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The Early Warning Procedure in Projects

Foundations, Approaches and Challenges

Thesis for the degree of Philosophiae Doctor

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Norwegian University of Science and Technology
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This dissertation is lovingly dedicated to

My biggest source of joy and inspiration

My beautiful children, Anahita and Armin

And my wonderful husband, Hessam

Preface and Acknowledgments

The completion of my dissertation and subsequent PhD has been a long journey and I would never have been able to finish it without the guidance of my colleagues, help from friends, and support from my family.

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Sara Haji-kazemi

December 2014 Trondheim, Norway

Summary

Despite the application of project management tools and techniques in projects worldwide, still a large number of projects fail to meet their objectives. Based on studies on the history of failed projects, it is obvious that projects do not result in failure overnight. With hindsight, project managers are often able to point out the most likely factors leading to project failure. One approach towards prevention of project failure or deviation from the main goal is to attempt to detect possible signs of project failure in early stages of projects. These signs are referred to in the literature as Early Warning (EW) signs. The major challenge for the project managers is the identification of these signs and attempting to respond to them in order to prevent the negative circumstances. Although it is not a proven fact that identification of EW signals is a guarantee against project failure, there are a number of resources which consider paying attention to these signals and attempt to respond to them as a contribution to project success.

This PhD dissertation provides better understanding of the EW phenomenon, possible approaches for identifying EW signs and barriers against effective responses to these signs in projects. In addition to contributing to existing project management research by increasing the understanding of the application of EW procedure in projects, the present research attempts to contribute to development of more effective approaches towards responding to EW signs of potential future problems in projects. Three research questions (RQs) guide the research:

- RQ1: How are early warning detection approaches addressed in the existing literature?
- RQ2: How can the utilization of early warning identification approaches improve project performance in practice?
- RQ3: What are the possible barriers against effectively responding to early warning signs and how to enhance early responses to EW signs in projects?

The research questions are addressed through seven corresponding publications, based on extant literature review within the EW field and other relevant areas, alongside four different case studies among various industries (Oil and gas, Telecommunication, Transportation and R&D) and a survey among Norwegian project managers or leaders in different industries. The main focus points in the seven individual publications which comprise the dissertation include:

- Publication I: Investigation on possible EW identification approaches and their strengths and weaknesses

- Publication II: Presentation of a conceptual framework for application of performance measurement as an EW identification approach (An analysis on the case of London Ambulance Service (LAS) project)
- Publication III: Investigation on application of performance measurement as an EW system (A case study on the Tyrihans project within the oil and gas industry)
- Publication IV: Investigation on application of Project Health Check (PHC) as an EW system (A case study on LTE and MOVE projects within the telecommunication industry)
- Publication V: Investigation on how identification of EW signs in early stages of projects can aid project managers towards better decision making (A case study on the Norwegian High Speed Railway (HSR) project within the transportation industry)
- Publication VI: Investigation on behaviour of different filters against effective flow of information in international projects
- Publication VII: Investigation on possible barriers against identifying and responding to EW signs and remedies for improving the EW procedure.

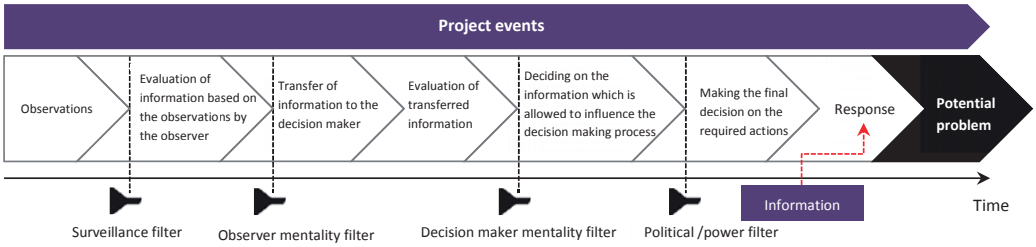
A model is developed based on the findings from the individual publications and the initial literature studies, which illustrates a detailed EW procedure. The initial idea for development of the model stems from Nikander's (2002) decision support model and the findings from each publication contribute to clarification of different stages of the model. The main stages within the procedure include:

- Observations in order to detect possible EW signs of potential future problems
- Evaluation of the information gathered via application of methods and the information perceived through gut feelings
- Transfer of information to the decision maker
- Evaluation of the information received from the observer and making decisions on what to accept or what to discard due to being unnecessary or irrelevant
- Evaluation of information regarding accepted elements as EW signs and deciding which one is allowed to influence the decision making process
- Making the final decision on what actions to be taken towards the identified EW signs
- Taking the actions in order to avoid actualization of potential problems

The figure below illustrates the main stages of the EW procedure alongside the filters throughout the procedure.

The findings of this dissertation clarify the process through which the information on a possible EW sign should undergo in order for the suitable response to be taken before the potential problem actualizes. It also indicates that an effective response requires the flow of information through each and every filter throughout the procedure and discusses the influencing factors on the strength of these filters. Based on the effects of each of the factors on the filters, this dissertation deliberates on possible approaches for improvements in order to lessen the negative affect of these aspects on the effectiveness of responses to EW signs. The suggested remedies are categorized into three main groups which offer suggestions for

improvement of the EW identification stage, information transfer stage and the response stage.



The EW procedure and the possible filters against flow of information[1]

The results of the studies which led to the development of this dissertation contribute to both theory and practice. The theoretical contributions aim to bridge three main identified research gaps including: Limited research on possible EW identification approaches within the project management area, limited understanding and elaboration on application of EW identification approaches and limited understanding of possible barriers against effective responses to EW signs and potential approaches for enhancing the response process. These contributions reside in the clarification of the full extent of EW identification approaches, evaluation of the level of efficiency of performance measurement and PHC as EW systems, introducing new insights to adding the EW procedure as part of the management system in early stages of projects, clarifying the behavior of the filters against flow of information in international contexts , clarification of possible barriers against effective responses to EW signs and suggestions for improvement of the procedure.

The Practical contributions of the dissertation reside in facilitating potential increased managers' understanding of strengths and weaknesses of possible EW identification approaches, enhancing manager's capabilities to identify EW signs through application of different EW identification approaches, highlighting the importance of having an open eye on possible EW signs of potential future problems from the early stages of projects , highlighting the challenges involved with carrying out an effective EW procedure in practice and suggesting remedies for overcoming these challenges.

In conclusion, this dissertation contributes to advancing theory and applications by providing insights into the utilization of an EW procedure in projects, the challenges involved within this procedure and suggestions for overcoming them. Further research in a range of contexts is, however, necessary for testing and enhancing the utility of the approaches and the remedies.

[1] The figure is presented in higher resolution in Chapter 5 (Figure 5.7, p. 129).

Sammendrag (Summary in Norwegian)

Til tross for utstrakt bruk av prosjektledelsesverktøy og -teknikker mislykkes mange prosjekter over hele verden. Studier av mislykkede prosjekter viser at de ikke har sviktet over natten. I ettertid er prosjektledere ofte i stand til å peke ut de viktigste faktorene som førte til prosjektet mislykkes. En måte å forebygge mislykkede prosjekter (avvik fra hovedmålet) på, er å avdekke mulige tegn på avvik i tidlige prosjektfaser. Disse tegnene er i litteraturen referert til som tidlig varslingstegn. Den store utfordringen for prosjektlederne er å identifisere slike tegn og håndtere dem for å hindre negative omstendigheter. Selv om det ikke er bevist at identifisering av tidlig varslingstegn er en garanti mot at prosjekter mislykkes, vurderer en rekke kilder å vie oppmerksomhet til tidlige varsler for å oppnå suksess i prosjekter

Denne doktoravhandlingen gir en bedre forståelse av tidlige varslingstegn- og fenomener, mulige tilnærminger for å identifisere og håndtere tidlige varslinger, samt barrierer mot effektive tiltak. I tillegg til å bidra til prosjektledelsesforskningen rundt tidlig varslingstegn, bidrar denne forskningen til å utvikle mer effektive metoder for å håndtere tidlige varslingstegn i prosjekter.

Studiet har tatt utgangspunkt i tre forskningsspørsmål:

- Hvordan er metoder for identifisering av tidlige varslingstegn adressert i den eksisterende litteraturen?
- Hvordan kan bruken av metoder for å identifisere tidlige varslingslingstegn forbedre prosjekter i praksis?
- Hva er barrierene mot effektiv håndtering av tidlige varslingstegn og hvordan kan håndteringen forbedres?

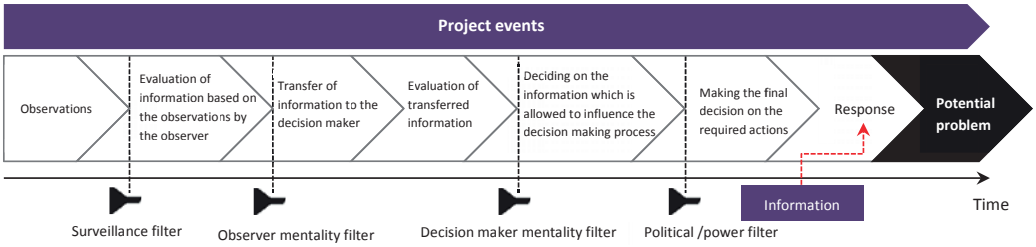
Forskningsspørsmålene er adressert gjennom syv publikasjoner. Publikasjonene er basert på gjennomgang av litteratur innenfor tidlig varsling og andre relevante områder, fire casestudier av ulike bransjer (olje og gass, telekommunikasjon, jernbane og R&D) og en undersøkelse blant norske prosjektledere og ledere i ulike bransjer. Fokuspunktene for de syv publikasjoner er:

- Publisering I: Undersøkelse om mulige metoder for identifikasjon av tidlige varslingstegn og deres styrker og svakheter
- Publisering II: Presentasjon av et konseptuelt rammeverk for bruk av prestasjonsmåling som metode for tidlig varsling (case-studie av London Ambulanse Service (LAS)-prosjekt)
- Publisering III: Undersøkelse av bruk av prestasjonsmåling som et system for tidlig varsling (casestudie om Tyrihans-prosjektet i olje- og gassindustrien)
- Publisering IV: Undersøkelse av bruk av Prosjekt helsesjekk som system for tidlig varsling (casestudie om LTE og MOVE prosjekter innenfor telekommunikasjonsindustrien)
- Publisering V: Undersøkelse av hvordan identifikasjon av tidlig varsler i tidlige faser av prosjektene kan hjelpe prosjektledere mot bedre beslutninger (casestudie om utredningsprosjektet for høyhastighet i jernbanen)
- Publisering VI: Undersøkelse av oppførselen til ulike filtre mot effektiv informasjonsflyt i internasjonale prosjekter
- Publisering VII: Undersøkelse av mulige barrierer mot identifisering og håndtering av tidlige varsler og rettsmidler for å bedre tidlig varsling prosedyre.

En modell er utviklet basert på resultatene fra de publikasjonene og de innledende litteraturstudiene. Modellen illustrerer en detaljert prosedyre for tidlig varsling. Den opprinnelige ideen for utvikling av modellen stammer fra Nikander (2002) «Decision support model» og funnene fra hver publikasjon bidrar til avklaring av ulike stadier av modellen. De viktigste elementene i prosedyren inkluderer:

- Observasjoner for å oppdage mulige tidlige varsler om potensielle fremtidige problemer
- Evaluering av informasjonen som samles inn via anvendelse av metoder og informasjonen oppfattet gjennom magefølelsen
- Overføring av informasjonen til beslutningstaker
- Evaluering av informasjonen mottatt fra observatøren, og ta beslutninger om hva du skal godta eller forkaste basert på av nødvendighet eller avvendelighet
- Evaluering av informasjonen med hensyn på aksepterte elementer som tidlige varsler og valg av hvilke elementer som får påvirke beslutningsprosessen
- Ta beslutninger om aksjoner som skal tas mot identifiserte tidlige varsler
- Gjøre tiltak for å unngå aktualisering av potensielle problemer

Figuren under illustrerer de viktigste fasene av tidlig varslings prosedyre sammen med filtrene som eksisterer i hele prosedyren.



Tidlig varslingsprosedyre og de mulige filtre mot informasjonsflyt

Resultatene av denne avhandlingen forklarer prosessen som informasjonen om et mulig tidlig varsel må gjennomgå for at passende reaksjon blir tatt før det potensielle problemet oppstår. Resultatene markerer også at en effektiv respons krever informasjonsflyt gjennom alle filtrene og gjennom hele prosedyren og diskuterer påvirkningsfaktorene på filtrenes styrke. Basert på effektene av disse faktorene, overveier denne avhandlingen mulige tilnærminger for å redusere negativ innvirkninger av disse aspektene på reaksjonsprosessene. De foreslåtte rettsmidler tilbyr forslag til forbedring av tidlig varslingsidentifikasjonsfasen, informasjonsoverføring fasen og tiltaksfasen.

Resultatene viser at det er: begrenset forskning på mulige tidlig varslingsidentifikasjonstilnærminger innenfor prosjektledelse, begrenset forståelse og utdypning på anvendelse av tidlig varslingsidentifikasjonstilnærminger og begrenset forståelse av mulige barrierer mot effektive tiltak mot tidlige varsler og potensielle tilnærminger for å øke reaksjonsprosessen. De teoretiske bidragene i avhandlingen inkluder: avklaring av det fulle omfanget av tidlig varslingsidentifikasjonstilnærminger, vurdering av effektivitet av prestasjonsmåling og prosjekthelsesjekk som tidlig varslingssystemer, tilføring av nye innsikt å legge til tidlig varslingsprosedyre som en del av styringssystemet i tidlige faser av prosjekter, avklaring av oppførselen av filtrene mot informasjonsflyt i internasjonale sammenhenger, avklaring av mulige barrierer mot tiltak mot tidlig varsler og forslag til forbedringer av prosedyren.

De praktiske bidragene av avhandlingen ligger i å øke ledernes forståelse av styrker og svakheter ved mulige tidlig varslingsidentifikasjons tilnærminger, styrke lederens evner til å identifisere tidlige varsler gjennom anvendelse av ulike tidlig varslingsidentifikasjonsmetoder, fremheve viktigheten av å være varsom rundt mulige tidlige varsler av potensielle fremtidige problemer fra de tidlige fasene av prosjektet, fremheve utfordringene med å gjennomføre en effektiv tidlig varslingsprosedyre i praksis og foreslå løsninger for å overvinne disse utfordringene.

I konklusjonen, bidrar denne avhandlingen til å fremme teori og anvendelse ved å gi innsikt i bruk av en tidlig varslingsprosedyre i prosjekter, gi innsikt i de utfordringene som er involvert i denne prosedyren og forslag for å overvinne dem. Videre forskning er imidlertid nødvendig for å teste og forbedre av bruk av tilnærmingene og løsningene.

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List of publications

This dissertation consists of an overview of the following publications which are referred to in the text by their Roman numerals.

I. Haji-Kazemi, Sara; Andersen, Bjørn; Krane, Hans Petter, 2013. A review on possible approaches for detecting early warning signs in projects. *Project Management Journal* 44 (5), 55-69.

II. Haji-Kazemi, Sara; Andersen, Bjørn; Krane, Hans Petter, 2012.A Conceptual Framework for Application of Performance Measurement as an Early Warning System in Projects, an Analysis on the Case of the London Ambulance Service Project. PMI Research and Education Conference, Limerick, Ireland, 2012-07-15 - 2012-07-18.

III. Haji-Kazemi, Sara; Andersen, Bjørn, 2013. Application of performance measurement as an early warning system: a case study in the oil and gas industry. *International Journal of Managing Projects in Business* 6 (4), 714-738.

IV. Haji-Kazemi, Sara; Andersen, Bjørn, 2014. Efficiency of project health checks (PHCs) as an early warning system in practice: a case study in Norway's telecommunication industry. *International Journal of Managing Projects in Business* 7(4), 678-700.

V. Haji-Kazemi, Sara; Andersen, Bjørn; Krane, Hans Petter, 2012.Identification of early warning signs in front-end stage of projects, an aid to decision making. *Procedia - Social and Behavioural Sciences* 74, 212-222

VI. Haji-Kazemi, Sara; Andersen, Bjørn; Eleftheriadis, Ragnhild; Capellán, Alvaro, 2014.The early warning procedure in an international context. IPMA World Congress, Rotterdam, Netherlands, 2014-09-29 - 2014-10-01. Also submitted to the *International Journal of Project Management.*

VII. Haji-kazemi, Sara; Andersen, Bjørn; Klakegg, Ole Jonny, 2015. Barriers against effective responses to early warning signs in projects. Accepted for publication in the *International Journal of Project Management.*

PART I: THEORETICAL BACKGROUND AND KEY FINDINGS

Chapter 1

1. Introduction

1.1 Background

Although the utilization of project management tools and techniques has improved significantly in the recent years, still quite many projects fail to meet their objectives. From studies of the history of projects that have resulted in either failure or remarkable deviations from their goals, it is clear that projects do not result in total failure in a relatively short period of time. In retrospect, project managers are quite often able to point out a number of the most likely factors contributing to the project failure, and can usually also identify a number of signs of the ensuing failure. Those signals, often in the post project phase, appear obvious and it is hardly possible to understand why they were not taken into consideration at the time.

One approach to avoid project failure or deviation from the original goal is to attempt to detect possible signs of project failure during the early stages of a project, in order to take the necessary corrective measures. Such signals, which can be seen variously as an expression, an indication, a proof, or a sign of the existence of some future negative issues, are defined by Nikander (2002) as “Early Warning (EW) signs.” A major challenge for project managers is the identification of these signs and attempting to respond to them in order to prevent the negative circumstances. Although it is not a proven fact that identification of EW signs is a guarantee against project failure, there are a number of resources which consider paying attention to these signs and attempting to respond to them as a contribution to project success.

Various researchers have introduced different approaches that the author believes may be used as possible means for detecting EW signs in projects. Some of these approaches include risk analysis (Niwa 1989; Nikander 2002), project success/failure models (Pinto and Slevin 1988; Lewis 1993), project assessment methods (Cooper et al., 1997; , 2005; Miller and Lessard, 2000; Klakegg et al., 2010), Earned Value Management (EVM) (Vanhoucke, 2012), decision support modelling of EWs (Nikander and Eloranta, 2001), performance measurement

(Andersen and Fagerhaug, 2002), and Project Health Checks (PHCs) (Humphreys et al. 2004; Construction Industry Institute (CII), 2006; Jaafari, 2007). Although these methods have been mentioned as possible EW sign identification approaches, very few literature sources have directly demonstrated the link between project EW signs and these methods.

Despite the fact that the above-mentioned methods are applied in many cases, project failures still occur. According to Williams et al. (2012), 'we are not very good at picking EW signs.' They highlight problems related to three main areas: understanding project risk and uncertainty, understanding project complexity, and the detection of people's tacit knowledge and comprehending their ways of responding and interacting. Williams et al. (2012) also state that established assessments fail to recognize EW signs, partly due to technical issues, but mainly due to the minds of the individuals concerned. Despite the challenges, studies have shown that although assessments are not completely successful in identifying all EW signs, the exercises themselves raise awareness and provide opportunities for critical questions to be raised and discussed. If the exercises are performed early enough, when real options are still available, the assessments may prove to be a powerful tool. Further, Williams et al. (2012) state that although formal methods are useful for identifying EW signs in the aspects they are designed to consider, informal 'gut feeling' approaches are a possible means for identifying signs without having a specific focus or issue in mind. When applying EW identification approaches, both formal assessments and informal 'gut feeling' approaches lead to essential information that, according to Nikander' s (2002) model, needs to be processed in order to evaluate the level of seriousness of the identified signs. After processing the information, it is necessary to respond to these signs in order to prevent real problems from occurring.

Although there is evidence that it is possible to detect EW signs in projects and despite the existence of the necessary information, in many cases the appropriate response is missing from project managers. This may be due to many reasons, such as time pressure, a tendency for optimism, and the effects of politics (Williams et al., 2012), over-optimism, lack of tolerance of warnings, and lack of an outside view (Lovallo and Kahneman, 2003), or the 'normalization of deviance' (Pinto, 2013).

The main objective of this dissertation is to develop a better understanding of the EW phenomenon, possible approaches for identifying EW signs and barriers against effective responses to these signs in projects. This is done by four case studies aiming for investigation on considering the EW procedure as part of the project management process in real life cases and a survey which aims for identifying the main reasons for lack of effective responses to EW signs of potential problems.

In addition to contributing to existing project management research by increasing the understanding of the application of EW procedure in projects, the present research attempts to contribute to development of more effective approaches towards responding to EW signs of potential future problems in projects.

The primary theoretical perspective used in this dissertation is the theory of weak signals by Ansoff (1975) which has been elaborated and scrutinized later by Nikander (2002) in his PhD dissertation. In addition to drawing from theory of weak signals and the EW phenomenon, this dissertation utilizes extant research on project management tools and techniques.

1.2 Research objectives

They key objective of this dissertation is to develop a better understanding of the EW phenomenon, possible approaches for identifying EW signs and barriers against effective responses to these signs in practice. The aim is to gain and present in-depth knowledge of the subject, thorough knowledge of different research methods and a good understanding of the practical application.

Three main research questions have been formulated in order to fulfil the research goal. The research questions tend to speculate how EW detection approaches have been addressed in the existing project management literature, how the utilization of these approaches contributes to overall project performance and what may be the possible obstacles against effective responses to identified EW signs in projects.

The author has endeavoured to fulfil the research objectives through development of seven individual publications. Publication I investigates the state of the art of existing EW identification approaches and their strengths and weaknesses. Publications II to VI investigate the implementation of these approaches in different projects from various industries and analyse the result of applying these approaches in practice. Finally publication VII presents the possible barriers against effective EW responses and possible remedies for overcoming these barriers.

The research questions and the rationales behind formulating them will be presented in detail in chapter 3.

1.3 Research scope

The research focus in this dissertation is the application of the EW procedure in projects and the possible obstructions against effective and timely response to them in order to prevent the undesired outcomes. The research scope of this dissertation includes three components. The first part includes an elaboration on the EW phenomenon and the possible approaches for identifying these types of signals in projects. The next one is to observe how the application of some of these approaches contributes to the overall performance in different projects. The projects have been chosen from various industries, including oil and gas, telecommunication, research and development (R&D) and transportation, in order to increase the validity and generalizability of the research results[2]. The third and final component of the scope is the possible barriers against effective responses to EW signs, the project and project organizational characteristics which influence the EW procedure and remedies for reducing the negative effects of these elements on effectiveness of responses to EW signs.

Figure 1.1 illustrates the relations and key differences in the research scope of the seven individual publications.

[2] The rationale for the case study selection will be dealt with comprehensively later in Chapter 3.

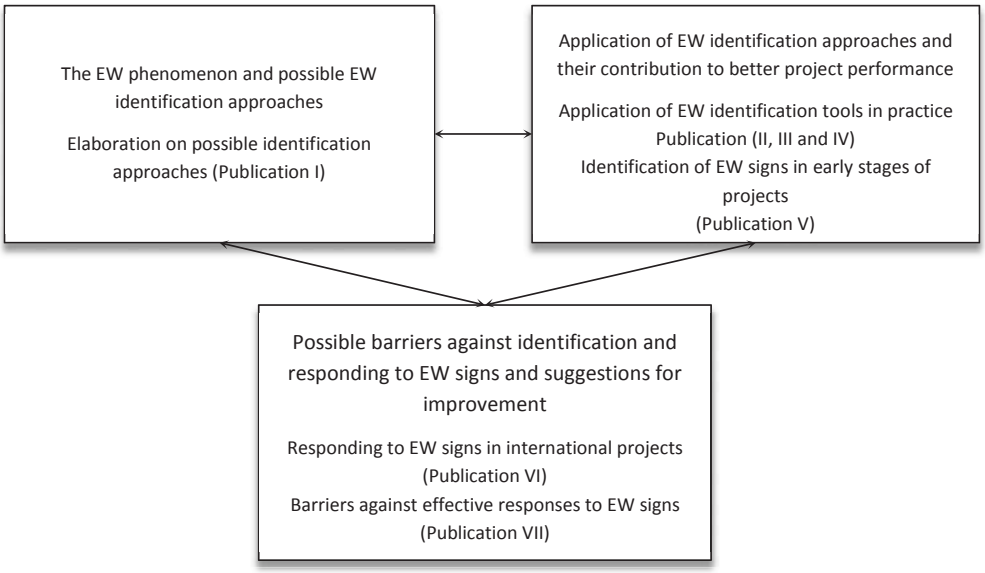

Figure 1.1 Research scope of the dissertation

1.4 Research process and publications

The overall procedure for the PhD project consists of development of the project plan, development of the seven individual publications and development of the dissertation. The development of the project plan started with initial identification of research gaps and formulation of research objectives and research questions. The research objectives were modified based on the findings of each stage as the research proceeded. The sub-objectives were then chosen based on the identified research gaps, the author's personal interest and the available resources (e.g. case projects and case companies). The sub-objectives provided the basis for development of the individual publications. The individual publications have been developed according to the research scope outlined in the previous section.

Writing the dissertation involves taking a step back to reconsider the motivations and background of the PhD project, the rationale for formulating the research questions, the methodology applied for carrying out the research and how the individual publications have contributed to answering the research questions. It also involves discussing the main findings of each individual publication. It is noteworthy that the published journal articles have been subject to extensive peer review and have been revised based on the reviewers' comments. The conference articles have also been under peer review in order to be accepted.

However the dissertation is more than the sum of the individual publications. The discussion section provides a synthesis of the individual publications and how the research as a whole contributes to both theory and practice. Figure 1.2 presents the overall procedure of the PhD project and the stages of the research process.

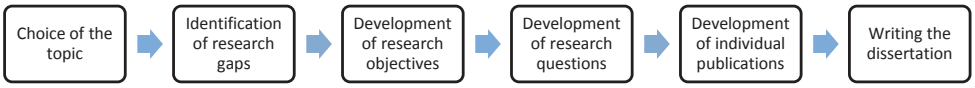

Figure 1.2 Overall procedure of the PhD project

1.5 Structure of the dissertation

This PhD dissertation consists of two parts: theoretical background and key findings (Part I), and individual publications (Part II). Part I consists of six chapters which present the theoretical background and summarize the key findings and contributions of the dissertation (See Figure 1.3). Chapter 1 is an introduction to the study that presents the background of the dissertation, research objectives and scope, research process and introduction to the individual publications and the structure of the dissertation. Chapter 2 provides a literature review on the key theoretical perspectives which are relevant to this study. Chapter 3 provides a methodological review and discussion in order to demonstrate why the research questions were formulated and how they have been answered through this dissertation. Chapter 4 provides a summary of the main results of the individual publications. Chapter 5 discusses the key theoretical and practical contributions of the research followed by the limitations of this dissertation. The first part is closed with chapter 6 which includes the main concluding remarks and suggestions for future research. Part II includes a collection of the individual publications, five journal articles and two conference articles that represent the main work and contributions of the PhD research.

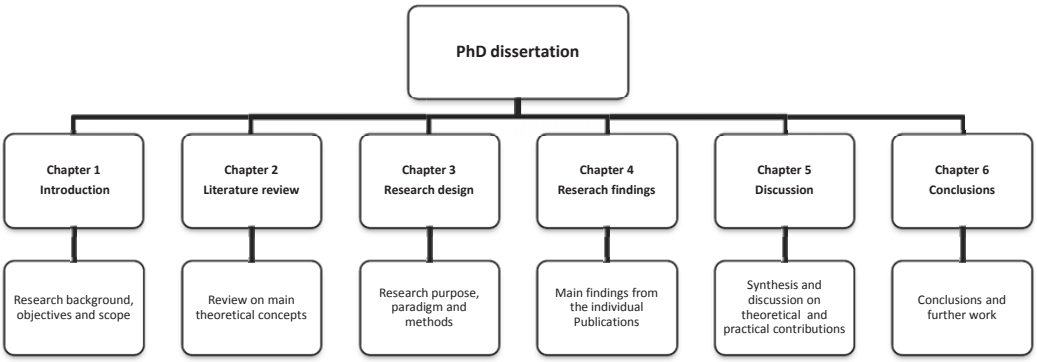

Figure 1.3 Dissertation structure

Chapter 2

2. Literature review

This chapter provides an overview of the main concepts and theories which are relevant to the dissertation. The key theoretical background of the dissertation is the EW concept, which provides a basis for understanding the approaches utilized for effective identification and response to these signs within projects. In addition the dissertation utilizes other relevant theoretical knowledge, developed in the field of project management including the risk management process and project complexity.

Section 2.1 provides an introduction to the definition of the EW phenomenon and the state of the art for the concept of EW signs in projects. Next the focus shifts to presenting research on the concept of EWs as it is presented in other scientific fields besides project management. Also it will be explained how the phenomenon is integrated into the project risk management process. The focal point of section 2.2 is the presentation of relevant theoretical perspectives that are used in the individual publications. These include approaches which are either directly or indirectly mentioned as EW identification tools in the literature. Section 2.3 focuses on possible obstacles against effective response to EW signs of possible future problems in projects. The emphasis is especially placed on the filters which agitate the flow of the information needed for taking actions upon EW signs within the project organization. The section is closed with a discussion on possible approaches for enhancing the EW procedure. Finally section 2.4 summarizes the literature review and elaborates upon research gaps addressed in this dissertation. For a more in depth review of the respective relevant research of the individual publications, see the literature review section of the attached publications. Figure 2.1 presents the different sections of this chapter and the aspects covered under each section.

