration, according to Telenor, was to implement a culture where risk management is an equally integral part of the project culture in addition to the focus on time, cost and quality. This applies to the project steering committee, making investment decisions as well as priorities, and following up benefits. On this basis, a mandate for Telenor's participation in the PUS-project was prepared. According to Telenor, risk management is to maximize the likelihood of the consequences of positive events and minimize the likelihood of the consequences of negative events. In Telenor, work on risk management was organized as a cross-organizational subproject. This subproject followed up uncertainty related activities throughout the organization and sought to create and enhance synergies of these activities in order to achieve the purpose of the collaboration.

Deliveries with respect methodology and tools during the collaboration are summarized below:

1. Establish "as-is" / status in the organization at the start of the PUS-project
2. Practical "early warning concept – Health Check: Health Check has been developed in collaboration with the PUS-project and will be a practical contribution for projects to identify risk. Using the software "Quest Back", the core team members can anonymously register their experiences in eight topics as responses to twenty questions. This registration of experiences (health check of the project) is done every 4 week, and the results are sent in a report to the project manager / risk manager. The report shows individual results separately and over time. The purpose of Health Check is that it will provide more / better information that can be used to sharpen risk assessment / identification work.
3. Specific and detailed requirements for managing risk in strategic (large) projects were tested in large projects in 2008, and the requirements were decided to be implemented in 2009. The PUS-project followed this pilot project.
4. The reason and background for Telenor to participate in the PUS-project was due to the focus on the project owner perspective. This is because Telenor wished that risk management should receive focus beyond the project group and project period. Telenor and the PUS-project were in a strong collaboration in order to prepare / formulate a new concept for owner-management of projects in Telenor.
5. Quality assurance of Telenor's training on risk / owner management.
6. Usage of portfolio management tool "Artemis A7" in following up of risk in project portfolio.



One of challenges that the organization had was to see all these elements as a whole and to make it understandable for the entire organization as natural concepts.

The PUS-project ended in the summer of 2010, and according to Telenor, the project helped Telenor to focus on risk related issues. Work on these issues would continue, and for this purpose, Telenor would establish a risk forum.

### ***Norwegian Directorate of Public Construction and Property Management***

#### ***(Statsbygg)***

Statsbygg has 830 employees (2010). It organizes plans and executes around 160 projects – large and small – at all times, and 20-30 large projects are completed every year.

Two master degree theses at Norwegian University of Science and Technology (NTNU), Trondheim, Norway (Løken et al., 2006; Lund, 2007) were carried out in the very start of the PUS-project. The theses focused on describing how uncertainty management in Statsbygg was actually carried out. Conclusion from this work pointed out that Statsbygg had an unstructured approach to uncertainty management, and that there was lack of methodology and supportive culture connected to uncertainty management in Statsbygg.

Statsbygg, in collaboration with the PUS-project, started its own development project called “Uncertainty management in Statsbygg” – in short, the SUS-project. Statsbygg (with its SUS-project) worked closely with the researchers connected to the PUS-project. Through the cooperation with the PUS-project, Statsbygg developed itself in such a way to deal with uncertainty effectively and efficiently.

The SUS-project had 3 phases:

Studies in the case projects: The case projects were: Lapp Science Center, Norwegian Central Bank, Domus Media (a part of University of Oslo), R6 (Government buildings), National Theatre, Halden prison, Vestfold University College, and Department of Computer Science II (IFI2, University of Oslo). Methods and tools were tested in this phase; for example, a matrix for visualizing situations of uncertainty, risk register for monitoring uncertainty and monthly reporting of uncertainty in the case projects. Other activities associated with this phase include: work related to establishing training courses, development of culture in accordance with the focus of the SUS-project, experience reports from 4 of the case projects.

Developing the systems – methods and tools: Based on experiences from the case projects, Statsbygg developed methods and tools. New governing documents were created, and a new role called “uncertainty coordinator” was established.

Implementing the systems: As per October 2010, the tools were used by about 20 projects. Procedures, guidelines, templates and training programs were in use. Statsbygg’s school offers courses and training for their employees. The courses are conducted according to Statsbygg’s own direction and guidelines. Uncertainty analyses and uncertainty workshops are conducted, and uncertainty analyses are seen as a basis for uncertainty management. Uncertainty analyses focus mainly on quantitative aspects, while uncertainty workshops focus more on qualitative aspects. Uncertainty workshops are conducted every other month. Five to 8 people participate in such workshops. People linked to other projects can participate in the

workshops as observers; this participation can be viewed as a means to transfer knowledge and experience.

In the beginning of 2011, the SUS-project won Statsbygg's innovation prize. A description that accompanied the prize says that the project has provided documentation of both threats and opportunities over time in projects, including effects and efforts related to the projects. The overview of uncertainty, provided by the documentation, gives both project managers and project owners more confidence in executing their roles in managing uncertainty in projects.

#### ***Norwegian Armed Forces (Forsvaret)***

Both the Norwegian armed forces and the Ministry of Defense (MoD), as an investment process owner and a project owner, have a strong focus on uncertainty management in projects. The purpose of dealing with uncertainty is to systematically identify potential and real uncertainty elements, and then handle these elements by taking measures in such a manner to increase the likelihood of obtaining projects' objectives, including result-objectives (performance, time and cost). Defense projects vary in size, scope and value, but common to all is that there is a requirement for managing uncertainty. Investment staff of the Norwegian armed forces' logistic organization (FLO) represented the armed forces in the PUS-project.

Armed force wanted to take part in the PUS project, because the collaboration could provide them a good indicator for the possibilities and limitations that the Norwegian armed force would face. Norwegian armed forces have participated in various seminars and workshops with the various contributions and suggestions.

Norwegian armed forces presented the following two effect-objectives with respect to the PUS-project:

- To create greater awareness of the fact that projects are inherently uncertain and that the projects must relate to an upside uncertainties (opportunities) and downside uncertainties (risk) in order to ensure value creation.
- To generate results that can affect the culture / maturity of the Armed Forces in relation to the management of risk in complex projects.

As per 30th November 2010, the Norwegian armed force considers that there has been a limited impact from PUS project on how it handles risk management. The limited impact is seen, at least to a certain extent, in connection with internal restructuring efforts in the Norwegian armed forces. Norwegian armed forces had been through a restructuring process during the PUS- project period, and planned to implement yet another restructuring during 2011. The restructuring efforts partly influenced the focus on risk management in the Norwegian armed forces, and could have significant effect on the investment staff of the logistic organization (FLO) and its various FLO divisions. The restructuring efforts could have taken the required attention and focus away from dealing specifically with risk management in this collaboration. The Norwegian armed forces recognizes that it must be more proactive in creating an environment where risk management is more focused and monitored / followed up at all levels (project manager, project locations, project and process owner (MoD)).

### *Norwegian Public Roads Administration (Statens Vegvesen)*

According to the Norwegian public roads administration, its participation and collaboration with the PUS-project have the following result-objectives:

- Establish tools and processes for uncertainty management so that uncertainty is identified, and it can be managed in a simple and uniform manner in all investment projects
- Small improvements in uncertainty management in several areas will provide significant gains
- Extracting practical uncertainty management as an independent part of project management in order to increase focus and improve uncertainty management significantly.

In summary, the concrete result-objectives are:

- Develop and implement new analytical tools for dealing with uncertainty in different phases

The Norwegian public road administration currently uses an IT tool called "Anslag 4.0" in order to calculate cost in road projects. The tool is newly developed and one of the changes with respect to the earlier version is greater focus on uncertainties and events. In addition, a spreadsheet for registering uncertainty is developed. The spreadsheet manages both risks (threats) and opportunities in projects. As a result of this development, a new module is made in the project management system that the Norwegian public roads administration adopts. The module is called as "G-Prog project economics", and it follows up the uncertainties. The matrix presented below shows that one can assess the risks and opportunities in the same matrix.

Uncertainty-matrix	Consequence							
	Risk				Opportunity			
	Catastrophic	Critical	Serious	Small	Small	Medium	Large	Extra Large
Probability								
Extra large >50%	20	10	10	5	-4	10	10	20
Large 25-50%	10	5	5	-4	-4	5	10	10
Medium 5-25%	5	5	5	3	-3	5	5	5
Small 1-5%	5	5	4	2	-2	4	4	4
Out of the question <1%	4	3	2	1	-1	2	3	4

Figure 5: Uncertainty matrix

- Develop procedures for uncertainty management in investment projects

A template and a guide for how uncertainty management should be dealt with were made in the Norwegian public roads administration. The guide consists of three parts: (1) a description of uncertainty management in the organization, (2) user manual for the template that is used in the uncertainty analysis plan, and finally (3) descriptions of various special topics.

- Ensure that risks are identified, processed, and followed up.

The tool that Norwegian public road administration uses shall ensure that uncertainty monitored throughout the project life cycle from "Anslag 4.0" via "G-Prog project economics" to "Cost Bank".

***Norwegian National Rail Administration (Jernbaneverket)***

National rail administration has the following rationale for its involvement in the PUS-project: National rail administration wanted to ensure the quality of their framework, by updating the tools and techniques and general knowledge of risk management; they wanted to be able to utilize best practices in this field of knowledge at any time. Furthermore, the organization wanted to document the required / relevant knowledge and share the knowledge in their work force.

Status of the work situation in National rail administration with respect to the rationale for its participation in the PUS-project that was mentioned above:

- Estimating Guide with estimating manual has been prepared and put into the Railway Administration's management.
- Established new structure that supports detailed estimation and experience gathering.
- Established new programs for training of process management and improved general education in risk management together with Norwegian University of Science and Technology (NTNU).
- Gathered other countries' experiences and analyzed their contexts, and compare them with their own experiences and contexts.
- Apply systematic quality assurance of projects using qualitative and quantitative uncertainty analyses.
- National rail administration added quality to the decision-portals in the project model. In this connection, the National rail administration invited external contractors / consultants to participate in the framework-agreements to secure resources for this quality assurance.
- Establish and implement new tools for estimation.

## 8. Summary – status per 2011 for all companies

Based on our study, we have made the following conclusion regarding the effect of an inter-organizational research project on the collaborating organizations.

Kerzner (2009) describes a maturity model (cf. Figure 6) in connection with project management. This model can be used to look at the levels through which an organization learns and develops itself.

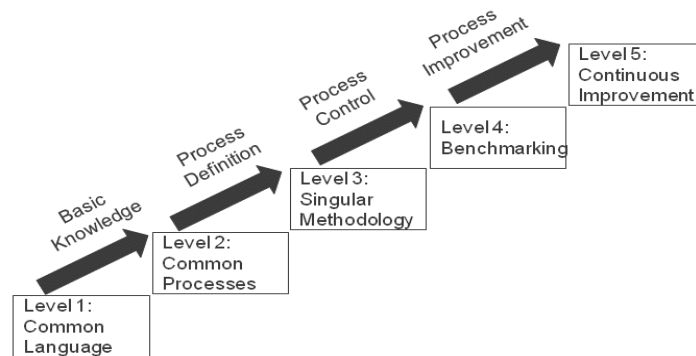


Figure 6: The five levels of maturity (Kerzner, 2009)

Table 1 shows the maturity level of the involved organizations (when it comes to managing uncertainty in projects) at the beginning of the PUS-project in 2006 (denoted by a small x), and the maturity level of the organizations (when it comes to managing uncertainty in projects) at the end of the project in 2010 (denoted by a large X).

Table 1: Subjective evaluation of maturity level in 2006 and in 2010 on uncertainty management.

Company	Level of maturity				
	1	2	3	4	5
Statoil (private)					xX
Telenor (Private)			x	X	
Norwegian Directorate of Public Construction and Property Management (Statsbygg)		x		X	
Norwegian Armed Forces (Forsvaret)			xX		
Norwegian Public Roads Administration (Statens vegvesen)			x	X	
Norwegian National Rail Administration (Jernbaneverket)		x		X	

As we can see in Table 1, Statoil was already a matured organization in the beginning of the PUS-project, when it comes to uncertainty management. They had a clear understanding of the importance of uncertainty management in their projects. They made systematic efforts to develop their work-force (humans), the models and techniques. In other words, they already started practicing some form of "living" uncertainty management.

When it comes to Norwegian armed forces, there has been no noticeable impact of the PUS-project. This can be due to, as we have described earlier, the recurring restructuring processes that would take away or reduce the needed attention and energy to work with managing uncertainty in projects.

Norwegian Directorate of public construction and property management improved its ability to manage uncertainty in its projects through its participation in the PUS-project. The organization established new roles (such as uncertainty coordinators), conducted courses for its employees to improve their knowledge and competence, developed their model for dealing with uncertainty management, and started to apply systematic techniques to improve uncertainty management. And, the organization's participation in the PUS-project and the good results were notified in a high profile manner in the organization by awarding innovation prize for its representatives in 2011.

Norwegian public road administration made its development in managing uncertainty. Conducting / arranging courses for own employees, developing and applying models and techniques (tools for analysis, etc.) were prominent focal points that the organization started to adopt in order to manage uncertainty effectively. This description also points out the role of "living" uncertainty management in the organizational setting.

The improvement that Telenor and Norwegian national rail administration experienced can also be considered with respect to the "living" uncertainty management. The focus on humans, models and techniques and on the interplay between these three elements could contribute to create a positive culture that promotes effective management of uncertainty. The wish and intention of creating a positive culture for uncertainty management was mentioned by the organizations that were participated in the PUS-project – for instance, by Telenor.

## **9. Concluding remark**

Collaborative research can create synergic effects. The PUS-project experienced this positive effect in several circumstances. Tools originally developed in one organization as a result of participating in the PUS-project, were made available for other organizations.

Collaboration between researchers and practitioners also created positive effects by creating a working atmosphere that encouraged each other parties to reflect on what they do and why they do that they do. Aspects such as reflection-on-action (reflecting on actions that have been done), reflection-in-action (reflecting on actions while the actions are being done) mentioned by Schön (1998) contributed to making sense of the various circumstances (Weick, 2001), learning and development.

Now that the PUS-project is finished, it does not mean that the involved organizations conduct their projects successfully all the time. There will always be room for improvement, because, among other things, the world that we live in is not always predictable. Changes happen all the time. New

things emerge. Better and a systematic uncertainty management can hinder catastrophes, but it does not guarantee success all the time. This is a fact that should be taken into account seriously.

The PUS-project managed to create a positive culture that can promote effective and efficient uncertainty management in projects. Organizations such as Norwegian directorate of public construction and Telenor acknowledged development of the positive culture in their organizations through the collaboration with the PUS-project and the need to involve project owner more in managing uncertainty in projects (Forum-report, 2010). Furthermore, the cooperation between the PUS-project and the involved organizations illustrates how a research project attempted to create value in the industry – an example of collaboration between researchers and practitioners.

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**Nr 9 Exploring uncertainty and flexibility in projects:  
towards a more dynamic framework?**

Exploring uncertainty and flexibility in projects:  
towards a more dynamic framework?

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## **1. Introduction**

Uncertainty is often said to have its root cause in lack of available information, available knowledge or competence (e.g. (Kolltveit & Reve, 2002), (Christensen & Kreiner, 1991)). In a project context, uncertainty management has traditionally been synonymous with risk management (Hillson, 2007). Some author's suggest that uncertainty can be positive or negative; positive as opportunities and negative as threats (Loch, De Meyer, & Pich, 2006; Perminova, Gustafsson, & Wikström, 2008). In this paper, we adopt the term uncertainty to include both the positive effects (opportunities) and the negative effects (threats) in the execution of projects. Projects have traditionally strived towards predictability and to keep all critical factors under control. However, for large and complex projects, such predictability is not the reality (Rolstadås, Hetland, Jergeas, & Westney, 2011). Major uncertainties play a large role in important areas. And especially under such conditions, it may not be a good strategy to strive for maximum predictability, but rather to choose a strategy of flexibility in the project, in order to be able to face changes in a better way (Olsson, 2006).

In this paper we will question some of what we believe are the basic assumptions regarding uncertainty and flexibility in projects. We will address/discuss three basic assumption that have strong impact on how projects are planned and executed in what some authors refer to as the task perspective (Andersen, 2008).

1. All projects should have clear objectives, and change of objectives in the execution phase should be avoided at any cost.
2. Every project has a project owner who
  - initiates the project
  - follows it up in the execution planning and execution phase
  - "owns" the effect and the delivered functionality from the project

3. The uncertainty and flexibility drops/ is reduced over the project life cycle, and in theory:

- The project owner and the project team will be responsible and "see" or have /focus on the same opportunities and threats. And they will be equally interested in maintaining the project flexibility during the project execution.
- The uncertainty will be reduced during the planning and execution phases, based on choices that the project manager and the project owner do together.
- Most projects will have much focus on opportunities and threat in all phase of the project.

All those three areas/assumptions are fundamentally important for how we think upon project.

We will argue that these assumptions in many cases are just partly correct, and in many cases they are not correct at all.

We think that there are three trends that will drive the project management field forward in the future. The first trend is that the project owner will expect more flexible solutions that give a high delivered functionality, and the project owner will demand that the project is delivered as effective as possible. This means that in the future it will not be acceptable to just deliver the result within the time, cost and quality – project managers must also understand the business case and deliver the required effects and functionality. The second trend that will drive the development of the project management field is that projects tend to become bigger (more and more mega projects), and this will further have an impact on the time we spend on planning and executing projects. The third trend is that we will see more rapidly changing demands from project owners – not one, but many owners. And, there will be more global competition - not one company but many companies deliver input and share responsibility of achieving the project objectives.

These three trends means that in the future we need to develop project owners and project mangers who understand the business case, understand the value of flexibility and have the skills and attitudes that are necessary to deal with uncertainty – i.e. both threats and opportunities – in a professional way.

The ideas presented here are based on the authors' work with projects as consultants and as researchers for more then 10 year in Norway. The authors have worked in the research project called "Practical uncertainty management in the project owner perspective – in short, the PUS-project (2005-2010). This paper is based on experience and knowledge that have been gained through the PUS-project. And, this paper is a product of collective reflection of that experience and knowledge. In this regard, we present research methods that were applied in the PUS-project. The research methods can also be seen as a source of inspiration to write this paper.

## **2. Research methods and scope**

The research presented in this paper is part of a larger research work. The main body of research is based on data from (a) a major research project on practical uncertainty management in the project owner perspective – the PUS-project. The PUS-project on uncertainty management had a duration of approximately 5 years and involved 6 major Norwegian public and private ‘project intensive’ companies / organisations.

The research method connected to this paper is of a combination of qualitative and quantitative nature.

Our results are based on a multitude of techniques and methodologies - there have been literature studies into the different areas of relevance (see for instance (Torp, Karlsen, & Johansen, 2008)), there have been several surveys, action research, in-depth interviews and discussions with experts. The results presented here are also based on a number of case studies of projects. Some of the case studies are also of a longitudinal and qualitative nature, where the authors have been involved as researchers and process contributors repeatedly in the case studies. The above description points out that this research endeavor includes quantitative, qualitative and mixed methods. This compound research basis means that we do not refer to just one dataset as the basis for our results and conclusions. We shall elaborate some methods that were applied in the research.

When it comes to conducting interviews, the interviews were based on interview guides prepared by the researchers in all of the studies. These questions and the following response and discussion can be considered as semi-structured, and there were both individual and group interviews. The organisations that took part in the interviews belonged to sectors such as telecommunication, construction, offshore and defence.

In some of the case studies in the PUS research project, the researchers applied action research. Here, several sessions of uncertainty analysis were carried out in various projects. One of the authors of this paper participated actively in and led / facilitated the sessions. In a typical uncertainty analysis session, approximately 20 members from the respective organisation would take part. The participants would belong to several professions / positions; for instance, project manager, assistant project manager and construction manager. Experience from these analyses was reflected upon in connection with the topic of uncertainty in projects, and this is used in this paper. Since the uncertainty analyses were led / facilitated by this author in order to improve the situation that the involved organisations encountered in connection with managing their projects, these analyses can therefore be regarded as action research, at least to a certain extent.

Two surveys regarding the uncertainty management of the projects were conducted in a number of the projects that were studied in the PUS research project. Questionnaires were distributed to a representative selection of participants related to the projects. Using both electronic and paper-based questionnaires, they were distributed to a total of 2701 persons, and overall there was a response rate of 29.7%.

Some of the quantitative studies, which were done in the PUS-project, were based on data extracted from the risk registers of seven large projects in the energy sector.

In the beginning of the paper we presented three fundamental basic assumptions regarding uncertainty and flexibility in projects.

1. All projects should have clear objectives, and change of objectives in the execution phase should be avoided at any cost.
2. Every project has a project owner that initiates, follows it up and "owns" the effect and the delivered functionality from the project.
3. The uncertainty and flexibility drops/ is reduced over the project life cycle.

We would like to illustrate why these three assumptions do not represent a sensible practice in many circumstances in the fast moving dynamic world. In this regard, we shall first present the underlying theories, and then discuss them in the light of experiences that we have obtained in our work.

### 3. Stage gate models and uncertainty

In the beginning of this paper, we claimed that projects have traditionally focused on maintaining predictability and keeping all critical factors under control. Hence one has encouraged more and more to establish a clear objective earlier in the planning phase and a type of stage gate model where central decisions are made. Figure 1 shows a stage gate model.

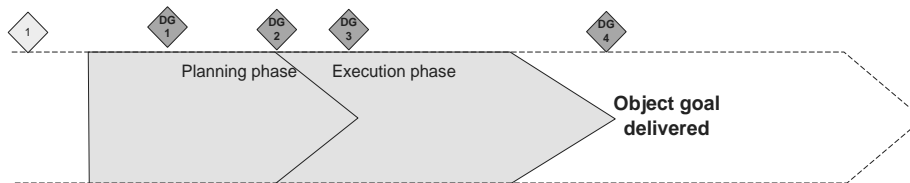


Figure 1 Stage gate model

The logic in the stage gate model is based on the principle that one starts with different alternatives (concepts) and develops them up to a stage gate, where the project owner decides which concept that should go over to the next stage.

From the project owner perspective, the purpose of this approach can be seen in three parts: One wants to choose a right project, one wants to reduce uncertainty and maintain flexibility as long as possible. But, the model has an inbuilt characteristic that when project has passed decision gate 3, then it should keep a steady course and avoid changes at any cost. Having this description as a background information, we shall look at Figure 2. Figure 2 is illustrates the dynamic of uncertainty – how uncertainty varies with respect to cost and time.

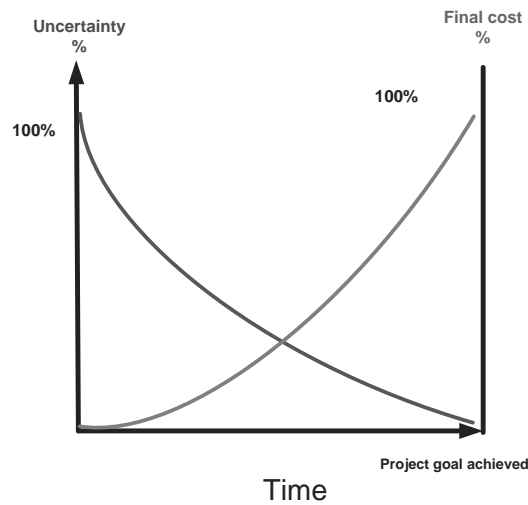


Figure 2 Uncertainty versus cost of late changes in the project (Husby et al, 2009)

An explanation for this illustration is simple – changes in the late stages cost a lot. After stage gate 3, the project managers will sign the contracts, and they have to compensate the contractors if they (the management) make any change with respect to the previously agreed project deliverables.