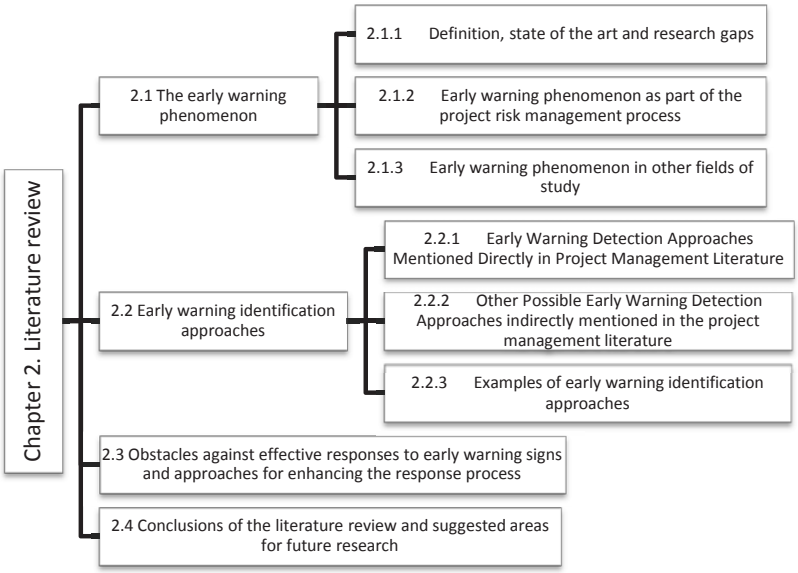

Figure 2.1 Chapter structure

2.1 The early warning phenomenon

2.1.1 Definition, state of the art and research gaps

The generic idea of EW is a wide concept. It applies to almost any activity, sector, or area where it has value to obtain indications as early as possible of some development that in the future will become clearer, typically of a negative nature. The term EW is applied in as diverse areas as health, meteorology, natural disasters, defense, and cost control. Before going deeper into a discussion of EW in a project setting, it is worthwhile to present some of the work that represents a platform for the little research that has previously been done by different researchers on project EW signs.

The first discussion about EW in a management context was initiated by Ansoff (1975). This is supported by Nikander (2002) who dealt extensively with this literature in his doctoral dissertation. Ansoff suggested that strategic surprises, for example the oil crisis in the early 1970s, do not appear out of the blue, rather they may be detected by the aid of pre-emptive signs. These signs he called weak signals. A weak signal was defined as "[. . .] imprecise early indications about impending impactful events" (Ansoff and McDonnell, 1990, p. 20). The core idea is thus that even unexpected discontinuities are heralded by some warning signals.

The theory of weak signals has not been uncontroversial. Critics include Webb (1987) who claimed such messages or information about the future could not be obtained and that Ansoff's work had no earlier foundation to confirm the claims of such weak signals. He believed that these signals only provide weak knowledge of the final threat or opportunity. Ashley (1989) turned the discussion around, saying that such discontinuities are only seen after they have occurred and possible precursors of their arrival only identified with the

benefit of hindsight. Makridakis and Hea´u (1987) stated that the concept of weak signals had remained a purely academic idea. Åberg (1993) stated that weak signals are usually so vague that they are easily missed, and that it is difficult to believe in them; in fact they are uncertain, irrational and not credible. But on the other hand, several other authors have described the same core idea using slightly different terms, for example symptoms, early indicators and soft form of information (Mintzberg, 1994; King, 1987; Juran, 1995). Leidecker and Bruno (1987) and Pinto and Slevin (1988) have also done some studies which can be regarded as research in support of the existence of weak signals. Ansoff's work was later supported by Nikander (2002) in his doctoral dissertation. In Nikander's words (2002), "an EW is an observation, a signal, a message or some other item that is or can be seen as an expression, an indication, a proof, or a sign of the existence of some future or incipient positive or negative issue. It is a signal, omen, or indication of future developments". In his study he devises a model illustrating the character of the EWs observations (See Figure 2.2).

This model sees project events as a time-bound consecutive stream of events. At a given moment, information about this stream can be obtained (e.g. EWs of potential future project problems). This is a time-bound current that is examined by the observer, or that "sends" a message to the observer. This information is then processed and responses are required in order to influence the flow of the project. A crucial factor in choosing a response appears to be, according to Ansoff, time available for responses before the potential problem significantly impacts the project.

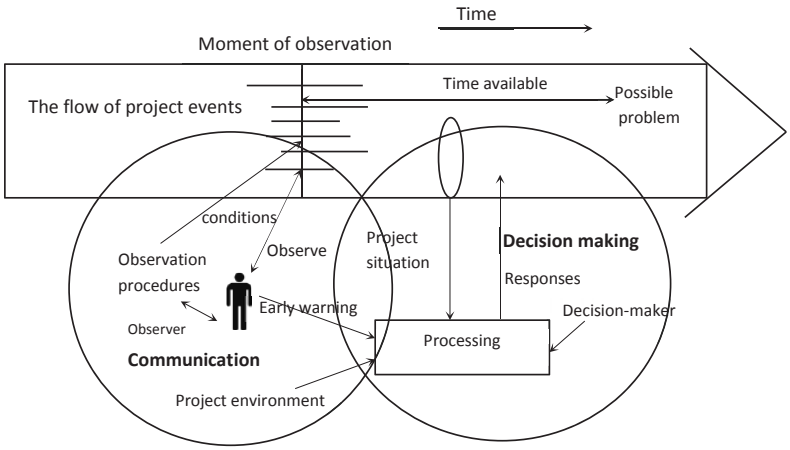

Figure 2.2 The character of the phenomenon of EW (Nikander, 2002, p. 115)

According to Nikander (2002), two stages of assessing the future are included in EW utilization. First the severity, likelihood of materialization and time available of the potential problems should be analyzed, based on the view point of the evaluator, and second the decision maker should examine the impact of the planned responses on the project, and the reactions, and responses of the various project parties and /or outsiders in the situation at hand. Nikander (2002) suggests a decision support model of EWs, including 6 stages, which will be briefly described here.

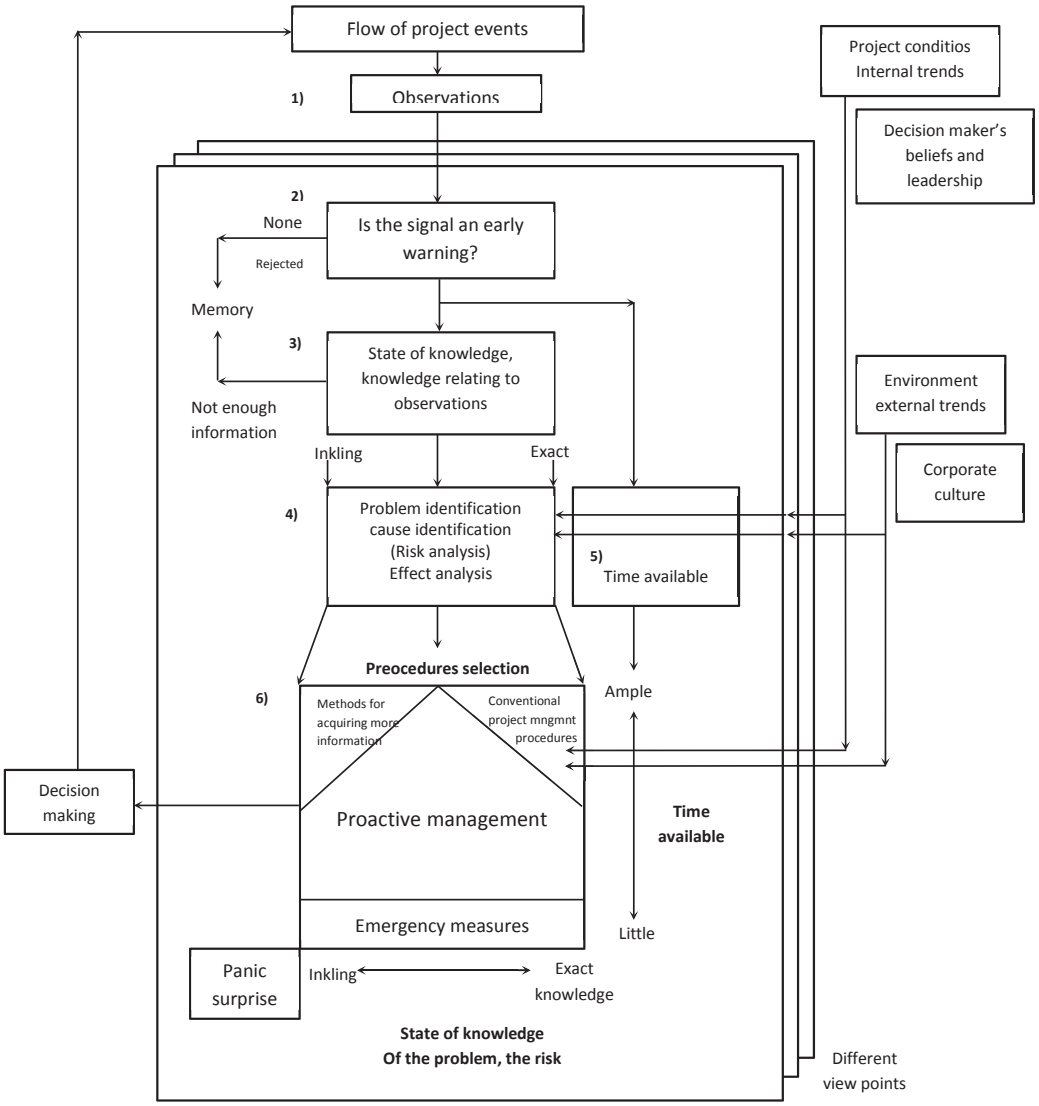

Figure 2.3 The decision support model of EW (Nikander, 2002, p. 122)

As Figure 2.3 shows, the model is divided into two main parts: 1) the communication phase where the EW are recognized and the fact that they actually provide information is approved (including stages 1 to 4 in Figure 2.3)

The first stage is detecting the EW signs. In the second stage, the observer interprets the signs in order to decide whether it is an EW sign or should it be rejected due to its insignificancy. In the third stage, the observer tries to determine the significance of the information provided by EW signs for the project. In the fourth stage the observer attempts to identify the problem (risk) that has emerged as well as its causes based on the information provided by the EW sign and other aspects such as project's situation and environment. The fifth stage includes an assessment on the time available for taking the right actions. This is explored along with

recognition of risks. The question in this stage is how much time is available for the responses, required by the problem and the level of urgency of the situation. This stage is also highly influenced by the project situation and environment. Finally at the last stage it is necessary to decide which responses are required towards the situation.

Not much has been mentioned in the literature about the exact time the EW sign identification should start in the project life cycle. According to Lewis (1993), the prerequisites of project success are the things that must be in order before the project is initiated. The author believes that in case EW signals are identified in the early stage of a project, the available time will be rather long enough for project managers to take the right actions in the subsequent stages of project. For example in case some warning signals related to cost and time limitation are identified in the early stage, budget estimating in the initiation phase can be done more accurately. In addition, it can be a guide to planning deliverables, baseline schedule and baseline budgets in the planning stage. Identification of EW signs related to technical issues, can aid the responsible persons to make better decisions on risk management and production of key variables in the execution phase. Of course the challenge lies in the possibility of detecting the EW signs and their level of reliability.
Nikander (2002) in his works points to findings by Ansoff (1984) on possible filters which a message or piece of information should go through before arriving to the firm from the environment of that firm. Assuming that this piece of information is the one mentioned in Figure 1, these filters can either restrict or ease the processing of the information. Three main filters are mentioned by Ansoff including the *surveillance* filter, the *mentality* filter and the *political/power* filter (see Figure 2.4).

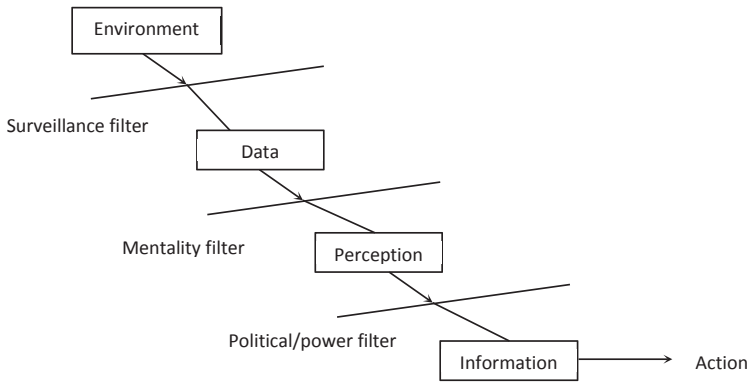

Figure 2.4 Management information (Ansoff and McDonnell, 1990, p. 66)

The first stage, exemplified by the surveillance filter, requires the company/ project/ organization to choose what kind of information is needed and what type of techniques should be employed to procure it. The mentality filter is in character sociological and psychological. The receiver at this point evaluates the arrived information and makes the decision on what to accept and what to eliminate due to being unnecessary, unrealistic or irrelevant. The last filter is used especially by the decision maker and determines what type of information is permitted to influence the decision making process.

2.1.2 Early warning phenomenon as part of the project risk management process

According to the Project Management Body of Knowledge (PMBOK, 2008), the EW phenomenon appears to be a part of the project risk management process (Nikander, 2002). In this section, the author would like to scrutinize how these two concepts are linked to each other and where the EW phenomenon stands in the risk management procedure. In order to do this, the definition of risk management process and its components will be discussed. The next step will be then to endeavor to explain the EW phenomenon as part of this procedure.

The objectives of project risk management are to increase the probability and impact of positive events and decrease the probability and impact of negative events in the project (PMBOK, 2008, p. 11). Kerzner (1995) sees risk management as the art of identifying, analyzing and responding to risk factors throughout the life of a project and in the best interest of its objectives. The situation which may give rise to one or more project risks is a "*risk factor*" (Nikander, 2002). Although the risk factor itself does not directly cause missing a product, schedule or resource target, however it tends to increase the chances that something may happen that will subsequently cause missing one. The character of the risk factor varies depending on the perspective and time of observation. The factors may be: 1) a cause of the problem or risk, when it precedes the problem or contributes to the risk, 2) a detected problem (observation) when the factor is currently active, or 3) an effect (problem, risk) when the factor is the result of a preceding factor (Nikander, 2002). For example the fact that a project manager has no previous experience with a specific type of project does not guarantee that the project will have problems such as cost overrun or low performance. But it does increase the chances that it might.

Kahkonen (1996), in Nikander (2002), distinguishes between risk and problem; problems and disturbances are in fact risks which have come true. The difference between these two phenomena is mostly composed by the uncertainty of the materialization of risk and by the association of risks with the future (Nikander, 2002). In fact a risk is a "potential problem" which may or may not happen in the future. Note that EWs do not seem to provide a clear picture of the exact time where the problem might become current. The most that it reveals is that there is very little time before the problem materializes. The EW phenomenon is linked to the risk management concept via the concept of "risk symptoms" which has been discussed in PMBOK (2008). Risk symptoms are evidences which reveal that a potential problem will actually materialize. To minimize the damage the problem causes for the project, responses are required to correct the situation.

However it is worth mentioning that according to Niwa (1989), the information provided by an EW about the time available before the potential problem becomes real, is not the same thing as the probability of materialization of a risk. These two concepts do not substitute each other and are not opposite factors. Rather they supplement the total knowledge.

Based on these definitions, the author would like to define the EW phenomenon as following:

"An EW sign is a specific element, happening or event which shows that the risk event will actually realize. The EW sign does not provide information on the exact time of the materialization of risk; neither does it reveal its expected magnitude. Rather it acts as an

alarm which triggers action in order to either prevent the realization of the potential problem or possibly lessen the undesired consequences."

Figure 2.5 illustrates the interconnectedness of the concepts; risk factor, risk/potential problem, EW and response.

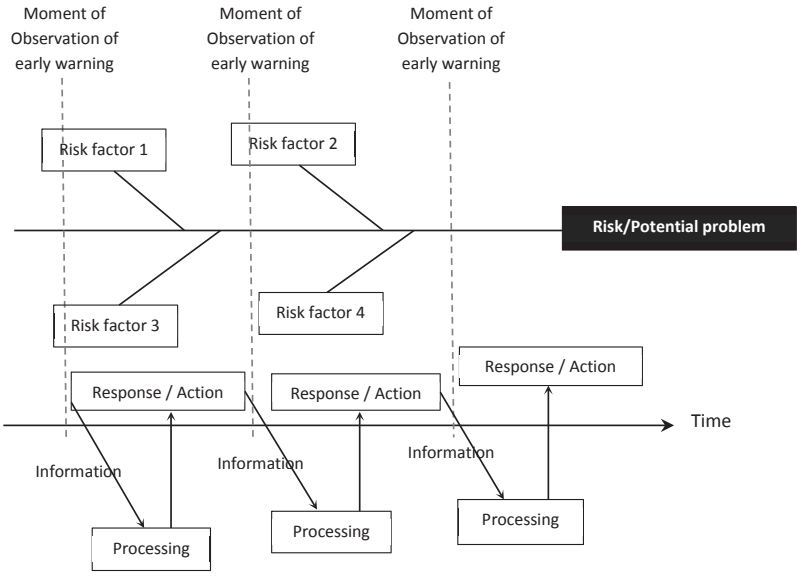

Figure 2.5 Interconnectedness of concepts (adapted from Nikander, 2002)

As mentioned earlier, the risk factors which are possible causes for one or more than one risky event within the project, do not guarantee that the risk/potential problem will materialize. However monitoring the project conditions throughout the project life cycle may provide EW signs that the problem may become current in some time. Therefor it is crucial to take action and respond to the EW sign in order to prevent the problem or lessen its undesirable consequences.

2.1.3 Early warning phenomenon in other fields of study

There are many other fields besides project management which directly or indirectly deal with the concept of EW signs. The published information on the EW concept of possible problems covers a large range of areas from health related aspects to technical areas such as risk and safety and financial and economical fields.

In this section the concept of EW, as it is applied in different areas, will be briefly presented. The intention for carrying out this part of the study is to demonstrate a holistic view on the concept of EW signs in various fields and thus reveal its significance as a phenomenon which in case realized and acted upon, can prevent diversified undesired consequences. In addition, the relevant information obtained, can be transformed to the project management context, which is the main focus point of this dissertation. The author will then endeavor to further explain certain areas, which have been found most relevant to the project management area.

The motive is to scrutinize the EW systems developed within these areas and thus adapt the learnings to the project management area. This will establish a base for the understanding of the barriers for identifying and responding to EW signs of problems in projects. The areas which mostly deal with this concept include: diseases and health disorders, natural disasters, child abuse/ domestic abuse, genocide, risk and safety, global warming and environmental destruction, ecosystem collapse, financial/economic distress/crisis/failure and business failure.

The information available on EW signs of diseases and health problems create one of the largest categories of published data within this field. The other terms used in addition to "EW" in this area include symptom, early indicator and early hint. The research done within this area shows that ignoring these types of EW signs can have deadly or severe irrecoverable consequences. Examples are nerve damage and major damage to organs due to overlooking EW signs of diabetes (American Diabetes Association, 2013). Also a recent study on strokes in the UK reveals that up to 10,000 cases of stroke could have been avoided in the UK each year, if the warning signs had been identified and acted upon (Dailymail reporter, 2012).

Natural disasters and their consequences have always been one of the most drastic origins of fatality and damage. Disasters in the past 35 years have taken an estimated 2.5 million lives (Pearson, 2012). A new United Nations report indicates that disasters have resulted in $2.5 trillion in damage within the last 13 years alone mainly in developing countries (Bredenberg, 2013). Global Assessment Report on Disaster Risk Reduction (ISDR,2009) states that in order to reduce the risk of catastrophic consequences, there has been quite a lot of focus on developing EW systems to help communities respond to the possibility of further disasters. Villagran de Leon et al. (2006) in their study on disaster risk management demonstrate that the lack of awareness regarding the possible disastrous event, the lack of an EW system and the lack of training to respond to the warnings are the main reasons for facing undesired negative outcomes.

Another area which is now evermore applying the concept of EW signs is the child and parenting area. Findings by the world health organization (WHO, 2006) show that 25 to 50 percent of children around the world suffer from physical abuse and around 20% of girls and 5-10% of boys experience sexual abuse. These numbers cannot be ignored due to substantial consequence not only for the affected person but also for the society as a whole. Consequences of child maltreatment can ultimately slow a country's economic and social development (WHO, 2014). This is why many countries in the world have now enacted laws and policies that define state roles and responsibilities in protecting vulnerable children from abuse and neglect. These laws include mandatory reporting, screening reports, etc. These actions are in fact responses to EW signs of child maltreatment which when ignored, can result in dreadful consequences.

Genocide is, according to Lemkin (1947), a term which is used to describe the deliberate and systematic destruction, in whole or in part, of an ethnic, racial, religious, or national group. Millions of people have died throughout the history due to genocidal acts. This explains the demand of international communities and organizations on the need for recognition and responding to the EW signs of genocidal attempts. A United Nations special event, in the 20th anniversary of Rwanda genocide, stated that "the consequences of failing to heed the warning

signs were monumentally horrifying, the world must respond early to the risk of mass atrocities amid mounting religious and ethnic polarization and demonization" (UN, 2014). The same concern applies to terrorist activities, which also demands attention from the officials.

One of the issues which have received much attention, by the environmentalists, in the past few decades, is global warming, referring to an unequivocal and continuing rise in the average temperature of earth's climate system. Examples of these EW signs are increased CO_2 concentrations which will lead to a polar warming that is greater than the global average, with more warming over land than sea (Kattenberg et al., 1996). Emission of greenhouse gases (GHGs) by humans is also another severe warning. Many worldwide organizations are now focusing on evaluation of the EW signs in order to take proactive actions for example pioneering new renewable energy projects and establishing forward-thinking innovation centers.

The danger of environmental destruction and ecosystem collapse pretty much fit into the same category as global warming. It is a serious concern for all human beings, particularly environmentalists, and has a rather extended timeline before the negative consequences are actually realized. Researchers are now more than ever monitoring bio-indicators in order to obtain information on EW signs of environmental damage and EW signs of potential harm to human health based on the responses of wildlife to different types of pollutions (Hamza-Chaffai, 2014). Scientists and ecologists believe that radical changes in an ecosystem can be detected in advance, possibly in time to prevent ecological catastrophes (Carpenter et al., 2011). Examples of EW signs of ecosystem collapse are extinction of animal species and lakes and rivers drying up which if not prevented can to a large extent influence the ecosystem cycle.

Examples of accidents in the engineering field are oil rig and offshore accidents which absorb lots of attention due to the potential disastrous consequences. For example the explosion of Piper Alpha platform 1988 caused to death of 167 workers (NASA safety centre, 2013). These types of accidents not only harm lives of individuals abut also have hazardous consequences for the environment. The Macondo Blowout (Gulf of Mexico) in 2010, among taking lives of 11 men, was the beginning of a catastrophe that sank the Deepwater Horizon drifting rig and spilled over 4 million barrels of crude oil into the Gulf of Mexico. The spill disrupted an entire region's economy, damaged fisheries and critical habitats, and brought vividly to light the risks of deep water drilling oil and gas (Christou and Konstantinidou, 2012). A study done by Christou and Konstantinidou (2012) on analysis of lessons learned from past accidents in the oil and gas operations articulates that one of the important organizational and management failures which leads to accidents is the lack of timely recognition and reaction to EW signs.

Many models have been established, over the last few decades, for predicting financial distress due to it becoming a very strong threat to emerging economies. Through the search within literature sources, the author managed to find not only studies on prediction of financial failure but also on specific EWs of financial distress, crisis or failure. A research by Korobow et al. (1976) has been aimed at the development of EW indicators from financial

reports that banks file routinely with regulatory agencies. The results strongly suggest that substantial improvements in the allocation of supervisory resources could be achieved by focusing attention primarily on banks designated as vulnerable by the criteria set forth in the EW procedures.

Large numbers of studies have been done on the causes and EW signs of economic distress which in many cases have resulted to development of prediction models. Cheang (2009) states that one of the preventive actions regarding financial crisis is to apply an EW system providing signals that reflect the likelihood of an economy facing financial crises over a given time horizon. Kaminsky et al. (1998) and Kaminsky and Reinhart (1999) have developed EW systems which monitors several indicators which tend to exhibit an unusual behavior in the periods preceding an economic crisis. This has been done by designing certain set of indicators which in case monitored and measured effectively can shed light on signs of failure. Whalen (1991) on a study on USA bank failures examines a particular type of EW model called a Cox proportional hazards model which generates estimates of the probability that a bank with a specific set of characteristics will survive longer than some determined duration of time in the future. Another prediction method, named "rough sets model", has been developed by Tay and Shen (2002), who demonstrate that it is applicable to a wide range of practical problems pertaining to economic and financial prediction. In addition, the results of their work show that the rough sets model is a promising alternative to the conventional methods for economic and financial prediction. A number of other researchers have also developed models which are aimed for prediciting financial crisis (Sarkar and Sriram, 2001; Bussiere and Fratzscher, 2002; Xu and Wang, 2007).

According to Dimitras et al. (1999) and Balcaen and Ooghe (2005) Business failure prediction is a scientific field which many academic and professional people have been working on, in the last few decades (Courtis, 1978, Altman, 1993, Boritz et al., 1995; Slowinski and Zopounidis, 1995; Beaver, 1966). Also, financial organizations, such as banks, credit institutions, clients, etc., need these predictions for firms in which they have an interest (of any kind).

Table 2.1 presents the EW systems which have been developed by different researchers within the above mentioned fields.

Nikander (2002), with whom the author's previous findings are consistent, states that very little literature to date deals explicitly with EWs in projects and project management. However expanding the view beyond management literature, the belief in EWs seems more profound. Whereas detecting minor behavioral changes in competing industrial enterprises that eventually lead to the introduction of profoundly new technologies can be challenging, identifying physical changes, such as the formation of a low pressure system or an increased concentration of a certain type of algae could be easier. Not surprisingly, there is an abundance of articles, reports, and web pages dedicated to or dealing with EW signs in many different sectors. In the next section, some of these sources, when looking into specific approaches to the identification of EW signs, will be reviewed.

Table 2.1 The concept of EW sign as applied in different scientific areas

Scientific area	Consequences of ignoring EW signs	Examples of Developed EW systems
Diseases and health disorders	Loss of human lives Irrecoverable damages to the body and mind	Surveillance systems for infectious diseases (WHO, 2014) EW system for epidemics (Kaay and Bouma, 1996) Disease EW systems (Swanton et al., 2009) System used in the context of communicable diseases threats (Coker et al., 2008)
Natural disasters	Loss of human lives Displaced population Health risks Food scarcity Costly damage to the environment	EW system for natural and manmade disasters (Flanagan, 2001) EW systems for natural disaster reduction (Zschau and Kuppers, 2001) Global EW systems for natural hazards (Basher, 2006) The EW of humanitarian disasters (Schmeidl and Jenkins, 1998) Earthquake EW systems (Gasparini et al., 2007)
Child abuse/ domestic abuse	a child's health, growth and intellectual development complex social and economic problems ; education failure and unemployment, substance addiction, crime and delinquency	Community nursing and home visits (Browne, 1995) Societal and community strategies (WHO, 2006) Promoting family wellness (Prilleltensky et al., 2001)
Genocide and terroristic actions	risk of mass atrocities amid mounting religious and ethnic polarization and demonization	Systematic EW of humanitarian emergencies (Harff and Gurr, 1998) Strategic model for forecasting genocide (Ulfelder, 2012)
Risk and safety	Fatalities and injuries Hazardous consequences for the environment Economic losses	Trapezoidal fuzzy AHP method (Zheng et al., 2012) Resilience based EW indicator (REWI) (Øien et al., 2010) Safety indicator development (Skogdalen et al., 2011) Condition monitoring systems (Wackers and Kørte, 2003)
Global warming Environmental destruction Ecosystem collapse	Polar warming Harms to human health and wellbeing Lakes and rivers drying Extinction of animal species	'Synoptic-based' weather-watch warning system (Patz et al., 2005) Tipping elements monitoring (Lenton, 2011) EW system for shellfish production sites (Gourmelon et al., 2010) Ecosystem monitoring and EW system (Contamin and Ellison, 2009) Ecosystem catastrophe predictive tools (Guttal and Jayaparkash, 2008)
Financial/economic distress/crisis/failure	Negative impacts on human well being Bankruptcies Unemployment	Economic distress indicators model (Kaminsky and Reinhart, 2000; Zhuang and Dowling,2002; Cheang,2009) EW system model for predicting financial crises, based on a multinomial logit model (Bussiere and Fratzscher, 2002) EW indicators of banking and currency crisis (Goldstein et al., 2000)
Business failure	Job losses High costs Bankruptcies	Statistical approaches ; Ratio analysis, Multiple regression models, Multiple descriminant analysis (Altman z-scores), Neural networks (Boritz and Kennedy, 1995) A model for predicting crises in small businesses (Laitinen and Gin Chong, 1999) Earlywarning/opportunity systems for intelligence (Hedin et al., 2011) Early-warning system to guard against failure for family businesses (Finkelstein and Jackson, 2007)

2.2 Early warning identification approaches

2.2.1 Early warning detection approaches directly mentioned in project management literature

According to Nikander (2002), very little existing literature deals explicitly with the EW in projects and project management. The same observation was made by Klakegg et al. (2010) addressing that this topic is under researched. However, the project management literature does include some statements that are possible to interpret as examples of EWs. For example, Kerzner (1995), Cleland (1994), and Zeitoun and Oberlender (1993) have pointed to this phenomenon in their studies (Nikander, 2002). The approaches which will be discussed in this section include risk management, EVM, project success/failure factors and project assessment methods.

A broad range of the project management literature points to EW signs through the treatment of risk management as one important part of the field's toolbox. The body of work on risk management is too large to review here, so it is suffice to say that various authors have mentioned terms such as 'risk symptoms' and the 'occurrence of symptoms and issues' which are closely related to the EW phenomenon. According to Nikander (2002), since EW refers to a problem that may arise in the future, the relation between the EW phenomenon and risk management is rather obvious. Kappelman et al. (2007) also link these two concepts by stating that EW signs provide an indication of evident risks and thereby an assessment of a project's exposition to future problems and failure.

An example of the research done on the link between risk and EW is the work done by Niwa (1989) which outlines an approach based on the use of computer-based expert systems. The concept of risk alarm was introduced as an advance warning of emerging problems.

Earned value management (EVM) is mentioned to be another approach that provides triggers or EW signals (Fleming and Koppelman, 2000). According to Vanhoucke (2012), the EVM system relies on a set of metrics that measure and evaluate the general health of a project. Kim et al. (2003) also refer to this approach by stating that EVM is perceived as being a good forecasting or an EW tool that enables project managers to plan and control projects proactively.

In addition, there are other authors who have referred to this method without directly using the EW term, but emphasizing its usefulness as a tool that enhances proactive problem solving (Brandon and Daniel, 1998; Anbari, 2003, Lipke et al., 2009; Vanhoucke, 2010). Lipke et al. (2009) mention this method as a predicting tool for a project's final outcome. They claim that it can actually start predicting the outcome as soon as 10% of the project is completed, thereby giving project managers a good time for taking timely actions in the case of negative predictions.

Another large body of literature in the project management field deals with so-called project success factors, or sometimes their inverse, project pitfalls. This topic was also extensively researched by Nikander (2002) and listed a number of key publications on the topic.

Important work includes Baker et al. (1988), Pinto and Slevin (1987; 1988), Lewis (1993), Cleland (1994), Harrison (1993), Lim (1987), Keil and Montealegre (2000) and Miller and Lesard (2001). Similarly, on project problems or pitfalls, some relevant material can be found in Nikander and Eloranta (2001) and Nikander (2002), where compilations of typical project problems were presented, while both Kerzner (1994) and Lientz and Rea (1995) discussed cause-and-effect (cause-and-problem) chains in projects.

There is an abundance of literature outlining ways to ensure that success factors are promoted or pitfalls avoided. The recommendations range from specific tools like project planning and stakeholder analysis to good advice about communication, leadership, and other soft management skills. Paying attention to these signs, earlier in the project, increases the probability of successful outcomes. However, still very little seems to focus on the EW aspect of trying to detect either the absence of success factors or movement toward pitfalls. To the extent that the different empirical studies of successful or failed projects have been able to identify truly generic issues, these should represent a suitable platform for developing EWs. Thus, it is perhaps a little surprising that little work has been done pursuing this idea.

Various project assessments have also been discussed as a way to identify areas that should be addressed by EW monitoring. Project assessments go by many names, some of which are project reviews, PHCs, benchmarking, post project evaluation and project audits (Klakegg et al., 2010). Assessments can take place during the project initiation stage and up to the project mandate stage, when the go/no go decision is made and even post-project completion. There is much literature on the stage gate approach and how it aims to preempt potential problems that make a project non-viable (Cooper et al., 1997; Cooper, 2005; OGC, 2007); however, as Flyvbjerg et al. (2003) caution, overoptimistic assessments of benefits and underestimates of problems and risks can subvert this process as a way of flagging risk that may result in an unsustainable project.

As mentioned earlier, the concept of EW signs has been underrepresented in the literature. It is not easy to find specific approaches for the detection of EW signs and responding to them. Looking at the overall picture of what the literature already contains on this topic, it can be seen that the importance of detecting EW signs is emphasized as a means for avoiding the full impact of problems. However, there is still a great deal to be found out on how to detect these signs and how to act upon them. The author believes that there are many fields in which this topic is alluded to without using the exact term of “EW”. Therefore further investigations into such fields will be done in order to extract the useful information for coming up with a statement on how EWs can be detected in a systematic way. This will be presented in the following section.

2.2.2 Early warning detection approaches indirectly mentioned in project management literature

In addition to the approaches indicated in section 2.2.1, which have been directly mentioned in the project management literature as EW identification approaches, research within the project management literature revealed that there are other possible approaches which can

be applied as a means for arriving to EW identification of possible future problems within projects.

These approaches, which will be reviewed in this section, include stakeholder analysis, brainstorming, maturity measurement, extrapolation from earlier projects, cause and effect analysis, gut feelings, and interface management (See Table 2.2)

Table 2.2 EW identification sources reported in published sources

Early warning sources directly discussed in the literature	Potential of early warning sources discussed indirectly in the literature
Risk analysis (Niwa 1989; Nikander 2002)	Stakeholder analysis (Savage et al. 1991; Cleland 1986)
Project success / failure models (Pinto and Slevin 1988; Lewis 1993; Miller and Lessard 2000)	Cause / effect analysis (Leszak et al. 2000; Parker and Skitmore, 2005; Sambasivan and Soon, 2007; Ohatka and Fukazaw, 2009; Klakegg et al., 2010)
Project assessment methods (Cooper et al. 1997; Cooper 2005; Wateridge 2002; Jaafari 2007; Miller and Lessard 2000; Klakegg et al. 2010)	Maturity assessment (Andersen and Jessen, 2003; Ahern et al., 2004; Cooke-Davies and Arzymanow 2003; Ibbs and Kwak 2000; Kerzner, 2001)
EVM (Vanhoucke 2012)	Interface analysis (Calgar and Connolly 2007; Voss 2012)
Decision support model of early warnings (Nikander and Eloranta, 2001)	Extrapolation from previous projects (Pinto and Slevin 1988; Kerzner 1987; Miller and Lessard 2000; Kappelman et al. 2007; Klakegg et al. 2010)
	Gut feelings (Nikander and Eloranta 2001; Klakegg et al. 2010; Whitty 2010)

One of the sources that don't directly refer to the EW concept, although is quite related to its identification throughout the project, is stakeholder analysis. Every single project is "surrounded" by entities that directly or indirectly participate in or influence the design, execution, and effects of the project. These are commonly termed 'stakeholders,' defined by Project Management Institute as (PMI, 2000, p. 16):

Individuals and organizations who are actively involved in the project, or whose interests may be positively or negatively affected as a result of project execution or successful project completion.

There are a number of models proposed that outline the process of undertaking a stakeholder analysis, (for example, Savage et al., 1991; Cleland, 1986; Karlsen, 2002) but they have clear similarities, which include activities to identify the project's existing and presumed future stakeholders; gain a better understanding of their needs and expectations toward the project and its outcomes; and anticipate their strategies and actions. Irrespective of which approach is used, the outcome of a stakeholder analysis will be some level of insight into what stakeholders the project has to relate to and what they expect from the project and how they might react if they don't achieve this. The issues emerging from such an analysis can clearly be utilized to identify EW signs.

Brainstorming, in particular based on the project team's knowledge of prior projects and their problems, can also be a source of EW signs. Although brainstorming in its most basic form is a very simple technique, there are more advanced varieties as well. The technique has its roots in work in advertising as early as 1939 (Osborn, 1953). Rules were defined to

aid brainstorming, but there are also doubts about its effectiveness. Stroebe et al. (1992) identified three processes that derailed brainstorming efforts; free riding, evaluation apprehension, and blocking. Issues arising from the brainstorming effort can then feed a process to identify EW signs.

The data that EW is built on should indicate pending problems as far in advance as possible. An approach of possible relevance is that of maturity measurement. This is a type of measurement that represents an even earlier warning than events; the maturity of the organization to undertake the project that it has been mandated to do. The key idea is that it might be possible to assess how mature (i.e., how qualified) an organization is to run projects, and thus very early, even before the project starts, determine whether it seems likely that the project will run smoothly or end up in trouble. Andersen and Jessen (2003) discussed the term and pointed to the dictionary definition of maturity; having reached a state of full natural or maximum development. This definition fits product and organizations alike, although it might be argued that organizations never reach a state of full maturity. Maturity models have also been extensively used as an improvement tool, where organizations conduct self-assessments (Ahern et al., 2004). If such maturity assessments reveal areas of lower maturity, it is natural to consider these targets for EW monitoring.

To extrapolate from earlier projects is a way of using the experience gained, but the validity for the current situation must of course always be ensured first. The project management literature has numerous references to how experience from earlier projects is used in order to identify EW signs. See, for example, Pinto and Slevin (1988), Kerzner (1987), Pinto and Prescott (1988) and the IMEC study (Miller & Lessard, 2000). A somewhat different approach has been used by Kappelman et al. (2007) and Klakegg et al. (2010), in which experience from earlier projects is used as a basis for discussions with project management experts, in order to get their qualified assessments of the relative importance of the EW signs.

Another concept that is indirectly related to EWs in projects is the cause and effect analysis approach. The author believes that since this topic focuses on causes and origins of issues, it is closely related to the success and failure factors in projects. Nikander (2002) provided a model indicating that problems, their causes and EWs are connected through a chain. There are other sources, which although not mentioning the term “EW” directly, refer to cause and effect analysis and root cause analysis approaches for the identification of risks in advance in order to prevent future problems (Leszak et al., 2000; Parker & Skitmore, 2005; Sambasivan & Soon, 2007; Ohatka & Fukazawa, 2009; Williams et al., 2012).

In addition to the EWs that can be identified through project assessments, another category of signs can be "gut feeling" signs. These signs are described by Nikander and Eloranta (2001) through the statement: "anticipatory feelings are the least easy to detect, identify and interpret, intuitive feeling" (p. 387). Klakegg et al. (2010) make a very simple categorization of EWs, where they are either identified through assessments or they are based on "gut feeling" (Table 1). Such a “gut feeling” will usually be closely related to the tacit knowledge of the recipient of the signals. Whitty (2010) showed the importance of emotions as an expression of knowledge, and also the use of body language as such an expression, and

exemplified the importance of reading body language in a project setting in order to read some of the - sometimes even critical - signs about the state/condition of a project.

The last approach is interface management, described by Cleland and Morris (1988) as an element that serves as a natural checkpoint for managers in order to monitor performance and thus prevent problems from falling into a snowball process. Calgar and Connolly (2007) defined it as a means for the development of effective communication and information exchange among project participants. The main objective of this process is to facilitate agreements with other stakeholders regarding roles and responsibilities, timing for providing interface information, and identification of critical interfaces early in the project through a structured process.

The overall goal for the process is early identification of issues that have the potential to impact cost or schedule. This is done in order to minimize or to remove this impact, and also to promote clear, accurate, timely, and consistent communication with other organizations for exchanging interface information. Voss (2012) emphasized the importance of clear interfaces among project participants as a vital part of the project portfolio management process. Findings about interfaces among components or actors can be sources of EW.

2.2.3 Examples of Early warning identification approaches

Among the approaches discussed in section 2.2, two specific approaches were chosen to be thoroughly studied in order to examine the utility of these tools, as an EW system in practice. The reason these two approaches were chosen to be scrutinized, is first of all the scope and time limitations which dispute the examination of each and every approach mentioned in section 2.2, in practice. The second driver for carrying out the detailed research on these two approaches was the availability of cases which applied these tools in practice.

Performance measurement as an EW identification tool

In this section, the application of performance measurement as a tool for identifying EW signs will be explained. Since the specific case was an oil and gas project, the literature study has close links to the oil and gas industry.

Many authors have investigated the purpose of performance measurement and how performance measures are used in different types of organizations. With some variations, a common theme in all these frameworks is the use of performance measurement as a means to improving performance. Sink and Tuttle (1989) posed the question “Why measure?” and answered by saying; measure to improve, to provide the management team with new insights into why the system performs the way it does, where it can be improved, and finally when the system is in control or out of control. According to Bond (1999), performance measures provide a mechanism for relating product or process improvement policies developed by senior management to action at a local organizational level. For the balanced scorecard, Kaplan and Norton (1996) linked the purpose of measurement more to strategic management aspects: 1) clarify and update strategy, 2) communicate strategy throughout the company, 3) align unit and individual goals with strategy, 4) link strategic objectives to

long-term targets and annual budgets, 5) identify and align strategic initiatives, and 6) conduct periodic performance reviews to learn about and improve strategy.

This also seems valid in a project setting. Pillai et al. (2002) supported this idea by stating that performance measurement plays an important role in ensuring project success and its usefulness to the sponsoring organization. Toor and Ogunlana (2010) took a step further by identifying performance measurement as one of the most important aspects of project management, which strongly affects project success. Almahmoud et al. (2012) believe that performance measurement is the force that drives project management improvement.

Another popular approach in the recent years has been the development of different performance frameworks to explain what constitutes performance and how it should be measured. Prominent examples include the supportive performance measures matrix (Keegan et al., 1989), the Performance Pyramid also known as SMART (Strategic Measurement and Reporting Technique)(Cross and Lynch, 1989), the results/determinants matrix (Fitzgerald et al.,1991; Fitzgerald and Moon, 1996), the balanced scorecard (Kaplan and Norton, 1992), PHC (Jaafari,2007), the EVM approach as a performance measurement tool for cost control (Bower and Finegan, 2009), a multidimensional project Performance Measurement System (PMS) to enable managers to deal with large volumes of data (Marques et al., 2010), and the Swiss cheese performance management model (Almahmoud et al.,2012). Also Ika et al. (2010) in their study mentioned several performance measurement tools such as cost benefit analysis (CBA), logframe, scoring techniques, etc.

Clearly, performance measurement is a versatile tool that has found a wide range of application areas in different sectors. However, from this brief review of some sources, a common pattern seems to be emerging; performance measures, in the capacity of representing a metric used to quantify the efficiency and/or effectiveness of action (Neeley et al., 1995), is very much directed at performance improvement. Performance measurement links strategy to action, motivates employees, supports budgeting and control, allows benchmarking, etc., all of which are geared toward improved performance. As was explicitly stated by Behn (2003), the only real purpose is to improve performance; the others are simply means to achieving this ultimate purpose. It is crucial to note that recent findings show that in today's competitive, complex environment, the performance management approach that focuses only on traditional progress indicators can no longer be sustained and project managers need to manage project's performance in a proactive rather than reactive manner (Almahmoud et al., 2012).

In the work done by Andersen and Fagerhaug (2002), a potential for using performance measurement as a tool for EW was noticed. There are a few other references to EW in the performance measurement literature, and these are discussed a little later in the dissertation. EW is also closely related to the concept of leading indicators, which will also be discussed later on. However, there seems to be a consistent difference in how EW and leading indicators are perceived from what we think of in the context of projects. This point will be further elaborated on, but briefly explained; performance measurement is normally focused on detecting the presence of positive performance drivers, or alternatively, the absence of these, and as such constitutes some EW that a negative development could be imminent. In

a project setting, EW should be more aimed at detecting predictors of negative events or crises, which is the inverse of how performance measurement usually works.

Within the area of performance measurement, at least one specific application of EW, in the area of product development processes, has been found. However, the author also believes that the concepts of leading and lagging indicators need to be included here, as there seems to be a link to EW. Syamil et al. (2002) carried out a research on performance measures in product development processes that also discussed briefly the potential of such measures as EW signals. The idea is that measurements can be taken both at the end of a process, in this case a product development process, and during the process. Such measurements, the authors claimed, have been ignored, but could be very useful. If measured early enough, they could predict later problems that would only show up after-the-fact in traditional end-result measurements.

This view, however, is really not different from the gradually prevailing view in the field of performance measurement; performance indicators must be balanced, both with regard to performance dimensions covered and the time of measurement. When introducing the balanced scorecard approach, Kaplan and Norton (1996) emphasized both these aspects and also referred to this time balance as a matter of leading and lagging indicators. Lagging means they are measured at a late stage in a process or a chain of processes, thus presenting management with a rear-view mirror assessment of events that have happened and can no longer be influenced. Such indicators show up too late to have any value in EW. Leading indicators, contrary to what seems to be a common belief, are not able to measure "before the fact". Also leading indicators need to measure an event or status after they have occurred. What sets them apart from lagging indicators is what they measure. Typically, when designing leading indicators, the objective is to capture events or developments in an early stage of a cause-and-effect chain, thus being able to predict future performance. In support of this idea, Keil and Montealegre (2000) recommended that managers need to ask themselves in the earliest possible stage of the project if there are any "red flags" serious enough to lead to project termination or remarkable redirection. Paying attention to these signs earlier in the project increases the probability of successful outcomes.

Future knowledge can be impacted, but not the current, so the prediction ability of the leading indicator lies in its location in the cause-and-effect chain. This is equal to the thinking of Ansoff (1974), Nikander (2002) and others who have discussed EW and project EW, i.e., the crucial issue is to be able to interpret signals that appear early in a chain of events. The answer of performance measurement is to define performance indicators or metrics that track these signals, thus allowing management to respond to them early enough. Performance measurement seems to have the capacity to close the gap not addressed by other authors discussing project EW, where it is simply assumed that weak signals will be detected and interpreted correctly.

Project health check as an EW identification tool

The project health indicator (PHI) tool, developed by CII (2006), is a tool which is directly referred to as a predictive evaluator of future project risk. It utilizes a prioritized list of measures and a weighting system based on the statistical correlation of these indicators to

project health and phase. The PHI tool is a management process which implements periodic project reviews based on composite and individual scoring systems. This tool which does not rely only on hard data and allows projects to identify issues earlier has a broader application comparing to traditional tools. In fact it attempts to fill the gap between the project definition rating index (PDRI) and traditional project control methods. The management can use it at all levels of the organization to assess project health.

The 43 developed indicators, which are introduced as "leading indicators", are defined as fundamental project characteristics and/or events that reflect or predict project health. Revealed in timely manner, these indicators allow for proactive management to influence project outcomes.

The five key project outcomes are mentioned to be cost, schedule, quality/operability, safety and stakeholder satisfaction.

Another tool later discussed by Jaafari (2007) is the Project Health Check (PHC) which denotes how systematic the project team is in its management of the project variables. The aim of this tool is to systematically define the management of project variables in order to determine whether the project is healthy (in case managed systematically) or ill (in case managed haphazardly).

This framework is intended to shift management focus from measuring performance effects to learning from project behavior as a complex system, and to focus on the state of managerial approaches e.g. the enabling factors (Almahmoud et al., 2012). The role of PHC is presented in Figure 2.6.

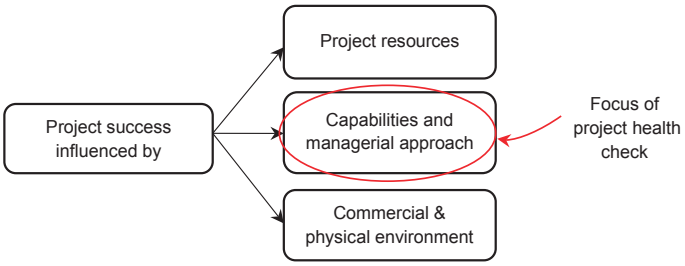

Figure 2.6 The role of PHC (Jaafari, 2007, p. 782)

PHC consists of 18 criteria including business and strategic assessment and project implementation assessment. Each management area of a project can be assessed according to these criteria in order to assure systematic management of project business concerns and to ensure that management of project implementation is in alignment with project business goals. It can also be used as part of organization's strategic management and business improvement exercises (Betts, 1999).

PHC can be applied at any point in the life of a project. A project can be assessed right from the conceptualization phase through to the completion and operation phase. Assessments done at different points in time on a given project/program can be archived and plotted to

observe the trends. It can also be implemented as a benchmarking tool as it allows the project planners to select an appropriate target in terms of the management approaches. It should be mentioned that the questions in the PHC can be modified according to the project.

When the project is in its formation stage, application of PHC will guide the planners towards adopting optimal approaches to the management of the enabling factors. As the project evolves, the application of PHC helps diagnose the areas of poor capability and managerial performance, or misalignment of resources with project goals and priorities. So the management team will be able to introduce measures to realign the managerial approach and address any shortcomings identified.

Several authors have pointed in their works to PHC as a useful tool for following up the trend of project progress. Betts (1999) propose a strategic health check for IT management, in the construction industry, which is intended to lead project managers toward more effective strategic IT exploitation by gauging the current position of the company. The health check is meant to ease the successful application of IT by ensuring that the right people are given the right opportunity at the right time.

Basu (2013) states that in line with quality audit, performance management and maturity or excellence models, there is evidence of the value of well-structured checklists to perform holistic health checks. These processes can greatly contribute to continuous improvement.

Jordan and Silcock (2005) believe that application of a health check is a proactive and defensive action that an organization can take and is proven to be extremely more cost effective than recovery and restoration. The focus of their work is on the IT domain and they believe that it is possible to cope with many IT risks, with irresistible consequences which cause organization fatalities, applying the health policy.

Wateridge and Atkinson (2009) in their work present a PHC blueprint that enables users to establish their success criteria, manage stakeholders, manage any people issues and use the established project management techniques and methodologies.

The literature studies show that this tool can be applied in various domains such as IT (Flinn, 2010; Jordan and Silcock, 2005; Betts, 1999), construction (Almahmoud et al., 2012; Humphreys et al., 2004; Betts, 1999), and telecommunication (Andersen et al., 2005).

According to Kerzner (2013) while metrics such as cost and time may provide a reasonable presentation of where the project is at a specific time, the use of these metrics for giving forecasts into the future produces “gray” areas and may not indicate future problem areas. This can prevent a successful and timely completion of the project. The simple solution may be to perform periodic health checks on the project. The focus of health check is on the future and the items to be searched within the use of this tool is possible destructive issues and possible cures.

Health checks can also be used at the organization level for monitor how well the organization supports change projects established for management of the change process (Turner et al., 1996). Periodic health checks, if done correctly and using good metrics, eliminate ambiguity so that the true status can be determined.

As mentioned earlier, the proactive and defensive actions which organizations take, are proven to be massively more cost beneficial than recovery and restoration (Jordan and Silcock, 2005). Health policy which recognizes the benefit of prevention over cure can be a good approach for identifying the EW signs of problems in projects. Kerzner (2013) also points to this issue by stating that one of the benefits of health check includes identifying problems early enough that sufficient time exists to take corrective actions.

The use of PHC at different project phases, e.g. initiation, planning and execution phase, indicates if the project is exceeding the warning zone. If it has passed the limit, it is an EW for the project and the project manager should take corrective actions in order to avoid failure.

The link between PHC and EW has been thoroughly discussed in the work done by CII (2006). According to CII (2006), the leading indicators defined for the PHI tool provide real-time EW signs of an unhealthy project. These indicators are meant to provide additional insight into the health and vitality of a project. This can aid to assure that the project meets the desired performance targets and adds value for all participants in the project development process.

The model presented in Figure 2.7 has been developed based on PHC and the project life cycle model developed by Jaafari (2007) and the preliminary model suggested by Nikander (2002) for introducing the EW phenomenon. Also it considers the work done by CII (2006) on the link between project health and EW signs. The model views project events as a time-bound continuous stream of events (project life cycle). Information about this stream can be obtained at any given moment. This information is processed, in this case by application of PHC tool, and responses are required in order to influence the flow of the project. As it is shown in Figure 2.7, the project health is assessed at time t_1 and the information which contains the results obtained from the PHC report card, is processed. In case the information reveals any warning on possible future problems which is likely to occur at some time in the future, for example t_3, there is a need for responding to this sign by applying corrective actions in order to avoid the potential problem. The available time between t_1 and t_3 provides the opportunity for project managers to make the right decisions for responding to the detected warning sign.

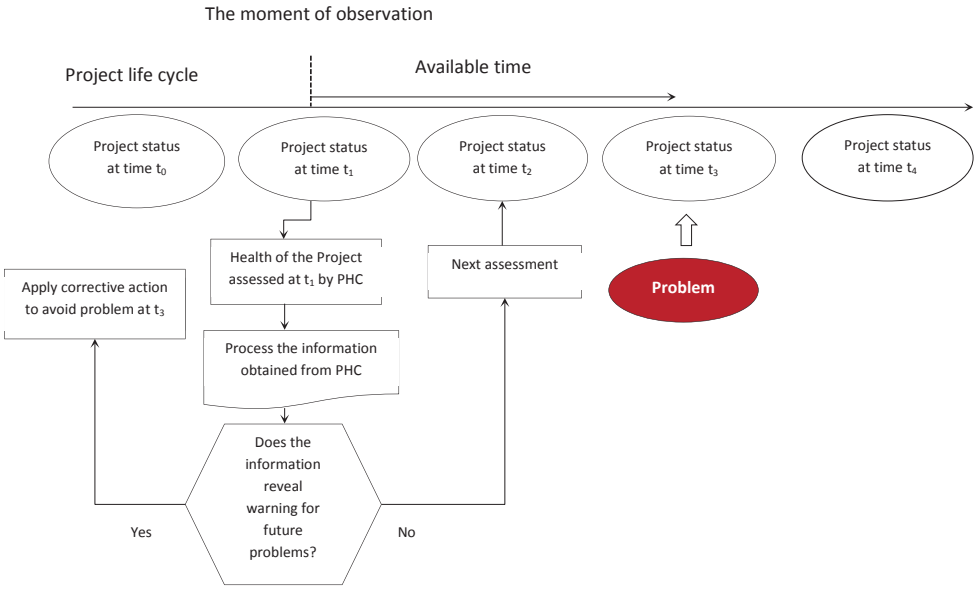

Figure 2.7 PHC and the EW phenomenon

2.3 Obstacles against effective responses to early warning signs

In this section, more detailed description on possible barriers to responding to EW signs and possible recommendations for improvement of the procedure, in the areas of finance and business will be demonstrated. The motive was that these two areas were found most relevant to the project management field. The findings will be used to build a foundation for further investigations on existing barriers within the EW procedure and suggestions for overcoming them, within the project management area.

As mentioned earlier, although there is evidence that it is possible to detect EW signs in projects and despite the existence of the necessary information, the appropriate response is missing from project managers in many cases. This may be due to many reasons, such as time pressure, a tendency for optimism, and the effects of politics (Williams et al., 2012), over-optimism, lack of tolerance of warnings, and lack of an outside view (Lovallo and Kahneman, 2003), or the 'normalization of deviance' (Pinto, 2013).

In the course of this study, the available literature regarding the identification of possible sources of EW signs within projects has been examined (See section 2.2). Some sources are directly mentioned in the literature and some are indirectly mentioned as possible approaches to identifying EW signs of future problems. The same approach was applied in order to find possible barriers to project managers' responses to EW signs within projects. Very few references exist, besides Williams et al.'s (2012) work, which refers to possible reasons for lack of responses to EW signs within projects by directly mentioning the obstacles against responses to such signs. Although Ansoff's management model discusses the possible filters, it does not explain why these filters are created. Therefore, a study of

different fields relevant to project management was conducted in order to find possible reasons that may contribute to the formation of these filters.

The approach was to investigate on concepts closely related to the EW concept. A thorough literature study on all the areas which deal with the EW phenomenon was carried out in order to identify the fields which are most relevant to the project management area. The author found that the closet concepts are 'forecasting' and 'prediction', due to the fact that EW signs of problems are identified on the basis of predictions and assumptions of future. Within the sources pointing to these concepts, the ones which discussed "possible drivers for making irrational or false decisions" were chosen.

According to Lovallo and Kahneman (2003), high numbers of business failures are not mainly due to rational choices that later become inappropriate, but rather as a result of faulty decision making, which occurs when decisions are based on *delusional optimism* rather than on rational weighting of gains, losses, and probabilities. In the former case, the benefits are overestimated, the costs underestimated, and potential problems and miscalculations are overlooked.

Wu (2012) claims that business failure prediction methods are generally important and purposeful due to the possibility for corporate managers to apply failure prediction methods to develop EW systems for possible business failure and thus take proper actions to prevent such failures. Moreover, also sponsors and financial institutions can utilize the methods to enable better decision-making processes.

In order to improve the accuracy of forecasts, Lovallo and Kahneman (2003) suggest the application of two distinct modes of forecasting: the inside view and the outside view. The forecasts prepared by an internal project team focus closely on the case objective and the obstacles to its completion, and are characteristically extremely optimistic. By contrast, the outside view completely neglects the project's details and rather examines the experiences of a class of similar projects, draws up a rough distribution of outcomes for this reference class, and then positions the current project within that distribution, and the result is much more accurate than that obtain using the inside view (Flyvberg, 2013; Lovallo and Kahneman, 2003). It should be noted that optimism should be promoted to keep employees motivated. The innate optimism of professional project managers allows them to deal effectively with the contradictory characteristics of their work environment (Dolfi and Andrews, 2007), but at the same time the decision makers should generate realistic forecasts (Lovallo and Kahneman, 2003).

Another view is that the optimism bias is one of several results of negative dynamics caused by the *normalization of deviance* within project organizations (Pinto, 2013). The concept of the normalization of deviance was initially published by sociologist Diana Vaughan (1996), based on a study of the National Aeronautics and Space Administration (NASA) culture prior to the Space Shuttle Challenger disaster, and suggests that *the unexpected becomes expected, which in turn becomes accepted.* Social normalization of deviance means that people within an organization become used to a given deviant behaviour to the extent that they no longer consider it deviant, although such behaviours far exceed their own elementary safety rules. The concept also represents a cultural attitude that deliberately

creates conditions under which mistakes are made, and as a result it provides a perfect environment for corporate or project misbehaviour. Problems appear when actions and attitudes such as organizational conflict become culturally embedded and destructive but remain viewed as a normal part of organizational processes without questioning the assumptions driving them. Pinto (2013) categorizes three main types of such behaviours: (1) project proposals and strategic misrepresentation, (2) client/contractor relationships and planning, and (3) scheduling dynamics. In order to resolve these issues Pinto (2013) suggests both remediation through project governance and reflection through organizational learning. The challenges related to these actions should not be overlooked. For example, organizational learning often faces challenges due to the unique nature of project-based work, which develops barriers and limits that prevent or slow down the transfer and use of knowledge obtained from earlier projects (Bartsch et al., 2013). A study by Bartsch et al. (2002) shows that project managers' *intra-organizational social capital* enhances organizational-level learning and can contribute to lowering the likelihood of undesired outcomes.

Anderson and Galinsky (2006) have a rather distinctive opinion on the source of optimism, stating that a sense of power increases the level of optimism in perceiving risks and thus leads to more risky behaviour. They also state that powerful people might be highly focused on the payoffs, lose sight of the possible consequences of their actions, and become increasingly optimistic that they can get away with a range of actions to the extent that their behaviour becomes more risky and they are more likely to violate social and ethical norms.

Another aspect which is likely to act as a barrier against effective actions towards EW signs of potential problems is the complexity involved with projects. There is abundance of literature on the concept of project complexity and its types (Baccarini, 1996; Williams, 2002; Jaafari, 2003; Cooke-Davis et al., 2007; Bosch-Rekveldt et al., 2011; Giezen, 2012 and Davis and Mckenzie, 2014). According to Klakkeg et al. (2010), it seems reasonable and quite well documented that increasing level of complexity makes it more burdensome to discover and interpret signals. In these projects EW signs are sometimes unknown unknowns and due to this fact may not appear relevant until too late. Klakegg et al. (2010) in their study, recommend several approaches which can aid project managers to overcome this barrier.