However, for large and complex projects, such predictability is not the reality (Rolstadås, Hetland, Jergeas, & Westney, 2011). Major uncertainties play a large role in important areas, also in the execution phase of the project. And especially under such conditions, it may not be a good strategy to strive for maximum predictability, but rather to choose a strategy of flexibility in the project, in order to be able to face changes in a better way (Olsson, 2006). We mean that there is no contradiction between working for a clear objective in the early phase of a project and acknowledging that the objective will change its characteristics on the way in a long term project. But, this understanding means that effective management of project uncertainty can no longer be isolated / allocated to as an activity in the planning phase. Effective projects need to deal with uncertainty in the execution phase too.

Figure 3 illustrates how the operational uncertainty has a steadily decreasing level during the project's planning and execution phases towards delivery. It is our experience that other categories of uncertainty, such as contextual and strategic uncertainty, in many cases will have a different development over time.

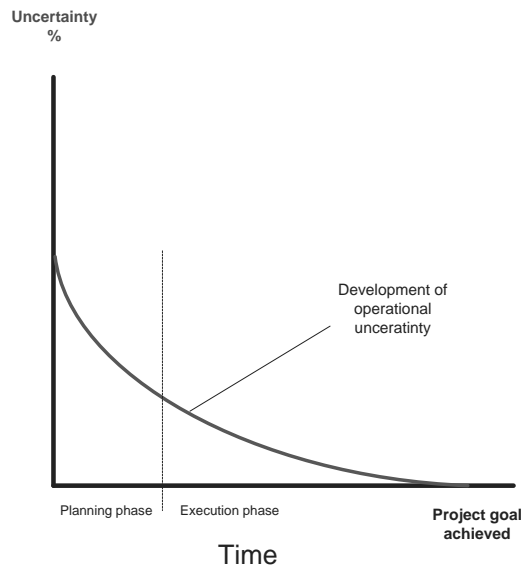


Figure 3: Uncertainty management in projects - Process of uncertainty management

#### 4. Managing uncertainty

Simister (2004) has developed a generic risk management model based on publications from national standards associations (British Standards Institute, Canada Standards Association, and Standards Australia), professional institutions (Institution of Civil Engineers (ICE, 1998), Japan Project Management Forum (2002), Project Management Institute (2008), and Association of Project Management), and government departments (U.S. DoD (2003), and the UK OGC (2002)).

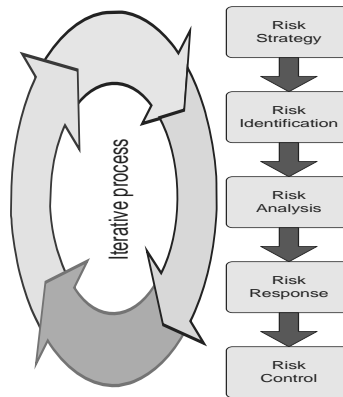


Figure 4 Risk management process (Simister, 2004)

Simister (2004) underlines the importance of undertaking risk management as a structured, formal process aligned with the overall project management approach. Simister says the risk management process should be commenced as early as possible in a project life cycle, and that the process has to be undertaken on an iterative basis since each assessment is a snapshot in time. Ward and Chapman (2004) elaborates on Simister's risk management process, and considers how risk management can be made more effective in a given project context. They



divide project uncertainty into five areas (Chapman & Ward, 2003):

1. Variability associated with estimates.
2. Uncertainty about the basis of estimates.
3. Uncertainty about design and logistics.
4. Uncertainty about objectives and priorities.
5. Uncertainty about fundamental relationships between project parties.

All of those areas of uncertainty are important, according to Ward & Chapman, and generally they become more fundamentally important to project performance as they go down the list, and the areas effect on one another. Some author's suggest that uncertainty can be positive or negative; positive as opportunities and negative as threats (Loch, De Meyer, & Pich, 2006; Perminova, Gustafsson, & Wikström, 2008). In this paper, we adopt the term uncertainty to include both the positive effects (opportunities) and the negative effects (threats) in the execution of projects.

In this article we will define uncertainty as follows:

*Project uncertainty is defined as controllable and non controllable factors that may occur, and variation and foreseeable events that occur during a project execution, and that have a significant impact on the project objective.*

We define threats as factors, variations and events that may lead to undesired changes to objective, scope, resources, frame conditions, that make the project cost more, spend more time or delivers less quality than was agreed up on in the beginning of the project.

Opportunities are factors, variations and events that may lead to changes, that make the project to deliver the same quality in less time or to lower price than was agreed upon in the beginning of the project. And all such factors, variations and events that cause changes can make the project to deliver higher functionality or lead to positive NPV after the project is delivered. In the project management domain, uncertainty is currently understood as lack of information but uncertainty could also be understood as lack of certainty. Rolstadås et al. state that uncertainty in project may take on a number of very different forms, and therefore they offer a structure for categorization of uncertainty into controllable and non controllable factors (Hetland, 2003). Rolstadås et al. (2011) suggest that uncertainty could be negative and positive for a project. And, they refer to the negative implications of uncertainty as risk factors. They refer to the positive implications of uncertainty as opportunity factors. Both may have a consequence if they occur. They refer to the consequence that is multiplied by its likelihood of occurrence as either risk (negative) or opportunity (positive). Loch et al (2006) state that uncertainty is about variation and more or less foreseeable events that happen during the project. We think that uncertainties should be divided as opportunities and threats – as illustrated in figure 5. The figure also illustrates how some factors influencing the uncertainty are more or less controllable and some are not controllable, and it gives some examples of such factors.

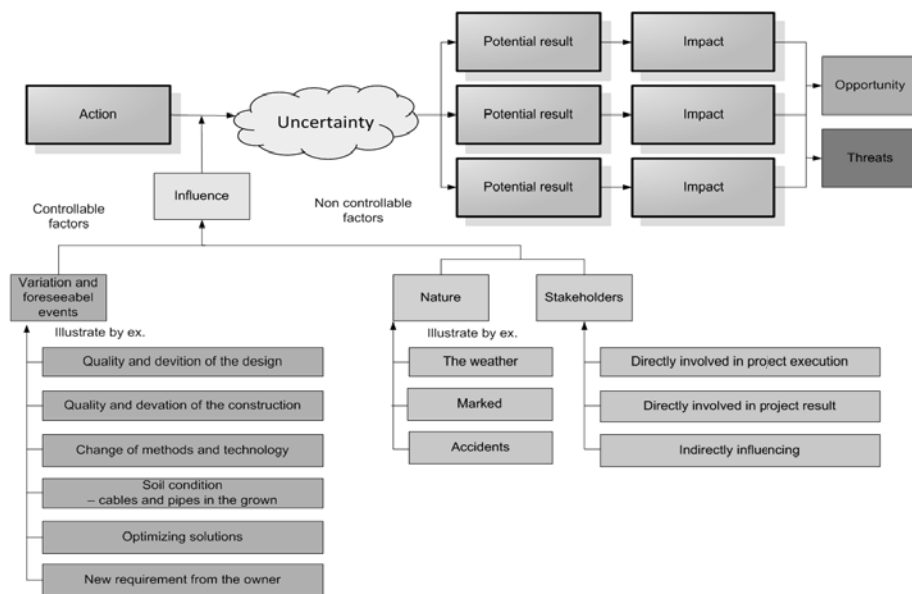


Figure 5 Uncertainty – opportunity and threats (Inspired from Loch (2006) et al and Rolstad et al (2011))

The PUS-project considered that uncertainty management is not just about avoiding risks; it is also about evaluating and making the most of opportunities that will provide the best outcome – seen from a lifecycle perspective. In our view, it is important that the project organization acknowledges and communicates the fact that the world is uncertain and is not always predictable, and that the project owner too acknowledges this situation. In this regard, we would like to present a description of uncertainty management in projects given by Perminova et al. (2008, page 78):

[...] key elements in managing uncertainty are reflective learning and sensemaking as enablers of flexibility and rapidness in decision-making regarding the choice of alternative actions in response to the situation. At the same time, standardized and modularized processes and procedures constitute a necessary basis for supporting reflective processes. All of these measures can be regarded as important tools for project managers to recognize and establish the core competences, and thus perform rather than simply conform to the plan. Continuous following of such procedures at different stages of the project is an essential part of project success.

Our view on uncertainty management reflects this description. And now, we shall look closely at the issue of management of both positive and negative uncertainty in projects.

## 5. Uncertainty management must focus equally on opportunities and threats

Many authors claim that uncertainty management should deal with opportunities and threats in the same way (Hillson, 2004; Loch et al., 2006, Perminova et al.). Ward et al. ((2003) mention that practitioners have a tendency to focus more on threats than on opportunities. Several research results also show this trend (Amdahl, et al., 2008). Perhaps as a reflection of this trend, there is comparatively less number of publications / literature on the topic of opportunities in projects than on the topic risk or threat management.

Several authors point out that there are at least 6 or 7 strategies that one could choose from as a response / way to manage uncertainty. (PMBOK, Hillson, 2004)

*Table 1 Strategies for uncertainty management response – opportunities and threats*

Opportunities	Threats
Exploit	Avoid
Share	Transfer
Enhance	Mitigate
Accept	

According to PMBOK the strategy, AVOID is about making an effort to ensure that the probability or impact of a threat is eliminated. Hillson (2004) states that AVOID includes two types of action (1) remove the cause of the risk (risk trigger); (2) execute project in a different way while still aiming to achieve project objectives. According to PMBOK, the strategy EXPLOIT is the opposite of AVOID – this strategy is about insuring a positive impact, striving for to realize an opportunity. Hillson (2004) states that EXPLOIT is the most aggressive of the response strategies and should be reserved for those “golden opportunities” with high probability and impacts. According to PMBOK and Hillson (2004), TRANSFERRING is a risk a strategy that involves finding another party who is willing to take responsibility for its management, and who will bear the liability of the risk if the risk occurs. Transferring risk can be an effective way to deal with financial risk exposure. Transferring project risk almost always involves payment of a risk premium to the party taking the risk, examples include: insurance, performance bonds, warranties, etc. Contracts may be used to transfer specified risks to another party. According to PMBOK, SHARING is a positive risk strategy that involves allocating ownership to a third party who is best able to capture the opportunity for the benefit of the project. According to PMBOK, MITIGATE (or reducing the risk) is a strategy that implies a reduction in the probability and/or impact of an adverse risk event to an acceptable threshold. Hillson (2004) suggests that every preventive response that project choose for avoiding threats is a part of a mitigation strategy. According to PMBOK, ENHANCE is a strategy that the project will choose for modifying the “size” of an opportunity by increasing probability and/or impact. The last strategy ACCEPT assumes/accepts that some threats or opportunities are not possible to eliminate, or they are so small that the effort to do anything is not worthwhile. These 7 management strategies are well-known – but it must be asked whether it is sufficient to have knowledge about them if a project should obtain full benefit of uncertainty management?

According to the PUS-project, uncertainty management includes focusing on analyzing and dealing with opportunities and threats that can affect the project. This view is different, at least to a certain extent, from the traditional risk management that would tend to focus much or solely on threats. The term uncertainty management is used by several authors – such as, Hillson (2004) and Chapman and Ward (2003) – to include an adequate focus on opportunities in addition to threats.

## **6. Flexibility in projects**

According to Husby et al. (1999), project flexibility is “*the capability to adjust the project to prospective consequences of uncertain circumstances within the context of the project*”. Flexibility is essential in order to tackle the changes and the uncertainties that the business environment comes across (Olsson, 2006). Volberda (1998, p. 89) says that “*Flexibility can be considered as a new way to achieve some form of control in extremely turbulent environments*”. And according to Birkinshaw (2000, p. 5), “*Flexibility means an ability to adapt aspects of the organization rapidly in the face of new opportunities and threats in the environment*”. This description reflects our discussion on opportunities and threats with respect to uncertainty. When it comes to managing a project successfully, we claim that uncertainty and flexibility are closely related to each other. It may even be expressed as uncertainty and flexibility being “*two sides of a coin*”.

We will here speak of flexibility primarily in connection with opportunities, although our focus includes threats (risks). In this regard, we shall first look at the role of project owner.

Figure 6 illustrates how the operational uncertainty and flexibility develop during the project's planning and execution phases towards delivery. For the operational uncertainty, it illustrates a steadily decreasing level. In the literature, this is commonly said to be the picture for project uncertainty in general. For the project's flexibility, the figure shows an uneven but overall dropping trend. The drops in flexibility will typically be related to large (and small) events and decisions in the project's environment.

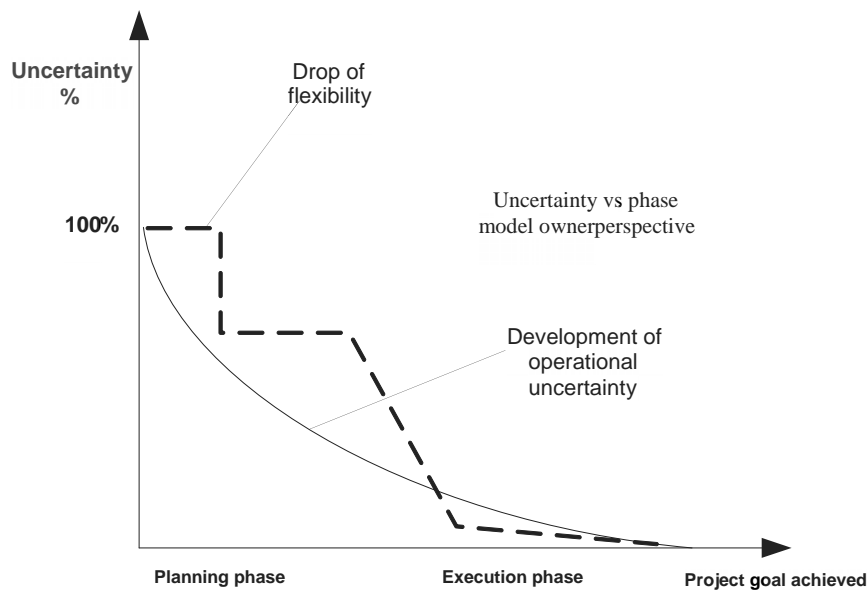


Figure 6 Development in operational uncertainty and flexibility during the project's planning and execution phases

It is not our assumption that all projects should be flexible, because some projects will definitely benefit from an earlier locking of scope and selection of specific solutions – the kind of decisions that will reduce the project's flexibility. But we suggest that projects need to develop dynamic capabilities in order to be able to explore benefits for the project, the project owner and for the society.

### 7. The role of the project owner

A project owner has rights to and is responsible for the project. The project owner takes the risk connected to the project's cost and its future (Eikeland, 2001) Olsson, *et al.* (2007) say:

The beauty behind the concept of a project owner lies in the fact that a project owner has incentives for weighing costs against benefits for a project. Project owners are therefore expected to strive for project governance aimed at maximising the value from the project.

Project managers and project owners traditionally deal with two types of information; project managers with detailed information (mainly projects' internal conditions – operational), and project owners with general / high level information (mainly, projects' external conditions – tactical and strategic). Establishing a common understanding by combining and studying these two types of information can lead the involved parties to deal effectively with opportunities and threats in projects.

However, cooperation between the project owner and the project manager is not always a problem-free affair. The project owner and the project manager can have varying understanding of opportunities and threats: what opportunities and threats actually are, and

how one can use them in order to improve result-oriented, effect-oriented and society-oriented objectives. Traditionally, projects are regarded as a way to carry out endeavors, in order to achieve specific objectives for an project owner. According to the task perspective there has been an assumption that a clear project objective should be established in the planning phase in order to fulfill the needs of the project owner. The task perspective further implicitly assumes that the project owner knows exactly what he/ she needs in the very beginning of the project. This line of thought or hypothesis points out further assumptions that are of implicit nature. These assumptions can be summarized as follows:

- A project can have only one owner
- The project will relate to one owner throughout its life
- Project owner knows what he / she wants when the project starts. This will mean that the owner can describe both the deliverables and the purpose of the project at the project startup.
- The owner does not change his / her opinion, and does not get any new needs and new expectations during the development of the project. This means that the owner is concerned about obtaining the deliverables (at the end of the project) that have been ordered at the project startup, without any changes regarding the objectives of the project

Most people who have worked in projects will intuitively say that many of those assumptions are wrong or only partially correct. In many projects, a project manager has to deal with multiple owners, both internal and external, who claim the right to determine what the project's final deliverables should be (Olsson, 2007). This means that projects in many cases must deal with a number of owners that would have different views as well as power to influence the results of the project. In project theory, there has been a strong focus on project objectives, and how important it is to have clear and unambiguous objectives of the project.

The project owner perspective (which also incorporates views of the project manager) provides a broader understanding of managing uncertainty in projects. This perspective can be helpful to understand important aspects that influence a project (including aspects that lie outside of the realm of traditional project management) as well as interrelation between the aspects. This understanding, which can be achieved through cooperation between the project manager and the project owner, can help to deal effectively with uncertainty in projects. A good cooperation between a project manager and a project owner can produce a holistic understanding of the project, which can in turn help to identify / create opportunities in the project. Olsson, R (2007) also emphasizes the importance of having a holistic approach in projects in order to identify and materialize opportunities.

Though there are challenges with respect to communication and attitudes, companies take certain measures in order to tackle those challenges. A study in the Norwegian telecommunication sector (conducted by the PUS-project) points out that there are training programs in which project owners and project managers learn about their roles, responsibilities and what they expect from each other. After the training programs, project managers seem to notice improvement in project owners' behaviour and in the collaboration. These training programs can be seen as arenas for reflecting on action and making sense of various situations. The matrix in figure 7 is intended to give a principal illustration of how the project owner (PO) and project manager (PM) is focusing (i.e., having high or low focus) on threats and on opportunities, and how this is typically developing through the project. At project start the main focus of both actors is on opportunities – and typically on the

opportunities that the project will or can bring. At later stages – in fact already when the project is detail planned and organized, the PM’s focus will turned from high on opportunities and low on threats and into a high focus on threats and low on opportunities. The project owner, being responsible for achieving benefits from the project, will still be highly focused on project opportunities, but will at later project stages usually also have a higher focus on threats.

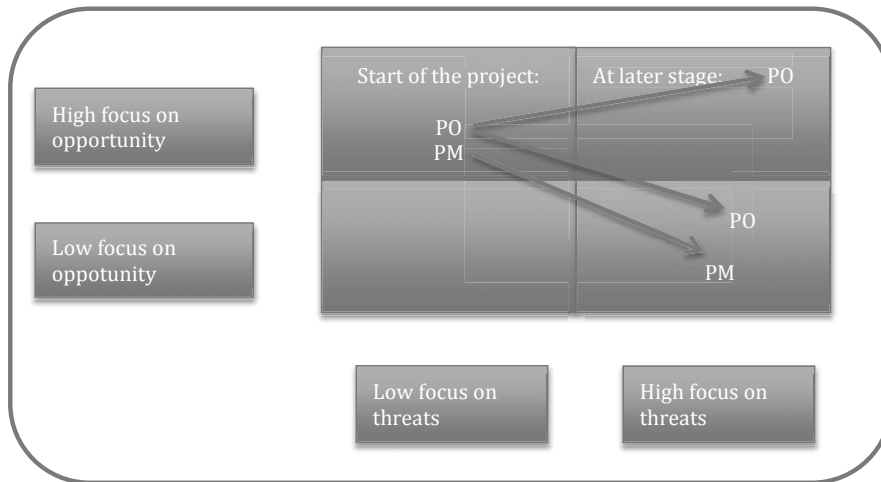


Figure 7 Focus on threats and opportunities

However, for some POs we observe that they assume the PM’s attitude to uncertainties and get a high focus on threats and low on opportunities. The gap regarding opportunity focus between the two types of owners that we here illustrate will represent a potentially large number of lost opportunities, i.e.; opportunities that may remain unidentified and very rarely will be utilized. This area or set of lost opportunities may then be called as the project’s “blind spot”.

Figure 8 illustrates the development in number of opportunities and threats during project planning and execution phases. In the figure to the left, the development regarding opportunities and threats is symmetrical, but with an overall, though uneven dropping trend towards delivery. In the figure to the right, the set of lost (i.e. un-exploited) opportunities due to a low opportunity focus that we earlier discussed in relation to figure 7 is also illustrated in figure 8 as the area called “blind spot”.

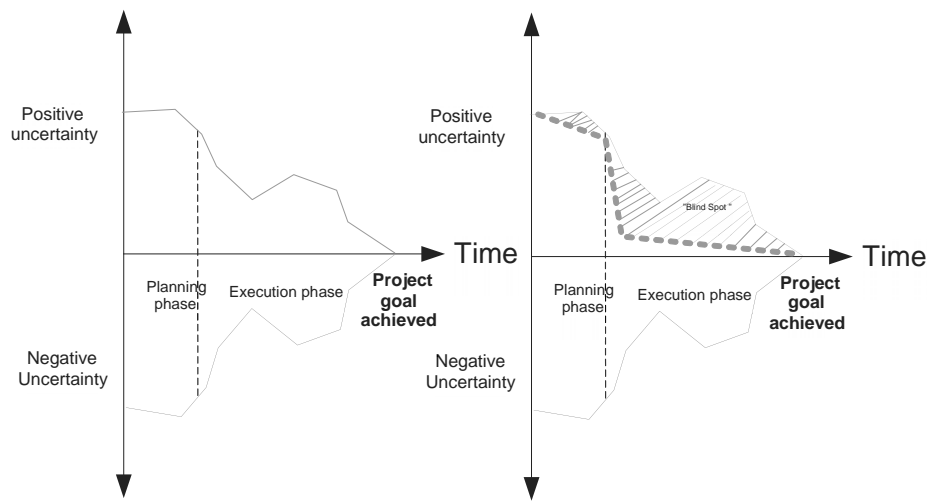


Figure 8 Number of opportunities and threats during project planning and execution phases

From this, we may get the impression that most project managers and project owners have realized that there is an opportunity side of uncertainty, and further on that those opportunities are pursued and utilized in most projects today. Findings from the PUS research project clearly indicate that project teams have the intention to focus on both opportunities and threats. In a Norwegian survey in large project organisations (Hald & Langlo, 2011), the response to a question regarding the focus on uncertainty management in their projects, 76% responded that it was “mainly on risks, but also on opportunities”, 15% said they did “equally focus on threats and opportunities”, and just 7% responded that they “only focused on risks”. However, those intentions expressed through the survey do not seem to be reflected by the contents of the projects’ risk registers. In another study done in the PUS project (Krane, Rolstadås, & Olsson, 2009), analyzing the risk registers of 7 large projects, it was revealed that 81% of the risk elements could be categorized as threats, 3% as opportunities and 16% could turn out as both threats and opportunities.

## 8 Towards increased flexibility and more exploration of opportunities

It is claimed that the project perspective is the contractor's or operator's perspective, and this can be related to the result oriented goal of the project. This perspective is measured primarily in terms of time, cost and quality. The user perspective sees a project from the future users' point of view. Effect oriented goal of the project is defined in the user perspective, and the focus here is primarily on the benefit, functionality and profitability of the project. The next level is the social perspective, where the consideration is primarily on the project's effects on society over time.