Table 2.3 summarizes the possible barriers against project managers' responses to EW signs and suggested solutions as reported in various literature sources.

Table 2.3 Possible barriers against responses to EW signs and suggested solutions

Reference	Barrier	Description	Solution
Lovallo and Kahneman (2003)	Over-optimism	Benefits are overestimated, costs underestimated, and the potential for problems and miscalculations are overlooked	Adopting a dual view (inside and outside view)
Pinto (2013)	Normalization of deviance	The unexpected becomes expected, which becomes accepted.	Remediation through project governance and reflection through organizational learning
Bartsch et al. (2013)	Fragmentation	Projects hinder organizational learning	Intra-organizational social capital
Hofstede (1984)	Culture of uncertainty avoidance	The extent to which the members of a culture feel threatened by ambiguous or unknown situations.	–
Flyvbjerg (2013)	Systematic fallacy (illusion) in decision making	Causes people to underestimate the costs, completion times, and risks of planned actions, whereas they overestimate the benefits of the same action Stems from actors taking an 'inside view', focusing on the constituents of the specific planned action rather than on the outcomes of similar actions already completed	Taking an 'outside view' on planned actions, which consists of using experience from similar ventures already completed, including (a) the average outcome in sets of such ventures, and (b) distributional information about outcomes
Flyvbjerg et al. (2009)	Optimism bias and strategic misrepresentation	Planners and project promoters make decisions based on delusional optimism rather than on a rational weighting of gains, losses, and probabilities Political-economic explanations and strategic misrepresentation account for the systematic underestimation of costs and overestimation of benefits found in data	Taking an outside view
Klakegg et al. (2010)	Time pressure	Difficulties for acting due to lack of time to think ahead and question assumptions	Secure transparency in decision making
	Mismatch in incentives between the organization and individuals	Individuals take their experience to the next project and fail to recognize the need to secure the ability of an organization to learn	Install project assurance
	Tendency to optimism	Trust in a project team's ability to fix the problems and that all will be fine in the end.	Improving project manager key competences and skills
	Effects of politics	Political pressure (exerted by the project owners) to implement a given solution	Improving formal assessment approaches
	Project complexity	A situation involved with flux and unpredictability and large amount of unknown unknowns	Using approaches which encourage more interactions so that patterns can emerge

2.4 Conclusions of the literature review and suggested areas for future research

The published research on the concept of EW signs is relatively limited, particularly on the practical side of project management. In the course of the literature study, the author came to understand that although there are abundant numbers of tools and techniques which can be utilized as EW identification approaches, the EW signs are in many cases not recognized timely enough to act upon them. In addition, even if the EW signs are in certain conditions detected, it is likely that they are not effectively responded to. This can cause a wide range of problems from minor deviations from the original plan to absolute catastrophes. As the number of failed project grow every day, the question still remains as to why the emergence of failures cannot be prevented.

The literature review seems to show that these problems are mainly addressed through indecisiveness in the utilization of the risk management process. Limited findings have emerged regarding the concept of EWs within the risk management procedure and how giving attention to this phenomenon can enhance the risk management process thus resulting to better handling of undesired outcomes.

The limited research on possible approaches for identifying EW signs, the application of EW identification approaches in practice and possible barriers against responding to them can be seen as research gaps, which are addressed in the individual publications. Figure 2.8 presents the recognized research gaps.

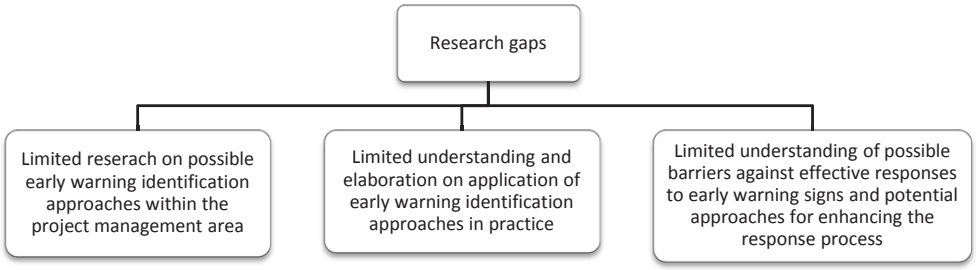

Figure 2.8 The research gaps

In the next section, the research questions and the rationale for each of the research questions, followed by the research methodology applied for answering the research questions will be presented.

Chapter 3

3. Research design

Research is about systematically acquiring and analyzing data in order to increase our knowledge about a topic in which we are interested. In the course of research, a question is to be answered or a problem is to be addressed. This is often being referred to as 'meeting the research aim' or 'addressing the research objectives' (Saunders and Lewis, 2012). However prior to this, it is crucial to overcome the "why" and "how" questions related to research. In other words it is required to indicate the purpose of the research and also provide a clear rationale as to why this purpose is important and worth studying. According to Phillips and Pugh (2010), research looks for explanations, relationships, comparisons, predictions, generalization and theories. These are the "why" questions in research. Having the rationale clarified, the purpose of research should be determined.

The effect which a research tends to have on its audience and the way this is intended to be produced, constitutes the research purpose. According to Yin (2012), the research purpose can be exploratory, descriptive, explanatory or policy-oriented. Since any research develops over time, more than one of these purposes may be identified. This is of course greatly influenced by the research problems.

The choice of the methodology, which is a way to systematically solve the research problem (Kothari, 2004), is perhaps one of the several major aspects that require significant consideration by researchers. Each research method has specific advantages and disadvantages depending upon three conditions including: type of research question, the level of control over actual behavioral event and focus on contemporary as opposed to historical phenomena (Yin, 2012). Another driver for the choice of methodology is, according to Zikmund (1991), the level of uncertainty about the research problem. Holden and Lynch (2004) believe that choosing a research methodology that is, the how of research, involves something much deeper than practicalities. In fact it necessitates a philosophical

solution to "why" research? The major philosophical approaches, involving either a subjective or objective approach to research, are described by assumptions regards ontology (The reality), epistemology (the knowledge), human nature (predetermined or not) and methodology.

According to Mukhrejee et al. (2002), all research approaches have something to offer. However, selecting a research methodology is not just a question of academic validity –the feasibility of it must also be considered given the constraints of the research project.

The purpose of this chapter is to provide a methodological review and discussion in order to demonstrate why the research questions were formulated and how they have been answered through this dissertation. Figure 3.1 presents an overview of the research process which will be later described in the following sections.

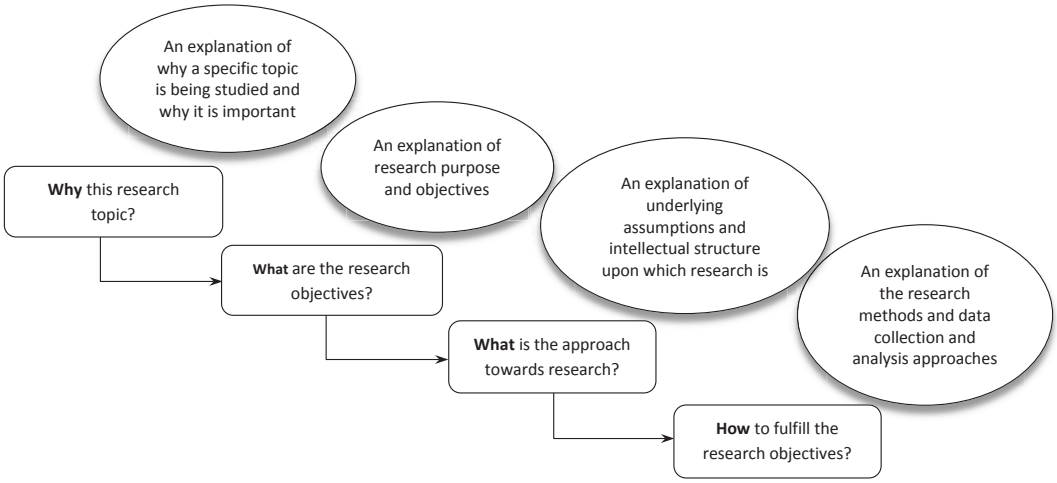

Figure 3.1 Applied research process

3.1 Identifying the research problem (Why?)

The focus of this dissertation is on the concept of EW signs of potential problems in projects and an investigation on possible approaches which can be applied in order to identify and act upon EW signs. In addition this study endeavors to scrutinize possible barriers against effective responses to EW signs within projects.

This study was motivated by earlier research and literature review which revealed that despite the improvements in utilization of project management tools and techniques in the recent years, quite a significant number of projects still fail to meet their objectives. An approach to avoiding this is to attempt detecting possible project failures at the early stages of projects, in order to take the necessary corrective measures. In retrospect, it is quite often possible to point out a number of the most likely factors contributing to projects' failure. A number of signs of this failure can also be seen in advance. Those signals, with the benefit of hindsight, often appear as obvious and it is hardly possible to understand why they were not taken into consideration at the time.

However the concept of EW signs is underrepresented in the literature. Apart from a few key works, e.g. Ansoff (1975), Nikander (2002) and Klakegg et al. (2010), not much work has been done on EWs within the project management research literature. This was considered as an area that should be looked into more closely.

According to Nikander and Eloranta (2001), conventional methods of project control only tend to address issues within the scope of the project and are unable to perceive surprising situations which are developed outside the scope of project plans. Identification of EW signs and relating them to the appropriate project problems and their causes is the first step for preventing undesired consequences. It is then important not to stay content with this knowledge and to actively start acting to lessen the threat, the sooner the better.

Klakegg et al. (2010) also state that current methods of project assessment such as project reviews, PHCs, benchmarking, post project evaluations and project audits are often unsuccessful in picking up EW signals in projects. Anyhow there are also evidences that even though there are cases where it is possible to detect EW signs in projects and despite the existence of the necessary information, the appropriate response is missing from project managers.

Based on this evidence, the rationale for this dissertation spans the following elements:

1. The concept of EWs in projects is underrepresented in the literature.
2. There is lack of information on practical implications regarding the utilization of the EW procedure.
3. The application of the EW procedure in the industry is rather limited.

3.2 Research design – research purpose (What?)

The purpose of research according to Yin (2012) can be exploratory, descriptive, explanatory or policy-oriented. Since any research develops overtime, more than one of these purposes may be identified. The exploratory approach tends to fulfill the need for better understanding of a phenomenon while descriptive method seeks to provide accurate description of observations of it. The explanatory method looks for explanations of the nature of certain relationships and finally the policy-oriented approach aims to focus on approaches for solving or preventing a specific problem.

As described in the introduction section, the general objective of this work is to develop a better understanding of the EW phenomenon, possible approaches for identifying EW signs and barriers against effective responses to these signs in practice. This opens up for a wide range of research questions. Obviously this research area cannot be reduced down to a few questions by any reductionist approach and also there is a scope limitation in order to cover it all. Therefor the research questions are simply chosen according to the author's interests and availability of the empirical information.

Research question 1*: How are EW detection approaches addressed in the existing literature?*

The purpose of research on possible approaches for identifying EW signs in practice is to understand the state of the art of the concept of EW signs in projects and the approaches mentioned which can be utilized for detecting these signs in the existing literature. This will provide a foundation for better understanding the existing research gaps and thus building a foundation for further investigations on the application of the EW procedure in practice and the possible limitations and flaws. Both *descriptive* and *exploratory* approaches are taken in order to answer this question.

Research question 2**:** *How can the utilization of EW identification approaches improve project performance in practice?*

The purpose of this research question is to explain how different EW identification approaches can be utilized as a source of data for an EW approach signaling that a project is about to experience problems at some stage in the future. It is also of question the extent to which these approaches are able to provide the responsible party with enough information for taking the right corrective action in order to avoid failure. An *exploratory* approach is taken in order to answer this question.

Research question 3: *What are the possible barriers against effectively responding to EW signs and how to enhance early responses to EW signs in projects?*

Although there is evidence that it is possible to detect EW signs in projects and despite the existence of the necessary information, in many cases the appropriate response is missing from project managers. The purpose of this research question is to better understand the issues associated with barriers to project managers responding effectively to EW signs as a means to prevent failure. An *exploratory* approach is taken in order to answer this question.

Figure 3.2 presents the process through which the research rationales led to development of the research questions and thus development of ideas for the individual publications which address each of the questions. The methods applied for fulfilling the research objectives are also presented. The statement of involvement of the author in each of the individual publications, including her contribution to the research design, data gathering, data analysis and writing the paper is presented in table 3.1.

The chronology of different parts of the research carried out during the PhD period is presented in Figure 3.3.

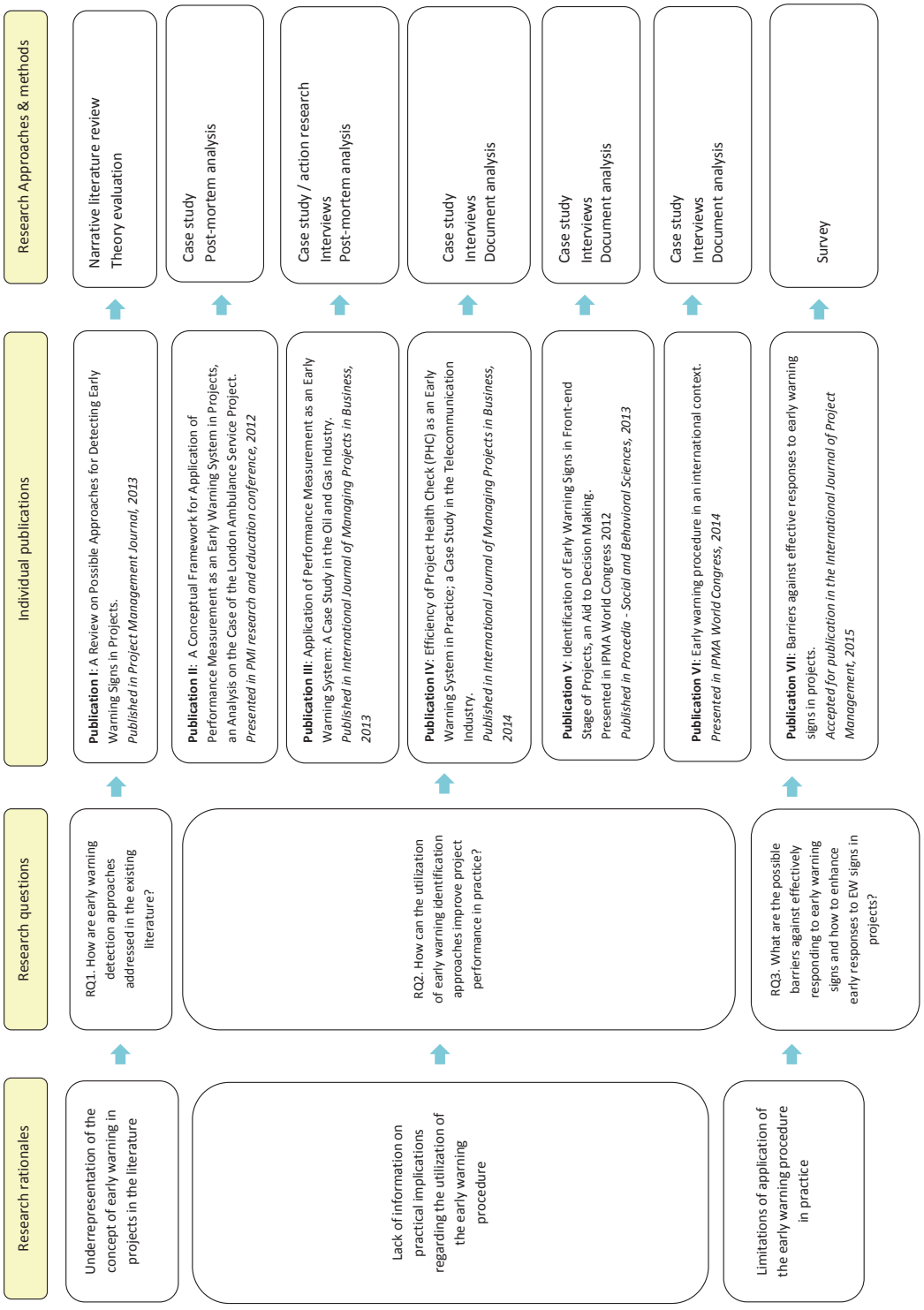

Figure 3.2 Research rationales, objectives, individual publications and applied methods

Table 3.1 Author's statement of involvement in the PhD research strands

Publications	Research approaches and methods	Author's role and involvement in data gathering and analysis
Publication I	Narrative literature review Theory evaluation	The literature review and analysis has been done by the author in equal collaboration with the co-authors.
Publication II	Case study Post-mortem analysis	The London Ambulance Service project was executed in 1992, long before the author started this research. The author has studied the published information on the case project and has investigated on the post-mortem analysis done by other researchers. Based on this, the author has carried out further analysis on the case and has developed a conceptual framework.
Publication III	Case study / action research Interviews Post-mortem analysis	The Tyrihans project was executed between 2005 and 2011. The preparatory stage of the study, being the action research, was carried out by another research team during 2005 and 2010. In 2011, The author carried out a thorough post-mortem analysis based on the data gathered through the action research and also performed three extensive interviews with the project manager and project control manager of the project.
Publication IV	Case study Interviews Document analysis	The LTE project was executed between years 2010 and 2013 and the MOVE project was executed between years 2007 and 2014. The author started the research in 2012, when both projects where still in the execution phase. The results of the application of the PHCs, which were carried out prior to the author's involvement, where thoroughly studied and analyzed. Further data was gathered through four extensive interviews with the project managers of both projects.
Publication V	Case study Interviews Document analysis	The Norwegian High Speed Railway (HSR) feasibility study project was executed between years 2010 and 2012. The author initiated the case study in 2011 by carrying out a broad document analysis on the published assessments on this project. Further data was gathered through four extensive interviews with the project manager of the feasibility study project.
Publication VI	Case study Interviews Document analysis	The IFaCOM project started in 2012 and is planned to be finished in 2015. The author carried out an analysis on project related documents followed by four extensive interviews with the project management team members in 2014. The findings were then discussed with the main project coordinator.
Publication VII	Survey	The survey was designed by the author in collaboration with the co-authors. The results were then discussed and analyzed in several group meetings with the co-authors.

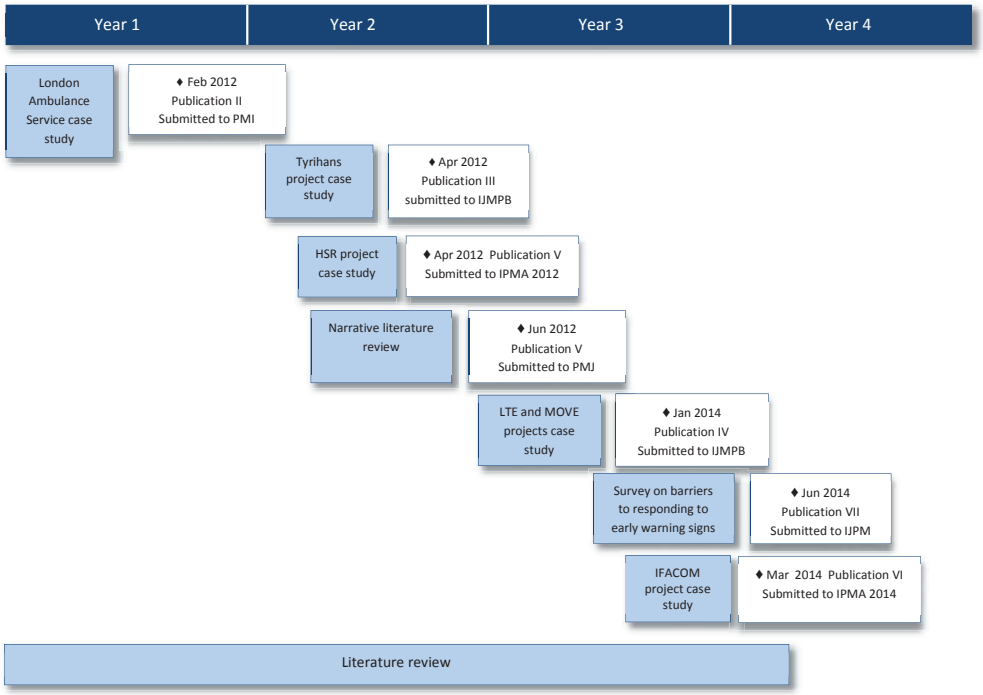

Figure 3.3 Research Chronology

The research paradigms, research approaches and research methods applied in this study will be described in the three subsequent sections.

3.3 Research paradigms

Paradigm as defined by the Webster Dictionary is "a philosophical and theoretical framework of a scientific school or discipline within which theories, laws, and generalizations and the experiments performed in support of them are formulated". The most quoted definition of paradigm is Kuhn's (1970) concept which refers to paradigm as the underlying assumptions and intellectual structure upon which research and development in a field of inquiry is based. Other definitions in the research literature include:

1. Shared understandings of reality (Rossman and Rallis, 2003).
2. A world view, a general perspective, a way of breaking down the complexity of the real world (Patton, 2002).
3. A definition of how the world works, how knowledge is extracted from this world and how one is to think and talk about this knowledge (Dill and Romiszowski, 1997).
4. A basic belief system or world view that guides the investigation (Guba and Lincoln, 1994).

According to Guba (1990), paradigms can be characterized through their: ontology (what is real?), epistemology (what is the relationship between the inquirer and the known?) and methodology (methods for exploring this knowledge). These beliefs and assumptions are consequential to each other meaning that; the researcher's view of ontology effects their

epistemological belief which consequently affects the choice of methodology (Holden and Lynch, 2004).

Different paradigms have been developed in the past century due to significant growth in social science research. However there are principally two paradigms to the verification of theoretical schemes, i.e. *positivism* and *anti-positivism* (or naturalistic inquiry) (Dash, 2005). The anti-positivism paradigm has been also referred to as the *interpretivism* paradigm by Rossman and Rallis (2003).

According to Dash (2005), the positivist paradigm is based on experience of senses and can be acquired by observation and experiment. In contrast, the anti-positivist paradigm emphasizes that social reality is viewed and interpreted by individuals according to the ideological positions they acquire.

The positivism paradigm, which emphasizes an objectivist approach to studying social phenomena, attaches significance to research methods focusing on quantitative analysis such as surveys and questionnaires. While the anti-positivism approach, which emphasizes a subjectivist approach, demands for research methods focusing on qualitative analysis such as interviews, observations, case studies and personal constructs (Dash,2005).

A third alternative paradigm is *Critical realism*. Critical realism is, according to Easton (2010), a coherent, rigorous and novel philosophical position that not only substantiates case research as a research method but also provides helpful implications for both theoretical development and research process. This approach has some common features with positivism and interpretivism paradigms but recognizes that multiple causes usually influence events and situations in open systems. Sayer (1992) believes that "social science must be critical of its object and in order to be able to explain and understand social phenomena we have to evaluate them critically" (Sayer, 1992, p. 5).

This approach encourages multidisciplinary research. Compared to positivism and interpretivism approaches, critical realism is compatible with a rather wide range of research methods. However it implies that the choice of the method should depend on the nature of the object under study and what the researcher is willing to learn about it (Sayer, 2000). Another reason for this choice is that this approach is well suited to relatively clear bounded but complex phenomena such as organizations, inter-organizational relationships or nets of connected organizations.

This dissertation applies a critical realism approach in order to fulfill the research objectives. The research questions in this dissertation cover a wide variety of aspects which demands for pluralism in approaches and methods, thus the critical realism was found to be a suitable paradigm as a platform for the research strategy.

In general, data collection is done through applying a quantitative approach, qualitative approach or a combination of both methods (Creswell, 2009). Although a combination of qualitative and quantitative methods have been employed in this dissertation in order to obtain the essential data, the author tends to subjectively analyze the data, based on the fact that human factors are the most influencing aspect within the EW procedure.

Figure 3.4 presents the research paradigms and methods applied for carrying out this study.

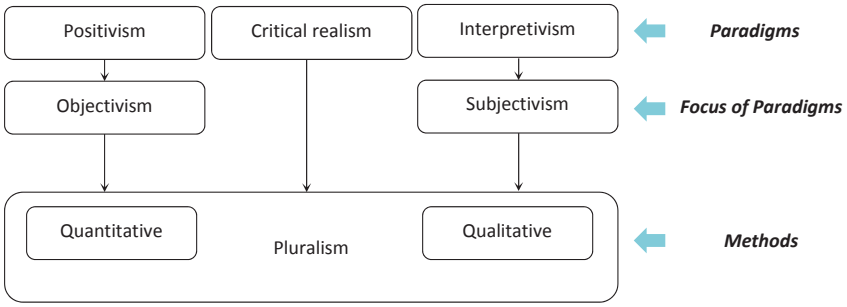

Figure 3.4 Methodological approaches applied in this dissertation

Qualitative research

Qualitative research has an emphasis on words rather than quantification in the collection and analysis of data (Bryman, 2008). As presented in Figure 3.4, this method is extensively interpretivist. A list of characteristics of qualitative research, based on Creswell's (2009) work is mentioned below:

1. Up closed information is gathered by directly talking to people and monitoring their behavior and actions within their context.
2. Data is collected by qualitative researcher through examining documents, observing behavior or interviewing participants.
3. Multiple forms of data, such as interviews, observations and documents are gathered by researchers, rather than relying on a single data source. The gathered data is then reviewed and organized into categories that cut across all the sources.
4. The inductive process of qualitative research involves building patterns, themes and categories from the bottom-up, by organizing the data into more abstract units of information.
5. The focus is on learning the meaning that the participants hold about the problem or issue and not the meaning that researchers bring to the research or writers express in literature sources.
6. The research plan for qualitative research cannot be determined tightly in advance. All phases of the process might change or shift after the data collection starts.
7. A theoretical lens, considering cultural, social, gendered is applied for viewing the studies.
8. The research is a form of interpretive inquiry in which researchers make an interpretation of what they observe, hear or understand. This interpretation cannot be separated from the researchers' background, history and mindset.
9. A complex picture of the problem or issue under study is developed by qualitative researchers.

According to Watkins (2012), the following methods are the most common methods associated with qualitative research:

- Group interviews/focus groups: six to eight people discussing a particular phenomenon.
- Individual interviews: meeting with individuals to discuss a particular phenomenon (can be open-ended, unstructured, semi-structures or structured).
- Participation observation: observing individuals in a particular setting to study a specific phenomenon.
- Document review: systematic document analysis which provides insight on contextual history/information on study group.

This dissertation applies a qualitative data collection approach by carrying out interviews, action research and case studies. This is mainly due to the fact that qualitative research is of significant relevance to study of social relations, owing to the fact of the pluralization of life worlds (Flick, 2007).

Quantitative research

Quantitative research is according to Aliaga and Gunderson (2000), explanation of phenomena by collecting numerical data which are analyzed through mathematically based methods, in particular statistics. The difference between quantitative and qualitative research is often seen as quite fundamental. The quantitative view is described as being 'realist' or sometimes 'positivist', while the world view underlying qualitative research is viewed as being 'subjectivist' (Muijs, 2011).

Most common methods associated with quantitative research, according to Bryman (2008), include:

- Questionnaire / survey
- Observations schedules ; arranging schedules for recording the observations
- Coding frames; a transcript of respondents' replies which identifies the types of answers associated with each question and the respective codes.

Table 3.2 presents some of the contrasts between quantitative and qualitative research. This comparison reveals the strengths and weaknesses of each method, thus show that the use of a combination of these two methods can cover pretty much most of the needs of the research.

Table 3.2 Common contrasts between quantitative and qualitative research (Bryman, 2008)

Quantitative	Qualitative
Numbers	Words
Point of view of researcher	Point of view of participants
Researcher distant	Researcher close
Theory testing	Theory emergent
Static	Process
Structured	Unstructured
Generalization	Contextual understanding
Hard, reliable data	Rich, deep data
Macro	Micro
Behavior	Meaning
Artificial setting	Natural setting

This dissertation applies a combination of qualitative and quantitative data collection approaches in order to make a triangulation of the results thus achieving more credible and accurate outcomes.

3.4 Research approaches (How?)

3.4.1 Literature search and review

Robinson and Reed (1998: 58) define literature review as "a systematic search of published work to find out what is already known about the intended research topic." It also allows researchers to acquire an understanding of the research topic, how it has been researched and what the key issues are (Hart, 1999). Aitchison (1998) states that a literature review allows the researcher to find out what has been done in terms of the problem being investigated thus ensuring that duplication does not occur.

The literature review for this study was carried out to provide information relating to the general background and context of the current research. Due to the largely exploratory nature of the study, an extensive search of literature was conducted.

As mentioned earlier in section 2.4, the published research on the concept of EW signs is relatively limited, particularly on the practical side of project management. This triggered the need for investigating published literature on areas which were found to be most relevant to this topic. In fact, although the literature search has been kept focused on the "EW" concept, has been made of broad interest. This has been done by breaking down the research question into distinct concepts that can be searched for separately. The focus of the literature search has been on academically authoritative texts like academic books, journals, research reports and government publications. Figure 3.5 presents the research questions and the terms applied in order to carry out the literature search.

In addition to the search among the project management literature, an investigation on the concept of EW signs as it is applied in other fields of study was carried out. The intention for carrying out this part of the study was to demonstrate a holistic view on the concept of EW signs in various fields and thus reveal its significance as a phenomenon which in case realized and acted upon can prevent diversified undesired consequences. In addition, the relevant information obtained, can be transformed to the project management context which is the main focus point of this dissertation.

The results of the literature search demonstrate that although there are not many literature sources which directly refer to the concept of EWs in projects, there are many more which discuss concepts which are closely associated with this phenomenon and have been extensively applied for answering the research questions. Over 200 literature sources including journal articles, conference articles, books, public documents, etc. were studied in the course of this research.

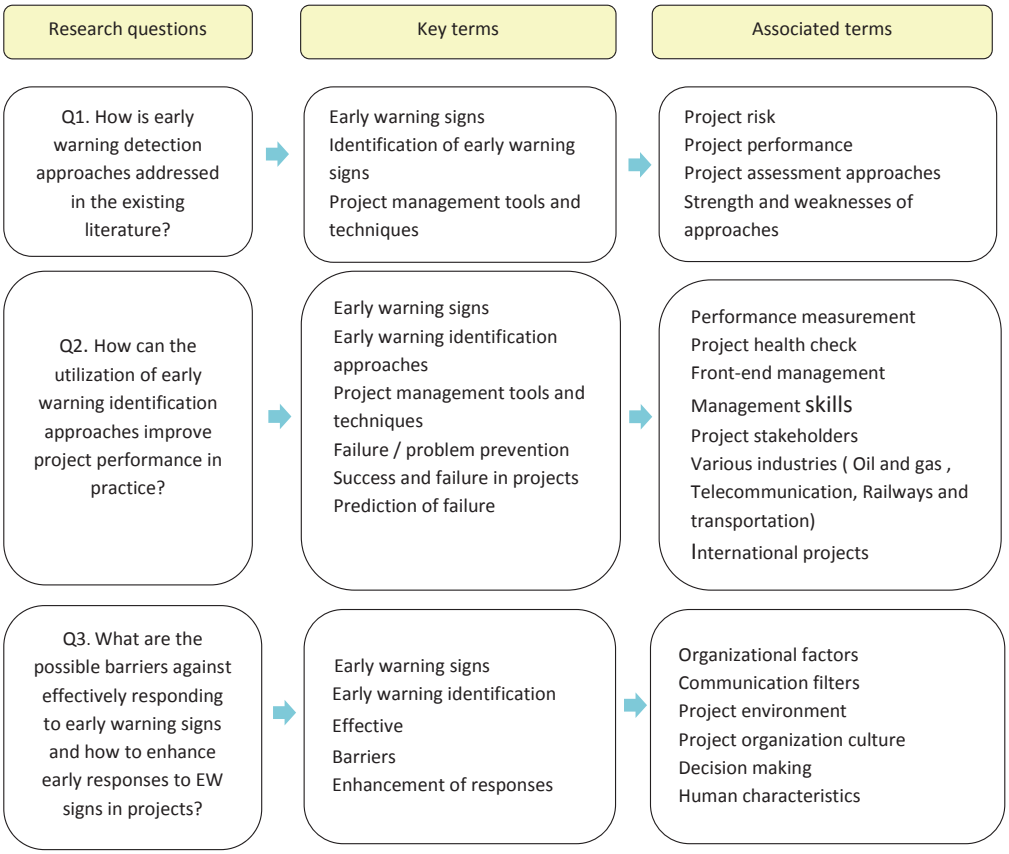

Figure 3.5 Literature search structure

3.4.2 Case study

Case studies have been traditionally criticized for lacking objectivity comparing to other research methods within the field of social sciences. On the other hand, they have often been viewed as a useful tool for the preliminary, exploratory stage of a research project, as a basis for the development of the 'more structured' tools that are necessary in surveys and experiments (Rowley, 2002). This approach allows more in-depth development and testing of one specific approach, typically combined with action research where the researcher takes an active role in developing and implementing the changes to be validated (Greenwood and Levin, 2007).

Yin (2012) defines the case study research method as an empirical inquiry that investigates a contemporary phenomenon within its real-life context; when the boundaries between phenomenon and context are not clearly evident; and in which multiple sources of evidence are used. The aim of case study research is to not just describe a situation but rather to understand the conditions under which events occur (Yin, 2009). In addition, this approach is particularly well suited to new research areas or research areas for which existing theory seems inadequate (Eisenhardt, 1989).

According to Yin (2012) case study research is generally a preferred method when a "how or "why" question is being posed or when the investigator has little control over events. Some of the best and most famous case studies are explanatory. This dissertation is mainly based on case study as a platform for the research strategy.

This study applies case study research as one of the research approaches in order to scrutinize how different EW sign detection methods are utilized in different project settings. With the principles of EW already researched by different authors, the next phase of research is logically the development, implementation, and testing of more specific methods for identifying and acting on EW signs, thus validating EW as a feasible approach to improve project performance. For this type of research, the case study approach which allows better understanding of the concept by thorough examination of specific approaches in practice is a suitable solution. The case study methodology used is an empirical approach built upon data collected via action research, empirical data bases, public documents and structured and semi-structured interviews.

In order to select a case for studying, there are several criteria one can apply; variety in types of project and context, suitability for testing of the chosen approach, access to data, etc. Marshall (1996) defines three main sampling strategies for carrying out a qualitative study:

- Convenience sample involves the selection of most available subjects. In terms of time, cost and effort, this strategy is said to be the least costly to the researchers.
- Judgment sample has traditionally been the most common sampling technique. The researcher actively selects the most productive sample in order to fulfil the research objectives.
- Theoretical sample is explained as building interpretive theories from the emerging data and selecting a new sample to examine and elaborate on this theory.

In order to select a case for studying, there are several criteria one can apply; variety in types of project and context, suitability for testing the chosen approach, access to data, etc. In reality, a dominant criterion is the convenience sample which is the sample where the researcher is allowed suitable assess.

The process of choosing the samples within this study consisted of two phases; 1) choice of industry and 2) choice of specific case projects within the industries. The author chose to carry out the study within different industries. The rationale for this decision was to be able to generalize the results to a wide range of projects within different industries. The convenience sampling strategy was applied in order to choose the specific project cases. Of course, the cases were chosen among the ones which applied the EW identification approaches.
In the course of this study, three cases from different industries (e.g. Oil and gas, telecommunication and transportation) were thoroughly analyzed in order to observe how application of EW identification approaches can be used to improve projects' performance and lead to preventing problems. Two other cases from the manufacturing industry and the ambulance service industry were studied less thoroughly just as examples which are used as aids to better clarify the concepts under focus. The information regarding the studies cases are presented in Table 3.3.

Table 3.3 Characteristics of the studied cases

No.	Project	Owner	Country	Domain	Sector	Years
1	London ambulance service (LAS)	UK National Health Service	UK	Transportation	Public	1992
2	Tyrihans	Statoil	Norway	Oil and gas	Private	2005-2011
3	Norwegian High speed railway (HSR)	Jernbaneverket	Norway	Transportation	Public	2010-2012
4	LTE and MOVE	Telenor	Norway	Telecommunication	Private	2007-2014
5	IFaCOM	European Commission	International	R&D	PPP[3]	2012-2015

Case 1. The London Ambulance Service project

The LAS project, operated in year 1992, has been known as "A comedy of errors" (Finkelstein and Dowell, 1996). The reason it was chosen to analyze this case is that this project, according to Williams (2002), was a highly complex, long-duration project and experienced a number of serious problems during the operation phase. The author was not directly involved in the post-mortem analysis on this case, however the analysis has been based on post-mortem studies done by author researchers including Finkelstein and Dowell (1996) and Dalcher (1999)[4].

[3] Public Private Partnership
[4] As earlier mentioned in table 3.1, the author was not directly involved in the case study on the LAS project. Further analysis on the case, which led to the development of a conceptual framework, was based on the published post-mortem analysis done by other researchers.

The LAS is referred to as the largest ambulance service in the world, covering an area of over 600 square miles and a population of approximately 7 million people. The service was divided into two sections: one providing routine patient transport and the other an accident and emergency service. In 1990, the LAS decided to commission the development of a computerized dispatch system in order to improve its performance. A supplier who offered to meet the deadline was chosen. The computerized dispatch system went live on 26 October 1992. However the system failed to handle the number of calls and consequently lost control of its fleet. On the same day this fact was established, the service reverted to a semi-manual system, using only part of the original software (i.e., the one for taking incoming calls). This functionality also failed several weeks later due to a program error, and the system was then completely abandoned.

The failure of this system attracted a great amount of media attention and there were allegations that approximately 20 people had possibly died as a result of the delays of up to 3 hours in ambulances arriving at incident sites.

The analysis on this case was performed in order to illustrate the feasible problems pertaining to a real case and its consequences. The rationale behind this selection was not to offer criticism relating to this specific project's performance but to learn constructively from it and move towards a better practice. A statement was made that, with application of a PMS in the project phase, chaos and perhaps total failure in the operational phase could have been prevented. Also, a conceptual PMS was proposed, using the main problems in the project phase as a reference for addressing the dimensions of performance to be measured, objects to be controlled, and the indicators. The overall aim of the study was to increase understanding of the concept of EW signs in projects and offers a possible approach, which can assist project managers in taking timely preventive actions in order to avoid undesired outcomes.

The study was done through an analysis based on the work performed by Finkelstein and Dowell (1996) on the problems that drove the case of the LAS to total failure. In fact this method can be referred to as an analysis on the post-mortem report of the project failure. Benefiting from knowledge relating to the project conditions and the problems that landed the project in specific circumstances, a conceptual performance measurement framework was proposed to better illustrate possibilities for how this project could have been carried out differently.

It should be mentioned that the authors fully aware of the fact that it is easy to look back on history and state what could have been done differently. The real challenge is to identify the EW signs while the project is running and to be able to detect them early enough to take the right actions. The suggested framework is not a general framework that can be utilized in all cases. There is a need for more enhanced awareness of project conditions, thus enabling project management to choose the appropriate indicators and measurement dimensions.

Case 2. Tyrihans project

Tyrihans project was carried out by Statoil, a Norwegian oil company, which is an international energy company with operations in 36 countries. This project is an oil field

consisting of a subsea development attached to existing installations and infrastructure in the Norwegian Sea. The field is a gas and natural liquid gas field with a thin oil zone. The recoverable reservoirs are 186 million barrels of oil and condensate and 41.5 billion standard cubic meters of gas. The field was discovered in 1982/1983 and the plan for development and operation was submitted in 2005 and approved by the ministry of petroleum and energy in February 2006. The subsea templates were installed on the field in the spring 2007. The drilling began in 2008 and production was initiated the next year. The expected plateau production from the project in 2016-2017 is 96,000 barrels of oil equivalent per day. A number of success criteria were defined for this project, including cooperation and communication, technology qualification, and improvement activities. The project had a budget of 14.5 billion Norwegian kroner and the subsea production system has a life cycle of 20 years. Figure 3.6 provides an overview of the layout of the subsea production facilities and templates of Tyrihans.

The reason for setting focus on this specific industry was the fact that the oil and gas industry is the most important industry in Norway and influences virtually every aspect of the state and global economy. According to the Norwegian ministry of petroleum and energy, Norway is the fifth largest oil exporter in the world, with exports amounting to nearly 2.5 million barrels per day. Over the last ten years, oil production has been slightly higher than the level expected in the years to come. The future production level depends on a number of factors, such as technological development, oil price and whether new discoveries are made and developed. Norway is the second largest exporter of gas to Europe, with only Russia being larger. In 2006, Norway accounted for 30 percent of all gas production in Western Europe. On a world basis, Norway ranks as the fifth largest producer and the third largest exporter, despite the fact that the country only has 1.6 percent of the world's proven gas reserves. There is a strong demand from the industry for improving its performance towards a path to reaching an even higher success rate.
The purpose of the case study was to illustrate the usefulness of utilizing a PMS in a project as an EW system that can give indications of possible future problems and allow taking initiatives for resolving them before they can lead to failure.

The methodology used for this research was a combination of action research and post-mortem analysis of the project. The action research was carried out between the years 2005, when the plan for operation and development of the project was submitted to the Norwegian ministry of petroleum and energy, and 2009, when oil the production was commenced. The action research involved the researchers working together with the project management team, parts of the project organization, and the project owner within the main company. To select this case for action research, the "convenience sampling" strategy was applied.

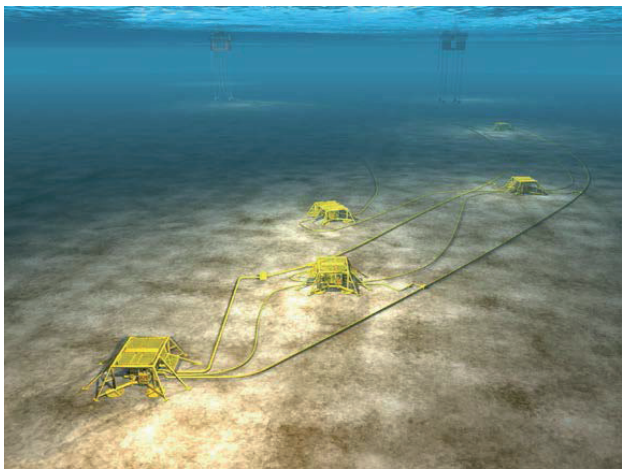

Figure 3.6 Tyrihans' subsea production facilities

The case study was inductive, as a PMS was implemented with the aim of problem prevention by detection of EW signs, with the purpose of further developing the theory of The action research included evolving stages, meaning that the stages were not fully defined at the outset of the action research; rather the findings in each stage led to the development of the next stages (Bassey, 1998). The first stage of the action research focused on outlining the EW approach to be employed in the project and developing performance indicators. This was achieved through discussions with the project management team and conducting brainstorming sessions and interviews with representatives from the project management team and the project organization at large. The outcome was a model depicting the EW approach and the initial performance indicators, approximately 40. During the second stage of the action research, further discussions and semi-structured interviews were performed to scope down the number of performance indicators and investigate whether the required data could be obtained. In the end, the set of performance indicators was reduced to eight key indicators, and these were implemented in the project's PMS. In the third phase of the action research, the performance measurement and EW system was used to test the approach during the second half of the project. During this phase, the researchers were present in relevant meetings in the project, and also carried out interviews to learn how the project management team and project organization found the approach to support EW detection.

The choice of modes of involvement during the action research and methods of data collection was discussed in the researcher team. Alternatives were identified; developing the performance indicators based on EW literature instead of brainstorming with the project management team, and the author also considered collecting data through a questionnaire survey rather than interviews. However, insufficient definitions of EW indicators in literature required tailoring the indicators to the case project, and it was concluded that a survey would be unable to capture richer information about the experiences with using the EW system.

The authors later interacted again with the project after the project was completed, and a post-mortem analysis was carried out in 2011. In general, a post-mortem analysis is ideally

performed either soon after the most important milestones and events or at the end of a project. The benefit is that post-mortems can often reveal findings more frequently and differently than project completion reports alone (Myllyaho et al., 2004). The main reasons for carrying out this type of analysis is to clarify how the project turned out and to identify relevant lessons which can to be learned from it. In this case, the post-mortem analysis was done with the aim of evaluating the overall performance of the project, how the EW system worked, and its effects on the project's overall success. This was done through several interviews with the project manager and project control manager of the project, as well as collecting quantitative performance data about the project. With the sample size of people having been actively involved in using the EW sign system, a survey was unsuitable and again interviews provided more thorough insight into the experiences.

Table 3.4 shows the stages of the project between 2005 and 2011, alongside the time periods of different phases of the authors' research involvement.

Table 3.4 Case study phases throughout the project

2005	2006	2007	2008	2009	2010	2011
Submission of Plan for development and operation	Approval of plan by ministry of petroleum and energy	Installation of seabed templates on the field	Start of drilling	Production start-up	Start-up of operation of a subsea facility for injection of seawater for pressure support	Project finished
Action Research						Post-mortem analysis

Case 3. Norwegian High Speed Railway (HSR) feasibility study project

The Norwegian High Speed Railway (HSR) feasibility study project was given its mandate by the Norwegian Rail Administration (Jernbaneverket) in February 2010. The HSR project which has been one of the major investment projects intended to be carried out for the first time in Norway has absorbed lots of attention from public and media since the discussions on it began in 2010. There were lots of discussions on it and since many stakeholders were involved with this project, there was a variety of opinions on whether it should or should not be executed. The intention of this feasibility study, which was carried out by different national and international consultant companies under the umbrella of Norwegian National Railway Company, was to provide recommendations on long-term strategies that will form the basis of long distance passenger traffic in Norway and for exploring opportunities for building HSRs in southern Norway in the following routes (See Figure 3.7):

1. Oslo - Kristiansand - Stavanger
2. Oslo - Bergen
3. Oslo - Trondheim
4. Oslo - Gothenburg
5. Oslo - Stockholm
6. Bergen - Haugesund - Stavanger in combination with routes 1 and 2.

The author's main focus was on the very initial stage in front-end phase of the Norwegian High-Speed Railway project which mainly dealt with the level of feasibility of carrying out such a large and important project. This phase particularly considered technical construction issues, environmental issues, costs, implementation requirements, market conditions, safety issues, and finance and socio economic effects.

The purpose of the case study was to perform a strategy analysis on the Norwegian high-speed railway project using an analytical framework to give an overall presentation of the project strategy and the key uncertainty factors that may affect the project realization. This was done based on the information provided by the various published reports by different consultants who were responsible for particular tasks. The author endeavored to conclude the level of feasibility of this project according to the uncertainties involved with each element of the project.

The case study was based on information gathered from different literature sources with a focus on the concept of front-end management and the tools and techniques for the choice and evaluation of the concept, mainly publications affiliated with the Norwegian concept program which had a great focus on this aspect. Since the main goal of the case study was to evaluate the level of viability of the Norwegian high-speed railway project, a general review on history of the high-speed railways was done as well. Relevant documents related to this project published on the Norwegian National railway company website were studied.

The feasibility study project with a total budget of 50 million Norwegian kroners was done in three phases:

Phase 1: give an overview and presentation of the knowledge base that already exists within Norway, with regard to HSR ways.

Phase 2: identify common premises for HSR concepts that might be relevant for Norwegian conditions. The premises comprise a number of topics including, market analysis, evaluation of different conceptual solutions related to the use of dedicated tracks, stop-patterns and station design, different speed standards, and the possibilities of incremental development of the existing rail network.

Phase 3: On the basis of the findings of Phase 2, Phase 3, undertake specific analysis of action plans for individual corridors, including recommendations for long-term development strategies.
The data was collected via the following published reports on the Norwegian high-speed rail project, followed by three extended interviews with the project manager.

1. High Speed Rail Assessment, Phase 3, Report – Risk and Safety Analysis, 18.01.12, Pöyry
2. Høyhastighetsutredningen 2010-12, Rapport - Security, 20.01.12, Railconsult AS
3. Norwegian High Speed Railway Project, Phase 3, Final report Version 2 - Environmental analysis – Climate, 03.02.2012, Asplan Viak AS, MISA AS
4. Høyhastighetsutredningen 2010-2012, Konklusjoner og oppsummering av arbeidet I fase 3, Del 1, Jernbaneverket, 23. Januar 2012

5. Norwegian high speed railway assessment project, Contract 6: Financial and economic analysis, Subject 5: uncertainty analysis, 04.02.2011, Atkins
6. Norwegian high speed rail assessment 2010-2012, Summary of phase 2 works, Jernbaneverket, 26.02.2011

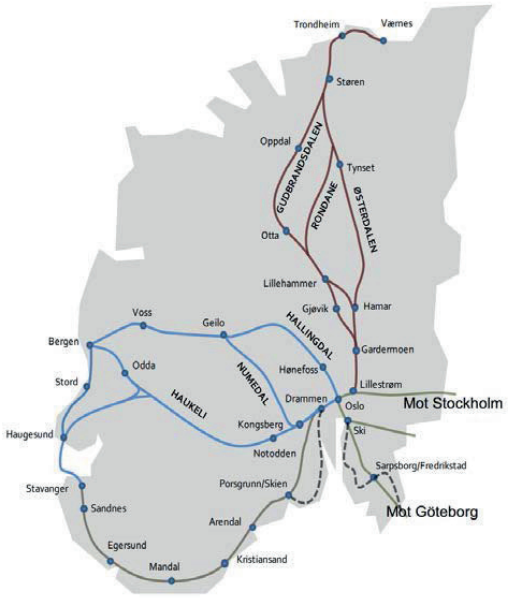

Figure 3.7 Norwegian HSR designated corridors

Case 4. LTE (Long Term Evolution) and MOVE (Mobile Office - Virtual Exchange)Projects

The case studies on LTE and MOVE project were carried out in a telecommunication firm in Norway, Telenor, in order to do an evaluation of the project management tool, where the health check had been tested out in two different projects since 2007. The health check consisted of 20 questions which were sent for evaluation in the project team (see Appendix). Respondents had 6 options for answering, including: Irrelevant, I don't know, completely disagree, Disagree a little, neither agree nor disagree, Agree and completely agree.

Since this tool had already been tested before this research started, the results of previous tests were also considered in the analysis of data. The goal was to identify how the use of this tool had contributed to identification of EW signs in the project and consequently leading to responding to them.

The reason for setting focus on this specific industry was the fact that in the past three decades, due to the latest liberalization and privatization wave in the world, the telecommunications industry has turned into a dynamic environment and is rapidly growing (Graack, 1996). In this rapidly changing industry, the availability of state-of-the art technological know-how, innovations and domestic and international market access are critical to a company's competitive success (Pennings et al., 2005).

The purpose of the case study was to illustrate the usefulness of utilizing PHCs in a project as an EW system that can give indications of possible future problems and allow taking initiatives for resolving them before they can lead to failure and hence contributing to project success.

The case study methodology used was empirical approach based on archival material, structured interviews and semi-structured interviews. The research was a data based research coming up with conclusions which are capable of being verified by observation or experiment. The aim was to not just describe a situation but rather to understand the conditions under which events occur (Yin, 2012).

For the purpose of this research, the cases which had been already implementing the PHC tool and cases which were, at the time of the study, applying it were chosen. This was done in order to examine the results of implementation of this tool alongside observing the way it was utilized and its potential for improvement.

It is important to mention that since this tool is still not that well known enough in the industry, at least in Norway and not many firms are currently applying it, the case studies have been rather limited, but the author has endeavored to make an inductive analysis taking into account all the limitations and constraints.

Multiple data sources were considered in order to make a triangulation of the results. The data sources included archival material consisting of progress reports and health check reports and semi-structured interviews with key responsibles within the case projects.
The data obtained from the archived material and interviews were analyzed using a qualitative approach. Data retrieved from the archival material, which presented the results of the use of PHC in previous projects, were used to shed light on the reality of implementation of PHC in practice and how it is received in a real working environment. The trend indicated the performance of the project in each aspect assessed by the PHC tool over the time which the assessments had taken place.

The information derived from the interviews mainly exhibited the process of implementation of the tool, alongside the challenges and possible areas for improvement. It also revealed how the utilization of this approach had acted as an EW system in the project. The following section presents both parts of the case study results.

Case 5. IFaCOM (Intelligent Fault Correction and self-Optimizing Manufacturing systems) project

This case study was carried out in order to investigate on the relationship between implementing the EW procedure and better management of international R&D projects. The intention was also to do an investigation on possible obstacles which exist throughout the EW procedure.

The ongoing international R&D project which was used as an example of a real life case consisted of 15 partners from 5 different countries (See Table 3.5). The empirical results were based on analysis of available project documents and semi-structured interviews with members of the project management team. The project was established as an initiative from NTNU, responsible for management of coordination of the project. The project budget was

10+ million Euros and the duration was estimated to be 3.5 years. At the time of the study, the project was in its third year.

The project consisted of 10 work packages. Work packages 1 to 6 being the research and technology development work packages which were planned as vertical activities to develop results to be applied and demonstrated in different applications. The estimated workload of the project was equivalent to 76 people working full time within the total project duration.

The main focus of this study was on work package 10, including project management related activities. This work package only covered legal, administrative and financial management of the project. Scientific coordination, scientific quality assessment/management, research risk management and other research and technology development related activities were covered by the corresponding scientific work packages.

The management structure which was based on experiences from coordination of several international projects consisted of various interdependent elements including management of project according to approved plans, monitoring and performance of project control, implementation of procedures for quality management and administrative review process of deliverables, implementation of risk management procedures and implementation of tools to establish a basis for efficient and easy communication within the project.

Table 3.5 IFaCOM partners

Partner	Country	Sector
Norwegian University of Science and Technology (NTNU)	Norway	Academy
Swiss Federal Institute of Technology in Lausanne (EPFL)	Switzerland	Academy
Aachen University of Technology (RWTH)	Germany	Academy
Technical University of Denmark (DTU)	Denmark	Academy
Alesamonti	Italy	Industry
Leuphana University of Lüneburg	Germany	Academy
EMA	Italy	Industry
GKN Aerospace Norway	Norway	Industry
CADCAMation	Switzerland	Industry
AgieCharmilles	Switzerland	Industry
Inosens	Germany	Industry
University of Naples	Italy	Industry
Montronix	Italy	Industry
Strecon	Denmark	Industry
FIDIA	Italy	Industry

The analysis focused mainly on approaches used for identifying and responding to EW signs of future problems throughout the project and scrutinized the impact of implementing the EW procedure on effective prevention of future problems.

The data obtained from available project documents included detailed definition of project concept and objectives, information on project participants and their roles and responsibilities and the management structure and procedures. The interview data consisted of background interviews with members of the project management team, information on identified EW signs of possible problems throughout the project and the preventive actions which were taken. It also includes the challenges the project management team faced due to specific characteristics of an international project.

It is crucial to mention that the empirical study has its limitations due to the fact that the author based the findings built upon data obtained from one work package among the 10 existing work packages. Although this specific work package is the project management unit which in principal should have quite an extensive over view on the project as a whole, it is very important to get insights from other partners as well. Also since, at the time the study was done, the project was still not over, there are still potential problems which may come up or actualize in the future which are not considered in this study.

The research followed an inductive reasoning approach, concluding that the approach can contribute to better management of other similar projects as well. Of course the authors are fully aware of the fact that these types of results are not always logically valid and it is not always accurate to assume that a general principle is correct.

3.4.3 Action research

Action research is according to Coughlan and Coghlan (2009), a generic term which covers various forms of action oriented research. This type of research has applicability to unstructured or integrative issues. This is due to its broad relevance to practitioners and its contribution to theory. In all professional fields, the goal of action research is to improve processes. This is due to the fact that the action research cycle offers opportunity for continued reflection (see Figure 3.8).

According to Sankaran and Kumar (2010), Action research is a common means for implementing organizational change particularly in complex social situations where the people, whose lives or circumstances will be affected by this change, need to be involved in designing and implementing the change that affects them. A good example of the use of action research is its application with the aim of organizational change (Marcinkoniene and Kekäle 2007;Werkman and Boonstra, 2001 ; Heale, 2003).

It is noteworthy that action research always involves two goals. It is not only supposed to solve problems but is also aimed to contribute theory to the body of knowledge within the specific research area (Gummesson, 2000). The main steps in carrying out action research are illustrated in Figure 3.9. As presented in the Figure, this cyclical process continues as the project moves on from cycle to another cycle (See Figure 3.10).

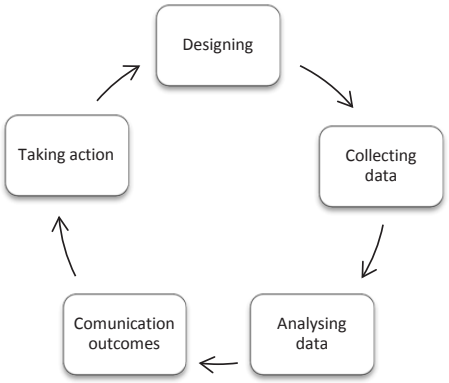

Figure 3.8 Action research cycle (Stringer, 2008, p. 5)

With the principles of EW already researched by different authors, the next phase of research was logically the development, implementation, and testing of more specific methods for identifying and acting on EW signs, thus validating EW as a feasible approach to improve project performance. For this type of research, the case study approach (as developed in detail by Yin (2012) lends itself naturally; it allows more in-depth development and testing of one specific approach, typically combined with action research where the researcher takes an active role in developing and implementing the changes to be validated (Greenwood and Levin, 2007).

As mentioned in Table 3.3, the action research, within project A, was carried out between years 2005, when the plan for operation and development of the project was submitted to the Norwegian ministry of petroleum and energy, and 2009, when oil the production was commenced. The action research involved the researchers working together with the project management team, parts of the project organization, and the project owner within the main company.

The action research included evolving stages, meaning that the stages were not fully defined at the outset of the action research; rather the findings in each stage led to the development of the next stages (Bassey, 1998). The first stage of the action research focused on outlining the EW approach to be employed in the project and developing performance indicators. This was achieved through discussions with the project management team and conducting brainstorming sessions and interviews with representatives from the project management team and the project organization at large. The outcome was a model depicting the EW approach and the initial performance indicators, approximately 40. During the second stage of the action research, further discussions and semi-structured interviews were performed to scope down the number of performance indicators and investigate whether the required data could be obtained. In the end, the set of performance indicators was reduced to eight key indicators, and these were implemented in the project's PMS. In the third phase of the action research, the performance measurement and EW system was used to test the approach during the second half of the project. During this phase, the researchers were present in

relevant meetings in the project, and also carried out interviews to learn how the project management team and project organization found the approach to support EW detection.

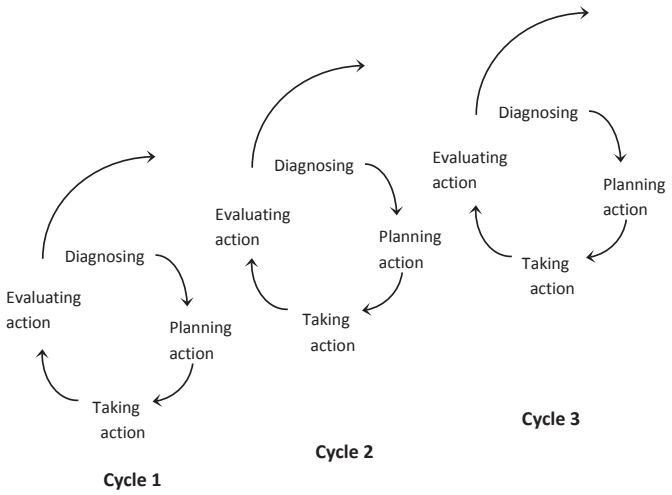

Figure 3.9 Continuing cycles of action research (Coghlan and Brannick, 2005, p. 24)

The result was the development of 40 indicators; too many and later reduced to 18, and finally down to 8 key indicators, through a prioritization of areas of importance. The procedure of reducing the number of indicators was done through a two-stage approach: First, the reduction from 40 to 18 was based on filtering the indicators according to their perceived importance for this specific case project, with the ones eliminated being related to conditions or factors not present in the case project. The resulting 18 indicators were then brought forward for implementation in the management information system, MIS, of the company. After starting this effort, it was realized that each indicator required much work to implement and for some of them, data was difficult to obtain. Thus, based on data availability and the effort required to implement each indicator, the final set ended up being the 8 most relevant ones. The required data needed to feed these indicators was partly collected from the MIS and partly from the project's various records as well as through surveys of personnel. The EW system was also implemented in the MIS; measurements could be retrieved from the system and various diagrams and graphs produced to display the data.