In most projects, people aim at making clear and unambiguous objectives in the planning phase. The reason for this is simple: you need to know where you should go (your destination) before you start your journey towards your destination. However, it is important to understand that the objectives are less explicit when a project is started. Typically, the



objectives will implicitly contain the intentions of what the project owner wants to achieve through the project within the time and cost limitation set by the owner. What specifically will be delivered in terms of result oriented goals will often have limited levels of detail, and is usually further refined and developed quite a long period into the planning phase. In addition, we often find that the objectives are perceived differently depending on the point of view that one has of the project. The project owner will often tend to be more concerned about the effect oriented goals and how well the project results can fit with a (carefully defined) business case. The project manager and the project team members, however, will focus more on the result oriented goal and what solutions and deliverables that it implies. There is no contradiction between aiming for good and clear goals and acknowledging that the goals can be adjusted or be changed over the course of a project. Project goals are uncertain; however, how one chooses to deal with uncertainties is a central issue when it comes to a project's reputation and to its success.

## **9 Changes regarding goals during the execution phase should be avoided at any cost**

When the project is in its execution phase, the project has already entered into large and costly contracts with contractors and subcontractors. There is a point of time when one goes from drawing and describing what is to be obtained at the end of the project to actually obtaining it and materializing the plan in a large scale. Changing the goal or introducing new functional requirements in the execution phase will hence lead to significant extra costs for the project owner. It will also significantly decrease the likelihood of delivering project results within the agreed time frame. Growing costs are associated with changes throughout the course of the project. Seen from a purely project perspective, this will imply that change of goals or intended/planned functionalities should be avoided or minimized and being a target in itself, and thereby running the risk of confusing means and ends.

Of course, not all project owners will agree that this interpretation is correct and relevant. Two situations that contradict this reasoning. They are;

- When an expansion or adjustment of the project will result in increased benefits for the project owner in the profit realization phase,
- Or when an extension or change will cause a reduction of the project's negative impacts on the society.

The project world has gained a great deal of experience with dramatic increments of costs due to late changes regarding objectives. Despite this, it must be emphasized that it is essential to do very concrete analyses of benefits and consequences of each desirable change with respect to achieving the effect goal of the project. Traditional ways of managing uncertainty has been very much focused on time, cost and project deliverables, and also focuses mainly on threats rather than opportunities. This traditional approach has its limitations, especially when it comes to creating or ensuring a wider effect that is to be produced by the project when it is completed. A project may be completed according to a predefined frame of cost, time and quality. But, the very purpose of the project (i.e.; the intended effect of the project) may not be achieved. An example that can be mentioned in this regard is a coastal fort in Norway (Sunnevåg, 2007) that was constructed according to the original plan. Once the construction was completed, the building was closed on the next day, since the strategic plans had been

revised, and hence the need for having the fort had disappeared during the construction. Furthermore, the traditional approach tends to assume that the world is stable and predictable. The PUS-project acknowledged that the world in which projects are a part of is dynamic, unpredictable and complex, and proposed a broader perspective: the project owner perspective.

We would like to present two examples that can illustrate that opportunities can appear / created during the course of projects:

- Project E18 Ostfold – a road construction project – was assessed by quality assurance procedure (QA2) and got a cost estimation of approximately 163 million euro. When the initial contracts came in, a new analysis showed that the project, with a low probability, would manage to keep itself within the predetermined frame of cost. The analysis showed that the cost forecast was approximately 176 million euro. The project carried out a process with the focus on finding potential opportunities that could reduce cost. In the course of four hour time, opportunities were found and they were used to reduce the cost more than approximately 20 million euro.
- Project R6 – Construction of 3 government buildings – was at the phase of developing keys and lock-systems that could deliver safe and secure solutions. This process originally included among other things, design / project engineering, purchase and installation. But, the project participants found out that there was another project that was going on primarily in connection with key and lock-systems in government buildings. Then, the project R6 cooperated with the other project. This cooperation produced benefit for the R6 project; for instance, reducing cost related to their project engineering activities, and purchasing the key and lock-systems at a cheaper rate.

These examples were obtained in uncertainty analysis sessions in which a researcher from the PUS-project was actively involved (action research). These examples, along with theories (Hillson, 2004; Olsson, R., 2007), point out benefits of having adequate focus on opportunities in managing uncertainty in projects. Changing goals and introducing new functionality is the project owner's responsibility as we see it. It is important that division / clarification of responsibilities between the project owner and the project management is maintained, and that potential new goals and functionality are dealt with through cooperation between the project owner and project management. And also, in an uncertain world, the project management should strive to achieve the objectives as effectively as possible, and they should strive to obtain as high efficiency as possible.

## **10 Conclusions and need for further research**

The main conclusions of this article can very briefly be summarized as:

- Projects must be better prepared to manage larger uncertainty and more complexity
- There is a need for stronger owner perspective regarding uncertainty management
- There should be more focus on opportunity management, and there is need to keep a larger flexibility in the projects, in order to exploit more opportunities and to utilise them better.

We have argued that more flexibility should be considered in order to explore more opportunities. We recognize that in order to be able to explore more opportunities and at the same time not jeopardizing projects, a deeper understanding of the interaction between project owners and project teams is needed. This means getting both a better theoretical and empirical grasp of the interaction. We have highlighted areas for both project owner and project managers that should be developed and strengthened.

As we described, the project owner perspective gives a broader framework for exercising flexibility and addressing issues related to flexibilities – issues such as finding and exploring opportunities.

This means that we see a need for further research in these directions:

- The management of projects from different sectors in environments where the projects experience larger uncertainty and greater complexity
- Research focused on opportunities for improving project effects for the project owner
- The management of flexibility in projects, in connection with opportunity management, in order to understand better the requirements for flexibility, and to give better support to opportunity management

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**Nr 10 Living uncertainty management – An approach to learning and improvement in project-based organizations**

# **Living uncertainty management – An approach to learning and improvement in project-based organizations**

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**Abstract** The main focus of the paper is learning and improvement in project-based organizations. Projects have been increasingly becoming a popular work-form in modern organizations. Many organizations consider that projects are an effective means to create focus and accomplish the intended results within a limited time frame. However, there are several important issues that are to be addressed in the world of projects. One such issue is managing uncertainty. This paper looks at uncertainty management in projects as its background, and focuses on learning in organizations.

Managing / dealing with uncertainty requires, among other things, the following aspects that are connected to learning and knowledge sharing: Reflecting and making sense of the situation individually and / or collectively Utilizing existing knowledge or explore new knowledge to manage uncertainty Gaining new knowledge and competence by managing uncertainty effectively These 3 aspects can go in a spiral to facilitate improvement in managing uncertainty, and contribute to develop learning organizations.

Key words: Learning in organisations, project management, uncertainty management, project maturity

## **1. How can research on Uncertainty management in project lead to new knowledge and knowledge creation?**

In 2006, Norwegian Center of Project Management funded and started a research and development project in collaboration with 6 companies and 3 academic partners, co funded by the Norwegian Research Council. The 6 industrial partners who were involved in the PUS-project had their own objectives, and they worked together with the researchers to achieve their objectives. Results produced by the project were shared amongst the 6 industrial partners, so that the new knowledge could be applied in new work- settings with or without modifications.

The ambition of the Project was to focusing on leadership and culture connected to practical management of uncertainty in major public and private projects. The research project had five objectives from the beginning: First; Development of theory / knowledge base within uncertainty management leadership. Second; Development of project-specific means for identifying and managing uncertainty in collaboration with the organizations that participate in the project. The third objective was to test the theoretical foundation and project-specific means in case projects from the project participants (participating companies). The fourth objective was to gather experience based knowledge from the companies. And finally the

project was going to develop a maturity model with concrete Key Performance Indicators (KPI) for managing uncertainty.

In the beginning of the project was the focus on learning and knowledge creation not clearly expressed, in fact on of the funding body's (partner) emphasis that this should not be a part of the scope. But in the second year of the research project it became clear for the 6 industrial organizations (public and private organizations in Norway) that developing new knowledge in uncertainty management also need to deal with learning and knowledge creation.

- If projects should be efficient in dealing with uncertainty – they need to understand, interpret and handle uncertainty inside and outside the project. They must understand their surroundings and understand the impact of the efforts they have initiated- with out learning and knowledge creation as the project goes is uncertainty management not efficient
- The mother organization, how is responsible for training and developing of new methods, need a strong focus on learning and knowledge sharing so that the new methods, tool, and techniques is actual applied in "real" projects.

The research project PUS "Practical Uncertainty management in owner perspective" – in short had six main industrial organizations involved :

- Statoil (an international energy company with operations in 34 countries, headquartered in Norway)
- Norwegian Directorate of Public Construction and Property Management (Statsbygg)
- Telenor (one of the world's largest mobile operators with 33 200 employees worldwide, headquartered in Norway)
- Norwegian Armed Forces (Forsvaret)
- Norwegian Public Roads Administration (Statens vegvesen)
- Norwegian National Rail Administration (Jernbaneverket)

The learning and improvement that these 6 organizations achieved were based on an approach called "living" uncertainty management – a continuous, active approach towards managing uncertainty that the PUS-project applied. The aim of this approach is to discuss how to integrate uncertainty as a dynamic part of project management. In order to make uncertainty management "living", dealing with uncertainty needs to be an essential element of project team members' everyday routines.

## **2. Method and research design**

The research presented in this paper is part of a larger research work. Our results are based on a multitude of techniques and methodologies - there have been literature studies into the different areas of relevance (see for instance Torp and Karlsen, 2008), there have been several surveys, action research, in-depth interviews and discussions with experts. The results presented here are also based on a number of case studies of collaborative research projects. Some of the case studies are also of a longitudinal and qualitative nature, where the authors have been involved as researchers and process contributors repeatedly in all the cases. The above description points out that this research endeavor includes quantitative, qualitative and mixed methods. This compound research basis means that we do not refer to just one dataset



as the basis for our results and conclusions. We shall elaborate some methods that were applied in the research.

When it comes to conducting interviews, the interviews were based on interview guides prepared by the researchers in all of the studies. These questions and the following response and discussion can be considered as semi-structured, and there were both individual and group interviews. The majority of the studies based on interviews must be characterized as qualitative studies (Yin, 2003). There have been made a number of such studies in the work that this paper is based upon. In some of the case studies in the PUS research project, the researchers applied action research. Studies applying mixed methods (Creswell, 2003; Flyvbjerg, 2006; Tashakkori & Teddlie, 1998) include a majority of the research that was based on a combination of surveys and interviews.

### **3. What has uncertainty management too do with learning ?**

Several authors has written about uncertainty management over the last decade (Johansen et al, Hillson, Jaafari, Chapman and Ward, Torp et al, Loch et al) . Most of the books and articles are focusing on the uncertainty management process and the more technical part of the management issues that project need to understand to deal whit uncertainty in project. Loch et all is one out of few authors that suggest that dealing with uncertainty has something to do whit learning. They suggest that three types of learning going on in project in general (single loop, double loop and deuteron learning). They make close link between Uncertainty management in project and knowledge creation

Loch et al state that single loop learning is going on when a project analysis and detect deviations from the plan – and based on the findings make knew action. Double loop is going when the project or the mother organization detected deviations in the processes, methods or the techniques that involves and the project or the mother organizations choose to modify the process, methods or the techniques that are involved. The finale level of learning "deuteron learning" , involves changing the way the organization detect and act on deviation in projects.

Simister (2004) has developed a generic risk management model based on publications from national standards associations (British Standards Institute, Canada Standards Association, and Standards Australia), professional institutions (Institution of Civil Engineers (ICE, 1998), Japan Project Management Forum (2002), Project Management Institute (2008), and Association of Project Management), and government departments (U.S. DoD (2003), and the UK OGC (2002)).

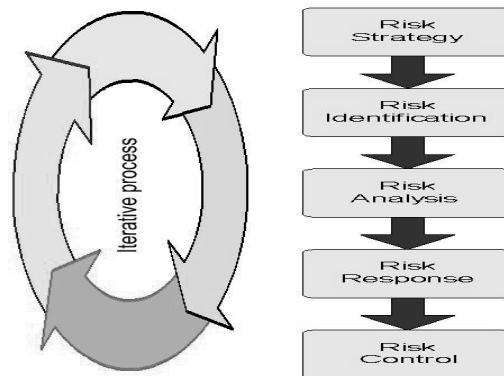


Figure 1 Risk management process (Simister, 2004)

Simister (2004) underlines the importance of undertaking risk management as a structured, formal process aligned with the overall project management approach. Simister says the risk management process should be commenced as early as possible in a project life cycle, and that the process has to be undertaken on an iterative basis since each assessment is a snapshot in time. Ward and Chapman (2004) elaborates on Simister's risk management process, and considers how risk management can be made more effective in a given project context. They divide project uncertainty into five areas (Chapman & Ward, 2003):

1. Variability associated with estimates.
2. Uncertainty about the basis of estimates.
3. Uncertainty about design and logistics.
4. Uncertainty about objectives and priorities.
5. Uncertainty about fundamental relationships between project parties.

All areas of uncertainty are important, according to Ward & Chapman, and generally they become more fundamentally important to project performance as they go down the list, and the areas effect on one another. In the context of this paper, we claim that learning and knowledge creation are closely related to all of the above areas and that project need single loop learning to deal with uncertainty in a proper way.

#### **4. "Living Uncertainty management" - tool for learning and knowledge creation.**

How did the partners in the PUS project address learning as part of developing knew methods and technique in the filed of uncertainty management? When the PUS project started, the 6 different companies had different maturity in the field of uncertainty management.

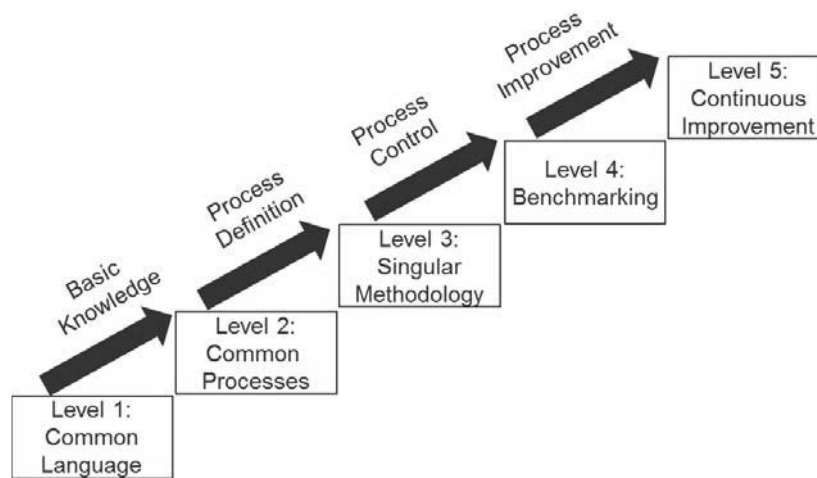


Figure 2 Maturity in uncertainty management - presented ECKM 2011

Two of the companies had long experience and very well defined methods' and techniques and four of the companies where less mature on the topic.

The different experience with the topic contributed to several different learning strategy on project and corporate level in the 6 companies:

Three of the companies need too develop system and models for Uncertainty management. They all started with defining the proses and testing them in pilot project together with researchers. This can be seen as knowledge creation strategies in and a strategy for institutionalization knew methods' and techniques.

In all 6 companies where researcher participant in uncertainty analysis. This can be seen as reflection in / on action strategy because the participating in the analysis made the project and the researcher more aware how project deals with deviation from the plan . But it can also be seen as autopoietic knowledge systems strategy seen from the research project view. Based on the observation of the proses it was suggested a new role "uncertainty coordinator " and more specific responsibility for the project owner role.

Five of the companies developed training course in uncertainty management and uncertainty analysis. This can be seen as tacit and explicit elements of knowledge creation, and institutionalization of the new methods'.

Two of the companies developed control system on the area uncertainty management, this can be seen as strategy for checking how well the system and methods are institutionalized and therefore a tacit and explicit learning strategy

Three companies performed benchmarking of the process– this could be seen as tacit and explicit elements of knowledge creation, and a way to better institutionalization of the methods in the companies.

All six companies participated in Forum and the sharing of knew methods', proses and techniques on the open project website supported by the research project. This can be seen as open knowledge creation strategy and strategy for sharing knowledge across company boarders. All six companies had seminars on Uncertainty management during the project. This can also be seen as open knowledge creation strategy and strategy for sharing knowledge across company boarders. Three companies participated on research paper together with researcher from the PUS project This can also be seen as open knowledge creation strategy and strategy for sharing knowledge across company boarders.

## **5. Concluding remarks**

Most of the projects needs too deal with uncertainty and learning and knowledge creation is an essential part of effective uncertainty management process. The classic project management approach focuses on predicting as accurately as possible what is going to happen and tries to establish a kind of bandwidth within which one can expect project deviations. In this world front end engineering becomes important, and sophisticated tools for assessing and analysing risk are frequently applied.

Dealing with opportunity side of the uncertainty means that one may be moving away from the protective approach and taking a step towards a more "offensive" project management. Systematic learning and reflection make it possible to move decisions points from the front of the project where the information is low to towards the back where the information about the needs is high.

Project management work in the future is heading for a way to release creative forces as a part of the project as well as planning. Keywords like "learning", "participation", "renewal" and "innovation" will become as common in project management terminology as they have been in organization literature (Packendorff 1995). Although traditionally research in the field of project management has focused of tools and methods, with a goal to achieve success within the iron triangle, and maybe still is both in some theoretical and practical field, we are sensing a change in the field towards management of networks and people. We strongly believe that companies that wants to developing knew knowledge in uncertainty management also need too understand and deal with how people and organizations learn.

All six companies that participated in the PUS project have significant improvement in handling uncertainty in project over the last 5 year. We believe that systematic approach that the six companies have developed too learning, knowledge creation, knowledge shearing have played a vital role in the improvement of handling uncertainty in projects. And hopefully have participation in a reach project on the area also made a small contribution to the success story.

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**Nr 11 Uncertainty Management in Projects – A New  
Perspective"**

# Uncertainty Management in Projects – A New Perspective

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## Abstract

This paper focuses on a Norwegian research project, called “Practical uncertainty management in a project owner’s perspective – in short, the PUS-project. The PUS-project had 6 major industrial partners – from public and private sectors. Both qualitative and quantitative methods were associated with this collaborative project work. This paper describes some of the major results produced by the PUS-project. In this regard, this paper touches upon approaches, methods and practices related to managing uncertainty in projects. The PUS-project emphasised on the role of project owner and giving adequate consideration on opportunities, when it comes to managing uncertainty. This emphasis, which is not common in the project world, is discussed in this paper with relevant theories and practical examples. This paper also presents examples from the industry to highlight some of the benefits that the involved organisations obtained in collaboration with the PUS-project – a research project’s contribution to create value in the industry.

## Key Words

Uncertainty, Project management, Opportunity, Project owner, Research project

## 1. Introduction

This paper focuses on a research project called “Practical uncertainty management in a project owner’s perspective” – in short, the PUS-project. The purpose of this paper is to describe some major contributions of this research project to create value in the industry and academia.

In order to materialize this purpose, this paper has the following structure: The paper starts with a short description of the PUS-project. A brief description of methodology follows it. Then, some contributions of the PUS-project are described. Firstly, the topic of dealing with opportunities in uncertainty management in projects is discussed. This is one of the significant focus-areas of the PUS-project. And then, examples from the industries are presented to point out some concrete benefits that the involved organisations achieved in collaboration with the PUS-project. Contribution to academia is then briefly described. Finally, concluding remarks wind up the whole discussion.



## 2. The PUS-project

The PUS-project (2006-2010) had an ambition of focusing on leadership and culture connected to practical management of uncertainty in major public and private projects. Lot of work was done on the issue of uncertainty analysis both in Norway and abroad, and much of this kind of work was carried out in the early phase ("front end loading") of projects. But, there was less research on the issue of how to manage opportunities and threats in a project's life cycle in a practical manner. Furthermore, there was not much research on what the project owner role should be with respect to management of uncertainty. PUS had an ambition to shed light on the owner's role in uncertainty management throughout the project life cycle. The project had a keen interest in influencing large organisations' thinking patterns and actions associated with identification and management of uncertainty elements in projects.

The PUS-project collaborated with the Research Council of Norway and the Norwegian Centre of Project Management (NSP). The main industrial partners (both from public and private sectors) of the project were:

1. Statoil (an international energy company with operations in 34 countries, headquartered in Norway),
2. Norwegian Directorate of Public Construction and Property Management
3. Telenor (one of the world's largest mobile operators with 33200 employees worldwide, headquartered in Norway)
4. Norwegian Armed Forces
5. Norwegian Public Roads Administration
6. Norwegian National Rail Administration

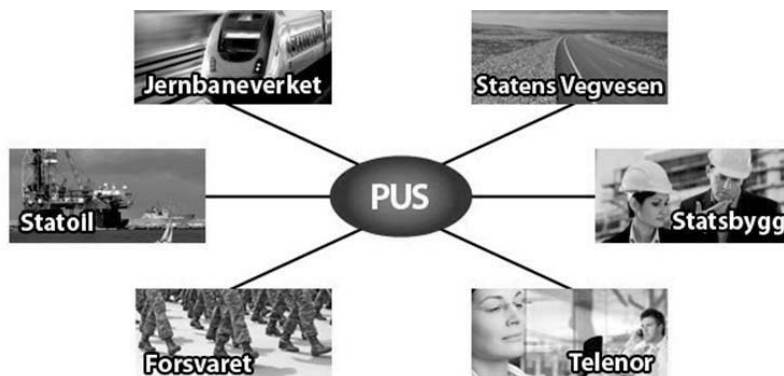


Figure 1: Major industrial partners of the PUS-project

Apart from these main industrial partners, other Norwegian organisations were also involved in the PUS-project. The project's cost frame was approximately 4 million euro. This frame included spin-off projects and own efforts.

## 3. Methodology

Methodology that we mention here is a mode of cooperation that the PUS-project had with its industrial partners. During the cooperation, the PUS-project used both qualitative and

quantitative research methods: (1) Questionnaire studies (2) Interviews (3) Document analysis (4) Action research.

During the project, two focus-seminars per year were conducted with the intention of anchoring plans, developing new models, procedures, routines, and transferring experiences between project managers and project owners in the involved organisations.

#### **4. Focus on opportunities**

When it comes to managing uncertainty in projects, there has been more focus on dealing with threats than with opportunities (Ward & Chapman, 2003).

We believe that it is relevant and important to look at opportunities – the positive outcome of uncertainty adequately, because it can generate benefits to projects / organisations.

A project can be seen as a system. The system is basically instable and flexible at the start of the project, and it tries to achieve stability and order by the help of establishing objectives, sub-objectives and plans. This will reduce uncertainty of the system. And, the system becomes gradually more stable and controllable. Though the system becomes more controllable when it goes from the early phase to the execution phase, it becomes more rigid, and the flexibility with respect to changes and adopting new opportunities in later phases of the project therefore tends to diminish.

However, new opportunities can emerge at any time in a dynamic work environment. There can be new internal conditions (such as, higher level of competence, effective resources / work methods) and new external conditions (such as cooperation with new projects in the nearby area, which can lead the project to save money by, for instance, common procurement; new products in the market, which can lead the project to simplify its technical solutions) that the project did not consider when objectives and plans were established.

If these conditions are exploited effectively, then the project can deliver the product / service with the predetermined quality at a lower cost, or quicker than previously expected. Active involvement, knowledge and authority are required from the management in order to materialize the benefits of opportunities.

Here are two examples that can illustrate that opportunities can appear / created during the course of projects:

- Project E18 Ostfold – a road construction project – was assessed by quality assurance procedure (QA2) and given a cost estimation of approximately 163 million euro. When the initial contracts came in, a new analysis showed that the project, with a low probability, would manage to keep itself within the predetermined frame of cost. The analysis showed that the cost forecast was approximately 176 million euro. The project carried out a process with the focus on finding potential opportunities that could reduce cost. In the course of four hour time, opportunities were found and they were used to reduce the cost more than approximately 20 million euro.
- Project R6 – Construction of 3 government buildings – was at the phase of developing keys and lock-systems that could deliver safe and secure solutions. This process originally included among other things, design / project engineering, purchase and installation. But, the project participants found out that there was another project that was going on primarily in connection with key and lock-systems in government buildings. Then, the project R6 cooperated with the other project. This cooperation produced benefit for the R6 project; for instance, reducing cost related to their project engineering activities, and purchasing the key and lock-systems at a cheaper rate.

These examples were obtained in uncertainty analysis sessions in which a researcher from the PUS-project was actively involved (action research). These examples, along with theories (Hillson, 2004; Olsson, R., 2007), point out benefits of having adequate focus on opportunities in managing uncertainty in projects. One of the ways for project managers to deal with opportunities effectively and efficiently is cooperation with their project owners. In order to discuss this issue, we shall categorise consequences of projects in 3 orders. These consequences reflect different objectives that are associated with the project.

#### 4.1 Having a broader view on the consequences of a project

Consequences of a project can be seen in several dimensions; first, second and third order consequences. The first order consequences are the concrete result that the project is intended to produce (for example, constructing a hospital building with respect to time, cost and quality). The second order consequences are the effect of the project's concrete result (for example, applying new knowledge that has been gained by the people and organization(s) that were involved in the project, curing and taking care of sick people). The third order consequences are a larger, social impact (for example, better health care system, wellbeing, new business establishments near the hospital – kiosk, etc.)

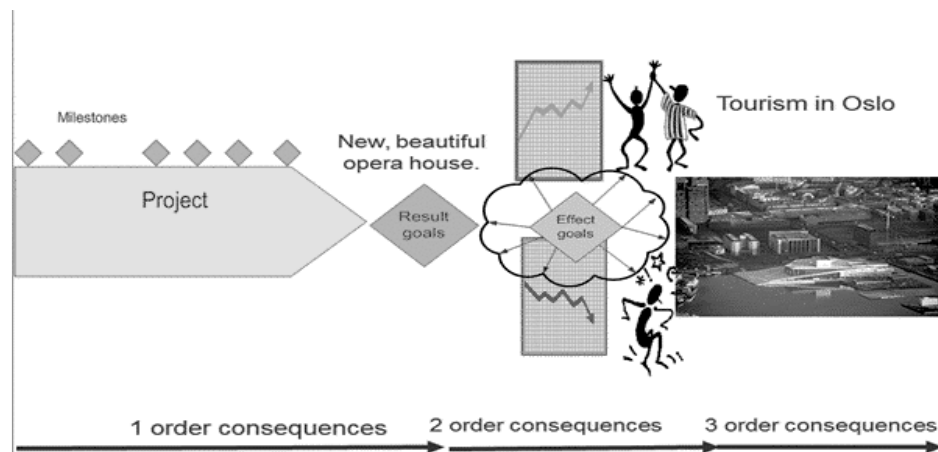


Figure 2: 1<sup>st</sup>, 2<sup>nd</sup> and 3<sup>rd</sup> order consequences (Johansen, Jermstad & Ekambaram, 2009)

#### 4.2 Opportunities – 1st, 2nd and 3rd order consequences

Opportunities can be looked at with respect to different levels of consequences (see Figure 2). Opportunities can produce effects and benefits for stakeholders of a project. How an opportunity is viewed is dependent on the stakeholders; for example, a consequence of a project can be seen as positive by a stakeholder, while another stakeholder views the consequence negatively.

The first order consequences emerge within the framework of the execution of a project and deliverance of the project's result-objective. (Result-objective focuses on time, cost and quality). Opportunities are in this respect connected to achieving project's result-objective:

- Opportunities in terms of cost: The project can deliver more at the cost that was previously determined, or with the predetermined quality at a lower cost.

- Opportunities in terms of time: The project can deliver a predetermined product / service quicker than planned, without increasing the cost and with the predetermined quality.
- Opportunities in terms of quality: The project can deliver a concept that is better than the one which was originally agreed upon, within the same frame of time and cost. Operational solutions can also be considered here; for example, a project can deliver a product / service according to the predetermined frame of time and cost, and the delivery is more optimal to operate.

The second order consequences are the effects that emerge after the project is completed. These effects include benefits to the organisations that have been involved in the project, *i.e.*, access to new markets and technology, development of new knowledge and competence within the respective organisations.

The third order consequences are broader effects of the project on the society. Opportunities in this regard encompass establishment of new organisations and services as the result of the completion of the project. An example in this regard is a construction project called Snow-white project in the Finnmark region, Norway. When the construction project was completed and operations were begun, then the surrounding environment / society started to obtain benefited from it; for instance, there were new work opportunity for the local people, day care facilities for children, and schools. Table 1 shows examples of first, second and third order consequences.

Table 1: Examples of consequences

Project	First order consequences (Result-objective)	Second order consequences (Effect-objective)	Third order consequences (Society-objective)
The Opera house, Oslo	- A modern building where opera shows can be arranged.	- Having the possibility to apply the experience that the involved organisations gain in future projects.	- Tourism in Oslo / Norway - Town-development (Bjorvika)
Constructing the highway E6 Ostfold	- New, modern road	- Less accidents - Faster traffic-movement - Shorter queues.	- New firms / businesses; f. ex. gas station, grocery store, restaurant

Now, we shall use the description of the 3 orders of consequences (the 3 different objectives that are associated with projects) to illustrates the role of project owner in handling opportunities in projects.

### 4.3 Cooperation between project managers and project owners

It is beneficial to have a broader perspective in managing projects. The broader perspective can be developed by establishing a good cooperation between project managers and project owners – with a strong involvement from project owners.

A project owner has rights to and is responsible for the project. Olsson, Johansen, Langlo, & Torp (2007) say:

“The beauty behind the concept of a project owner lies in the fact that a project owner has incentives for weighing costs against benefits for a project. Project owners are

therefore expected to strive for project governance aimed at maximising the value from the project.”

The project manager focuses on achieving the result-objective of the project in accordance with the predefined time, cost and quality (1<sup>st</sup> order consequences), whereas the project owner focuses on ensuring the effect-objective as well as the society objective (2<sup>nd</sup> and 3<sup>rd</sup> order consequences).

Project managers and project owners traditionally deal with two types of information; project managers with detailed information (mainly projects’ internal conditions – operational), and project owners with general / high level information (mainly, projects’ external conditions – tactical and strategic). Establishment of a common understanding by combining and studying these two types of information can lead the involved parties to identify / create opportunities effectively in projects.

However, cooperation between the project owner and the project manager is not always a problem-free affair. The project owner and the project manager can have varying understanding of opportunities: what opportunities are and how one can use them in order to improve result-objective, effect-objective and society-objective.

Though there are challenges with respect to communication and attitudes, companies take certain measures in order to tackle the challenges. A study in the Norwegian telecommunication sector (conducted by the PUS-project) points out that there are training programs in which project owners and project managers learn about their roles, responsibilities and what they expect from each other. After the training programs, project managers seem to notice improvement in project owners’ behaviour and in the collaboration. These training programs can be seen as arenas for reflecting on action and making sense of various situations.

#### **4.4 Creative thinking**

We see that there is a clear connection between creativity / innovation and the topic of opportunities in projects. It can be said that creative and innovative thinking can promote identifying and creating opportunities in projects. In this regard, it is relevant to mention what Hillson says (2004, page 256):

“[...] techniques designed to stimulate or support creativity and innovation are well suited to encouraging organizations to think positively, see opportunities, and develop strategies to capture benefits.”

Brainstorming, scenario thinking and creation of artificial crises are some of the methods that can be used to promote creative thinking to identify and create opportunities in projects. These methods were applied by the organisations that have been involved in our research study on the topic of uncertainty in projects. Identifying and creating opportunities, materializing them and harvesting the benefits of them can also encourage innovative and creative thinking in organisations (Ekambaram, Johansen, Jermstad, & Okland, 2010). We believe that the topic of opportunity in projects can contribute to the wider management field. The focus on opportunities can influence creating an organisational culture that promotes innovation and creativity; uncertainty can thus be seen as a potential source of generating opportunities, not as a condition that exclusively deals with threats. The lessons and

experiences of how uncertainty is managed in projects can be transferred / transformed in order to make positive effects on wider organisational settings.

## **5. Examples from the industry**

The Norwegian Directorate of Public Construction and Property Management (Statsbygg), in collaboration with the PUS-project, started its own development project called “Uncertainty management in Statsbygg” – in short, the SUS-project. And, Statsbygg worked closely with the researchers connected to the PUS-project. Through the cooperation with the PUS-project, Statsbygg has become a mature organisation when it comes to dealing with uncertainty effectively and efficiently. And, Statsbygg acknowledges it (PUS-project, 2011).

The SUS-project has 3 phases. They are:

- Studies in the case projects: There were 8 case projects, and methods and tools were tested in them; for example, a matrix for visualizing situations of uncertainty, risk register for monitoring uncertainty and monthly reporting of uncertainty in the case projects.
- Developing the systems – methods and tools: Based on experiences from the case projects, Statsbygg developed methods and tools. New governing documents were created, and a new role called “uncertainty coordinator” was established.
- Implementing the systems: As per October 2010, the tools were used by about 20 projects. Procedures, guidelines, templates and training programs were in use. Statsbygg’s school offers courses and training for their employees.

In the beginning of 2011, the SUS-project won Statsbygg’s innovation prize. A description that accompanied the prize says that the project has provided documentation of both threats and opportunities over time in projects, including effects and efforts related to them, and that the overview of uncertainty, provided by the documentation, gives both project managers and project owners more confidence in executing their roles in managing uncertainty in projects.

Another industrial example is Telenor (from the private sector). Telenor developed a tool called “Health check” in collaboration with the PUS-project. The tool has 20 questions that can be used to check how project participants experience their work situations. The questions can be used in different phases of a project – as a kind of an early warning system. The tool is now available at the website of the Norwegian Centre of Project Management (<http://www.nsp.ntnu.no/>) to its members. Telenor indicated its willingness to continue the work, which had been started with the PUS-project, through its “risk-forum” (PUS-project, 2011).

## **6. Contribution to academia**

The PUS-project contributed to academia too. In this regard, 17 master degree theses and 11 student project theses were produced at the Norwegian University of Science and Technology (NTNU), Trondheim, Norway. Two doctoral theses were also connected to the PUS-project. Eleven journal articles and 22 conference articles were published during the 4 year period.

The academic contribution was in collaboration with the industry.

## **7. Concluding remarks**

In this paper, we have described some major contributions that the PUS-project made to the industry and academia in Norway. The PUS-project managed to create a positive culture that can promote effective and efficient uncertainty management in projects. Organisations such as Statsbygg and Telenor acknowledged the development of the positive culture in their organisations through the collaboration with the PUS-project and the need to involve project owner more in managing uncertainty in projects (PUS-project, 2011). The organisations involved in the PUS-project agreed on the relevance and necessity to pay adequate attention on opportunities, when they deal with uncertainties. Furthermore, the cooperation between the PUS-project and the involved organisations, such as Statsbygg, illustrates how a research project attempted to create value in the industry – an example of collaboration between researchers and practitioners.

### **Acknowledgementt**

We sincerely thank Mr. Tor Inge Johansen (Chairman, the PUS-project), Ms. Ragnhild Aalstad (Project Manager, Statsbygg) and Mr. Helge Marheim (Project Manager, Telenor) for their support to the PUS-project and thus to the work related to this paper.

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**Nr 12 Opportunities in projects and the role of project owners**

# Opportunities in projects and the role of project owners

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## Abstract

Dealing with uncertainty (risk) is a vital part of project management. Uncertainty includes threats and opportunities. Several research studies show that organisations focus notably more on threats than on opportunities, when it comes to managing uncertainty in their projects. This paper chooses to look at opportunities; how to identify and create opportunities in projects. Exploring potential opportunities in a project and utilising them require, among other things, a broader understanding of the project as well as of its effect, and a greater influencing power in the organisation. In this regard, this paper takes into account the role of project owners and their interaction with project managers. Interviews and action research were applied to collect data in this study. This paper provides an understanding of the importance of focusing on opportunities in managing uncertainty in projects and how the role of project owners can facilitate identifying and creating opportunities in projects.

Key words: Opportunities, Uncertainty, Project management, Project owner, Project manager

## 1. Introduction

Uncertainty is an important aspect in projects. According to Galbraith, uncertainty can be described as the gap between available information and the information that is needed in order to do a task (Galbraith, 1977). Uncertainty includes both positive and negative elements. The positive elements are considered as opportunities and the negative elements are considered as threats (Hillson, 2004; Loch *et al.*, 2006). Several research studies show that there is more focus on threats than on opportunities, when it comes to managing uncertainty in projects (Amdahl *et al.*, 2009).

This paper aims to look primarily at opportunities with respect to managing uncertainty in projects with a special consideration on the role of project owners. In this regard, this paper first presents different objectives that are associated with projects. These objectives can be considered as a framework for finding / creating opportunities in projects. Cooperation between the project owner and the project manager is discussed based on this framework.

This paper is a part of one of the ongoing research studies related to the project called, “Practical management of uncertainty viewed from the perspective of project owner” – in short, the PUS-project. Different organisations are involved in the PUS-project; including Statoil, Directorate of Public Construction and Property Management, Norway, Telenor,

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Norwegian Armed Forces, Norwegian Public Roads Administration and Norwegian National Rail Administration. PUS-project is associated with Norwegian Center of Project Management (NSP).

## **2. Methodology**

The study related to this paper is mainly descriptive; however, it also includes certain extent of explorative characteristics. We applied the following two research instruments / methods:

**Interviews:** Discussions were conducted at different points of time over approximately 6 months on this topic. The discussions were primarily carried out in the form of workshops that focused exclusively on the topic of opportunities in projects, in which representatives from different organisations participated. The organisations belonged to sectors such as telecommunication, construction, offshore and defence. There were 12 persons who participated in the workshops. Discussions at the workshops were carried out with the help of sets of questions. These questions and the following response and discussion can be considered as semi-structured, group interviews. **Action research:** Several sessions of uncertainty analysis were carried out in various projects. One of the authors of this paper participated actively in and led the sessions. In a typical uncertainty analysis session, approximately 20 members from the respective organisation take part. The participants belong to several professions / positions; for instance, project manager, assistant project manager and construction manager. Experience from these analyses were reflected upon in connection with the topic of opportunities in projects and used in this paper.

## **3. Opportunities**

A project can be seen as a system. The system is basically instable and flexible at the start of the project, and it tries to achieve stability and order by the help of establishing objectives, sub-objectives and plans. This will reduce uncertainty of the system. And, the system becomes gradually more stable and controllable, once objectives and plans are developed in the course of the early phase. Though the system becomes more controllable when it goes from the early phase to the execution phase, it becomes more rigid, and the flexibility with respect to changes and adopting new opportunities in later phases of the project therefore tends to diminish.

It is commonly accepted that opportunities are more in the early phase of a project, where flexibility in connection with choosing solutions is high and the system is in imbalance. But, it does not necessarily mean that opportunities do not exist in later phases (for example, in the execution phase), or that the cost of exploring and utilizing the opportunity in later phases is higher than the benefits.

New opportunities can emerge at any time in a dynamic work environment. There can be internal and external conditions (new opportunities) that the project did not consider when objectives and plans were established.

- Examples of internal conditions: Higher level of competence, effective resources / work methods, better team development, Optimal choice of technical solutions
- Examples of external conditions: Cooperation with new projects in the nearby area, which can lead the project to save money by, for instance, common procurement; new products in the market, which can lead the project to simplify its technical solutions.

If these conditions are exploited effectively, then the project can deliver the product / service with the predetermined quality at a lower cost, or quicker than previously expected. The extent to which opportunities are identified and utilized is dependent on the focus on managing uncertainty. If opportunities are considered as positive that they can influence the project to be more optimal (better, cheaper and quicker), then appropriate measures are to be made to bring the opportunities into the system and ensure that they are utilized. Active involvement, knowledge and authority are thus required in order to materialize the benefits of opportunities.

Here are two examples that can illustrate that opportunities can appear / created during the course of projects:

- Project E18 Østfold – a road construction project – was assessed by quality assurance procedure (QA2) and given a cost estimation of NOK 1.25 billion (1 NOK = ca 0.12 EUR). When the initial contracts came in, a new analysis showed that the project, with a low probability, would manage to keep itself within the predetermined frame of cost. (The analysis showed that the cost forecast was NOK 1.35 billion.) The project carried out a process with the focus on finding potential opportunities that could reduce cost. In the course of four hour time, opportunities were found and they were used to reduce the cost more than NOK 150 million.
- Project R6 – Construction of 3 government buildings – was at the phase of developing keys and lock-systems that could deliver safe and secure solutions. This process originally included among other things, design / project engineering, purchase and installation. But, the project participants found out that there was another project that was going on primarily in connection with key and lock-systems in government buildings. Then, the project R6 cooperated with the other project. This cooperation produced benefit for the R6 project; for instance, reducing cost related to their project engineering activities, and purchasing the key and lock-systems at a cheaper rate.

These examples were obtained in uncertainty analysis sessions. These examples, along with theories (Olsson, R, 2007; Hillson, 2004), point out benefits of having adequate focus on opportunities in managing uncertainty in projects. One of the ways for project managers to deals with opportunities effectively and efficiently is cooperation with their project owners.

In order to discuss this issue, we shall categorise consequences of projects in 3 orders. These consequences reflect different objectives that are associated with the project.

#### 4. First, second and third order consequences

Opportunities can produce effects and benefits for stakeholders of a project. How an opportunity is viewed is dependent on the stakeholders; for example, a consequence of a project can be seen as positive by a stakeholder, while another stakeholder views the consequence negatively.

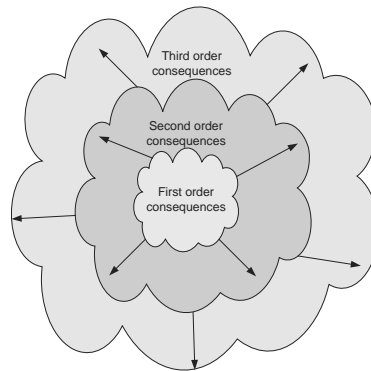


Figure 1: Opportunities – 1<sup>st</sup>, 2<sup>nd</sup> and 3<sup>rd</sup> order consequences

Opportunities can be looked at with respect to different levels of consequences (*cf.* Figure 1):

The first order consequences emerge within the framework of the execution of a project and deliverance of the project's result-objective. Opportunities are in this respect connected to achieving project's result-objective – particularly improving the result-objective; project delivers a product / service that is better than that which was expected earlier.

- Opportunities in terms of cost: The project can deliver more at the cost that was previously determined, or with the predetermined quality at a lower cost.
- Opportunities in terms of time: The project can deliver a predetermined product / service quicker than planned, without increasing the cost and with the predetermined quality.
- Opportunities in terms of quality: The project can deliver a concept that is better than the one which was originally agreed upon, within the same frame of time and cost. Operational solutions can also be considered here; for example, a project can deliver a product / service according to the predetermined frame of time and cost, and the delivery is more optimal to operate.

The second order consequences are the effects that emerge after the project is completed. These effects include benefits to the organizations that have been involved in the project, *i.e.*, access to new markets and technology, development of new knowledge and competence within the respective organizations, taking care of patients as a result of constructing a university hospital.

The third order consequences are broader effects of the project on the society. Opportunities in this regard encompass establishment of new organizations and services as the result of the completion of the project. An example in this regard is a construction project called Snow-white project in the Finnmark region, Norway. When the construction project was completed and operations were begun, then the surrounding environment / society started to obtain benefited from it; for instance, there were new work opportunity for the local people, day care facilities for children, and schools. Table 1 shows examples of first, second and third order consequences.

Table 1: Examples of consequences

Project	First order consequences (Result-objective)	Second order consequences (Effect-objective)	Third order consequences (Society-objective)
The Opera house, Oslo	- New, beautiful opera house - A modern building where opera shows can be arranged.	- Experience that the involved organizations gain; experience of constructing such a building.	- Tourism in Oslo / Norway - Town-development (Bjørvika)
Introducing a new IT-based system for processing salary and travelling expenses	- IT-based system was installed in 25 computers	- Better operation, better service, reduced need for employees to process salary and travelling expenses (reduction in workforce)	- Tax is reported to right places (sections) at right time
Constructing the highway E6 Østfold	- New, modern road	- Less accidents - Faster traffic-movement - Shorter queues.	- New firms / businesses; f. ex. gas station, grocery store, restaurant
Building of a new university hospital, Trondheim	- New, fine hospital	- Many organizations that were involved in the project gained new knowledge - Taking care of patients more effectively and efficiently - Increment in the ability to treat the patients	- Quicker treatment - Improvement in the health situation - Less absentees at work

Now, we shall use the description of the 3 orders of consequences (the 3 different objectives that are associated with projects) to illustrate the role of project owner in handling opportunities in projects.

## 5. Cooperation between project managers and project owners

It is beneficial to have a broader perspective. The broader perspective can be developed by establishing a good cooperation between project managers and project owners – a strong involvement from project owners.

A project owner has rights to and is responsible for the project. Olsson, N. O. E, *et al.* (2007) say:

“The beauty behind the concept of a project owner lies in the fact that a project owner has incentives for weighing costs against benefits for a project. Project owners are therefore expected to strive for project governance aimed at maximising the value from the project.”

The project manager focuses on achieving the result-objective of the project in accordance with the predefined time, cost and quality (1<sup>st</sup> order consequences), whereas the project owner

focuses on ensuring the effect-objective as well as the society objective (2<sup>nd</sup> and 3<sup>rd</sup> order consequences).

Project managers and project owners traditionally deal with two types of information; project managers with detailed information (mainly projects' internal conditions – operational), and project owners with general / high level information (mainly, projects' external conditions – tactical and strategic). The difference in types of information is also highlighted by the results of a recent research study (Andersen, 2010) Establishment of a common understanding by combining and studying these two types of information can lead the involved parties to identify / create opportunities effectively in projects.

Cooperation between project managers and project owners can generate several positive results (though the cooperation can be challenging at times). Some positive results are:

- Create better / broader understanding of the project (and opportunities) by comparing and studying operational, tactical and strategic aspects connected to the project.
- Contribute to ensure that opportunities are in tune with the project's result-objective, effect-objective and society-objective (1<sup>st</sup>, 2<sup>nd</sup> and 3<sup>rd</sup> order of consequences).
- Implement initiatives (with responsibility as well as authority) in order to identify, create and utilise opportunities.