3.5 Research methods

This dissertation applies a combination of qualitative and quantitative data collection approaches in order to make a triangulation of the results. The rationale behind triangulation is that if a number of different methods or sources of data are used in order to fulfill a research objective, the results are more likely to be precise and accurate (Yin, 2012). Following, the research methods applied in this study will be described (See Figure 3.2).

3.5.1 Interviews

Interview is one of the most important sources of case study and is commonly found in case study research (Yin, 2012). According to (Gill et al., 2008), There are three fundamental types of research interviews: structured, semi-structured and unstructured. Structured interviews are, basically, verbally administered questionnaires, where predetermined questions are asked, with little or no variation and with no scope for follow-up questions to responses that warrant further elaboration. Consequently, they are relatively quick and easy to administer and may be of particular use if clarification of certain questions are required or if there are likely to be literacy or numeracy problems with the respondents. However, by their very nature, they only allow for limited participant responses and are, therefore, of little use if 'depth' is required. Conversely, unstructured interviews do not reflect any preconceived theories or ideas and are performed with little or no organization. Unstructured interviews are usually very time-consuming (often lasting several hours) and can be difficult to manage, and to participate in, as the lack of predetermined interview questions provides little guidance on what to talk about (which many participants find confusing and unhelpful). Their use is, therefore, generally only considered where significant 'depth' is required, or where virtually nothing is known about the subject area (or a different perspective of a known subject area is required).

According to Gill et al. (2008), semi-structured interviews involve several key questions which help to define the areas to be explored, but they also permit the interviewer or interviewee to deviate from the main direction in order to conduct an idea or response in more detail. This interview format is used most frequently in healthcare, as it provides participants with some guidance on what to talk about, which many find helpful. The flexibility of this approach, particularly compared to structured interviews, also allows for the discovery or elaboration of information that is important to participants but may not have previously been thought of as pertinent by the research team.

Yin (2012) defines another categorization for case study interviews: prolonged interviews, shorter interviews and survey interviews. Prolonged case study interviews might take place over 2 or more hours, either in a single sitting or over an extended period of time covering multiple sessions. In this type of interview, the interviewees are asked about their opinions and interpretations about events or people or their explanations and ideas related to certain situations. These propositions can be then used as a basis for further inquiry. The interviewees can suggest other people for further interviews, as well as other sources or evidence. Shorter case study interviews may be more focused and take only an hour or so. The main purpose of such an interview might be simply to validate certain findings that have already been established but not asking further about other topics of a broader, open-ended nature. The last type of case study interview is the typical survey interview by applying a structured questionnaire. Explanations on this method will be presented in section 3.5.5.

As mentioned in Figure 3.2, 4 out of the 5 cases which were studied, applied the interview method for collecting data. The interviews, based on categorizations of both Yin (2012) and Gill et al. (2008), have been prolonged semi-structured interviews.

3.5.2 Narrative literature review

An initial literature review is a crucial part of any type of research. This is due to the fact that it is a means of demonstrating the author's knowledge about a particular field of study, including vocabulary, theories, key variables and phenomena, and its methods and history (Randolph, 2009). But writing an article which is purely based on literature review, in order to be approved for publication, needs to follow a systematic approach.

According to Baumeister and Leary (1997), writing a major literature review article is very infrequent but often a very important career contribution. There are several goals that literature reviews tend to attain. Five main goals have been identified as follows (Baumeister and Leary, 1997):

1. *Theory development* is the most ambitious goal of literature review. In this type of papers, the primary objective of the author is to propose a novel conceptualization or theory concerning some psychological phenomenon.
2. *Theory evaluation* is a slightly less ambitious but more common type of literature review which has a focus on theory evaluation. In this type of review, the author does not provide new theoretical perspectives but rather reviews the literature relevant to the validity of an existing theory (or often two or more contradictory theories).
3. *Surveying state of knowledge* is the third type of literature review. In this type of literature review, the state of knowledge on a particular topic is examined. Such reviews might provide useful overviews and integrations of an area. However they are not intended to offer novel ideas. They can rather be valuable as a means of pulling together what is known about a particular phenomenon.
4. *Problem identification* is a type of literature review, done by the aim of revealing problems, weaknesses, contradictions or controversies in a particular area of investigation. This type of studies typically raise more questions than they answer, rather leaving it to future researchers to straighten out the mess.
5. *Providing historical account of developed theory* is the final, less common goal of literature review. Such types of studies are particularly organized chronologically and provide an ongoing commentary regarding the impact and shortcomings of various contributions to the field.

In the course of this study, alongside the initial literature review on the concept of EW in project management, an article which was mainly based on literature review, applying the *theory evaluation* approach, was developed.

The aim of this article was to create a conceptual understanding of the extent of approaches available for identifying EW signs. This was done through reviewing current literature within the field, looking into studies of industrial practice, and partly building upon authors' own experiences in various forms, both through advising and supervising project management teams and through observations and studies of projects. Possible approaches for EW identification were extracted from the literature and practical experience. This was followed by a thorough discussion of their possible strengths and weaknesses. The main research questions were (1) What approaches exist for detecting EW signs and how can they be categorized; and (2) What are the strengths and weaknesses of different EWS detection

approaches under different circumstances? This approach to the research stemmed from previous exploratory investigations into the area, strongly indicating that there are obvious gaps in the literature regarding the field of EW signs.

3.5.3 Post-mortem analysis

According to Dingsøyr (2005), a postmortem is defined as:

"… a collective learning activity which can be organized for projects either when they end a phase or are terminated. The main motivation is to reflect on what happened in the project in order to improve future practice—for the individuals that have participated in the project and for the organization as a whole."

Ideally, a post-mortem analysis is performed either soon after the most important milestones and events or at the end of a project. The benefit is that post-mortems can often reveal findings more frequently and differently than project completion reports alone (Myllyaho et al., 2004). The main reason for carrying out this type of analysis is to clarify how the project turned out and to identify relevant lessons which can be learned from it.

This approach is strongly recommended for software projects as an important opportunity to learn from mistakes (Davis, 1995; Collier at el., 1996). The rationale mostly cited for postmortem analysis is that only by analyzing our shortcomings can we learn to do better (Collier et al., 1996). Post mortem analysis is in fact part of the knowledge management process which is applied in order to increase quality and decrease costs in software development (Dingsøyr, 2005). Of course this approach can be applied in to other types of projects as well.

Two of the case studies done through this study applied the post-mortem analysis approach. In case of project A, the post-mortem analysis was done with the aim of evaluating the overall performance of the project, how the EW system worked, and its effects on the project's overall success. This was done through several interviews with the project manager and project control manager of the project, as well as collecting quantitative performance data about the project. With the sample size of people having been actively involved in using the EW sign system, a survey was unsuitable and again interviews provided more thorough insight into the experiences.

In the case of the LAS it was clear that some issues could have been handled differently, and certain EW signs could have been detected in advance to prevent encountering serious problems in the end. Several authors have carried out post-mortem analyses in order to determine the reasons why this project ended in such a disaster (Hougham, 1996; Beynon-Davis, 1999; Dalcher, 1999; Fitzgerald and Russo, 2005).

In this case, the post-mortem analysis was not personally done by the author. However, the analysis on what could have been done differently in order to prevent total failure was based on post-mortem analysis, including detailed list of problems during the project and operational phase and main causes of failure, done earlier on the same case.

The author then endeavored to analyze this case from a management point of view and discuss how the application of a PMS in the project phase could have contributed to preventing chaos and perhaps total failure in the operational phase.

3.5.4 Documents as a source of data

Document research also known as document analysis involves the study of existing documents within an organization in order to either understand their substantive content or to shed light on deeper meanings which may be revealed by their style and coverage (Crinson and Leontowitsch, 2006).

As presented in Figure 3.2, two of the cases within this study applied organizational documents as a source of data. In the case of the Norwegian HSR feasibility study project, due to it being a public project, abundant number of reports were available online through the organization's website. These documents included all the reports developed by different consultant companies which carried out various parts of the feasibility study. A SWOT analysis and strategy analysis was done based on the data gathered via the published documents and the interviews as a complement.

The case of IFaCOM project, being a private project, was rather different regarding to the confidentiality of the published documents. The description of the work (DOH) of the project, the meeting minutes and developed progress reports on different stages of the project were kept confidential and the author used the data which is published in the relevant individual publication by permission from the project management team.

3.5.5 Survey

In common with other types of field study, applying surveys as a research method, can contribute to the advancement of scientific knowledge in different ways (Forza, 2009). According to Pinsonneault and Kraemer (1993), survey research is a quantitative method that requires standardized information about the topics being studied and the subjects studied might be individuals, groups, organizations, they might also be projects, applications, or systems. Correspondingly, researchers often differentiate between exploratory, explanatory, and descriptive survey research (Filippini, 1997; Malhotra and Grover, 1998 cited in Forza, 2009; Pinsonneault and Kraemer, 1993).

The survey research design adopted in this study was a combination of exploratory and explanatory research. An *exploratory* research design is performed in the early stages of investigation and research on a phenomenon and used when the researcher's aim is to obtain preliminary insight into a subject, while an *explanatory* survey research design is performed when knowledge of a phenomenon has been articulated in a theoretical form using well-defined concepts, models and propositions (Forza, 2009).

As mentioned earlier, there is deficiency of literature on the phenomenon of early warning in projects and the early warning procedure as a whole. The main research within this area has been done by Nikander (2002) and Klakegg et al. (2010). Further, with the exception of Klakegg et al. (2010), the author has found very few sources that directly indicate the main reasons for project managers to overlook the early warning signs of problems within

projects. So there is a need for exploratory research in order to investigate on possible barriers against an effective early warning procedure. However, during the research for this study, both literature studies and semi-structured interviews resulted to identification of certain elements which can be interpreted as possible barriers against identification and thus the lack of response to early warning signs of problems, based on which, a survey was conducted within industrial and academic organizations in Norway during the spring of 2014.

Although the survey tends to test the research findings, since the theory is still not concrete and well defined, it is hard to state that the survey is completely explanatory, but is rather a combination of exploratory and explanatory research.

The respondents included members of "Project Norway" association, which is a national arena for the exchange of experiences, building networks and providing an external reference to the member organization's own project expertise. It is a research-based collaboration with Norwegian project-based organizations in the public and private sector. The questionnaires were sent to the respondents via email, with an online option for providing answers. The target population of the survey included a wide representation of project-based organizations without any expressed interest in the study topic. The questionnaire was sent to approximately 350 potential project manager respondents for whom had valid email addresses. Completed questionnaires were received from 86 respondents. This gave a return rate of approximately 24%.

The survey was designed in three main parts. In the first part information about the respondents (e.g. their work title, years of experience, and the industry in which they were working) were gathered. During the second part, the respondents were asked to answer a set of questions based on their experiences of the most recent project in which they had been involved. The focus was mainly on identifying and categorizing the major sources for identifying EW signs in projects and the reasons why they were not identified and acted upon in specific cases. In the third and final part of the survey, the respondents were asked for their recommendations and suggestions on approaches for improving the EW identification and response process. The required data and the types of questions in each section are presented in Table 3.6.

Although the authors were aware that the use of discrete visual analogue scales (DVAS) within the survey can influence the results in a subjective manner. The authors were also aware that this scale is one-dimensional and only gives 5 options of choice, so the space between each choice cannot possibly be equidistant. However, the tool was chosen to be used first of all due to the fact that the DVAS is suitable for measurement of attitudes, beliefs and opinions and second of all it is easily understood, easily quantifiable and subjective to computation of some mathematical analysis.

The analysis focused mainly on correlating the characteristics of the projects and project organization with the approaches taken by project managers in response to the identified EW signs. Following the analysis the correlation among the obstacles to responses to EW signs and other characteristics of the projects and project manager characteristics covered in the questionnaire survey were evaluated. By using exploratory research, the author was able

to define the existence and strength of the relationships between specific projects' characteristics and factors related to the projects' EW procedure.

Table 3.6 The contents of the questionnaire

Section	Required data	Type of question
1	Q1. Industry which they worked in	Multiple Choice
	Q2. Year of experience	Open ended
	Q3. Working title	Open ended
2	Q4. Role in the project	Multiple Choice
	Q5. Complexity level of the project	DVAS (1-5)
	Q6. Optimism level within the project organization	DVAS (1-5)
	Q7. Possibility for all project participants to express their opinion	DVAS (1-5)
	Q8. Methods systematically used in the project	Multiple choice
	Q9. Frequency of use of systematic methods	Multiple choice
	Q10. Level of activeness in analysis of methods	DVAS (1-5)
	Q11. Most important problems experiences within the project	Open ended
	Q12. Identified EW signs of those problems	Open ended
	Q13. EW identification stage	The Rating Scale
	Q14. Difficulty level for discussing EW signs	DVAS (1-5)
	Q15. Level of effectiveness of discussions on identified EW signs	DVAS (1-5)
	Q16. Importance of different sources for identifying EW signs	Rank Order Scaling
	Q17. Action taken against identified EW signs	Open ended
	Q18. Strength of responses to identified EW signs	DVAS (1-5)
	Q19. Reasons for not identifying EW signs	Multiple choice
	Q20. Importance of reasons for not responding to EW signs	Rank Order Scaling
3	Q21. Recommendations for improving the EW identification process	Open ended
	Q22. Recommendations for improving the EW response procedure	Open ended

The literature research on correlation factors revealed different opinions on the categorization of correlation factors according to their strength. For example, Field (2005) states that when estimating the intensity of relationships between two variables, a partial correlation coefficient (r) below ± 0.3 shows a small effect, the correlation coefficient between ± 0.3 and ± 0.5 shows medium effect, and a correlation coefficient above ± 0.5 shows a strong effect. However, according to Shortell (2001) there is no rule for determining whether the size of a correlation coefficient is considered strong, moderate, or weak. Further, the interpretation of a coefficient partly depends on the topic of study. For example, when subject material is difficult to quantify, such as the contents of a person's mental life, one should expect the correlation coefficients to be lower. In such studies, correlations above 0.6 are quite rare. Rather, correlations above 0.4 are generally considered to be relatively strong, correlations between 0.2 and 0.4 are considered moderate, and those

below 0.2 are considered weak. When items that are more easily countable are studied, one can expect higher correlations.

In the survey carried out within this study, since the variables included human issues, the level of precision in the responses received was not very high, whereas the level of subjectivity was quite high. Therefore the correlation factors were expected to be lower, and consequently the above mentioned categorization was chosen as a base for the analysis of the correlations. It is also important to calculate the p-value for each correlation since they are designed to provide a measurement of evidence against the null hypothesis. In other words the p-value reveals the probability that the results have been due to chance (Nix and Barnette, 1998). In general, the smaller the p-value, the more evidence exists against the null hypothesis. According to Cleophas et al. (2009) a p-value < 0.05 is generally used to indicate a significant difference from the null hypothesis while a p-value > 0.05 is most likely to indicate no difference from the null hypothesis. The results of the survey were analyzed based on this definition.

3.6 Reliability, validity and generalization

Validity and reliability are two factors which any researcher should be concerned about while designing a study, analyzing results and evaluating the quality of the study (Patton, 2002). This is related to the question that “How can an inquirer convince the audiences of her/his work that the research findings are worth paying attention to?" (Guba and Lincoln, 1994).

The idea of discovering the truth through measures of reliability and validity is to establish confidence in the research findings (Golafshani, 2003). Although reliability and validity are treated separately in quantitative research, these terms are not viewed separately in qualitative research (Golafshani, 2003). According to Guba and Lincoln (1994), validity does not exist without reliability, so a demonstration of validity is adequate to establish the reliability. Bryman (2008) also indicates that although reliability and validity are analytically distinguishable, if a measure is not reliable, it cannot possibly be valid either.

Validity refers to whether a research is really measuring what it claims to be measuring and *reliability* refers to the consistency of a measure of a concept, meaning if similar results would be obtained if another group containing different respondents or a different set of data points were used. According to Cooper and Schindler (2003), both validity and reliability should be present at the same time to ensure sound research. The relationship between them is best illustrated in Figure 3.10.

The Figure presents the relation by using targets as a metaphor. The salvo is reliable if the shots are closely grouped together as indicated at the top of the Figure where reliability and validity are both high. This means that the shots hit the same spot each time the gun is shooting. The salvo is said to have high validity when the shot aims what you aim for, in this case the center of the target. In fact validity is a measure for how well you hit what you aim for and reliability is a measure for the spread of the salvo. A measure has high validity and reliability when the shots hit the same spot each time the gun is shooting and at the same time the shots hit the center of the target.

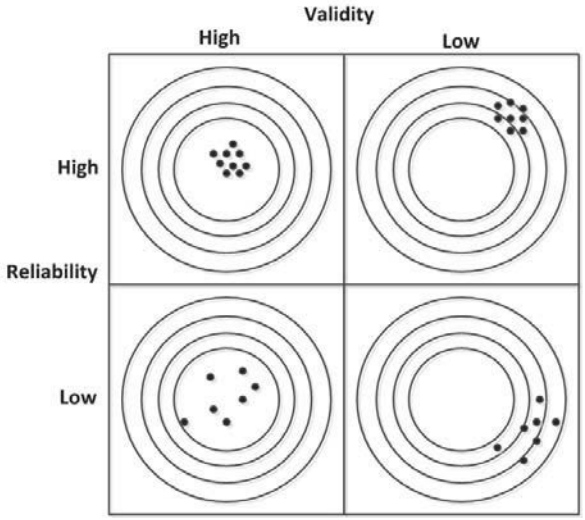

Figure 3.10 Understanding validity and reliability (Cooper and Schindler, 2003, p. 235)

According to Johnson (1997) in Golafshani (2003), if the validity and thus reliability of results of a study can be maximized or tested, it will result in having more credible and justifiable results which may lead to generalizability. Generalization is according to Bryman (2008) usually concerned with the ability to generalize the research results beyond the constraints of the particular context under which the research has been conducted.

The question which should be answered now, is how to test and maximize the validity and as a result the reliability of a study which leads to generalization of the results?

Yin (2012) suggests a set of criteria for judging the quality of research design. According to Yin (2012), four tests are commonly used to establish the quality of any type of empirical social research. These tests are presented in Figure 3.11. The validity and reliability of the research methods applied within this dissertation will be tested according to these criteria.

Tests	Case study tactic	Phase of research in which tactic occurs
Construct validity	Use multiple sources of evidence Establish chain of evidence Have key informant review draft case study report	Data collection Data collection Composition
Internal validity	Do pattern matching Do explanation building Address rival explanations Use logic models	Data analysis Data analysis Data analysis Data analysis
External validity	Use theory in single case studies Use replication logic in multiple case studies	Research design Research design
Reliability	Use case study protocol Develop case study data base	Data collection Data collection

Figure 3.11 Case study tactics for four design tests (Yin, 2012, p. 45)

Construct validity

Construct validity is a measure for how accurate a case study's measure reflects the concept under study. In other words the researcher should develop a sufficiently operational set of measures and that subjective judgments are not used to collect the data (Yin, 2012).

This study applied multiple sources of evidence for collecting the required data. The case studies employed mixed methods for collection of the required data including: interviews, document analyses and post-mortem analyses. The cases were chosen from various industries in order to cover a wider range of projects, thus increasing the chances to be able to generalize the findings and results.

The author endeavored to establish a sound chain of evidence by making clear the sections on the case study databases that it draws upon and by appropriate citation of documents and interviews. The data collection followed the protocol, and the link between the protocol questions and the propositions was made transparent.

The findings acquired through interviews and documents provided by the case project organizations were presented to them regularly in order to receive confirmation prior to moving to later stages of data analysis, thus avoiding any type of failure in interpretation and illusions regarding the provided data.

Internal validity

The key issue in internal validity is the extent to which causal conclusions can be drawn from the study (Gray, 2004). The essence of internal validity is whether or not a researcher can definitively state that the effects observed in the study were in fact due to the manipulation of the independent variable and not due to another factor. "Third variables" that the researcher may not consider or may not be able to control can affect the outcome of a study and can therefore prevent internal validity. A study is considered to be internally valid if the researcher can demonstrate that variable caused the observed effect.

This type of validity is to be ensured for explanatory or causal studies only, and not for descriptive or exploratory studies (Rowley, 2002). So it cannot be tested for the exploratory survey done within this study. However the case studies were explanatory case studies which their results should be tested for internal validity. Yin (2012) suggests *pattern matching*, *explanation-building* and *time-series analysis* in order to ensure internal validity within case studies.

Pattern matching logic compares an empirically based pattern - that is the one based on the findings from the researcher's case study- with a predicted one made before the data was collected or with several alternative predictions (Yin, 2012). Within this study, the findings from each case study were compared to related theoretical patterns thus avoiding coming up with spurious cause and effect relationships among the studied concepts.

Explanation building has a goal of analyzing the case study data by building an explanation about the case (Yin, 2012). In this dissertation, explanation building was utilized by clearly indicating the conditions under which the cases were chosen to be studied. This was done by describing "how" and "why" the projects performed in a specific manner. Explanation

building was employed in order to identify the factors influencing the EW procedure and the obstacles within the process. Also it was applied to demonstrate the importance of appropriate application of the EW procedure within projects. The explanation building process is iterative in nature, as each case study contributed to fulfilling the overall research objective.

Time series analysis is the third analytic technique to be conducted. According to Yin (2012), time- series analysis includes the analysis of case study data by arraying the data according to time markers and comparing the trends against those originally designated prior to data collection. In this study, the time series analysis was considered through the examination of performance measurement and health check tools as EW identification approaches. Within the case studies on Tyrihans project and LTE and MOVE projects, certain variables were measured over time in order to discover the trend through which the use of EW identification approaches can affect the projects' performance.

External validity (Generalization)

External validity is according to Yin (2012), the extent to which the findings from a case study can be analytically generalized to other situations that were not part of the original study. In general, a researcher cannot often work with the entire population of interest, but instead must study a smaller sample of that population in order to draw conclusions about the larger group from which the sample is drawn. External validity is concerned with the extent to which the conclusions can be generalized to the broader population. A study is considered to be externally valid if the researcher's conclusions can in fact be accurately generalized to the population at large (Pelhalm and Blanton, 2006).

This study has endeavored to partially ensure external validity by applying the replication logic which is according to Yin (2012), the logic for selecting two or more cases within a multiple case study. This has been done by choosing the case projects from various industries within different organizational contexts. Yet there are still many more industries which have not been considered within this study due to time and scope limitations. Besides as presented in Table 3.2, 3 out of 5 studied case projects were located in Norway (IFaCOM project also mainly managed from Norway), therefor the results cannot be easily generalized to all types of projects in different contexts. However due to the universal common characteristics of projects and human beings, the results can be partially used as a basis for further research on projects within different contexts.

It should be mentioned that in this study, external validity has not been the main objective. The intention has rather been to enhance understanding on the concept of EW in projects and elaborate on the efficiency of application of EW identification approaches in practice. Furthermore, the existence of possible barriers against responding to EW signs has been scrutinized. The latter issue can vary in different project contexts due to it being heavily dependent on human factors.

Reliability

Reliability is the consistency and repeatability of the research procedures applied in a case study (Yin, 2012). The reliability of a study can be ensured by demonstrating that the operations of a study - such as the data collection produced can be repeated with the same results. This is achieved through documentation of procedures and appropriate recording keeping (Rowley, 2002).

This study has endeavored to ensure reliability by using a case study protocol and development of a case study database, which are Yin's (2012) suggested tactics for increasing the reliability of case study research. This was done by thoroughly documenting all the case study questions, hypotheses and propositions and also producing a sound theoretical framework for each case study. In addition a data collection plan was made prior to carrying out the interviews and document analysis. A case study database was developed consisting of description of the case projects, information regards the interviewees, interview results and the data gathered via analysis of relevant documents.

Triangulation is also a typical strategy which improves the reliability of research findings (Golafshani, 2003). Triangulation is defined by Bryman (2008) as:

"The use of more than one method or source of data in the study of a social phenomenon so that findings may be cross-checked."(P. 717)

Miles and Huberman (1994) distinguished have five kinds of triangulation in qualitative research:

- Triangulation by data source (data collected from different persons, or at different times, or from different places)
- Triangulation by method (observation, interviews, documents, etc.)
- Triangulation by researcher (comparable to inter-rater reliability in quantitative methods)
- Triangulation by theory (using different theories, for example, to explain results)
- Triangulation by data type (e.g., combining quantitative and qualitative data)

Table 3.7 presents the different triangulation methods applied in this study.

Table 3.7 Triangulation methods applied in the study

Triangulation methods	Approaches
Triangulation by data source	Data collection from different projects in various industries and in diverse project phases (e.g., front-end phase, execution phase, closure phase)
Triangulation by method	Data collection via interviews, documents and survey, followed by post-mortem analysis
Triangulation by researcher	Trying to involve other researchers in the data analysis phases of case studies and survey (e.g., co-authors of individual publications)
Triangulation by theory	Application of different theoretical perspectives , framework and models
Triangulation by data type	Utilization of a combination of qualitative and quantitative data collection approaches

Chapter 4

4. Research Findings

The aim of this chapter is to present an overview of the research strands and individual publications of the dissertation. For each publication, the theoretical background, key objectives, relevant details about the applied research methods which were not discussed in chapter 2, empirical context and key findings are presented. Table 4.1 presents the key issues which will have been covered in each publication. A summary of the key findings and academic and industrial contributions of each publication will be presented at the end of this chapter (See Table 4.x).

Table 4.1 Covered issues in each publication

Publication	Title	Relevant research objective	Key issues covered
I.	A Review on Possible Approaches for Detecting EW Signs in Projects	How is EW detection approaches addressed in the existing literature?	Project management methods which can be utilized as EW systems
II.	A Conceptual Framework for Application of Performance Measurement as an EW System in Projects, an Analysis on the Case of the London Ambulance Service Project	How can the utilization of EW identification approaches improve project performance in practice?	Performance measurement as an EW system
III.	Application of Performance Measurement as an EW System: A Case Study in the Oil and Gas Industry		Performance measurement as an EW system
IV.	Efficiency of project health checks (PHCs) as an EW system in practice: a case study in Norway's telecommunication industry		PHC as an EW system
V.	Identification of EW Signs in Front-		EW identification in

	end Stage of Projects, an Aid to Decision Making		early stages of projects
VI.	The EW Procedure in an International Context		Influence of International project characteristics on performing the EW procedure
VII.	Barriers against effective responses to EW signs in projects	What are the possible barriers against effectively responding to EW signs and how to enhance early responses to EW signs in projects?	Obstacles against effective responses to EW signs

4.1 Possible approaches for detecting early warning signs *(Publication I)*

This article presented an overview of the full extent of EW detection approaches, which are directly or indirectly addressed in the literature. The study was based on a review of current literature within the field of EW in project management and the authors' own experiences gained from practice. An analysis of the strengths and weaknesses of each approach and their application in different contexts was also performed. It was concluded that the choice of the most effective approach is arguably dependent on the type of project, organizational culture, and the project environment.

4.1.1 Early warning identification approaches mentioned in the project management literature

The aim of this article was to create a conceptual understanding of the extent of approaches available for identifying EW signs. This was done through reviewing current literature within the field, looking into studies of industrial practice, and also building upon the authors' own experiences in various forms, both through advising and supervising project management teams and through observations and studies of projects. Possible approaches for EWS from the literature and practical experience were extracted and a thorough discussion of their possible strengths and weaknesses was made.

The main research questions were (1) What approaches exist for detecting EW signs and how can they be categorized; and (2) What are the strengths and weaknesses of different EWS detection approaches under different circumstances? This approach to the research stemmed from previous exploratory investigations into the area, strongly indicating that there are obvious gaps in the literature regarding the field of EW signs.

The EW identification approaches which were both directly and indirectly mentioned in the project management literature are discussed in detail in section 2.2.1 and 2.2.2 and briefly presented in Table 2.2. Following, a summary of the authors' industrial experiences on application of EW detection approaches will be demonstrated.

4.1.2 Industrial experiences on application of early warning detection approaches

A study of a selection of eight cases from different industries (both the public and private sectors) with varying degrees of complexity, in three countries, was done in order to investigate the most important EW signs that were detected by the project teams, the

approaches that were implemented for performing this task, and also to assess the level of usefulness of the EW detection systems. The analysis process of these cases was not very easy due to the different range of projects, which varied in size, complexity, and task uniqueness. According to the authors' findings, the approaches used for detecting these signals were mainly project assessment tools and "gut feelings." Many of the experts involved in the case projects pointed out that many EW signs are of a less measurable nature and thus depend on more "gut feeling" approaches.

In general, the case studies suggested further possibilities for the detection of EW signs, many of which consisted of soft atmospheric or "feeling" issues, such as introducing the existence of a culture of openness and effective communication among actors, as an aid to detection of EW signs. In addition, there were suggestions on more reliance on personal antennas than on systematic analyses and other assessments.

Table 4.2 shows some of the main findings from typical "assessment-based" approaches compared with some findings of a more "gut feeling" based type. From the Table it is apparent that by using a formal assessment and looking for indications of issues such as the ones mentioned in the left column of the Table, it is rather unlikely to be able to detect the types of indications mentioned in the right column, unless being very much aware of their potential as EW signs.

Table 4.2 Additional important EW signs from case studies (Klakegg et al., 2010).