This situation can be seen in connection with systems thinking; a holistic approach that is based not only on the understanding of individual elements of a system, but also the understanding of the connection and interaction between the elements of the system (Senge, 1990). A good cooperation between a project manager and a project owner can produce a holistic understanding of the project, which can in turn lead to identify / create opportunities in the project. Olsson, R (2007) also emphasizes the importance of having a holistic approach in projects in order to identify and materialize opportunities. A research conducted in industries (including construction, offshore, railroad and telecommunication industries) in Norway on the issue of relationship between the project manager and the project owner also suggests that the cooperation between these two parties helps to develop a holistic understanding of the situation (Berglid, 2009).

However, developing a holistic understanding is not a problem-free affair. A project owner and project manager can have varying understanding of opportunities: What opportunities are and how one can use them in order to improve result-objective, effect-objective and society-objective. Here, it is relevant to mention the following:

“And most risks identified are perceived as risk to the project, not necessarily as risks for the project owner [...] (Langlo, *et al.*, 2007)”.

This statement is applicable not only for risk / threats, but also for opportunities (Rolstadås, *et al.*, 2008).

A research study presented by Andersen (2010, page 7) suggests that “there is potential for bettering the communication between the project owner and the project manager”. This research result is further highlighted by Müller (2009) who conducted a research on the

communication between project owners and projects managers. He says that a significant difference in project performance can be noticed depending on the degree of interest that the project owner has towards the project and on the willingness to communicate.

Though there are challenges with respect to communication and attitudes, companies take certain measures in order to tackle the challenges. A study in the Norwegian telecommunication sector (the study was involved with the PUS-project) points out that there are training programs in which project owners and project managers learn about their roles, responsibilities and what they expect from each other. After the training programs, project managers seem to notice improvement in project owners' behaviour and in the collaboration (Mytskevych, 2010). These training programs can be seen as arenas for reflecting on action and making sense of various situations.

## **6. Concluding remarks**

This paper is a part of one of the ongoing research studies related to the project called, "Practical management of uncertainty viewed from the perspective of project owner" – in short, the PUS-project. Our studies show that there is more focus on threats than on opportunities, when it comes to managing uncertainty in projects. In this paper, we have chosen to emphasize the focus on opportunities – the focus that the topic of opportunities in projects deserves.

A positive attitude is an essential ingredient in order to deal effectively with opportunities in projects. Being positive or optimistic does not necessarily mean that the person is being unrealistic. Having the positive view / attitude can be compared with concepts such as positive organisational behaviour (Luthans, 2002) and positive organisational scholarship (Cameron *et al.*, 2003), at least to a certain extent.

Based on our research, we believe that opportunities can be identified / created to a greater extent through better cooperation between project owners and project managers. This cooperation can lead to develop a holistic understanding of the project or of the situation at hand by reflecting on operational, tactical and strategic information, and find opportunities and utilise them.

We adopted qualitative research method. The research instruments that we applied reflect semi-structured, group interviews (conducted in workshops that exclusively focused on the topic of opportunities in projects) and action research (in the form of uncertainty analyses in project organisations). The research method / research instruments that we applied have their limitations – possibly lack of extensiveness of the study. We did not study a particular project extensively as a complete case study, viewing it from different perspectives through all of its phases. Conducting such an extensive study can be future work that can shed more light on the topic of opportunities in projects. Number of participants at the workshops may also be considered as limited. However, we have to mention that the participants were actively involved and contributed to open and valuable discussions.

We do not claim that our paper covers all the major aspects of the topic of opportunities in projects. We try to present a framework within the scope of this paper, mentioning relevant theories coupled with empirical examples. Our major intention is to stimulate discussion on the topic that can lead to further development in both the theoretical and practical front.



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**Nr 13 Opportunities in projects and innovative thinking**

## Opportunities in projects and innovative thinking

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### Abstract

Projects are popular work-form in the modern organisational world. They can be considered as learning arenas, where new knowledge and solutions can be developed and applied. This paper considers an important aspect of the concept of project, namely uncertainty. Dealing and managing with uncertainty in projects is then looked at in connection with creativity and innovation. In order to establish the connection between managing uncertainty in projects and innovative thinking, this paper utilises relevant organisational theories, as well as observation and reflection on practice.

Projects generally encounter uncertainty. Studies that were carried out in Norway and England concluded that focusing on threats is the dominating aspect in managing uncertainty in projects. Firstly, this paper tries to look at the positive side of uncertainty, *i.e.*, opportunities. In this regard, the paper attempts to characterise opportunities in projects – in general as well as with respect to different types of objectives that are associated with projects. Secondly, this paper suggests ways of finding / creating opportunities. The suggestions have two elements. They are (1) cooperation between project managers and project owners and (2) project members' attitudes and reflection. Cooperation between project managers and project owners can produce a holistic understanding of projects. Attitudes point out the manner that project members approach and deal with uncertainty (and opportunities) in projects. Thirdly, this paper tries to connect the major concepts of this paper; connecting cooperation (between project managers and project owners), project members' attitudes, reflection, innovative thinking and managing uncertainty and opportunities.

In addition, this paper discusses how important it is to focus on the issue of innovation in project work and in the development of the field of project management.

Keywords: Uncertainty, opportunity, holistic understanding, attitudes, innovative thinking

## 1. Background

This paper is a part of one of the ongoing research studies related to the project called, "Practical management of uncertainty viewed from the perspective of project owner" – in short, PUS-project. Different organisations are involved in the PUS-project; including Statoil, Directorate of Public Construction and Property Management, Norway, Telenor, Norwegian Armed Forces, Norwegian Public Roads Administration and Norwegian National Rail Administration. PUS-project is associated with Norwegian Center of Project Management (NSP).

## 2. Introduction

Uncertainty is one of the important aspects in the field of project management. Christensen *et al.* (1991) defines uncertainty as the difference between currently available information and required information when there is an effort of decision making.

Uncertainty can be seen positively or negatively; positively as opportunities to obtain better results and negatively as threats related to obtaining worse results (Hillson, 2004; Loch *et al.*, 2006; Perminova *et al.*, 2008). When it comes to managing uncertainty in projects, there has been more focus on dealing with threats than with opportunities. Ward *et al.* ((2003) mention that practitioners have a tendency to focus more on threats than on opportunities. Several research results also show this trend (Amdahl, *et al.*, 2008). Perhaps as a reflection of this trend, there is comparatively less number of publications / literature on the topic of opportunities in projects.

We believe that it is relevant and important to look at opportunities – the positive outcome of uncertainty adequately, because it can generate benefits to projects / organisations.

This paper aims to describe:

- How relevant / important it is to focus adequately on opportunities in managing uncertainty in projects: In this regard, we characterise opportunities in projects – in general as well as with respect to different types of objectives that are associated with conducting projects, and present relevant examples.
- Suggestions for identifying / creating opportunities in projects
- Potential positive outcome of focusing on opportunities: We believe that creativity and innovative thinking is closely connected to dealing with opportunities in projects – developing and facilitating innovative solutions to improve effectiveness and efficiency of projects. This experience and knowledge, which is obtained from dealing with uncertainty in projects, can then be applied in wider organisational settings to obtain benefits.

### **3. Methodology**

Our study is primarily descriptive. However, it also incorporates explorative characteristics, at least certain extent. The manner data was obtained and looked at is of qualitative nature. The research instruments / methods that we used are:

Interviews: Discussions were conducted at different points of time over approximately 6 months on this topic. The discussions were primarily carried out in the form of workshops that focused exclusively on the topic of opportunities in projects, in which representatives from different organisations participated. The organisations belonged to sectors such as telecommunication, construction, offshore and defence. There were 12 persons who participated in the workshops. Discussions at the workshops were carried out with the help of sets of questions. These questions and the following response and discussion can be considered as semi-structured, group interviews.

Action research: Several sessions of uncertainty analysis were carried out in various projects. One of the authors of this paper participated actively in and led / facilitated the sessions. In a typical uncertainty analysis session, approximately 20 members from the respective organisation take part. The participants belong to several professions / positions; for instance, project manager, assistant project manager and construction manager. Experience from these analyses were reflected upon in connection with the topic of opportunities in projects and used in this paper. The uncertainty analyses were led / facilitated by this author in order to improve the situation that the involved organisations encountered in connection with managing their projects. These analyses can therefore be compared with action research, at least to a certain extent. In this regard, it is relevant to look at a definition of action research. Greenwood *et al.* (2007, page 3) define action research as

[...] social research carried out by a team that encompasses a professional action researcher and the members of an organization, community, or network ("stakeholders") who are seeking to improve the participants' situation.

This definition suggests the relevance of action research to our research study.

As we see it, our research methods helped us to obtain data in two different settings. Interviews can be seen as arenas where the participants reflect on their past actions and experiences. Uncertainty analysis sessions can be seen as arenas where the actual work is looked at while it goes on.

## 4. Characterizing opportunities

The topic of uncertainty can be seen from various perspectives, and we would like to use the systems perspective. We believe that systems perspective can be used to create a better understanding of the topic that we focus on here. Systems thinking deals with an understanding of how a system functions; it deals not only with the understanding of the individual parts of the system, but also the relationship between the parts of the system (Senge, 1990).

A project can be considered as a unique system (one-time activity) that delivers a result-objective within a limited period of time. Result-objective is, for instance, a building that is delivered as a result of a construction project. This system consists of an organisation that delivers a product or a service, and a supporting process (project management) that has the responsibility for coordinating and managing resources, so that the result-objective will be delivered according to the time, cost and quality that have previously been agreed upon.

Figure 1 shows an illustration of the systems perspective in connection with our discussion on opportunities in projects.

The system is basically instable and flexible at the start of the project, and it tries to achieve stability and order by the help of establishing objectives, sub-objectives and plans. This will reduce uncertainty of the system. Though the system becomes more controllable when it goes from the early phase to the execution phase, it becomes more rigid, and the flexibility with respect to changes and adopting new opportunities in later phases of the project therefore tends to diminish.

Before determining objectives and plans, threats do not appear, or they are not perceived; there is only the positive side of the uncertainty, namely opportunities. Once the system defines its objectives and assigns responsible people to accomplish the objectives, threats will be experienced. A threat for the system can be defined as everything that can hinder the system to accomplish its objectives.

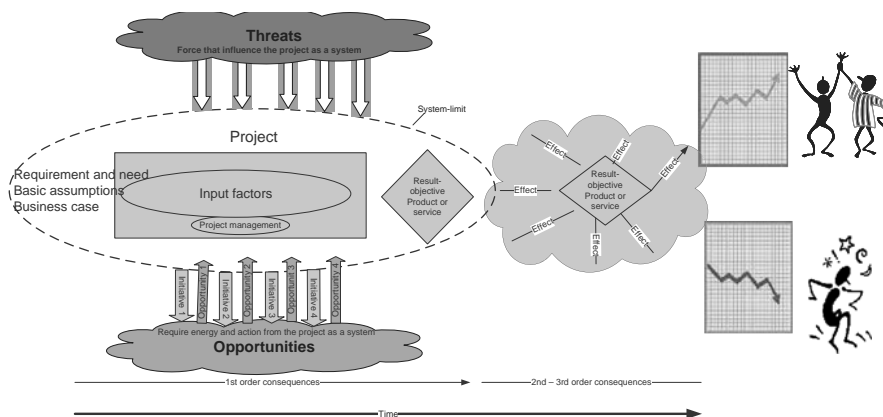


Figure 1: Project as a system – Opportunities and threats

Whether a condition in a project setting is seen as a treat or an opportunity will be based on the stakeholders' understanding of and association with the objectives of the system.

New opportunities can emerge at any time in a dynamic work environment. There can be internal and external conditions (new opportunities) that the project did not consider when objectives and plans were established. If these conditions are exploited effectively, then the project can deliver the product / service with the predetermined quality at a lower cost, or quicker than previously expected.

- Internal conditions: Higher level of competence, effective resources / work methods, better team development, optimal choice of technical solutions.
- External conditions: Cooperation with new projects in the nearby area, which can lead the project to save money by, for instance, common procurement; new products in the market, which can lead the project to simplify its technical solutions.

Here are two examples that can illustrate that opportunities can appear / created during the course of projects:

Project E18 Ostfold – a road construction project – passed through a quality assurance procedure (QA2) with an estimation of NOK 1.25 billion. When the initial contracts came in, a new analysis showed that the project, with a low probability, would manage to keep itself within the predetermined frame of cost. (The analysis showed that the cost forecast was NOK 1.35 billion.) The project carried out a process with the focus on finding potential opportunities that could reduce cost. In the course of 4 hour time, opportunities were found to reduce the cost more than NOK 150 million.

Project R6 – Construction of 3 government buildings – was at the phase of developing keys and lock-systems that could deliver safe and secure solutions. This process originally included among other things, design / project engineering, purchase and installation. But, the project participants found out that there was another project that was going on primarily in connection with key and lock-systems in government buildings. Then, the project R6 cooperated with the other project. This cooperation produced benefit for the R6 project; for instance, reducing cost related to their project engineering activities, and purchasing the key and lock-systems at a cheaper rate.

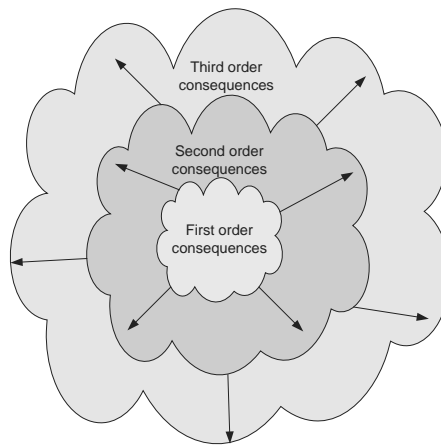
These examples were obtained in uncertainty analysis sessions.

The extent to which these opportunities are identified and utilised is dependent on the degree of consideration on managing uncertainty. Active involvement, focus, energy and creative thinking are required from the project manager or management team in order to materialize the benefits of the opportunities.

## 5. Opportunities as 1st, 2nd and 3rd order consequences

Opportunities can produce effects and benefits for stakeholders of a project. Whether a condition in a project setting is seen as a treat or an opportunity will be based on the stakeholders' understanding of and association with the objectives of the system; for example, a consequence of a project can be seen as positive by a stakeholder, while another stakeholder views the consequence negatively.

Opportunities can be looked at with respect to different levels of consequences (*cf.* Figure 2)



**Figure 2:** Opportunities are dependent on effects that they create for project stakeholders – 1<sup>st</sup>, 2<sup>nd</sup> and 3<sup>rd</sup> order consequences

The first order consequences emerge within the framework of the execution of a project and deliverance of the project's result-objective. Opportunities are in this respect connected to achieving project's result-objective – particularly improving the result-objective.

- Opportunities in terms of cost: The project can deliver more at the cost that was previously determined, or with the predetermined quality at a lower cost.
- Opportunities in terms of time: The project can deliver a predetermined product / service quicker than planned, without increasing the cost and with the predetermined quality.
- Opportunities in terms of quality: The project can deliver a concept that is better than the one which was originally agreed upon, within the same frame of time and cost. Operational solutions can also be considered here; for example, a project can deliver a product / service according to the



predetermined frame of time and cost, and the delivery is more optimal to operate.

The second order consequences are the effects that emerge after the project is completed. These effects include benefits to the organisations that have been involved in the project, *i.e.*, access to new markets and technology, development of new knowledge and competence within the respective organisations, taking care of patients as a result of constructing a university hospital.

The third order consequences are broader effects of the project on the society. Opportunities in this regard encompass establishment of new organisations and services as a result of the completion of the project. An example here is a construction project called Snow-white project in the Finnmark region, Norway. When the construction project was completed and operations were started, then the surrounding environment / society has benefited from it; for instance, there were new work opportunity for the local people, day care facilities for children, and schools.

## **6. Finding / creating opportunities**

Dealing with opportunities (identifying and utilising opportunities) in the course of a project can be seen in connection with the 1<sup>st</sup>, 2<sup>nd</sup> and 3<sup>rd</sup> order consequences. In this respect, how can a project manager deals with opportunities effectively and efficiently?

**Cooperation between project managers and project owners** A broader perspective is beneficial to deal with opportunities. A broader perspective can be developed by establishing a good cooperation between project managers and project owners – a strong involvement from project owners. There are several definitions of the notion of project owner. We consider the following description of the notion: A project owner has rights to and is responsible for the project. The project owner takes the risk connected to the project's cost and its future (Eikeland, 1999).

Project managers and project owners traditionally deal with two types of information; project managers with detailed information (mainly projects' internal conditions – operational), and project owners with general / high level information (mainly, projects' external conditions – tactical and strategic). Establishment of a common understanding by combining and studying these two types of information can lead the involved parties to identify / create opportunities effectively in projects.

Cooperation between project managers and project owners can generate several positive results (though the cooperation can be challenging at times). Some positive results are:

- Create better / broader understanding of the project (and opportunities) by comparing and studying operational, tactical and strategic aspects connected to the project.

- Contribute to ensure that opportunities are in tune with the project's result-objective, effect-objective and society-objective (1<sup>st</sup>, 2<sup>nd</sup> and 3<sup>rd</sup> order of consequences).
- Implement initiatives (with responsibility as well as authority) in order to identify, create and utilise opportunities.

This situation can again be seen in connection with systems thinking; a holistic approach that is based not only on the understanding of individual elements of a system, but also the understanding of the connection and interaction between the elements of the system. A good cooperation between a project manager and a project owner can produce a holistic understanding of the project, which can in turn lead to identify / create opportunities in the project. Olsson (2007) also emphasizes the importance of having a holistic approach in projects in order to identify and materialize opportunities.

This description of holistic understanding can be seen with respect to a discussion presented by Steiner (1995). Quoting on Heidegger's theories and thoughts, Steiner says that it is important to have a total understanding when it comes to innovation. This total understanding comprises both an understanding of the aspect that is under consideration as well as an understanding of how the aspect is linked to other aspects in its surrounding environment. This total understanding can ensure the intended usefulness / functionality of innovative solutions (products, work-methods, *etc.*).

**Attitude and reflection.** When project managers and other project participants have a tendency to look at uncertainty as an undesirable situation, then they will probably miss the opportunities that the project has or can generate. The focus on avoiding changes in projects can result in neglecting opportunities. Exploration of opportunities requires that one has to accept imbalance now and then, and accept that it is not always possible to predict the future. At the start of a project, no one would have a total understanding of what the project will achieve and deliver. This means that the project manager and the project owner must explore and evaluate internal and external conditions, which are of dynamic nature, through out the whole project and ensure the accomplishment of the objectives.

Effective exploration of opportunities demands a positive attitude towards uncertainty – that the world is indeed unpredictable and uncertain. An apparent threat can incorporate hidden opportunities. The way one looks at situations can make a difference. As the French writer Marcel Proust said,

The real voyage of discovery begins not in seeking new landscapes but in having new eyes.

The positive attitudes towards dealing with uncertainty can pose a question: Does this attitude promote too much optimism (Flybjerg, 2007; Lovallo *et al.*, 2003)?

However, we believe that in order to avoid too much optimism we should not abandon the avenues of finding and creating opportunities. Being positive or optimistic does not necessarily mean that the person is being unrealistic. This view can be compared with concepts such as positive organisational behaviour (Luthans, 2002) and positive organisational scholarship (Cameron *et al.*, 2003), at least to a certain extent.

If the danger of becoming unrealistic is felt significantly, then there can be a possible solution for it: Reflecting on the current situation and continuously evaluating it.

This kind of continuous evaluation of uncertainty-elements can be done by asking fundamental questions regarding what the project / organisation does; for example,

- Why do we do that we do?
- Why do we do it the way we do?

These questions are mentioned by Hammer *et al.* (1995) in connection with business process reengineering (BPR). We believe that these questions can also be used in the context of reflection and exploration that we describe here in connection with opportunities in projects.

Asking fundamental questions can lead the project / organisation to identify and utilise new opportunities both internally and externally.

Asking fundamental questions can be seen in connection with what Schön calls the reflective practitioner. He (Schön, 1998, page 61) says,

A practitioner's reflection can serve as a corrective to over-learning. Through reflection, he can surface and criticize the tacit understanding that have grown up around the repetitive experiences of specialized practice, and can make new sense of the situation of uncertainty or uniqueness which he may allow himself to experience.

The description mentioned above points out the possibility of new ways to approach and tackle the situation at hand.

**Innovative thinking** There are several ways that the term innovation can be understood. According to an introductory article in the International Journal of Project Management,

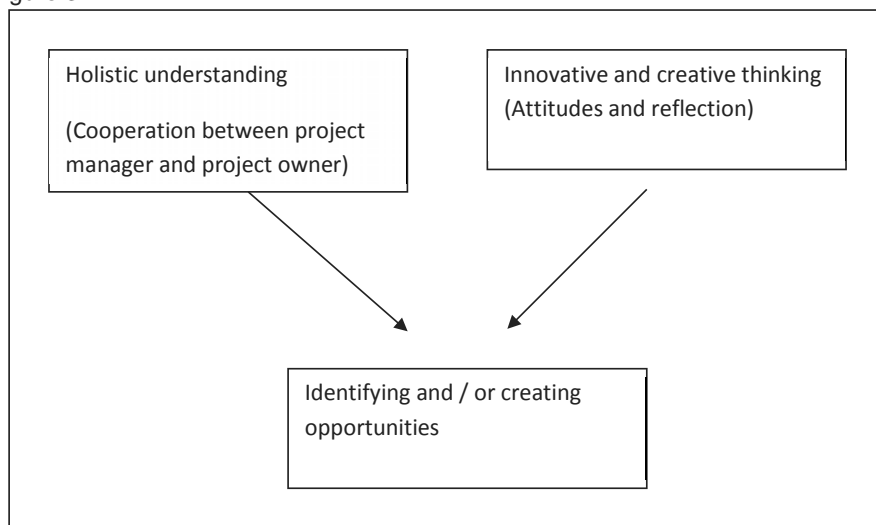
Innovation is often used to signify something new, either a new product, service or other output, and / or a new process and method (Guest editorial, International Journal of Project Management, 2008, page 466).

Lenfle (2008) mentions that innovation can refer various situations, and it can be classified in different ways. This description suggests the vastness and complexity of the term innovation. We consider innovation as something new and creative that is intended to produce desired results.

In this paper, we look at innovation with respect to identifying and creating opportunities in projects. We see that there is a clear connection between creativity / innovation and the topic of opportunities in projects. It can be said that creative and innovative thinking can promote identifying and creating opportunities in projects. In this regard, it is relevant to mention what Hillson says (2004, page 256):

[...] techniques designed to stimulate or support creativity and innovation are well suited to encouraging organizations to think positively, see opportunities, and develop strategies to capture benefits

This connection combined with the aspect of holistic understanding is depicted in Figure 3.



**Figure 3:** Connection between holistic understanding, innovative thinking and opportunities in projects.

There is also another way of looking at the connection between opportunities in projects and innovation / creativity. Identifying and creating opportunities, materializing them and harvesting the benefits of them can also encourage innovative and creative thinking in organisations.

There can be several methods / mechanisms that can be used to promote innovative / creative thinking that can lead to identify and create opportunities in projects. Some of them are:

- Brainstorming
- Six hat thinking
- The approach of business process reengineering
- Scenario thinking
- Creating artificial crises
- SWOT analysis
- Reward systems

These methods were applied by the organisations that have been involved in our research study on the topic of uncertainty in projects. The respondents (participants at the workshops) emphasized the significant role that organisational culture (attitudes, values, beliefs, etc.) plays in applying these methods. The respondents also highlighted the importance of knowledge transfer in organisations. A representative from an organisation that conducts construction projects mentioned that they had learned many valuable lessons from the problems and challenges connected to one of their earlier projects. The lessons were transformed as opportunities in the later project. Another respondent from an organisation that belongs to the same sector mentioned that they had used worst case scenario thinking (considering a kind of a financial disaster) as a method to come up with new understanding. This new understanding enabled them to tackle effectively the financial crisis that took place later.

## **7. Reflection and concluding remarks**

This paper is a part of one of the ongoing research studies related to the project “Practical management of uncertainty viewed from the perspective of project owner” – in short, PUS-project. The PUS-project itself is an innovative project that, among other things, aims at developing new methods and routines with respect to managing uncertainty in projects.

Through our studies, we have seen that there is more focus on threats than on opportunities, when it comes to managing uncertainty in projects. We have chosen to emphasize the focus on opportunities – the focus that the topic of opportunities in projects deserves.

The way we look at innovation in this paper is not about conducting a pure innovative project or a product development project. Instead, we look at the issue of managing uncertainty in projects as a point of departure and take into account innovative thinking and holistic understanding as significant elements that can be used to identify and create opportunities in projects. These opportunities can be materialized in the forms of, for instance, new work methods, new organisational relationships, new products and new services.

We adopted qualitative research method. The research instruments that we applied reflect semi-structured, group interviews (conducted in workshops that exclusively focused on the topic of opportunities in projects) and action research (in the form of uncertainty analyses in project organisations). The research method / research instruments that we applied have their limitations – possibly lack of extensiveness of the study. We did not study a particular project extensively as a complete case study, viewing it from different perspectives through all of its phases. Conducting such an extensive study can be future work that can shed more light on the topic of opportunities in projects. Number of participants at the workshops may also be considered as limited. However, we have to mention that the participants were actively involved and contributed to open and valuable discussions.

The focus on innovation with respect to projects and managing uncertainty in projects is a relevant theme for project management in the future.

There was a discussion at the 8<sup>th</sup> conference of the International Research Network of Organizing by Projects (INROP VIII) in Brighton in September 2007 regarding the issues of the future of projects and the link between projects and innovation. There was a paper published in the International Journal of Project management in this regard that deals with the need to focus on the chaotic reality and creative side of projects rather than limiting them to the narrowed frame of structure and discipline (Geraldi *et al.*, 2008). The paper also suggests and encourages “enhancement of maturity of project management as a research discipline to facilitate a more comprehensive contribution to the wider management field (*ibid*, page 588).

We believe that the topic of opportunity in projects can contribute to the wider management field. The focus on opportunities can influence creating an organisational culture that promotes innovation and creativity; uncertainty can thus be seen as a potential source of generating opportunities, not as a condition that exclusively deals with threats. The lessons and experiences of how uncertainty is managed in projects can be transferred / transformed in order to make positive effects on wider organisational settings.

The research network on Rethinking Project Management funded by the UK government’s funding agency Engineering and Physical Sciences Research Council (EPSRC) highlights the need for future research in project management in the following directions (Guest editorial, International Journal of Project Management, 2008, page 466):

1. From research on the lifecycle model of projects and project management to theories of complexity of project management
2. From projects as instrumental processes to project as social processes
3. From product creation as the prime focus to value creation as the prime focus
4. From narrow conceptualization to broader conceptualization of the projects
5. From practitioners as trained technicians to practitioners as reflective practitioners

The topic of opportunities in projects can be compared with each of these directions to certain degree. Our focus accepts the unpredictable, ambiguous and dynamic nature of projects that reflects complexity of project management. Dealing with uncertainty, sharing project experiences and finding and creating opportunities in projects is a social process (brainstorming, *etc.*). Considering 2<sup>nd</sup> and 3<sup>rd</sup> order consequences in addition to the 1<sup>st</sup> order consequences with respect to finding and creating opportunities in projects is more of a value creation process than of a mere product creation. Focusing adequately / equally on opportunities rather than mainly on threats in uncertainty management points out that this focus represents relatively a broader conceptualization of projects. Finding and creating opportunities requires establishing a holistic understanding of projects and engaging on reflection-on-action and reflection-in-action.

We do not claim that our paper covers all the major aspects of the topic of opportunities in projects. We try to present a framework within the scope of this paper, mentioning relevant theories coupled with empirical examples. Thus, we attempt to address the issues related to the aims of this paper, mentioned earlier in Introduction. Our major intention is to stimulate discussion on the topic that can lead to further development in both the theoretical and practical front.

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## **Nr 14 From Protective to Offensive Project Management**

## **From Protective to Offensive Project Management**

### **Abstract**

The project risk management focus on risk analysis at the front end loading. This is a protective strategy leading to higher cost estimates than necessary. An offensive strategy focusing on both opportunities and threats can be obtained by considering simultaneously the three dimensions of project risk (level of detail, time, and type of risk). Seven challenges in going from a protective to an offensive strategy is developed and discussed in relation to two cases. This shows a difference between current practice and literature findings. There are research opportunities in further studying the influence and the management of the strategic and contextual risks.

### **1 Introduction**

Large and complex projects often hit the attention of mass media. Unfortunately, the message conveyed is less focused on technical achievements. The media attention is usually caught because of cost or schedule overrun. This public attention creates a pressure to exactly forecast the cost of a project.

The cost of a project is a figure carrying uncertainty. No one can exactly predict what is going to happen in a project. Any project carries a risk. This is inherent in the dynamic nature of a project. Wysocki (1995) relates this to the cost-time-resources triangle and talks about scope, hope, effort and feature creep.

Fortunately there are numerous techniques available for assessing, analysing and managing risk, and project risk management is one of the nine key knowledge areas defined by the Project Management Institute in its standards (PMI 2004).

Risk management is included in every large and complex project, but at different levels and with different scope and ambitions. The project owner or sponsor wants to avoid a financial loss or deviation and is thus dependent on adequate risk analysis. The project manager is using risk management approaches to create awareness about uncertainty and risk and in this way control the project performance.

Managing risk should be part of any project planning and execution. However, it is mainly applied in development and construction projects and mainly for large projects (which can be seen from a study under development amongst a number of Norwegian projects). For smaller projects the consequences of unforeseen events and project development is smaller and easier to accept. However, in a professional project management world all projects should include project risk management.

Several authors have published risk management approaches (Chapman and Ward 2003, Gareis 2005, Hartman 2000, Kerzner 2002, Morris and Pinto 2004). The classical approach to project risk management normally contains 4 – 6 steps. PMI defines an approach using 6 processes (PMI 2004, p 237): Risk Management Planning; Risk Identification; Qualitative Risk Analysis; Quantitative Risk Analysis; Risk Response Planning; Risk Monitoring and Control. The underpinning idea is to identify risk factors, evaluate and analyse them and

finally try to manage them. The analysis may be purely qualitative or quite sophisticated quantitative.

The classic approach focuses on predicting as accurately as possible what is going to happen and tries to establish a kind of bandwidth within which one can expect project deviations. In this world front end engineering becomes important, and sophisticated tools for assessing and analysing risk are frequently applied. The focus on front end loading for assessing risk is supported by several authors (Hilson 2004, Samset 2001). We will refer to such an approach as “protective”. The purpose is to protect the owner from a financial loss by trying to predict the future. In the later years, there has been a stronger trend to consider opportunities arising from uncertainty in projects (Hilson 2004). One has started to distinguish between negative and positive risk. Hartman (2000) has developed a 2x2 matrix with risk and complexity on the two axes. He claims that traditional risk management deals with small risk and small complexity. If complexity is increased, there will be stronger focus on structure. If risk is increased, there will be stronger focus on flexibility. He also argues that the future project will be high risk and high complexity and that this will require an approach that he has called SMART (Strategically Managed, Aligned, Regenerative work environment, Transitional management). In our opinion, such projects will benefit from an offensive project management approach.

Seeking opportunities means that one may be moving away from the protective approach and taking a step towards a more “offensive” project management. This moves decisions points from front end towards the back end. For example a decision on some process equipment may be taken quite late in the project allowing the project to take advantage of technology development that might (or might not) happen during the project life. Freezing the decision on equipment at the front end stage gives predictability, but misses the opportunity of the upside created by the technological development. Some authors refer to such an approach as agile project management (Highsmith 2004).

We will discuss how improved risk management can contribute to a more offensive approach to managing projects. We will discuss applications in the light of three dimensions of project risk management, and we will define seven challenges in moving from protective to offensive approaches. They will be discussed related to two cases that we have chosen.

## 2 Definitions

Although uncertainty and risk are two different terms, there exists a great deal of confusion concerning this terminology. There are conflicting definitions found in different literature.

In this paper, *uncertainty* is defined as “*a state of having limited knowledge where it is impossible to exactly describe existing state or future outcome*” (Wikipedia 2008). There are other definitions focusing on more than one possible outcome or the gap between needed and available information (Torp and Karlsen 2007). Uncertainty is connected to an event. It may be a desired or a non-desired outcome of the event. Uncertainty can be expressed by the probability of the outcome (discrete) or as a probability density function (continuous).

The term *risk* is by PMI defined as “*an uncertain event or condition that, if it occurs, has a positive or negative effect on a project’s objectives*” (PMI 2004, p 373). Risk is usually

calculated as the probability of a desired outcome multiplied by the consequences if that outcome should occur. According to PMI's definition, risk can be both positive and negative. Often positive risk is referred to as "opportunity". Risk can mean the negative risk, but it can also mean both positive and negative risk (according to the PMI definition). This is confusing, and the authors will in this paper use risk as a term covering both negative and positive risk. Positive risk is referred to as "opportunity" and negative risk as "threat". Risk is thus a term covering both opportunities and threats

### 3 The Three Dimensions of Project Risk Management

Uncertainty, and consequently risk, follows the project throughout the life cycle. The uncertainty may vary over the time span of the project. Many authors claim that the uncertainty is largest at the front end, and then is gradually reduced towards the end of the project (Samset 2001). The main point is, however, that uncertainty and risk may vary over time.

Risk analyses may be made at different levels of detail. In some cases, it is sufficient to identify the major risk factors at an aggregate level and assess their impact. In other cases, it is necessary to break the project down to small work packages and perhaps do a Monte Carlo simulation to assess the risk.

Normally, when we talk about risk, we think about the operational risk. Operational risk connected to internal circumstances in the project and can be controlled by the project team. This may be resource variations, productivity, coordination, team spirit and culture, etc. Some authors also refer to this as tactical risk (Westney and Dodson 2008). These authors also introduce the term strategic risk. Strategic risk is the prospective impact on earnings or capital from adverse business decisions, improper implementation of decisions or lack of responsiveness to industry changes. It is beyond the control of the project team, but may be controlled by the project owner or sponsor. It is a function of the compatibility of an organisation's strategic goals, the business strategies developed, the resources deployed and the quality of the implementation.

In addition to operational and strategic risk, there is contextual risk. This is risk connected to circumstances outside the project that may influence the scope of work and the performance of the organisation. Examples are competing projects, change in ownership and management, legislation and governmental directives, media attention, extreme market conditions, accidents, etc. Contextual risk also includes black swans. A black swan meets three criteria: it is an outlier; it carries extreme impact; human nature makes us concoct explanations for its occurrence after the fact, making it seem explainable and predictable (Taleb 2007).

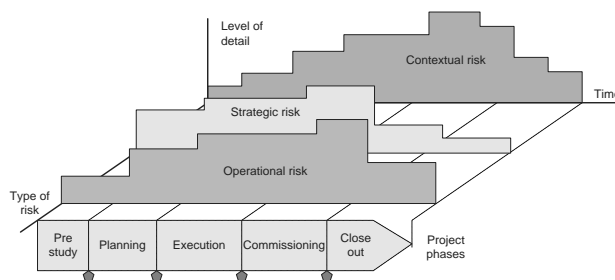


Exhibit 1 – The Three Dimensions of Project Risk

The time, the level of detail, and the type of risk constitute what the authors refer to as “the three dimensions of project risk”. This is illustrated in Exhibit 1. The authors will claim that most projects have a major focus on only one of the dimensions: the level of detail. Risk analysis is usually executed during the pre study or the planning phase (front end loading), but then it happens often that it is not maintained and managed over time. Most risk analysis is directed towards managing the operational risk. The contextual risk is often neglected. Offensive project management takes all three dimensions into account.

It is well accepted that risk vary over time. Most authors discuss operational risk and paint a picture where it is gradually reduced to zero as indicated by the blue field in Exhibit 2. We have also indicated the strategic and contextual risks. It is important to note that the strategic and contextual risks will have a residual value by the project end. This residual value can not be eliminated by a protective risk management strategy trying to predict the future.

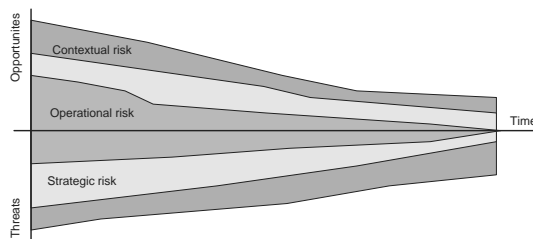


Exhibit 2 – Risk development over project life

In addition to the three dimensions, there are two different perspectives for risk in a project: the owner perspective and the contractor perspective. The owner has the overall responsibility for the project charter and for approval (at a high level) of design, approach and plans (Andersen 2005). The contractor is responsible for the execution of the project and the delivery of the project results. The relationship between the owner and the contractor is regulated through a contract comprising a contract format and a pricing format (Rolstadås 2006).

The owner and the contractor may carry different risk in a project. For example, the reliability and the performance of the contractor may be a risk on the owner’s hand, and the feasibility of the fabrication technology may be a risk on the contractor’s hand. The owner and contractor may also share risk in a project. This is typical for handling and compensation of variations dependant on the contract and the pricing format. Finally a risk on the hand of the owner may turn out to be an opportunity on the hand of the contractor. This is the case if for some reason, the owner must make substantial changes to the work scope, or if there are errors in the design provided to the contractor as part of the contract. In both cases, the contractor is in a strong position to negotiate time and cost compensation for this.

#### **4 Seven Challenges in Moving from Protective to Offensive Risk Management**

The discussion above shows that there is a major incompleteness in the way risk is managed. The typical strategy is protective trying to develop a robust plan and minimize risk exposure

and sensitivity at the front end. To move from a protective to an offensive management strategy, seven challenges can be defined:

1. *Include all the three types of risk.* In addition to operational risk, both strategic and contextual risk should be taken into account in identifying and analysing risks and opportunities. Failing to do so will probably result in under estimation such as described by Flyvbjerg (2003).
2. *Manage risk throughout the project life.* Risk analysis made during front end loading should be maintained and updated at all decision gates. Focusing on operational risk at front end will tend to give too high estimates.
3. *Go beyond the project perspective.* Risk analysis is most often made for the execution of the project and seen from the project manager's point of view. However, the owner also carries a risk which may part of the same risk as the contractor carries, but also may be different. A risk on the hand of a contractor may be an opportunity on the hand of the owner, and vice versa. This is also true for other stakeholders in the project than the owner and the project organisation.
4. *Use risk management to capitalise on opportunities.* Often risk analysis is focused only on negative risk. Empirical evidence for this has been published by Olsson (2007). Moving to offensive risk management strategies, involves focus on the opportunities and using their uncertainty for improving the project delivery.
5. *Avoid risk averse strategies from the project organisation.* Whereas the project may be established for a complex task, one may find that the project organisation may try to maximize its benefits by focusing on close out in order to reduce risk and make success.
6. *Place decision points as late as possible.* Late decisions open opportunities for benefiting from development during project execution. It may increase risk, and it requires that the project team members can enjoy the necessary trust. The tight control regime has to be broken.
7. *Develop project risk maturity in the organisation.* There has been much focus on organisational project maturity (PMI 2003, Shenhar and Stefanovic 2006). Risk management is of course included in such models. The authors will, however, argue that risk needs additional attention, and that it should be supported by special competence development programs.

These challenges correspond to a set of six dilemmas published by Langlo, Johansen and Olsson (2007):

1. Some uncertainties can be treated as a risk by a project organisation, while the same uncertainties can be treated as opportunities by the project owner. (This dilemma corresponds to challenge 3).
2. While a line organisation often initiate a project master a more complex environment or situation than normal, the project organisation itself often use a close out strategy to minimise risk. (This dilemma corresponds to challenge 5).
3. Tangible project uncertainty is prone to underestimation. (This dilemma corresponds to challenge 1).
4. In order to maximise chances to be perceived as successful, it will in the early phase often actively work to widen its financial frames and to obscure its goals. (This dilemma corresponds to challenge 4).

5. In order to maximise benefit or return on investment in a life cycle perspective, you need to understand the project and its complexity in both totality and detail. (This dilemma corresponds to challenge 2).
6. When intervening in a project uncertainty management, there is a potential danger for a project owner to take over the responsibility of the project manager. (This dilemma corresponds to challenge 3).

## 5 Case Descriptions

Two cases have been selected to verify these seven challenges. We now describe these two cases. In the next section, we will discuss how they relate to the challenges.

The first case is the construction of a new university hospital in Trondheim, Norway (St. Olavs Hospital). Plans for this were made in 1991 and approved by the Norwegian Parliament in 1993. In 2002 the parliament decided to build the hospital at its current location. The first phase, consisting of four centres (90.000 m<sup>2</sup>), was completed in 2006. Phase 2, consisting of six centres is scheduled for completion in 2013/2014.

The project organisation early understood the complexity of the project. One could not construct a future-oriented agglomeration of buildings on the location of an existing hospital, without influencing the operation and effectiveness of the old hospital. It was in fact at least three separate projects: construction of the ten centres, implementation of the ICT systems, and integration of the ten centres. The risk management had to reflect this complexity.

An iterative approach was decided, splitting the project into two phases with smaller contracts rather than larger EPC contracts. An interaction based contract model was implemented. In phase 1, the contracts were successively awarded building on experience from previous contracts. Uncertainty analyses were carried out for each contract, and control limits and schedule/cost contingencies defined at contract, project, and management levels. These limits and contingencies allowed each organisational level to utilize opportunities and handle threats as emerged. Phase 2 was run as an interaction for the five centres using a contractor/operator model. Risk management training has been given throughout the planning and construction phases.

This approach has allowed the project to use time as a flexible cost saving variable. The contract model has enabled successive planning of each contract, drawing on experience and updated information. Had EPC contracts been used, the opportunities to make adjustments as the project evolved would have been reduced. The model allows flexibility, but also carries higher risk.

The second case is the construction of a new building block for the Norwegian government in Oslo, Norway. The government is extending its office area, and has decided to erect three new buildings for new offices for two ministries. One building will be demolished and replaced, one has antiquarian value and will be renovated, and the third is to be partially renovated. The construction area is situated in a sensitive agglomeration of buildings, thus involving a number of stakeholders with strong interests to negative consequences of the new building and the reconstruction. The project started its preparations in 2006. The Directorate of Public Construction and Property (Statsbygg) is responsible for execution of the project.

Total cost is estimated to 870 mill. NOK.

Risk management for this project started different from traditional projects at Statsbygg since it is very complex and challenging. Political influence is strong, as the Government has an interest in co-localizing of the two ministries. The co-localization is vulnerable to changes in government, and completion of the building is therefore of political importance. The project decided to bring in all stakeholders as early as possible in the process of defining needs, goals and specifications. First, all stakeholders contributed in creating a stakeholder map and defining their requirements and expectations. Then they developed a layer to the map showing the influence of each stakeholder at different phases and milestones along the timeline. In this manner each stakeholder obtained an understanding of the other stakeholders' requirements. In this way the project created ownership and a positive attitude within and between the stakeholders. They learnt to see the opportunities that the project will open. So far, this has proved to be a solid foundation for further progress.

A process for managing risk witch has been developed. This includes weekly monitoring of the operational risk and biannually evaluation of the strategic and contextual risks. The cost and schedule uncertainty is reassessed every year. The tools applied for managing risk includes an uncertainty log (intranet based bulletin board where goals, opportunities and threats are updated continuously) and monthly risk reports at the same level as schedule and cost reports.

## 6 Discussion and Conclusions

In the listing below, we have shown how the seven challenges have been addressed in the two cases. Exhibit 3 shows to which degree they have been successfully managed. We have used a scale from 1 to 5 where 1 represents "not at all" and 5 represents "very well".

1. *Include all the three types of risk.*
  - *St. Olavs Hospital.* there was a strong focus on operational risk in the monthly progress reports. Strategic and contextual risks were discussed in the biannual reports and in connection with the annual budget updates.
  - *Government building block.* The operational and contextual risk was focused at front end risk analysis. Strategic risk has been handled by the internal owner in Statsbygg.
2. *Manage risk throughout the project life.* Risk has been actively addressed throughout the project life for both projects.
3. *Go beyond the project perspective.*
  - *St. Olavs Hospital.* LCC analysis has been used to decide on effective operational solutions.
  - *Government building block.* Stakeholder management and risk management have been integrated into one system. This has promoted cooperation strategies and enabled forms for managing risk.
4. *Use risk management to capitalise on opportunities.*
  - *St. Olavs Hospital.* A number of seminars focusing on opportunities and coordination throughout phase 1. An experience transfer seminar has been held in going from phase 1 to phase 2.
  - *Government building block.* Opportunities have been focused from day 1.



5. *Avoid risk averse strategies from the project organisation.*
  - *St. Olavs Hospital.* The organisation tried to lock the project to one location. This created problems when the Government later decided to explore alternative locations.
  - *Government building block.* The project has decided to communicate a 35/65 probability estimate and at the same time focused an open process towards the owner. This has prevented risk averse strategies.
6. *Place decision points as late as possible.*
  - *St. Olavs Hospital.* This has been obtained through the successive construction program.
  - *Government building block.* The Norwegian Quality Regime focusing on detailed risk analysis at front end has partly prohibited this.
7. *Develop project risk maturity in the organisation.*
  - *St. Olavs Hospital.* There has been extensive training and risk management has been implemented at all levels.
  - *Government building block.* The project is a pilot in a risk management development project.

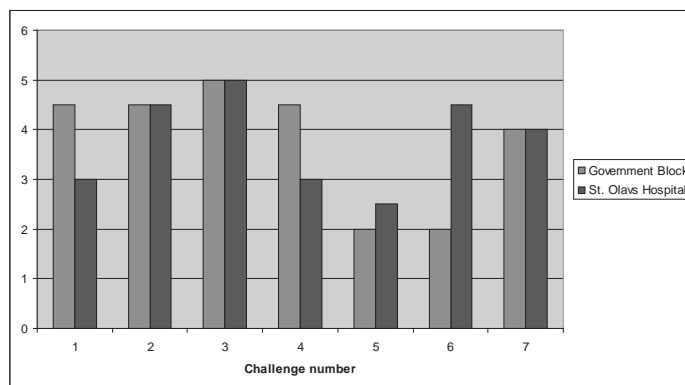


Exhibit 3 – Degree of Success in Managing Challenges (1=Low, 5=High)

The discussion above shows that current industrial practice deviates somewhat from what is published in recognised project risk management literature. Current practice shows that many of the challenges found from studying state of the art literature, has been partly met in real life. Of course, it is premature to draw reliable conclusions based on two cases. However, they serve well as indications. Only the challenge of avoiding risk averse strategies has not been well met.