Through assessments	Based on "gut feelings"
The numbers or information missing	Lack of culture of openness and good communication between the actors
Assessments not performed / documentation not completed	Strained atmosphere
Plans and reports delayed or unclear	Evaluating the reality of needs
Contract obligations not fulfilled	Inconsistent arguments about agendas
Milestones /activity definitions unclear or missing	Changes in positions over time
Lack of an implemented governance framework	Uneasy comments and body language
	Stating uncertainty, unwillingness to conclude
	What kind of information is willing to be shared
	How questions are asked and answered
	Making reservations
	Lack of showing trust in the project organization

For answering the question about how useful the used approaches for detecting EW signs are, it was concluded from the findings of the case studies that EW signs may be identified via assessment methods, and in this respect, assessments are considered to be successful, but in the studied cases, this knowledge did not always lead to actions for dealing with them. This led to the conclusion that assessments, no matter how successful they are in the identification of relevant issues, can be a waste of time and effort. Some experiences, however, showed that the exercises themselves were most important due to their allowance of crucial questions to be raised early.

In addition, it was revealed that dialogue and organizational culture play key roles in detecting EW signs and this confirms the need for "gut feeling" approaches that can detect signals that are not easily covered by formal approaches. Generally, comparing the two approaches, it was concluded that "gut feeling" approaches are limited in the way that there is no awareness as to what to look for, but this is also its strength because there is no preoccupations with looking for specific indicators. This can provide the opportunity for detecting any type of EW sign.

4.1.3 Analysis of possible early warning detection approaches

This section presents an analysis on the EW identification approaches mentioned in Table 2.2 and analyzes them in order to clarify how each approach can be used as an EW source (See Figure 4.1). To summarize some main facts regarding the sources for EW signs, Table 4.3 has been compiled. For each of the EWS sources, a categorization has been done of the types of data used, the data sources that will typically be used, and what kind of analysis is performed. Furthermore, the Table provides a classification of the kinds of issues that are focused on in the process and shows in which project phase that each of the EWS sources will typically be useful.

In addition, the most typical and/or common strengths and weaknesses for each of the approaches are summarized in Table 4.4 which also pinpoints the most important factors that the predictive power of each of them will depend on.

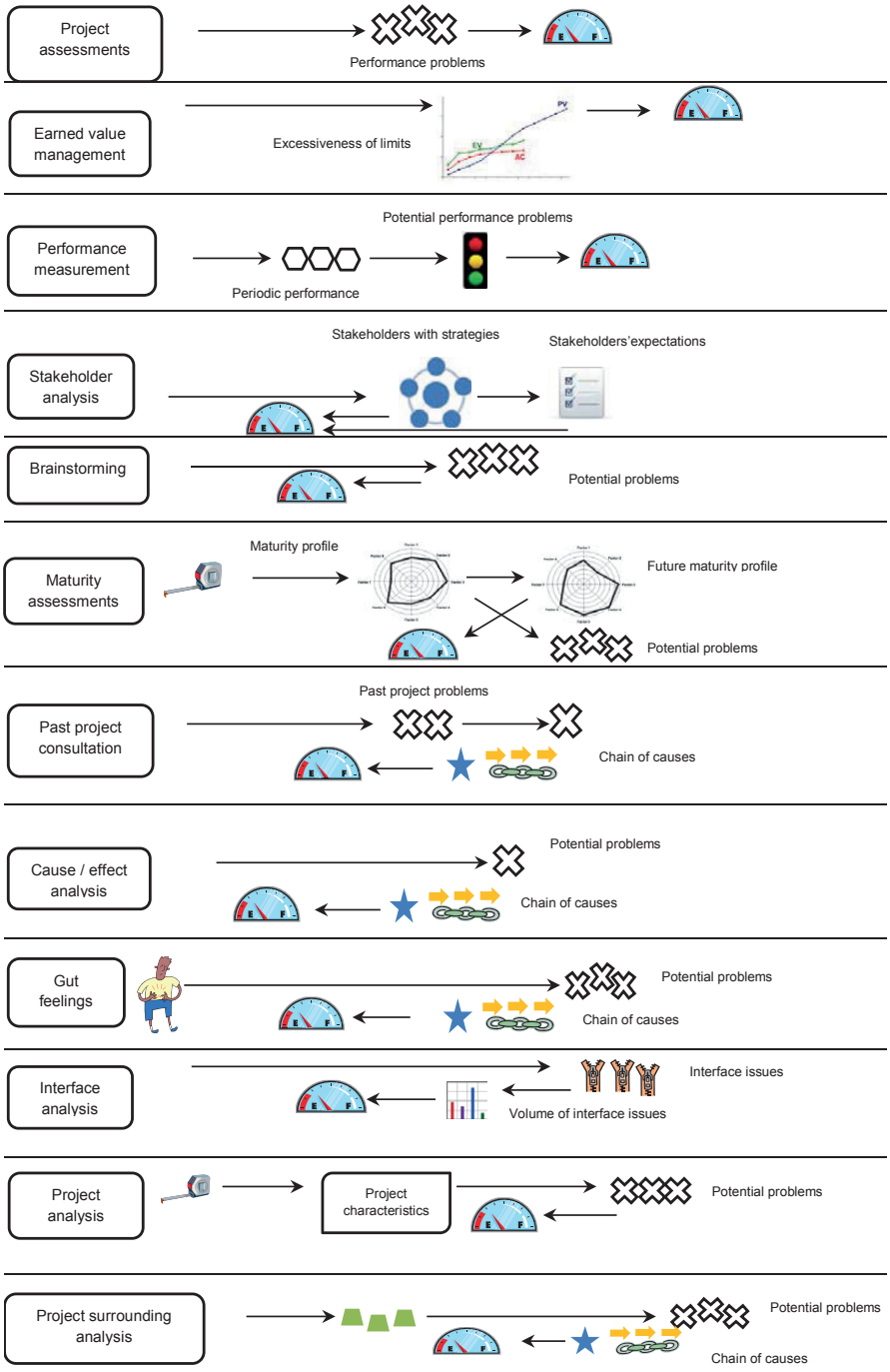

Figure 4.1 Different possible EW identification approaches

Table 4.3 Categorization of different EW sources according to various aspects

EWS Source	Type of Data [5]	Type of Analysis	Focus/Type of Issues	Data Sources	Project Phase
Risk analysis	Hard and soft, qualitative and quantitative analyses	Structured process blending; qualitative and quantitative analyses	Significant external/ internal, strategic/ operational threats	The project team, contextual data, previous projects	All phases, at decision gates/other milestones
Stakeholder analysis	Hard and soft, qualitative analysis	Structured process of qualitative analysis	Potential external and internal stakeholder issues	The project team, contextual data, stakeholders, previous projects	All phases, but front-end/early phase bias
Project assessments	Hard and soft, qualitative and quantitative	Snapshot analysis of project status	Internal and external problems	Internal and external project data	All phases
Performance measurement	Hard and soft, qualitative and quantitative analyses	Continuous analysis of project performance	Trends indicating internal and external problems	Internal and external project data	All phases
Brainstorming from team insight	Soft, qualitative analysis	Creative exercise	Potential internal and external problems	Individual participant judgment, previous projects	All phases, but front-end/early phase bias
Cause-and-effect/root cause analysis	Hard and soft, qualitative and quantitative analyses, qualitative bias	Structured process, applying different analysis tools, often combined with creative insights	Sources of internal and external problems	Any source of data about the problem being analyzed	All phases
Interface analysis	Hard and soft, qualitative and quantitative analyses	Identification and resolution of non-clarified interfaces	Avoidance of problems at non-clarified interfaces	Project team knowledge, project documentation	All phases

[5]"Hard issue" or "formal dimension" refers to technical managerial aspects, which consist of formal integrative mechanisms through tools and techniques and "soft issue" or "social dimension" refers to the dynamics and complexities of the human side of the project (Mustafa & Bowels, 2005).

EWS Source	Type of Data [5]	Type of Analysis	Focus/Type of Issues	Data Sources	Project Phase
Extrapolation from previous projects	Hard and soft, qualitative and quantitative analyses	Creative exercise	External and internal problems encountered in previous projects	Risk analyses, project documentation, close-out reports, interviews, experience	Front-end/early phase
Project characteristics	Hard and soft, qualitative and quantitative analyses	Classification of characteristics, benchmarking with baseline/other projects	Identification of singular characteristics and specific requirements stemming from these	Project documentation, project team knowledge	Front-end/early phase
Maturity assessment	Soft, qualitative and quantitative analyses	Questionnaire-based measurement of the maturity of the project and/or project organization	Identification of weaknesses in the project and/or project organization	Individual project team member assessments	All phases, but front-end/early phase bias
EVM	Hard and soft, quantitative analysis	Calculation of earned value	Shortcomings in value creation	Resource consumption data, assessment of task completion	Project execution
"Gut feeling"	Soft, qualitative analysis	Creative exercise	Potential internal and external problems	Individual participant judgment, previous projects	All phases
External factors	Hard and soft, qualitative and quantitative analyses	Identification and analysis of external factors	External factors that could negatively influence the project	Contextual data	All phases

Table 4.4 Strengths and weaknesses of different EW sources

EWS Source	Strengths	Weaknesses	Predictive power dependent on
Risk analysis	Easy to perform the underlying analysis because it is a structured method; everyone can contribute; generally little need for collecting additional data	Quality of the analysis outcome dependent on the selection and insights of the participants; propensity to focus on concrete; often technical risks and overlook less tangible issues;	Type of project where technical/immediate risks are of importance for project success

EWS Source	Strengths	Weaknesses	Predictive power dependent on
		danger of not updating the analysis to capture dynamics of risk issues	
Stakeholder analysis	Easy to perform the underlying analysis because it is a structured method; encourages the project to consider broader issues	Quality of the analysis outcome dependent on the selection and insights of the participants, easy to overlook stakeholders not encountered in previous projects or downplay the importance of some stakeholders, danger of not updating the analysis to capture dynamics of stakeholders	Whether the analysis identified the right stakeholders and their future behavior and the complexity of the stakeholder situation
Project assessments	Wide selection of project assessment tools available, which covers many aspects and gives longitudinal insight if repeated at certain intervals	Give only one snapshot assessment if performed only once, usually a need for collecting additional data, requires knowledge about the method, The results not always lead to actions for dealing with the identified EW signals (according to case study results)	The choice of assessment method and the frequency of analysis
Performance measurement	Provides continuously updated data that encourage frequent analysis, continuous data allows keeping track of developments, puts focus on issues covered by measurements	Often a need for collecting extensive amounts of data; for some issues not easy to find relevant data, risk of overlooking issues not covered by the measurements (black swans)	The choice of performance indicators
Brainstorming from team insight	Easy to perform because it is a "simple" analysis; no limitation on issues that could come up; everyone can contribute and generally little need for collecting additional data	Based solely on previous experience, risk of overlooking issues outside the contributors' mindsets, danger that some people can dominate the exercise	The team's experience
Cause-and-effect/root cause analysis	Looks for early triggers of undesired events or developments, uncovers relationships between triggers leading up to events	More complicated analysis because it requires creative backtracking from undesired event, relies on different analysis methods; typically a need for collecting additional data	The identification of undesired developments/events and the interpretation of the connections along the chain of cause-and-effect

EWS Source	Strengths	Weaknesses	Predictive power dependent on
Interface analysis	Looks for issues in the "white space" of the project that might otherwise go unidentified	Provides only a first indication of potential issues, but gives no method for monitoring these issues	People looking for interface issues and transparency about the project, the complexity of the project
Extrapolation from previous projects	Relevant source of issues in cases of similar projects, sources for this knowledge often found internally in the organization	Danger of indiscriminately applying findings from previous projects, often relies on tacit knowledge	Similarity of projects and their conditions
Project characteristics	Counters the tendency to assume that all projects face the same issues; provides a basis for benchmarking against relevant other projects	Specific analysis method or checklist does not exist	The accuracy of the characteristics profile developed
Maturity assessment	Analyzes underlying factors influencing project success, focuses on issues not covered by any of the other sources	Doubts about the accuracy of the measurements, relies on subjective assessments by individuals; must collect large amounts of data	The accuracy of the measurements and the correlation between maturity profile and project success
EVM	Easy to generate frequent measurements; uses partly objective data	Uses partly subjective assessments of completion, targets only the issues of cost and performed work	The accuracy of the subjective assessment of completion
"Gut feeling"	Independent of analysis methods with a specific focus; can capture issues otherwise overlooked; detects issues that are not easily covered by formal approaches; not preoccupied with looking for specific indicators (according to case study results)	Can be difficult to prove validity of issues, No awareness as to what to look for (according to case study results)	The experience and background of people involved; the persuasive power of the person identifying an issue and the openness of the rest of the team
External factors	Looks at the whole context of the project; could capture issues otherwise overlooked	Focuses on issues that can be difficult to predict the developments of, if only analysis undertaken risks overlooking internal factors	The correlation between the external factors and project success

4.1.4 Conclusions of Publication I

This article explored the degree to which various possible approaches for identifying EW signs in projects exist. Many of which are not mentioned directly as an EW source in the literature. The choice of the right approach is of course very much dependent on the project itself, the project organization, and the project context. The authors have endeavored to categorize the various EW identification approaches. This has been done based on the type of data that can be gathered by implementing the specific approach, the type of analysis required, the focus point, the source of data, and finally, the particular phase in which the approach can be used as an EW source. The results show that each approach has its own strengths and weaknesses. The choice of approach in a given project will be up to the discretion of the project management team, in order to exploit as many EW signs as possible and timely enough to be able to take preventive actions. The choice of the most effective approach is for sure dependent on the type of project, organizational culture, and the project environment. Findings from several case studies on the use of EW detection approaches, which the authors have been involved in, have been briefly described.

4.2 Application of performance measurement as an early warning system in practice (*Publication II and III)*

Two of the seven publications within this dissertation focus on performance measurement as an EW identification tool. Both studies explain how a PMS can be utilized as an EW system for avoiding failure. However different approaches have been taken for performing these two studies.

Publication II carried out the study by analyzing the published assessments of a project, executed in 1992, the LAS, which failed to fulfill its goals. The authors had basically no connections to this project. The rationale behind this selection was not to offer criticism relating to this specific project's performance but to learn constructively from it and move towards a better practice. In contrast, Publication III carried out the study by performing a combination of action research and a case study supplemented by a post-mortem analysis after project close-out. The project was executed during years 2005 and 2011. The authors were involved in the project in different phases of the project. Following, a summary of each of the publications will be described.

4.2.1 Application of performance measurement as an early warning system in the LAS project (*Publication II*)

In this article, a statement was made that, with application of a PMS in the project phase of the LAS project, chaos and perhaps total failure in the operational phase could have been prevented. Also, a conceptual PMS was proposed, using the main problems in the project phase as a reference for addressing the dimensions of performance to be measured, objects to be controlled, and the indicators. The overall aim of this article was to increase understanding of the concept of EW signs in projects and offer a possible approach, which can assist project managers in taking timely preventive actions in order to avoid undesired outcomes.

The first important issue that should be considered by project managers when attempting to measure a project's performance is to design a system that fits the context in which it will be used. The design of this system should be clearly in alignment with the project's environment. The environment is, according to Vittorio et al. (2007), defined as: (1) critical objectives of the project, (2) organizational and managerial practices adopted for the project process, and (3) characteristics of the project's tasks that are going to be internally taken. An appropriate definition of the standards against which to measure performance is necessary to ensure that the measurement system provides useful indications capable of correcting the course of action. In fact, there is a need for a proper "benchmark" to be in place in order to use it as a reference (Vittorio et al., 2007).

According to Andersen and Fagerhaug (2002) the process of designing a PMS includes:

1. Understanding and mapping business structures and processes
2. Developing business performance priorities
3. Understanding the current PMS
4. Developing performance indicators
5. Decide how to collect required data
6. Designing, reporting, and performance data presentation format
7. Testing and adjusting the PMS
8. Implementing the PMS

According to Andersen and Fagerhaug (2002), steps 1 and 2 are more complex than necessary, and step 3 can even be eliminated in small organizations. Steps 5 and 6 can be simplified and merged for projects in which a mass of performance data is not required. This is also applicable to steps 7 and 8. However, because the aim of this article was to design a PMS for projects in general, which also include complex and high-risk projects, it would be appropriate to approach each and every step dependently when designing a PMS. But it should also be taken into account that in large, complex project organizations such a process might not be able to capture the complex web of objectives, links between units, and so on. In these cases, it is recommended to apply the system design process to the independent tasks and units and then try to aggregate upward.

The authors chose to use the model designed by Vittorio and Frattini (2009), which is a framework for designing a PMS for new product development projects, as the main framework. Also, the steps are clearly illustrated in a graphic model and are easy to understand. The suggested framework is illustrated in Figure 4.2. Each element of this framework, which will be described in this article, matches each step of the design instructions suggested by Andersen and Fagerhaug (2002). The specific step that matches each element is also illustrated in Figure 4.2. The main aspects of this framework, as depicted below, are objectives, dimensions of performance, control objects, indicators, and the process of measurement. The objectives of measurement are to create a loop of never-ending improvement; the main objectives mentioned by Andersen and Fagerhaug (2002) are presented in the framework.

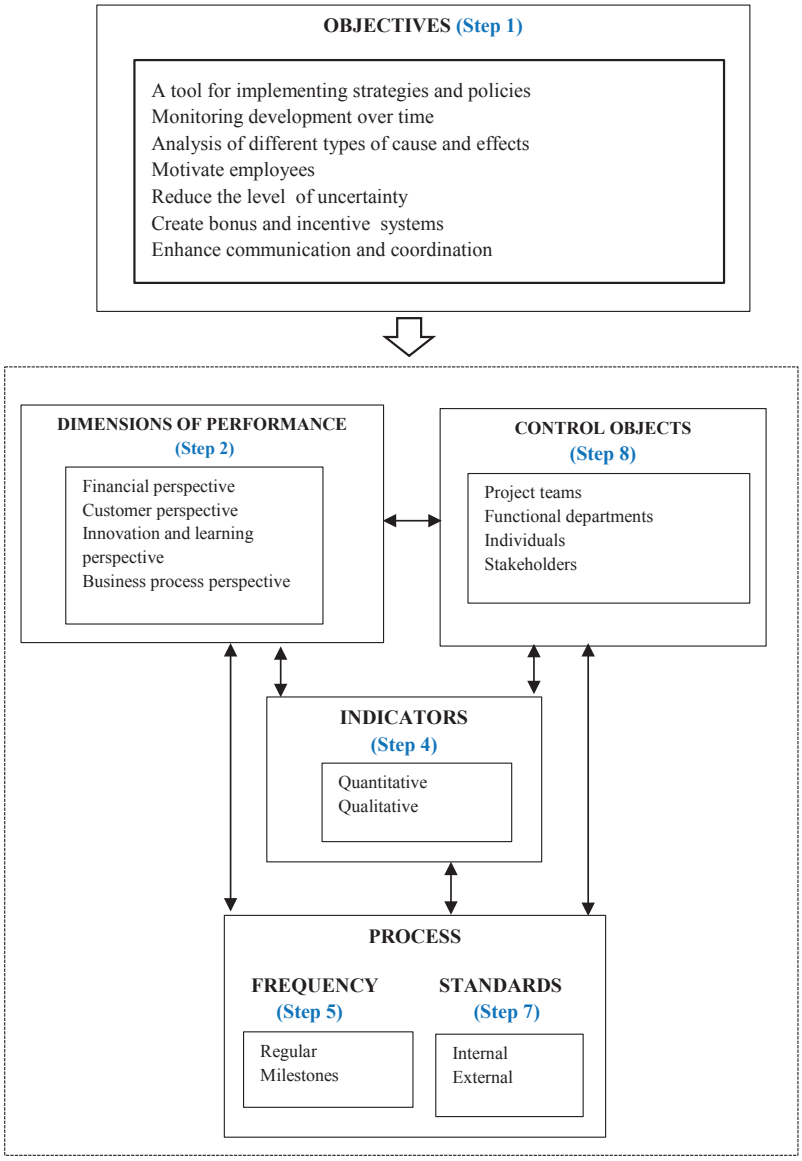

Figure 4.2 PMS framework (adapted from Vittorio and Frattini, 2009)

Having designed the main framework for measuring project performance, there was a need for clarifying the constitutive elements of the measurement system and describing which dimensions of performance should be monitored by the PMS, which indicators should be used to monitor each performance dimension and identify which organization level are being monitored, and also the indicators associated with each of these. In order to accomplish this, an objective must first be identified and the above-mentioned steps will then be followed according to this specific objective.

4.2.1.1 What could have been done differently in the LAS project?

In the case of the LAS it is clear that some issues could have been handled differently, and certain EW signs could have been detected in advance to prevent encountering serious problems in the end. Many studies have been done on the case of the LAS and analyses carried out to determine the reasons why this project ended in such a disaster (Hougham, 1996; Beynon-Davis, 1999; Dalcher, 1999; Fitzgerald and Russo, 2005). This case was analyzed from a management point of view and the application of a PMS in the project phase of the LAS which could have contributed to preventing chaos and perhaps total failure in the operational phase was discussed.

In his study, Kerzner (2013) introduces a list of typical EW signs in projects and indicates that the sooner EW signs are detected, the more opportunities exist for recovery and for improving the possibility for successful projects. The specific problems in the operational phase of the project could be matched to one of the typical EW signs introduced by Kerzner (2013) (See Table 4.5).

The authors suggested that a PMS might have been used as an EW system in this project. The suggested system followed the framework presented in Figure 4.2. Each element of the framework was adapted to the specific condition and aspect in the LAS project. In order to do this, the main problems that occurred in the project phase were used as a reference for addressing the dimension of performance, the objects to be controlled, the indicators of measured elements, and the suitable process of measurement. The system's components are presented in Table 4.6.

Table 4.5 Problems in the project phase as EW signs

Specific problem in the operational phase	EW sign
Software frequently late	Delayed decisions resulting in missed deadlines
Ad-hoc changes by software developers to achieve user satisfaction	Poor change control process
Users not adequately trained and skeptical about the benefits of the system	Different opinions on project's purpose and objectives
Short time scale	Unrealistic expectations
Software not tested	Technical failure
Lack of consultation with the users and clients	Failure in progress reporting, poor morale
Unjustified assumptions in the specification process	Unrealistic expectations

In this model, the dimension of performance that should have been measured to prevent problems in the operational phase of the project is mentioned. Each problem is related to one of the following areas, which are the components of the balanced scorecard:

1. Financial issues such as operating income, return on investment, and economic added value
2. Learning and growth issues such as employee satisfaction, employee retention, skills, and so forth
3. Customer issues such as customer satisfaction and customer retention

4. Internal business issues such as cost, throughput, and quality

Table 4.6 Components of the suggested PMS

Problems in project phase	Dimension of performance	Control objects	Indicators
Software frequently late	Service delivery on time (business process)	Project team	Percentage of project concluded on time (earned value)
No proper project management	Project management effectiveness (business process)	Project team	Value of schedule variance and cost variance
No experience with PRINCE (project management methodology adapted for development) for people involved	Capability of applying selected project management methodology (learning and growth)	Project team	Project performance during first month
Ad-hoc changes by software developers to achieve user satisfaction	Level of changes in the software (customer)	Project team	Percentage of customer satisfaction
Users not adequately trained and skeptical about the benefits of the system	Capability of clarifying goals of the project for users and level of training (learning and growth)	Individuals	Number of positive users in the beginning of the project
Short time scale	Level of proper planning (business process)	Functional department /project team	Percentage of project concluded on time according to the initial estimations
Software not tested	Quality of software performance (business process)	Project team	Percentage of "bugs" and errors
Lack of consultation with the users and clients	Quality of communication with customers (customer)	Customer/project team	Percentage of client satisfaction through the development stage
Unjustified assumptions in the specification process	Level of justification and reality of estimations (business process)	Functional department	Percentage of achievements according to the assumptions at each decision gate

In the proposed model, the dimension of performance for each aspect was matched to the area in which it fits. For example, "lack of consultation with users and clients in the development process" was a problem that occurred due to lack of a measurement system for customer satisfaction during the process.

The control objects, the objects whose performance should be kept under control, were set for each issue. For example, "too short project time scale" could be improved by controlling the project team's performance, their improvement during a specific period of time, and the

estimates they would have made to identify the right finishing time of the specific tasks they were responsible for. The frequencies of measurement, which can be on specific milestones or regularly throughout the project, are identified according to each aspect. For example, in the case of a "too short project time scale," if the project teams' performance had been measured regularly, comparing the planned work to be done with the actual work done (earned value method), the flaws could have been identified in advance.

Since the project team was not sufficiently experienced in developing this specific kind of system, there were no internal standards for use as a reference; however, any general software development standard that defines and establishes the routine process for software development can be used as a reference in order to prevent common risks and mistakes.

Having applied this model, the problems in the operational phase could have been overcome to some extent or even totally prevented. An example of the problems in the operational phase was failure of the system to eliminate duplicate calls and, as a result, dispatch ambulances to a scene more than once. According to the suggested performance measurement model, if the percentage of "bugs" and errors were measured, the software problems could have been identified in advance and, as a result, the above-mentioned errors could have been prevented in the operational phase. Each of the aspects mentioned in Table 2, in case they were noticed and acted upon, could have contributed to the prevention of the major problems that led the project to total failure.

Also, the level of customer satisfaction could have been evaluated during the project in order to identify their expectations in advance, thus avoiding surprising and unwanted events.

4.2.1.2 Conclusions of Publication II

The example of the LAS was chosen to better illustrate the problem and the possible solutions to it. In this specific IT project, the problems were clearly identified by looking back at what had already happened. This provided a good knowledge base for indicating what should have been measured, consequently identifying the EWs, and which measures could have been implemented in a different manner.

According to Holmes (2001), the LAS organization had the culture of "fear of failure," according to which senior management was continually under pressure to succeed. This could cause avoidance of even observing the EW signs, let alone taking proactive actions to respond to them. Klakegg et al. (2010) also discuss the problem pertaining to why project assessment methods are not capable of identifying EW signs in projects. They mention and discuss three particular areas that can contribute to this problem, including: complexity, understanding of risk, and interpersonal affects. Some of these issues are identified in the analysis done by Holmes (2002) on the case of the LAS. For example, the LAS organization had a history of severely problematical industrial relations between management and the ambulance crew. As a result, consultation with the ambulance crew during system validation was avoided. The author concludes that not only was a systematic approach not applied to detecting the EW signs in this project, but there was also a culture of ignorance, which led the project to such failure.

Another interesting point is to identify at what stage in the project life cycle it is possible to detect the EW signs. The supplier chosen to handle the LAS project didn't have enough experience to carry out this kind of system and the price was a major factor in selecting the winning bid. Looking at the bigger picture, it is somehow possible to see these two issues as EWs that the allocated tasks will not be carried out with the prerequisite quality.

4.2.2 Application of performance measurement as an early warning system in the Tyrihans project (*Publication III*)

The main objective of this article was to describe how implementing a PMS can contribute to the identification of EW signs in a project and outline the possible areas for improvement. It was also of interest to investigate how Key Performance Indicators (KPI) in projects, which are an important component of the information needed to explain a company's progress towards its stated goals, can be developed, implemented and used, and which effects it might produce for the project. This was done through carrying out a combination of action research and semi-structured interviews and document analysis supplemented by a post-mortem analysis on the Tyrihans project.

4.2.2.1 Development of a performance measurement system for the Tyrihans project

During the years 2005 and 2006, a PMS was developed in cooperation with the case project. 40 indicators were initially developed; being too many, later reduced to 18, and finally down to 8 key indicators, through a prioritization of areas of importance. The resulting 8 indicators were then brought forward for implementation in the management information system, MIS, of the company. After starting this effort, it was realized that each indicator required much work to implement and for some of them, data was difficult to obtain. Thus, based on data availability and the effort required to implement each indicator, the final set ended up being the 8 most relevant ones. The required data needed to feed these indicators was partly collected from the MIS and partly from the project's various records as well as through surveys of personnel. The EW system was also implemented in the MIS; measurements could be retrieved from the system and various diagrams and graphs produced to display the data.

The purpose of utilizing the final 8 EW indicators is presented in Table 4.7. Figure 4.3 shows an overview of the areas covered by measurement.

After having developed these indicators, including understanding the data required and how they should be presented, they were implemented into the MIS. Using internal programming resources, links were established to automatically collect the data already available in MIS or in other systems, and for data that needed to be collected manually, online surveys were created. The project management team put the system to use, making a review of the indicators a topic at weekly or semi-weekly management meetings. In addition, discipline managers shared and discussed the measurements with their sub-teams, and relevant indicators were also discussed with contractors and suppliers. A subsequent evaluation of the system and its use showed that the project management team found it practical to use and helped to both raise the awareness of many different issues and gave warnings about potential problems.

Table 4.7 EW indicators and their purposes

Indicator	Purpose
1. Competence and staffing	Providing the project management a notification of whether the project at any given time and sometime into the future had the necessary expertise and capacity.
2. Employee satisfaction	To "keep a finger on the pulse" of the project team's well-being and levels of contentment.
3. Interface actions	Facilitating smooth handling of all kinds of interfaces in the project, e.g., technical integration of components or sub-systems, providing documentation required by other actors, etc.
4. Supervision actions	Providing a planned check of the quality and timeliness of the deliverables by scrutinizing the project plan and the deliverables planned throughout the project in order to identify the critical items and targeted for so-called supervision actions.
5. Risks/uncertainties	Keeping track of the status of identified risks in order to provide EW about the development of risks throughout the project.
6. Growth in contracts	Keeping track of growth in project costs allocated to contracts with the suppliers and the economic impact on the project. Also measuring the evolution of both forecasts and actually billed value by the contractors.
7. Cost-related modifications	Measuring the extent to which a change in project scope would cost for the project.
8. Float	Monitoring schedule progress, based on collection of data about activities run by contractors and internally by the project team in order to measure how much dependent contracts and activities can be delayed without influencing the completion of milestones or the total project.