Based on this, we see the research opportunities in further studying the influence and the management of the strategic and contextual risks and in developing guidelines for setting the reference frame and capitalizing on opportunities.

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**Nr 15 Who owns a project? - (extended version)**

## **WHO OWNS A PROJECT?**

### **Abstract**

The purpose of this paper is to discuss ownership in a project perspective, and to illustrate different aspects of ownership in a set of selected cases. Owners are defined as stakeholders who have both control and responsibility for cost and income related to a project. Results from our study indicate that owner responsibilities are not always concentrated to one individual stakeholder in a project. While a traditional owner can be identified for some projects, it is a more complex picture in many other projects. In particular, this is the case for governmental projects. The research is based on a case study of owner structures in 11 projects from both the private and public sectors. For each case, an analysis was made of which stakeholder that held six different roles related to project ownership. Multiple sources of information are used in the research, including archives, interviews and observations.

### **Keywords**

Project Management; Ownership, Stakeholders, Governance

## **1 Introduction**

Project owners are in a special situation. In general, owners have both control and responsibility for cost and income related to a project. However, the background for this paper is that our experience indicates that this type of “pure” ownership of projects is less clear for many projects. While a traditional owner can be identified for some projects, it is a more complex picture in many other projects. The purpose of this paper is to discuss ownership in a project perspective, and illustrate different aspects of ownership in a set of selected cases.

### **Project actors and roles**

Project stakeholders are actively involved in a project, or their interests may be positively or negatively affected by a project. PMI (2000) defines stakeholders as individuals and organizations who are actively involved in the project, or whose interests may be positively or negatively affected as a result of project implementation or successful project completion. According to McElroy & Mills (2000), project stakeholders are persons or groups of people who have a vested interest in the success of a project and the environment within which the project operates. In a study of large engineering projects, Olander & Landin (2005) found that it is important for a project management team to identify stakeholders that can affect a project, and then manage their differing demands throughout the project stages. Mikkelsen and Riis (2003) point out that stakeholder analysis is not based on a democratic process to ensure equal rights or equal representation to all stakeholders. On the contrary, it could be said to be a process describing the project’s position in a political field of force between stakeholders with conflicting and congruent interests.

### **Project owner**

Simply put, ownership gives control and responsibility. In economic terms, ownership gives residual control rights, and residual profit responsibility (Foss and Foss, 1999). Control rights give the owner full right of use, possession and disposal of a resource. Within the legal framework, an owner does not need to be accountable to anyone else (Hart, 1995). Profit responsibility means that the owner is responsible both the cost and income related to the resource. That these rights are residual means that the owner can lease out or in other ways delegate the authority of the owned resource to others (Grünfeldt and Jakobsen 2006).

A project owner bears the owner rights and responsibilities of the project (Eikeland 2001). According to Eikeland (2001), it is the project owner that takes the risk related to the cost and future value of the project. Both these risks can to a certain extent be transferred to other actors in the project. Samsøe (2003) uses the term financing party in a meaning similar to project owner. According to Samsøe (2003), financing parties, or owners, have, as a rule, their main interest first and foremost linked to the long-term effect of the project.

### **Users**

The users of a project delivery can be described using a wide or a narrow definition. In the wide definition, users include everybody who uses the result of the project (the building, hospital, railway line etc.). During the project preparation and execution, users are not easily identified. This means that projects usually interacts with user representatives, who acts on

behalf of those who intend to use the result of the project. In a narrow definition, “users” mean the user representatives. These user representatives are not necessarily representative of the average user during the lifetime of the final product of the project. There can also be different layers of users, and a distinction can be made between primary and secondary users. Primary users are usually professional users of a project's delivery, such as the personnel working in a new building (hospital, office etc) or the train operators on a new railway line. Secondary users are the customers of these professional users, such as patients in a hospital or passengers on a train running on the new tracks. A distinction between primary and secondary users can be clear, and important for an analysis of project stakeholder.

### **Project manager**

In a project, many people will call themselves “project manager”, usually meaning that they are project managers of their organization's part of the project. However, the project manager acting on behalf of the project owner is responsible for the overall management of a project (Eikeland, 2001).

### **Governance and accountability**

According to Stame (2006) governance is related to 'the process of governing', in contrast to the 'institution of government'. Samset, Berg and Klakegg (2006) describe 'governance regimes' as the processes and systems that need to be in place on behalf of the financing party to ensure successful investments. The term 'Good governance' and 'Governance' can be used in the same meaning (Grünfeldt and Jakobsen, 2006). In more general terms, governance deals with the processes and systems by which an organization or a society operates. Kaufmann and Vicente (2005) relate governance to the traditions and institutions by which authority is exercised for the common good. Corporate governance is the set of processes and policies affecting the way a corporation is directed, administered or controlled (New York Society of Securities Analysts, 2003). Corporate governance also includes the relationships among stakeholders, including shareholders, top management and the board of directors, but also employees, suppliers, customers and regulators, among others. An important theme of corporate governance deals with mechanisms to ensure good behaviour and protect shareholders' interests. Corporate governance codes have been developed in different countries. Compliance with these governance recommendations is generally not mandated by law, although the codes linked to stock exchange listing, as is the case for the Oslo Stock Exchange. Listed companies have to practice corporate governance in accordance to the Norwegian Code of Practice for Corporate Governance (Norsk Utvalg for Eierstyring og Selskapsledelse, 2006). In other countries, companies may not need to follow the recommendations of their respective national codes, but they must disclose whether they follow the recommendations in those documents or not. In a project context, APM defines governance of project management as 'Governance of project management (GoPM) concerns those areas of corporate governance that are specifically related to project activities. Effective governance of project management ensures that an organisation's project portfolio is aligned to the organisation's objectives, is delivered efficiently and is sustainable.' (APM, 2007:4). The APM definition aims at the relation between an organisation and the projects carried out by the organisation. Governance then means to ensure that the projects are carried out in accordance with the overall objectives of the organisation.

Accountability can be used synonymously with such concepts as answerability, responsibility and liability. As an aspect of governance, accountability has been central in discussions related to problems in both a public and business context. Accountability is frequently seen as an important means of achieving governance. In Britain, accountability has been formally identified by Government since 1995 as one of the Seven Principles of Public Life (Committee on Standards in Public Life, 1995). Hardie (2005) and Vedung (1998) argues that an ambition to achieve accountability by openness and transparency, fits well with the rationalist view of deciding, but fits badly with what he claims to be the reality of good decisions. Flyvbjerg et al. (2003) argues that involvement of private capital in public investments can serve as a tool for accountability. Their idea is that private ownership gives incentives for scrutiny of a project in a way that contributes to realistic estimates of future cost and revenue from the project.

In both the public and private sectors, a key issue related to governance is that an executing stakeholder does not necessarily have the same incentives as owners who finance the endeavour. In a company, the managing director can be seen as the executing actor, while for public projects, it is often an agency or a project manager. As a summary, governance is seen as initiatives originating at owner level (including mechanisms for accountability), while accountability in practice is represented by justification of decisions, information etc flowing from the executing level to owners. This is illustrated in Figure 1.

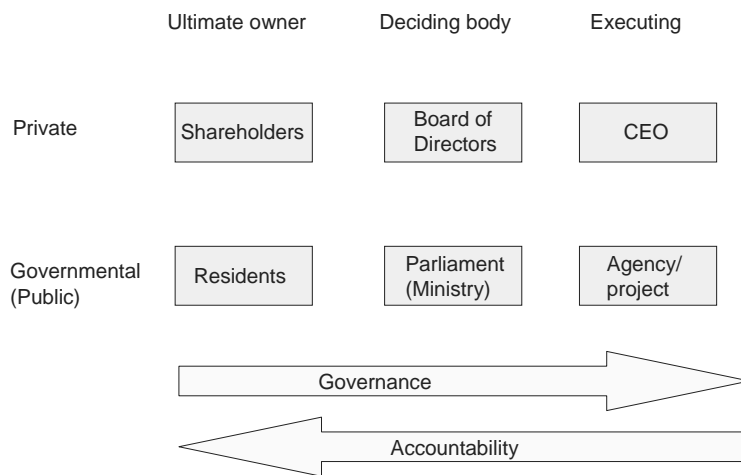


Figure 1 Governance and accountability

## 2 Why focus on owners?

As Grünfeldt and Jakobsen (2006) points out, the combination of control, along with the responsibility for both cost and income from the owned resource, put owners in a special position. A stakeholder who both has control and profit responsibility has incentives to maximise the value creation related to the resource. If a stakeholder has control, but no result responsibility, there is a danger that the control might be used to fulfil own interests. Similarly, to have ultimate responsibility but no control is a demanding situation. The beauty behind the concept of a project owner lies in the fact that a project owner has incentives for weighing costs against benefits for a project. Project owners are therefore expected to strive for project governance aimed at maximising the value from the project.

## 3 Methodology

This study is a case study based on trailing research (Finne et al. 1995). In the terminology of Yin (2003), this is a multi case study. Separate sets of research material have been used, particularly a combination of personal qualitative experience and quantitative decision support information. Multiple sources of information are used, including archives, interviews and observations. The data is not formally analysed in a statistical way. The applied research design was chosen in order to illustrate variations between the projects. In order to analyze the information related to the projects, codified data was entered into a database.

Table 1 Summary of studied projects. N=11. 8 NOK= 1 Euro

Sector	Type of projects	Studied projects	Number of projects	Size of projects
Private	Ship building	New buildings	2	About 700-800 mill NOK per ship
	Offshore oil and gas development	Ormen Lange	1	60 billion NOK
	New product development	New product	1	Confidential
Governmental	Internal change	ISO 9000 system	1	Estimated to about one-man year
	Public building	New Opera building in Oslo	1	4 billion NOK
	Railway	Gardermobanen Asker-Sandvika	2	3-6 billion NOK
	Road	E6 Østfold	1	2,1 billion NOK
Public Private Partnership	PPP Road	E39	1	1,5 billion NOK
Health	Hospital	St. Olavs	1	11,5 billion NOK (Des 04)

The authors have been personally involved in many of the analysed projects. This has benefits, but also calls for special attention. Due to the large size of the projects in question, the actual research and its results have most probably had little impact on the outcome of the projects, in contrast to what is the situation in action research, where the researchers have a stronger influence on the events that are studied and results from the research are fed back into the projects.



### **Variables - studied stakeholders**

To structure our experiences from such a wide range of projects, a set of key variables were established. The research has focused on which stakeholder that held different aspects of project ownership. For each project or type of projects, the actor filling the following six roles were identified.

### **Responsible for financing**

This is the stakeholder which was responsible for providing funds to the project, either using own funds or to coordinate the financing from different sources.

### **Ultimate owner of responsible financier**

The ultimate owners are legal owners of the stakeholder which is responsible for financing. Ultimate owners can be shareholders in a company. The inhabitants in the country are chosen as ultimate owners of governmental projects. There are also other types of ownership, including limited liability partnerships, which is a common way of organising consultancies and legal advisory, self-owning foundations or non-governmental organisations. However, different aspects of ownership in our studied projects are mainly related to either commercial actors, with shareholders as ultimate owners, or public projects with the country's inhabitants as ultimate owners. Many project included both of these actors.

### **Project management**

Project management is not traditionally seen as a candidate for project ownership. Vaagaasar (2006) has followed one specific project in public sector over a prolonged period of time, and has observed that the project actively tries to influence its surroundings and its owners through building relations and by developing and following a strategy of communication and proactive interaction. Responsibility for project management was included in the analysis because it adds important information about the project structure.

### **Responsible for operation of project delivery**

Operation of project delivery indicates which stakeholder that will operate the delivery of a project. This means responsibility for facilities management, maintenance etc. Note that this role is related to operation of infrastructure, which can be different from the value generating activity that utilises the infrastructure.

### **Responsible for value generating activity of project delivery**

These are the stakeholders that represent the value generating activity that utilises the project delivery. These stakeholders may also be referred to as users, and most frequently what was previously termed primary users.

### **Deciding body**

Formal decision to go ahead with a project is made by what has been called deciding body. This can be the board of directors for a company making a major investment, or the parliament for major governmental investments.

## Studied cases

In the following, we present the studied cases, with main focus on the strategic perspective of the projects. In the following section, we summarise key aspects of project ownership in the presented cases.

## Ship building

Generally, ship owners refer to owners of commercial ships. In this connection, ship owner refers to a commercial organisation, rather than an individual. Ship owners equip and exploit ships, usually for delivering cargo at a certain freight rate. Our experiences are based on new-building of tank ships. For commercial reasons, the involved parties are not mentioned by name.

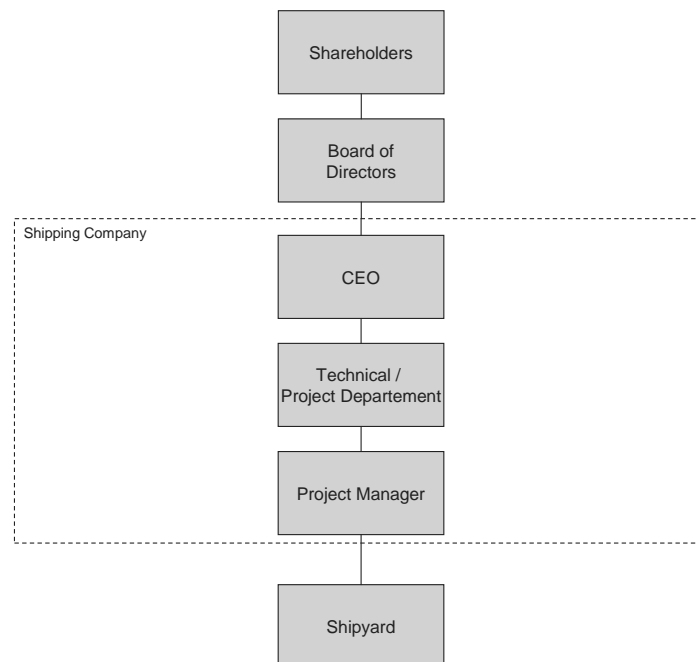


Figure 2 General organisation of a Ship building project in from a ship owner perspective

Ship building project typically consists of an established set of stakeholders. The new buildings were decided upon by a commercial company, referred to as the ship owner. The ship owner was also responsible for financing of the project, which involved financing institutions. Shipbuilding takes place in a shipyard. Shipbuilding encompasses the shipyards, the marine equipment manufacturers and a large number of service and knowledge providers. The ship owner we have studied had their own technical staff, which supervised the construction on site at the yard. Ships can be ordered on speculation, based on an expected demand for transport, or based on established transportation contracts that secure incomes for the ordered ships. As in our cases, commercial details about expected revenues are not publicly available.

### Off-shore – The complexity of Ormen Lange/Langeled

Ormen Lange/Langeled is one of the largest offshore projects in Norway, with a budget of more than 60 billion NOK. The project includes an offshore sub sea production facility, an onshore processing plant, pipelines bringing unprocessed oil and gas to the onshore processing facility and returning well fluid and waste back to the wells, and finally, an export pipeline to Easington, England. When working on full capacity, Ormen Lange/Langeled will provide 20 % of UK demand for gas. The project is complex due to both ownership structure, degree of technological innovation and the large number of organisations involved (more than 3000). Figure 3 illustrates how the project is organised on the executive level.

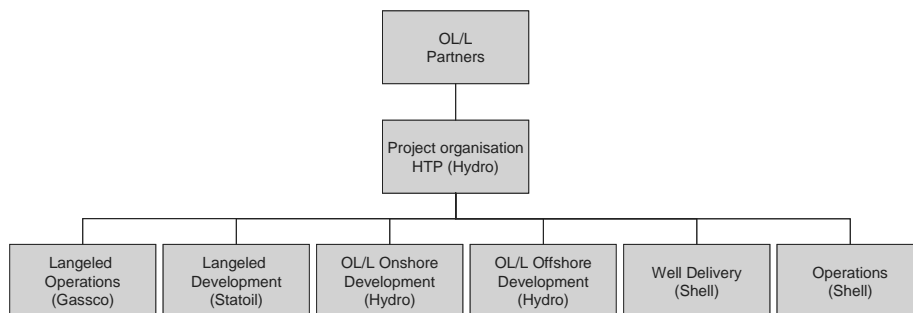


Figure3 Organisation chart for a complex offshore project (project perspective)

Ormen Lange partners include Hydro, Statoil, Shell, Petoro, DONG Energy and ExxonMobil. The Langeled joint venture includes Ormen Lange partners, Gassco and ConnocoPhillips. Hydro was awarded the responsibility for overall construction and development, while Shell was awarded with operation of offshore and onshore facilities. Statoil was awarded with construction of Langeled, while operation of Langeled was awarded to Gassco.

### ISO 9000 certification and new product development

We have studied two internal projects in an industrial company producing ships equipment. The first project was aimed at an ISO 9001 certification of the company. This was run as an internal project, utilising own resources. The quality assurance manager was project manager. The management group, consisting of all department managers and the CEO, acted in effect as steering committee for the project.

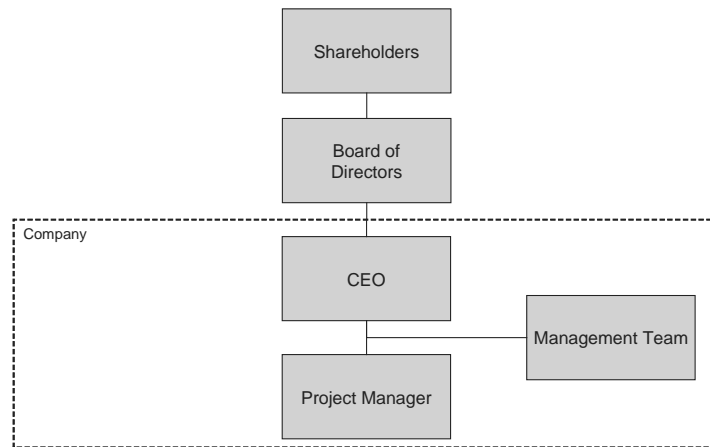


Figure 4 General organisation of the ISO 9000 and product development projects

The second project in the company was a product development project. This was also run as an internal project, utilising own resources. The research and development manager was project manager. Due to the importance of the project, the board of directors acted in effect as steering committee for this project.

### **New Opera house**

A new opera house is under construction in the Norwegian capital, Oslo. It will be located in the harbour area at the waterfront, and many see the new opera house as a new landmark for Oslo. The opera is located in a previously neglected part of central Oslo, and many see the new opera as a vitamin injection to trigger a wider urban development scene. For decades the area has been typified by harbour activities, heavy traffic and extensive railway activities. The project has therefore become part of a long time discussion regarding the use of Oslo's harbour areas. The planned finished for the project is 12 April 2008 and with a budgeted upper cost limit of 4.0 billion NOK (2006 value).

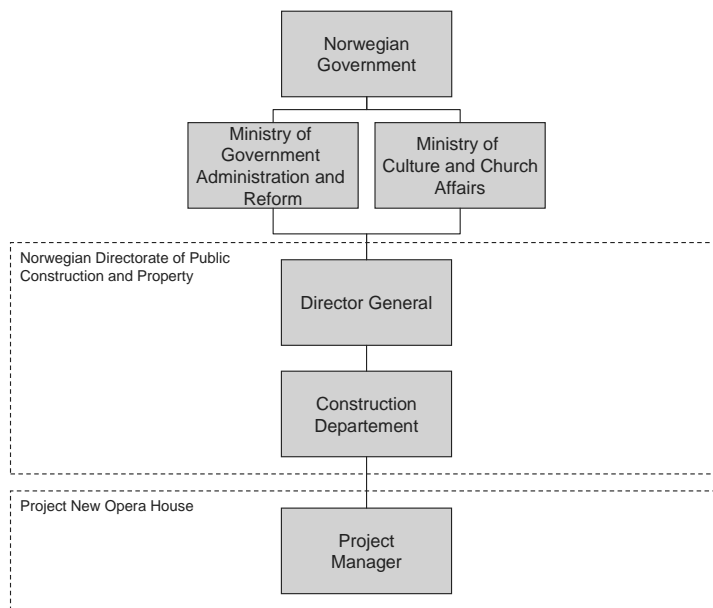


Figure 4 General organisation of the New Opera project

Statsbygg – *The Directorate of Public Construction and Property* acts on behalf of the Norwegian government as manager and advisor in construction and property affairs. As shown by Figure 4 Statsbygg is responsible for the planning and construction works for The New Opera House on behalf of The Ministry of Cultural and Church Affairs. Statsbygg is an administrative body, responsible to the Ministry of Labour and Government Administration.

### Railways – Gardermobanen

Our first railway case comes from the establishing of Oslo’s new airport Gardermoen, Gardermobanen (the Airport Express Train). The airport opened in 1998, and the complete railway line was taken into use during the following year.

The Norwegian State Railways (NSB) was split into the train operator NSB BA (now NSB AS), the Norwegian Railway Inspectorate and the Norwegian National Rail Administration in 1996. A basis for the decision to build Gardermobanen was that the revenue from the train passengers should cover both infrastructure and rolling stock investments as well as the cost of operation. As shown by later developments and one of the evaluations of the project (NOU 1999:28) this was not realistic.

Project management lay in a company, NSB Gardermobanen AS, owned by the state through NSB. The users of this project are the train operators and the travellers. Both project management as well as the primary important users - train operators - reported to the ministry of transportation. Figure 5 shows the organization of the Gardermoen project.

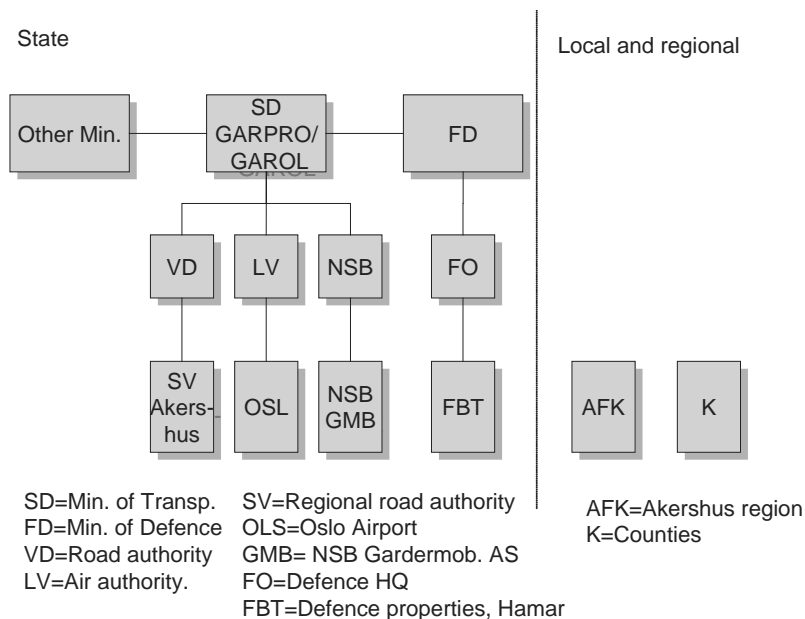


Figure 5. Organisation of the Gardermoen project. <sup>6</sup>

### Railways – Asker-Sandvika

The new double track between Asker and Sandvika was finished in 2005. The project budget was 4065 million NOK. The new double track section is the first part of a planned new double track to the west of Oslo, and comes in addition to the existing double track. Existing tracks are highly utilised especially in rush hours, and a capacity increase was necessary (Stortingsproposisjon nr. 1 2002-2003). The new double track will improve capacity in the network, reduce travel time and improve comfort. Construction work of the whole double track is to be completed by 2011 (Oslopakke 2, 2006).

The project is a part of Oslopakke 2. In 2001 local and national authorities approved the financing principles and economic framework for what is called Oslopakke 2. Oslopakke 2 is a plan for new and upgraded infrastructure and rolling stock for public transport in Oslo and Akershus (Oslopakke 2, 2006).

Oslopakke 2 is a financial plan for new and upgraded infrastructure and rolling stock for public transport in Oslo and Akershus. 71 % of the investment will be financed over the National Budget (Rail Infrastructure and Road Infrastructure), 5 % will be financed over Oslo's budget, 3 % will be financed by property developers and finally 21 % will be financed by payments from transport and road users. As shown in Figure , the project is organised in the infrastructure construction department of the Norwegian National Rail Administration. Prior to 1996, the infrastructure administration and construction of new lines, was in the same

<sup>6</sup> GAROL was the coordinating body for the project within the ministry of transportation during the planning phase. The same coordinating body was called GARPRO during the construction phase. Based on NOU 1999:28.

organization as the train operation. After 1996 the railway infrastructure has become a separate governmental agency.

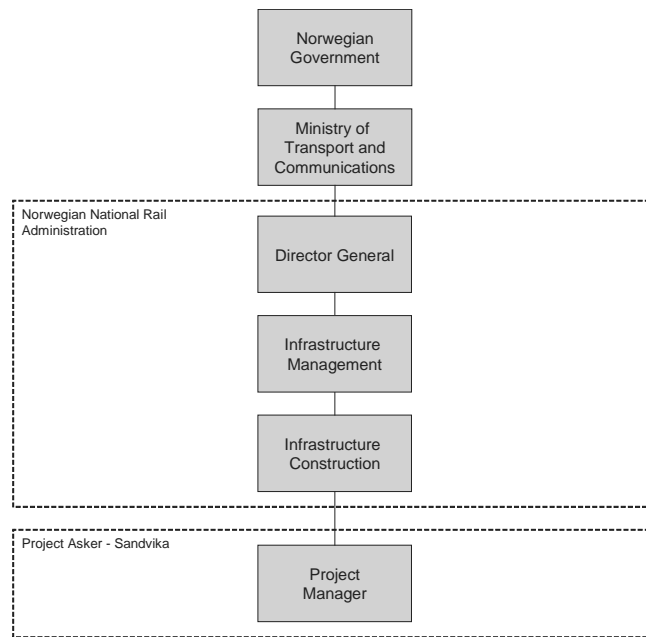


Figure 6 General organisation of the Asker-Sandvika project

### Road project – E6 Østfold

E6 is one of the main roads in Norway, bringing road-users from the Swedish boarder at Svinesund in the south all the way to Kirkenes in the most northern part of Norway. The project E6 Østfold is one of the largest road construction projects in Norway. It is a part of an ongoing upgrading of the main roads in Østfold County from Oslo to Svinesund. The output of project E6 Østfold is approximately 33 km of four lane highway. The construction is scheduled to be completed in 2009. The budgeted upper cost limit is approximately 2.1 billion NOK (2006).

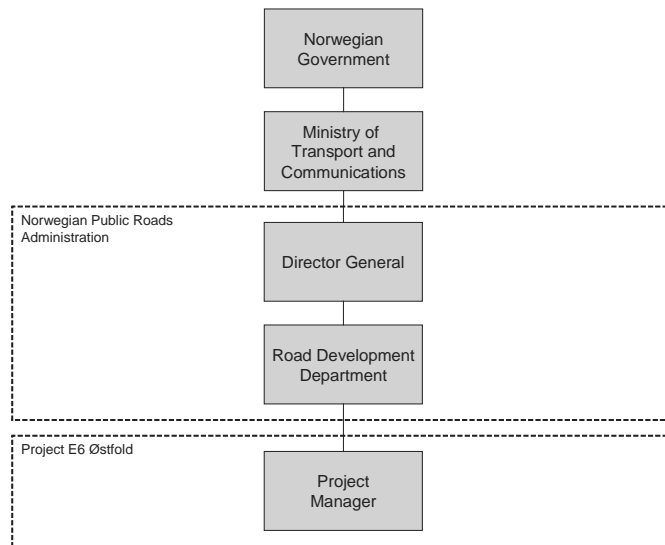


Figure 7 General organisation of the E6 project

The Norwegian Public Roads Administration (NPRA) is responsible for planning, construction and operation of the national and county road networks. NPRA usually use multiple prime contracts which mean that several contractors are competitively appointed to execute the work (Lædre et al, 2006). Figure 7 shows the general organisation of the project we have studied.

### Road projects PPP - Public Private Partnership

In Norway, the E39 Klett-Bårdshaug was the first of a total of three PPP pilot projects to be carried out in the period from 2002 to 2008. KPMG (2003) defines PPP as a 'public service that is developed (planning and executing) and provided from a private company (or together with public company) with joint risk between the public and the private company'. Koch and Buser (2006) points out that a PPP can be seen as a network, because PPPs usually involve a range of public and private stakeholders.



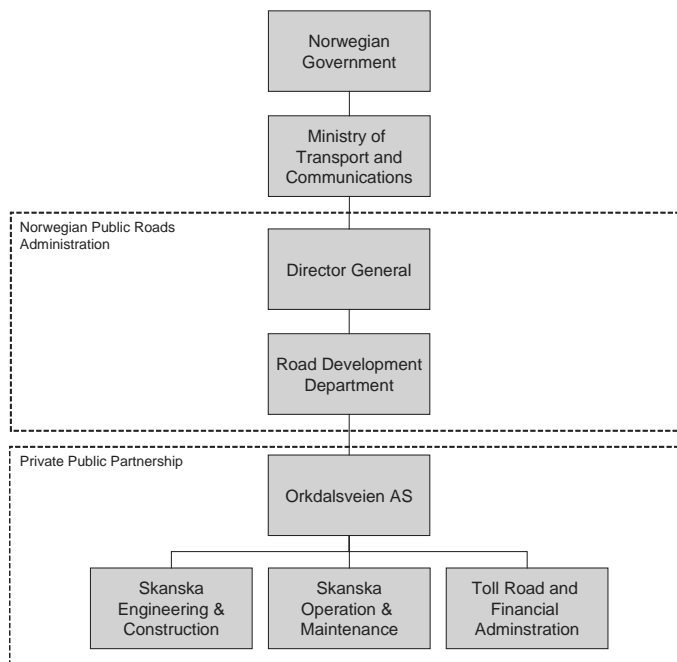


Figure 8 General organisation of the E39 project

The highway E39 between Klett and Bårdshaug is a part of the Norwegian network of European Highways and was finalized in June, 2005. The general organisation of the E39 project is shown in Figure . In addition to direct funding over the state budget, road toll will be collected, probably until the year 2017 (Orkdalsvegen 2006). Orkdalsvegen AS is a private company, owned 50 per cent by Skanska AB and 50 per cent by Laing Roads Ltd. The company acts as the client for the project and is in charge of, the total development, design and construction, financing as well as operation and maintenance till 2030. At the expiration of the contract in 2030 the highway will be returned to the public. An inter-municipal road toll company, independent of the development project, will collect the road toll. The Public Roads Administration (PRA) has been in charge of primary planning of the E39 highway project as well as the land acquisition. This work started in 1996. During construction the Public Roads Administration monitored the PPP contract and will continue this during the operational phase to ensure that the highway is delivered to the road user according to agreement.

### Hospitals – St Olavs

Plan for a new university hospital in Trondheim was made in 1991, which was approved by the Norwegian Parliament in 1993. To begin with, the project was organised under the local county, but a major part of the financing was to be supplied by the government. In 2002 the parliament decided to build the university hospital at its current location based on the plans for Phase 1 of the building programme. The first phase of the construction of the new hospital in Trondheim, consisting of four centres making a total of app. 90 000 m<sup>2</sup>, was completed on August 6th 2006. Phase 2, consisting of six centres is planned for completion in 2011/2012. Figure 9 shows the organisation of the project.

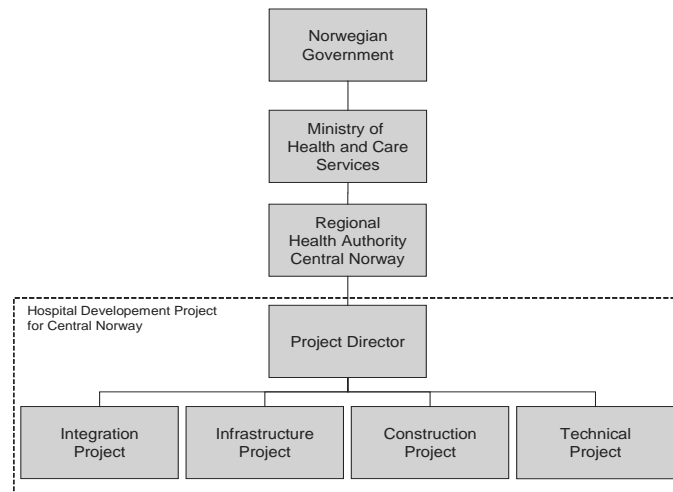


Figure 9. General organisation of the St Olavs project

The responsibility for providing health care services is delegated from the Ministry to five regional health authorities. In the case of St. Olavs hospital, it is the Central Regional Health Authority which is responsible for operation of the future hospital. A temporary public organisation called Hospital Development Project for Central Norway is responsible for construction of the hospital on behalf of the Central Regional Health Authority. The construction of St. Olavs hospital is complex, not only due to the construction of ten different medical centres, but also due to the fact that these centres should operate as one integrated and effective organisation in the future. The project actually consists of four main projects; construction of the centres, development of infrastructure, implementation of new technology, and integration of human resources, organisations, infrastructure and new technology.

#### 4 Summary of results

For each case we have made an analysis of which actor or stakeholder who holds the six different roles described previously in this paper. In order to compare the different cases and their business sectors, a summary showing selected ownership aspects of the studied projects is presented in Table2.

Sector	Type of project	Responsible for financing	Ultimate owner of responsible financier	Project management	Responsible for operation of project delivery	Responsible for value generating activity of project delivery	Deciding body
<b>Private</b>	Ship building	Company (Ship owner)	Shareholders	Supplier (Yard)	Company (Ship owner)	Company (ship owner)	Directors
	Offshore oil and gas development	Block owners (Oil and gas companies and government)	Shareholders and residents	Project organisation	One of the block owners	Block owners	Parliament and directors of block owners
	New product development	Company	Shareholders	Company	Company	Company	Directors
	Internal change (ISO 9000 system)	Company	Shareholders	Company	Company	Company	CEO
<b>Governmental</b>	Public building (New Opera House)	Ministry of culture	Residents	Directorate of Public Construction and Property	Directorate of Public Construction and Property	Norwegian National Opera	Parliament
	Railway	Ministry of transport	Residents	Own company/ Railway Authority Project Division	Railway Authority Region	Train operators	Parliament
	Road	Ministry of transport	Residents	Road Authority Project Division	Road Authority Region	Users, private and corporate	Parliament
	Hospital	Regional Health Care Authorities	Residents	Project organisation	Regional Health Care Authorities	Hospital	Directors
<b>Public Private Partnership</b>	PPP Road	Consortium	Shareholders	Project organisation	Consortium	Users, private and corporate	Parliament

Table2. Different aspects of project ownership in the studied projects

### **Characteristics of project ownership in private sector**

In the studied shipping and company internal projects, project ownership is relatively concentrated to one project actor. A ship owner is typically responsible for financing, operation of the delivered ship as well as both costs and income related to the ship. Note that the daily operation of ships can be outsourced and actual ownership can be hidden by a network of legal manoeuvres. In our studied ship building cases, the ship owner organisation has all the traditional characteristics of an owner. The ship yards had a contractor role, responsible for the delivery of ship, but no involvement in the operation. For internal projects, control and responsibility lie within the organisation in question. In particular, we studied one internal change project and one product development project. Both projects had department managers as project manager. Project ownership can still be an issue, but on an interorganizational level.

The Ormen Lange offshore project illustrates that projects in private sector can have a complex owner structure as well. In one perspective, one could say that the Norwegian government is the owner. Norwegian interests are handled through Petoro, which is the major shareholder in both the gas field and the export pipeline. In another perspective, the partners in Ormen Lange/Langed could be considered to be the owner(s). They will share the future profit of the gas production in accordance with the share they hold in both the gas field and the pipeline. In a third perspective, Shell Operations could be considered to be the owner, as they are responsible for efficient and reliable gas production, thus being responsible for actually providing and maximising the profit.

### **Characteristics of project ownership in public sector**

Project ownership was found to have nuances for the governmental projects. In many of the governmental projects, different stakeholders are responsible for project cost and project benefits, respectively. Responsibility for project cost is typically allocated to a governmental agency, which shall provide the new infrastructure in accordance with a traditional project management perspective on time, cost and according to specification. For governmental projects, it is typically different kinds of users who are responsible for the benefits generated from the project deliveries. The value generating activity related to the governmental projects is represented by the train operators, hospital or road users. By going up the administrative ladder, it is possible to find stakeholders with interests in both the cost and benefit side. For governmental projects, this is usually at the ministry level, but two or more Ministries can be involved (for example the New Opera House and the Gardermoen project).

## **5 Concluding discussion**

Most literature on project ownership focuses on one owner having all the characteristics of owner. It is based on one stakeholder who takes the risk related to the cost and future value of the project. Our case study shows that owner responsibilities not necessarily are concentrated to one individual stakeholder in a project.

A governance perspective aims at securing that an executing body works in accordance to the owner's interest. Such an executing body is a project in our cases, while a corporate governance perspective focuses on the management of a company. APM (2007) pointed out that project governance aims at ensuring that an organisation's project portfolio is aligned to the organisation's objectives. With reference to our studied projects, this description works well in most of the private sector projects we have studied. With the possible exception of the Ormen Lange/Langed project, our private sector projects were carried out by one identifiable "host organisation", which can be termed project owner.

Using a governance frame of reference, what is right to the project owner is by definition right to the project. At the end of the day, the owner takes responsibility for the value of the project. Related to stakeholder management, a governance perspective means that owners are a special kind of stakeholder.

Our studies indicate that not all projects have a single well identifiable project owner, as illustrated by Table 2. In particular, this is the case for governmental projects. A traditional owner is a stakeholder who takes the risk related to both the cost and future value of the project. Such a stakeholder has incentives to analyse and follow up a project based on weighting the costs against the benefits. Most stakeholders in governmental projects have their main incentives either on the cost or benefit side of a project. Even though the relevant Ministry has an interest in weighing costs against benefits for investments within their responsibility, our studies have also included projects involving more than one Ministry.

Figure 1 shows one “governance” arrow going to the right, indicating that governance originates from one owner, or a set of owners with aligned objectives. Accountability then flows back in the other direction, to the same owner, or group of aligned owners. Our studies indicate that for many governmental projects this flow can be described as two flows; one related to costs, and another related to benefits.

Governance of governmental projects can either acknowledge the dual flows and establish parallel governance regimes for both cost and benefits, or to strive to establish owners that have incentives for both cost and benefits. The studied projects include examples of the latter alternative, where project owners have been “created”. A driving force behind many PPP<sup>7</sup> initiatives internationally has been a lack of public funds. In Norway, other aspects of public management have also served as justifications for such partnerships. One objective has been to establish project structures where one stakeholder has incentives related to both costs and benefits for an investment, in a manner that resembles a private sector project owner. A similar justification was used for the reorganisation of the Norwegian health care sector.

This paper has primarily analysed project ownership on a macro level, between organisations. Challenges related to identifying a stakeholder with responsibility for both cost and benefits can to a certain extent also be found on a micro level, within the most involved organisations. Aspects of “internal project ownership” have not been the main focus of the research presented in this paper.

We have illustrated that project ownership can be diverse. Results from this study indicate that theories and practices related to ownership and governance are not necessarily directly transferable to a generic project context. While the question “Who owns a project” is easy to answer in some cases, it requires a more differentiated answer in other cases. Further research is proposed to investigate project ownership implications on project management. It will be interesting to explore how different ownership structures affects project costs as well as value realisation from finished projects. From a project uncertainty perspective, owners can be seen as a source of uncertainty to the project. In an owner perspective, uncertainty management is primarily related to future value of the project, which can be influenced by benefits and revenue from the project, alignment to overall objectives, project cost, and other issues. This is a wider perspective on project uncertainty than traditionally have been taken in project management. We propose further research related to project uncertainty and project stakeholder management from an owner perspective, in addition to the relatively established project perspective.

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<sup>7</sup> Public Private Partnership

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## Appendix II-Bibliography from the PUS project



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Artikler /articles – Konferanser /Conference

Poster – Konferanser/Conference

Artikler– Populærvitenskapelige tidsskrifter /Magazine article

Forum rapporter /Internals summary's from project forum in the PUS project

Rapporter /Research reports

Master og Prosjektoppgaver (ikke komplett) /List of Master and project reports from the PUS project (Not Complete list)

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Forfatter: Hans Petter Krane
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### 2009

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Forfattere Agnar Johansen Siri Bøe Halvorsen Amin Haddadi, Jan Alexander Langlo
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Forfattere Hans Petter Krane, Agnar Johansen Ragnhild Alstad
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Forfattere : Agnar Johansen, Jan Alexander Langlo

## Poster – Konferanse/ Conference

### 2008

- PMI Research Conference, 2008, Warszawa  
“We manage risk so well, so why speak of opportunities? A case study of practical uncertainty management in two railway projects” (Posteret ble valgt som **an Outstanding Student Poster**)  
Forfatter: Hans Petter Krane

## Artikler i Populærvitenskapelige tidsskrifter /Magazine articles

### 2011

- Bladet Prosjektledelse (Utgitt av Norsk Forening for prosjektledelse, Nr. 1, 2011)  
”Muligheter i prosjekter – Del-3”  
Forfattere: Agnar Johansen, Ole Jermstad og Anandasivakumar Ekambaram)
- Bladet Prosjektledelse (Utgitt av Norsk Forening for prosjektledelse, Nr. 2, 2011)  
”Praktisk styring av usikkerhet i et eierperspektiv ”  
Forfattere: Anandasivakumar Ekambaram og Agnar Johansen)
- Netlipse magasin nr 9. 2, 2011) – Norwegians views on what owner get in the end  
”Why do projects so seldom deliver the owners as expected  
Forfattere: Hans Petter Krane
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” The PUS Project -Practical Uncertainty Management in a Norwegian Project Owner’s Perspective  
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### 2009

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”Å finne opp hjulet på nytt og prosjektorganisasjoner - en oppsummering av et doktorgradsarbeid ”  
Forfatter: Anandasivakumar Ekambaram
- Bladet Prosjektledelse (Utgitt av Norsk Forening for prosjektledelse, Nr. 3, 2009)  
”Muligheter i prosjekter – Del-1”  
Forfattere: Agnar Johansen, Ole Jermstad og Anandasivakumar Ekambaram
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”Muligheter i prosjekter – Del-2”  
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## Forum rapporter

### 2007

- Forum-1: juni 2007
- Forum-2: oktober 2007

### 2008

- Forum-3: september 2008

#### 2009

- Forum-4: juni 2009

#### 2010

- Forum – 5: des 2010

### Rapporter /Research reports (Norwegian only)

#### 2007

- Bruk av modenhetsmodeller og indikatorer i styring av usikkerhet

#### 2008

- Teori, kunnskapsgrunnlag og rammeverk innen usikkerhetsstyring av prosjekter

#### 2009

- Levende usikkerhetsledelse - Institusjonalisering av metoder, modeller og mennesker
- Usikkerhetsstyring i Statsbygg - Kartlegging av erfaringer i 2008 og forslag til videre arbeid

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2. Anders Magnus Løken og Thorvald Gil Oliu Moe: PIANO – Usikkerhetsstyring i Statsbygg
3. Andreas Kjørholt: Praktisk usikkerhetsstyring -AF gruppen
4. Amin Haddadi: Praktisk usikkerhetsstyring - Utvikling av prosjektdemonstrator
5. Barjinder Sing Bharj: Helsesjekk i prosjekt
6. Erik Vikanes Hansen: Usikkerhetsstyring i Hærens investeringsprosjekter
7. Glenn Langli Bjørnsrud: Praktisk styring av usikkerhet –eierperspektiv vs prosjektperspektiv Innlevering
8. Gisle Melkild Hustavnes: Kostnadsestimering i bygg- og anlegg
9. Hanne Westgård og Ann Kristin Nystumoen: Identification and classification of real options in petroleum projects in StatoilHydro – using Gjøa and Tyrihans as project examples
10. Hege Færøy Bakken: Usikkerhetsstyring i et stort prosjekt (Tyrihans Statoil)
11. Jens Petter Lund: Usikkerhetsstyring i praksis- effektiv styring av muligheter gjennom bygging av usikkerhetskultur i organisasjons- og prosjektperspektiv
12. Jon Audun Alexander Vikan: Praktisk styring av mulighetssiden i komplekse prosjekter– kreativitet i et verdiperspektiv
13. Mina Nguyen: Holdninger til usikkerhetshåndtering hos personell i forskjellig organisasjoner som er involvert i vedlikeholds og modifikasjonsprosjekter i olje og gasssektoren i Norge
14. Morten Enger: Usikkerhetsstyring i Forsvarsbygg Utvikling Nord
15. Roger Tengsareid: Human and Organizational Error Prevention
16. Shalender: Development of IPRISKField model for Valemon-project
17. Åsne Godbolt: Usikkerhetsstyring i Statens Vegesen -casestudie

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1. Amin Hadaddi: Analyse og styring av usikkerhet Reinertsen as
2. Barjinder Sing Bharj : Bruke av modenhetsmodeller i usikkerhetsledelse av prosjekter
3. Daniel Mohn: Vurdering av praksis for risikoanalyser i en leverandør til oljeindustrien
4. Gisle M. Hustavnes: Usikkerhet i mega-prosjekter – Et case studium
5. Glenn Langli Bjørnsrud: Praktisk styring av usikkerhet – prestasjonsindikatorer og måling

6. Hege Færø Bakken: Usikkerhetsledelse i praksis – en case studie
7. Kjetil Skånshaug og Andres Kjørholt: Etter evaluering av prosjekt med fokus på usikkerhet
  
8. Lars Pörtner, Mareen Stiliz og Yolanda Y. Aguado: Challenges during purchasing in R&D projects
9. Mahshid Maleki: Risk Management Process in Construction Projects
10. Roger Tengsareid: Human and Organizational Error Causes.
11. Thorvald Gil Olie Moe: Anvendelse av erfaringsoverføring i prosjekters tidligfase

### **Andre relevante publikasjoner / other publication**

Tidligere bøker hvor Usikkerhet også inngår som sentrale element er:

#### 2001

- Tips og råd til prosjekt oppstart (Agnar Johansen, Olav Torp mfl)

#### 2008

- Vegene gjennom KS 2 (Agnar Johansen, Jan Alexander Langlo)

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