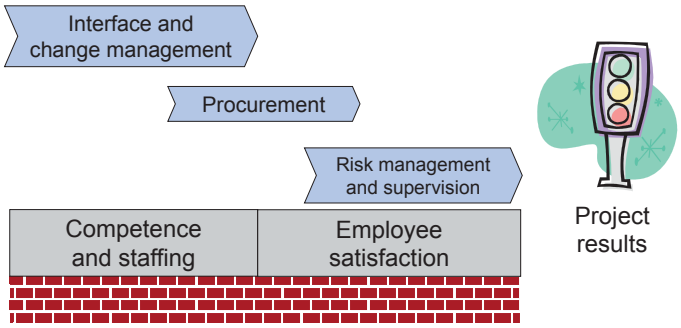

Figure 4.3 Various areas covered by measurement

4.2.2.2 Performance measurement system implementation results

Findings from the post-mortem analysis of the project and its use of the PMS showed two main messages; 1) the case project turned out to be highly successful measured against all success criteria and 2) the use of the PMS for EW seems to have led to early detection of future problems and thereby contributed to the project success.

According to the project control manager, this project, despite being a complex project from both a technological and organizational point of view was considered a clear success, being

completed on budget, on time, and with the specified quality. The realized oil production has exceeded what was planned, and the health and safety performance was very good.
Determining how much, if any, of these results were caused by the EW system is inherently difficult; attribution of effects is impossible to calculate, and running studies with a control group is also virtually impossible. The author therefore had to rely on assessments made by the people who were involved in the management of the project, even though these can be biased toward optimistic assessments, especially since these people were the ones to initiate the development of this system.

In any case, the view was that the PMS helped the management team, especially the top project management team, to put more focus and attention to aspects of the project otherwise easily overlooked. It provided a clear picture of the project as a whole and it definitely worked as an EW system in many situations, alerting the project to future issues and allowing these to be resolved. In total, it was claimed that it strongly contributed to the overall success of the case project. A further testament to the benefits of the system was the fact that another four projects used the same system, albeit with some additional indicators. An evaluation of these altogether five pilot projects showed the need for performance measurement and verification capabilities.
Reviewing the 8 indicators ex post, they were categorized in terms of their usefulness as an EW source, determined to a large extent by their nature as a lagging or leading indicators. Employee satisfaction, interface actions and risks were the most useful indicators in this respect. Supervision actions and float were two indicators that, despite being leading, were considered only to be of medium contribution to the identification of EW signs. The reason was that although they both displayed delays and obstacles to progress, these were in fact the result of a cause and effect chain that the indicators failed to detect the start of. The source of the problems should ideally have been identified even earlier, and often were identified by means of the indicators for interface actions and risks. The two least contributing indicators were growth in contracts and cost-related modifications. These were lagging indicators which were measured after the fact and provided little basis for detection of EW signs.

Table 4.8 Type of indicators in the designed PMS

Indicator	Type of indicator	Duration of measurement	Level of efficiency as an EW source
Competence and staffing	Leading	Until sanction of the project	Low
Employee satisfaction	Leading	Whole project	High
Interface actions	Leading	Whole project	High
Supervision actions	Leading	Whole project	Medium
Risks	Leading	Whole project	High
Growth in contracts	Lagging	After sanction	Low
Cost-related modifications	Lagging	After sanction	Low
Float	Leading	Whole project	Medium

4.2.2.3 Conclusions of Publication III

According to Almahmoud (2012), in today's complex and competitive environment, there is a need for managing project performance in a proactive rather than a reactive manner. Performance measurement of EW indicators is a direct response to this; the leading indicators can actively contribute to taking proactive action to prevent imminent problems. Lagging indicators, on the other hand, provide information about issues after the fact and can represent a basis for learning, but not as a tool for EW.

In the case project, according to neutral measurements of success and the project management team, EW based on performance measurement contributed very positively to the success of the project. This did not prove that use of a PMS can guarantee success in any type of project, but represented a promising result. The contributions from this study to the body of knowledge in this field were:

- A demonstration that performance measurement can be used as a tool to implement EW identification.
- Indications that EW can improve performance of a complex project.
- A procedure applicable for developing and implementing an EW system based on performance measurement.
- Insight into which aspects of a project can be exploited for EW and how performance indicators can be defined for these aspects.

In terms of practical implications, the authors proved that it is possible to define performance indicators capable of providing EW. Furthermore, it was shown that the data required to feed a PMS based on these indicators can be collected mostly from existing registers or through simple surveys. As such, this case study research tried to prove an inspiration to other projects to test the EW procedure. By providing detailed insight into the performance indicators applied, it would be also possible for other projects to copy or modify these. Finally, the process applied in the case project to develop and implement the system could be replicated by other companies.

4.3 Efficiency of project health checks as an early warning system *(Publication IV)*

This article presented an overview of the concept of EW signs in projects and explained how effective the utilization of Project Health Check (PHC) can be as a source of data for an EW approach signaling that a project is about to experience problems at some stage in the future. This was based on the assumption that application of PHC due to its systematic nature for managing all project variables in different phases can minimize the risk of project failure. Two case projects from the telecommunication industry which have implemented the PHC system were investigated in order to observe how the use of this approach can help indicate EW signs which arise in projects and specify the area in which the problem is about to occur.

The main objective of this study was to investigate how effective the application of project health assessment tool could be in order to point to the areas in which the project had a potential for facing problems. It was also of question the extent to which the tool was able

to provide the responsible party with enough information for taking the right corrective action in order to avoid failure.

In order to do this the tool developed by the case company with collaboration of the PUS-project[6] was applied. This was based on Pinto and Stevin's ten critical success factors in projects. Purpose of this project management tool was to give a helicopter perspective of the project performance and call attention to critical success factors for monitoring, improvement and follow up. The key goal was to continuously improve these areas (Bharj, 2008). The tool consisted of 20 questions that could be used to check how project participants experience their work situations (See Table 4.9)

Table 4.9 Health check questions

Health Check Questions
Q1. Goals of the project are clear and clearly defined?
Q2. Work in the project contributes to achieve goals of the project?
Q3. The goals are still relevant and correct?
Q4. The project has support and trust from project owner and there is good communication and cooperation?
Q5. Plans and estimation connected to the project are realistic?
Q6. The project has plans for uncertainty management?
Q7. The project team is marked by / experienced few conflicts?
Q8. I feel comfortable / happy working in the project?
Q9. The project has individuals with the competence that is required in order to do the job?
Q10. The project has the capacity that is required in order to do the job?
Q11. Progression of the project is followed up continuously?
Q12. Deviation from project plan is dealt with in a good manner?
Q13. I have information that I need in order to do my job in the project?
Q14. My tasks are well-defined and understood?
Q15. Communication in the project goes well internally (between sub-projects across)?
Q16. The project has an overview of other projects / efforts that depend on it and communicates with them?
Q17. A frequent dialog goes on with those who shall use / have benefits of the project results?
Q18. I contribute actively to register / report uncertainty?
Q19. The project performs / practices a good uncertainty management?
Q20. Changes are dealt with in a good manner in the project?

4.3.1 Results of application of project health check in the projects

Case 1.

The health check was initially implemented in this project in the first phase during fall 2010 and summer 2011.This period covered the planning and investment decision gates. The

[6] The PUS-project is a research project conducted in Norway during the period 2006 – 2010. The name PUS is a short form of "Practical uncertainty management in a project owner's perspective". The project was collaborated with Norwegian Center of Project Management (NSP) and the Research Council of Norway.

respondents were chosen among mainly top management and people who were working full time and in a central position towards the project.

The main results of implementation of the PHC in case 1 is listed below:

The number of respondents decreased over time. The reason according to the project manager was that the respondents found it too boring to go over the same questions as the time passed. Also there were signs that the project was approaching its purpose in a satisfactory manner so they found it not as necessary and helpful over time.

The total accumulated score within the period in which the PHC was implemented showed a downward trend up to November and suddenly a dramatic change from then on. The downward trend of the project health was perceived as an "EW". Therefor the steering committee made a decision for adding a project risk and change manager to the project.

The project found this solution useful. The recruitment of the project change manager certainly had a positive impact on enhancement of the health check indicators throughout the project.

Later throughout the project, in the second phase, in year 2013, two more health check assessments were carried out. This time the respondents were chosen both from the steering committee and the project team.

The average scores perceived in the second phase were mainly higher compared to the first phase of the project. The results of the PHC in the second phase showed that the plans were not realistic in order to reach the targets. The steering committee and the project team then decided to take action and arrange a planning workshop for 2 days with the aim of introducing a "revolutionary plan" which would help realizing the exact milestones.

The results obtained in the second assessment, in January, showed that the steering committee and the project team had quite common opinions regards almost all the issues while the result of the last assessment in March 2013 showed a rather high difference between project team's opinion and steering committee's opinion especially regards communication issues, conflicts and access to required information. This deviation could be a sign for lack of common view among steering committee and the project team during the period where the assessment was done.

Case 2.

For Case 2, one interview was conducted with one of the eight strategic project managers in the firm. This project had experienced a large schedule slippage. According to the interviewee, this was due to high level of complexity of the project, changes in the plan, and underestimation of vendors' resources. In this case, the health check acted as a "temperature gage" for the project, which monitored how the project team coped with the changes and challenges throughout the project. The use of the tool aids continual observations of all personnel, to ensure that they are motivated and inspired.

Five health check assessments had been carried out since 2011, to the point where the study took place, in addition to the assessments made since the beginning of the project in 2007.

Prior to 2011, PHCs were performed more frequently, but thereafter the top management team decided to perform them under two specific circumstances: either during long periods with no changes or at times of immense change. The team considered it unnecessary to repeat the checks at certain periods during the project.

The main results of implementation of the PHC in case 2 are listed below:

According to the interviewee, the use of other tools such as risk management, change management, and stakeholder management contributed to foreseeing the problems to a great extent. Hence, many of the project participants did not deem the use of health checks necessary. Rather, the health checks served as confirmation of what had already been identified by the project team.

Total accumulated scores obtained from the use of PHC in the duration between August 2009 and June 2011 showed that the lowest results of health check assessments were obtained in February and October 2010. This period corresponded to a period of major re-planning of the project, due to delays caused by poor quality of what the vendors had delivered. There were also major changes in the project organization.

The PHC results were not perceived as EW signs, but rather as a confirmation of the seriousness of the signs that would have resulted to large problems if they had not been acted upon.

The areas, in which the lowest scores were obtained included *project planning*, *project follow up*, and *capacity and competence*. Theoretically, these areas demanded special attention and were perhaps areas in which corrective actions should have been taken.

The lowest score among the project areas was in capacity and competence. According to the interviewee, this factor was the central cause of problems in the project. The company had struggled considerably with the poor quality of what the vendors offered and at the same time had had little possibility to hire more competent people internally, and therefore many of the existing resources had too much workload. The constant need for re-planning was directly related to this issue. As a consequence of the problems caused by lack of competence, the project follow-up actions also faced shortages.

Similar to Case 1, in Case 2 the project managers believed that applying a health check was a great support for their gut feelings. In this specific case, the health check only and precisely served as confirmation of what had already been identified, and the scores were seen as the consequence of foreseen problems.

The results of the case studies show that in practice the PHC tool does not always offer novel information about a project's status. In Case 1, the downward trend, which reached its lowest point in November , as mentioned by the interviewee - acted as an alarm for future problems and provided the project managers with adequate information to allow them to take the appropriate actions in order to prevent undesired events. However, this was not the only source of EW, as the health check acted as a trigger for further investigation into corrective actions that could be taken to prevent possible future problems. Although gut feelings were recognized as the most important source of EW, the PHC results were perceived as confirmation of this awareness. The results show that the tool can be employed

to prove the need for corrective actions. The results also reveal that it is not always easy to demand that changes should be made based only health check diagnoses. There is always resistance against acceptance that undesired events are forthcoming. The results of a PHC can serve as additional proof to substantiate the need for change.

The results of the second case study (Case 2) were slightly different from what was concluded from the first case. According to the interviewee, in this particular case the application of the health check had "only" acted as confirmation of what had already been identified through the use of other approaches, such as risk management, stakeholder management, change management, and progress follow-ups. Thus, the results obtained from the health check were a consequence of the foreseen problematic situation and not a predictor of it.

Looking at the two cases, it was apparent that although the projects were performed within the same company and using the same methodology, the results obtained from the application of the health check tool differed in some aspects. The authors believed that this was at least in part due to the different characteristics of the projects. Table 4.10 shows that the level of complexity of the second case was higher than the first case. This factor was definitely influenced by the larger number of vendors involved in Case 2.

The difference might have been due to the longer duration of the second project, which may have been a driver for the development of better communication and dialog among project members. The higher experience of project managers in the second case may have been a further reason why they identified problems prior to the use of the health check tool. The gut feelings and other obvious signs, such as delays and poor quality, had already made it clear that some future problem was likely to arise. The constant need for re-planning in Case 2 was another reason that rendered the PHC results less reliable. The solution would have been to have a new round of questions, customized for the new situation, after each change had been made to the original plan.

Table 4.10 Specifications of the two case projects

Characteristics	Case project 1	Case project 2
Duration	2010–2013	2007–2014
Level of complexity	Medium	High
Level of communication and dialogue[7]	Medium	High
Average experience of project managers	Medium	High
Changes made in the original plan	No	Yes

The case study results revealed that the PHC tool cannot act adequately and effectively as an EW system under all circumstances. Different factors, such as those listed in Table 4.8, can strongly influence the level of efficiency of the tool.

Complexity is one essential factor that influences the accuracy of the results obtained from the use of PHCs. According to Piperca and Floricel (2012), two types of complexity,

[7] The specification is based on the authors' subjective assessment of the interview results.

produce turbulent dynamics that can impact a project unexpectedly; one stemming from the number of distinct elements as well as the number and nonlinearity of relations between these elements in a project and the other stemming from the project environment and its relation to the project. The author believes that the health check tool utilized in complex projects tends to overlook the potential problems that may arise due to this aspect and thus it can only act as a supplement to the gut feelings of the project team members.

However, it should not be overlooked that in general increasing complexity consistently seems to make the detection and interpretation of EW signals increasingly more difficult (Klakegg et al., 2010).

In addition to the data provided by the interviewees on the usefulness of the PHC tool, the interviewees also pointed to some specific weaknesses of the tool. First, the scores given by different parties are quite relative. Second, some questions need to be customized to each particular phase of a project because otherwise they will not provide any useful information. Third, there is a need for continuous modification of the health checks as a project progresses in order to engage the project team in responding to the questions better and finding them useful for the project's progress. Some issues should be assessed throughout the whole project duration, while additional questions may be needed according to the specific phases or special situations.

It is very important to have a large variety of roles among health check respondents in order to have a holistic view of project performance in all areas, such as subproject managers and lower level project participants. This is due to the fact that each and every project resource is vital to project success, and individuals with different roles see the project from their own point of view where some positions allow for seeing things that others do not. Also, there have been suggestions that health check questions should be differentiated according to different resources, such as technical staff and management staff. One idea, which came from one of the interviewees, was also to add some resources at a larger distance from the core of the project, in order to include the "outside view," which according to Lovallo and Kahneman (2003) provides a reality check on the more intuitive side, reducing the odds that a project will face serious problems.

Although the literature sources regarding the application of PHC in projects mainly include projects from the construction industry (Almahmoud et al., 2010; Choi, 2007; CII, 2006; Humphreys et al., 2004; and Andersen et al., 2005), the authors found no reason which could prevent the application of this tool in other industries. Since the PHC concept is based on continuous improvement of the management processes, tools, and skills, its implementation can aid the leading of a project towards success.

A further issue that should not be overlooked was the fact that different industries experience different challenges when managing projects, and therefore managers from diverse industries focus on various project management processes and complete projects with a different level of project success (Zwikael, 2008).

4.3.2 Conclusions of Publication IV

The results of the case studies show that in practice the PHC tool does not always offer novel information about a project's status. Rather the health check acts as a trigger for further investigation into corrective actions that could be taken to prevent possible future problems. Although gut feelings were recognized as the most important source of EW, the PHC results were perceived as confirmation of this awareness. The results show that the tool can be employed to prove the need for corrective actions. The results also reveal that it is not always easy to demand that changes should be made based only health check diagnoses. There is always resistance against acceptance that undesired events are forthcoming. The results of a PHC can serve as additional proof to substantiate the need for change.

The results of the second case study (Case 2) were slightly different from what was concluded from the first case. According to the interviewee, in this particular case the application of the health check had "only" acted as confirmation of what had already been identified through the use of other approaches, such as risk management, stakeholder management, change management, and progress follow-ups. Thus, the results obtained from the health check were a consequence of the foreseen problematic situation and not a predictor of it.

Looking at the two cases, it was apparent that although the projects were performed within the same company and using the same methodology, the results obtained from the application of the health check tool differed in some aspects. The author believes that this was at least partly due to the different characteristics of the projects.

The findings from this study suggest that the PHC tool can, under specific circumstances, be helpful to project managers for identifying EW signs of problems. However, there are also many factors that influence its level of efficiency at different points in time. The tool also seems to require modifications in certain areas of a project. The strength of the tool lies in its focus on soft issues such as communication and dialogue, conflict handling, and interactions within the project. Since Projects largely fail for non-technical (Walley, 2013), therefore a focus on soft issues is to a great extent a contributing factor to project success. There is definitely a need for updating the obtained results from the use of PHCs when a project is finished, in order to evaluate the overall performance of the project within the areas that the health checks take into consideration.

4.4 Identification of early warning signs in front-end stage of projects *(Publication V)*

This article suggests that it can help to introduce new insights to adding EW identification as part of the management process in the front-end stage of projects. This is due to the fact that most of the critical decisions are made in the front-end stage of projects due to high level of uncertainty in this stage (both negative and positive uncertainty). At the same time there is high potential for corrective actions and reducing consequences of possible negative impacts in this stage.

At this stage, attempting to detect EW signals of possible future problems can be an aid to making the right decisions and ensuring the existence of crucial requirements. The earlier the warning signals are identified, the more time will be available for taking appropriate corrective actions before the negative consequences of a problem show up.

A case study on the Norwegian HSR project, which was in its front-end stage at the time the study took place, was done in order to better illustrate the key points of the research. This was done through an analysis on the possible EW signs which could be detected in this stage and showing how this could possibly contribute to a more effective decision making process for the project.

4.4.1 Uncertainty elements of the Norwegian HSR project

Having studied the published reports on the Norwegian HSR project, the uncertainties involved with different aspects in the project in order to identify the potential problems which may have rised during the project, were extracted. a total of 53 uncertainty elements have been identified in various aspects such as technical feasibility, climate factors, travel time, market, safety and security, development costs and environmental issues (See Table 4.11).

Assuming that all the uncertainty elements in this table were more risk- oriented rather than opportunity oriented, the discussions continued taking into account these elements as risk elements of the project. It was interpreted that each of the uncertainties mentioned in Table 4.11 were potential problems in case of occurrence on the negative side. It should be noted that although according to Aass et al. (2010), it is very important for all the organizations in the public sector to make the most out of the limited resources and create maximum value for the money but there are cases where the project is approved due to purposes which have a higher priority than costs. As the main purpose of the Norwegian HSR project was mentioned to be an environmental friendly solution for transportation despite the huge amount of development costs. The question which raised was what could be the EW signs to these risks in the front end stage of the project? It was also a challenge to identify EW signs of which category of problems could mainly be determined in this stage.

Table 4.11 Uncertainty elements in Norwegian HSR Project

Category	Uncertainty elements
- Technical feasibility - Climate factors	1. Suspension bridge over the Hardangerfjørd with a length of 1.6 km in Oslo-Bergen rout is feasible 2. 2 tube tunnel under Hardangerjøkuln in Oslo – Bergen rout 3. 2 tube tunnel under Boknafjørd with a length of 51 km in Stavanger-Haugesund rout is feasible 4. Underground portion of over 50% in Oslo-Trondheim rout is feasible 5. Establishing technological standards alongside the rapid development of international practice is feasible 6. Climate change is not so vast to require new technological solutions 7. The need for compatibility to Swedish lines does not require completely new, out of the scope technological solutions 8. Land wasting are detected early enough 9. Bed rocks are in good conditions so the rails can be built on them 10. Diagnosing in advance probability of water leakage in places where tunnels are intended to be constructed
- Travel time - Market - Safety and Security - Business - Development costs	11. Travel time is approximately 3,5 hours in all corridors in order to make replacement of flights beneficial 12. Number of passengers is adequate in all the routes 13. The investment pays back in good time 14. Socio economic value is positive 15. Cost of the project is reasonable and worth the service its providing 16. Development of labor market is satisfactory due to easier means of transportation between towns and large cities 17. Community acceptance is satisfactory 18. The HSR can operate safely under harsh climate of Norway 19. Distribution of population over time is relevant to the need of HSR 20. Travel duration is convenient and pleasant for passengers 21. Business travelers needs over time is still in alignment with the need for HSR in specific routes 22. Number of people working and living in different areas is relevant to the need of HSR 23. Employment growth in different areas is relevant to the need for HSR 24. Public reaction to public funding required for construction of HSR is positive 25. Passengers perception of use of HSR is positive 26. Inflations and change of interest rates does not affect the project costs in a negative way 27. World economy will not change in a manner which can negatively affect the project 28. Government policy does not turn negative against the project 29. Road improvements and new technologies does not decrease the public interest in HSR 30. Changes in legislations during HSR development and construction does not stop the project 31. Change in EU policies does not affect the project costs and scope (For example immigration laws preventing use of foreign contractors from outside EEU) 32. Communities in Norway approve the plans 33. Low rate of level crossing accidents 34. Low rate of tunnel accidents 35. Few fatalities during the construction phase (less than 11 fatalities per year for the total railway net) 36. few accidents due to collision with wild animals crossing the rail lines

	37. less than 2 accidents per 10 years with local people living near the railway area
	38. No successful terroristic accidents
	39. No serious accidents due to fire
	40. No serious accidents due to violence and sabotage actions
	41. No detonation accidents in the tunnels
	42. No bombing accidents near the rail lines
Environmental issues	43. Transfer of air traffic and road traffic to HSR is significant
	44. Environmental balance is achieved in good time
	45. Intervention effects on natural environment, cultural heritage, landscape, natural resources and society is not too high
	46. Amount of CO_2 emission due to tunneling is acceptable
	47. Amount of CO_2 emission while the HSR in operation is acceptable
	48. Amount of noise produced by HSR is not disturbing for people living in the area surrounding the places where train passes
	49. Amount of GHG emission per unit of traffic is acceptable
	50. Amount of GHG is decreased due to high volume of traffic transferred from air
	51. Public reaction to environmental effects from construction of HSR is positive
	52. The HSR is more environmental friendly than air transport
	53. New technologies such as hybrid cars, low hazard fuels for air planes etc. do not replace this solution

4.4.2 How identification of early warning signs can be an aid to decision making

Three categories of problems were identified as the main possible problems:

1. Problems related to technical feasibility and climate factors
2. Problems related to travel time, market, safety and security, business and development costs
3. Problems related to environmental issues

According to Nikander (2002), two stages of assessing the future are included in EW utilization. First the severity, likelihood of materialization and time available of the potential problems should be analysed, based on the view point of the evaluator, and second the decision maker should examine the impact of the planned responses on the project, and the reactions, and responses of the various project parties and /or outsiders in the situation at hand. Nikander (2002) suggests a decision support model of EWs, including 6 stages, which will be briefly described here. The first stage is detecting the EW signs. In the second stage, the observer interprets the signs in order to decide whether it is an EW sign or should be rejected due to its insignificancy. In the third stage, the observer tries to determine the significance of the information provided by EW signs for the project.in the fourth stage the observer attempts to identify the problem (risk) that has emerged as well as its causes based on the information provided by the EW sign and other aspects such as project's situation and environment. The fifth stage includes an assessment on the time available for taking the right actions. This is explored along with recognition of risks. The question in this stage is how much time is available for the responses requires by the problem and the level of urgency of the situation. This stage is also highly influenced by the project situation and environment. Finally at the last stage it is necessary to decide which responses are required towards the situation.

In this article, the authors stated that utilization of this model in the front end stage of projects could provide a clear view towards many possible problems which may have arose in the future. Although the EW signs of many risks are not possible to be detected in the front-end stage of the project, e.g. mainly technical issues, but the ones which can be detected provide a strong basis for decision making due to the adequate available time prior to the occurrence of the real problem and thus providing a high possibility for assessing the possible responses which can be taken in order to see if the project will or will not reach its purposes under the realized situation.

In case of the Norwegian HSR project, identification of EW signs related to important aspects of the project such as market conditions, environmental effects and different stakeholders' opinion about the project were considered to be able to highly assist the main decision makers of the project in order to first investigate if the project shall start at the first place and to what level the project's objectives will be met in case of execution. Table 4.12 presents an example of the actions which could have been taken in case of Norwegian HSR project, following the 6 step procedure which was defined above. The authors believed that although the final results of the Norwegian HSR project feasibility study claimed that this project was fully feasible, the EW signs of several serious problems which were discussed in the previous section, had been overlooked and the probability of the project not reaching its goals , in case of execution, should have been taken under consideration.

Table 4.12 Decision support model steps for an environmental issue in Norwegian HSR project

Decision support model Steps	Example from case of Norwegian HSR project
Detection of EW signs	50% of routes are underground
Interpretation of signs in order to approve or reject it as an EW signs	A serious EW signs due to high CO_2 emissions it will cause
Determination of the significance of information provided by the EW signs, for the project	Highly important due to its contradiction with the main purpose of the project : an environmental friendly means of transportation
Identification of the possible problems (risk) as well as its cause based on the information provided by EW signs	Hazardous environmental effects caused by construction of tunnels. Main cause is large amount of mountains and rocks in the defined routes.
Assessment of time available for taking the right action	Prior to the start of planning phase
Decision on responses required towards the situation	Possible alternative routes / alternative means of transportation

4.4.3 Conclusions of Publication V

The findings showed that although EW signs of a vast group of problems were not possible to be identified in the front-end stage, but the ones which were possible to be detected, could highly contribute to making major decisions such as level of feasibility of the project at the first place and the extent to which its objectives can be met.

It can be concluded that in general, identification of EW signs in the front-end stage can give more insights for the managers to choosing the right concept and making more effective decisions. Although the uncertainty is at its highest level, the possible EW signs which may be detected can predict, in many ways, the project's future conditions. Note that both the low cost of changes and the rather large amount of available time for taking preventive/corrective actions can be a great aid for making the right decisions.

4.5 The early warning procedure in an international context *(Publication VI)*

This article endeavors to scrutinize the EW identification process as part of the management system in international projects and the possible obstacles which exist within this procedure.

The idea emerged due to the fact that globalized business and organizational environment is creating a growing need for project managers that can operate in a variety of cultural and socio-economic settings and are capable of handling the complexities involved with international projects.

An ongoing international R&D project including 5 different countries and 15 partners from both academia and industry sectors was used as an example for better clarifying the concepts. This project was looked at from the point of view of the single partner which carried out the management and coordination responsibility within the project. The research objective of this study was to explain the importance of awareness of project managers of possible future problems and their actions in order to prevent undesired consequences.

4.5.1 Possible obstacles against effective response to early warning signs in international projects

According to Lientz and Rea (2003), international projects are different from local projects due to various factors such as cultural and social differences among participants from different countries, language and dialect variations, Legal, regulatory, and reporting requirements, time zone differences, etc. While there are many benefits to performing international projects, the growth of these types of projects has come at a cost. Surveys reveal that the probability of failure in international projects is higher than standard single country projects. One of the main drivers is the higher level of complexity of international projects (Lientz and Rea, 2003). Due to complexity, diversity and high risk of failure, they suggest certain steps which should be taken for performing an international project:

1. Strategy selection
2. Definition of project purpose and scope
3. Development of vision and benefits resulting from the project
4. Identification of roles and responsibilities
5. Performance of an analysis on potential issues
6. Determination of resource management
7. Establishment of a way for addressing communications

The main focus of this research was the 5th step where potential issues which can impact the project are identified at the start. In other words, this step was interpreted as the EW procedure introduced by Nikander (2002) where the signals of possible future problems are

first identified and the information obtained, after passing the filters presented in Figure 2.4, in section 2.1.1, leads to relevant actions for preventing the problem.

Although there are many EW identification approaches which exist and are applied in many cases (Haji-kazemi et al., 2013) there are still failures occurring. According to Williams et al. (2012), "we are not very good at picking EW signs". In their study they point out problems related to three main areas: understanding of project risk and uncertainty, project complexity and detection of people's tacit knowledge and comprehending their way for responding and interacting. They also state that established assessments fail to pick up EW signs. The reason is partly due to technical issues, but mainly found within the minds of individuals.

According to Grisham (2010), project teams must adapt to the international context and local practices, language, time zones, resources, laws, politics, etc. when embarking on projects which are conducted within multiple countries and cultures. The authors believe the filters presented in Figure 2.4 can act differently in different project environments. Following, the possible features of these filters in an international context where involves high level of complexity, dynamics and diversity are discussed.

Surveillance filter

International projects involve heterogeneous stakeholders with conflicting interest and high number of interactions. Also they are mainly multi-disciplinary projects associated with huge amount of information that needs to be processed resulting in complexity by volume and variety. Another influencing factor is the different organizational cultures within the project which results to having different points of view toward the project. It is very likely that a success criterion which is important and critical for one organization is not necessarily crucial for others as well. These characteristics can form a challenging situation where the project organizations due to their different views towards the project's goals and their varied interests may not reach a concrete decision on what type of data to look for and the approaches for obtaining them.

Mentality filter

This filter is in character sociological and psychological. Receiver of information evaluates the arrived information and decides what to accept and what to discard due to it being unnecessary, unrealistic, useless or irrelevant. International projects include a wide range of objectives and a broad and comprehensive scope. They involve many internal risks due to high complexity and high level of uncertainty due to unpredicTable global environment and novelty of the project. The information which the receiver obtains as a result of project assessments methods or via gut feelings (Klakegg et al., 2010) can have totally different level of importance for different receivers. It is also dependent on the perception of the project's goal by of each party. If different parties have different understanding of the goal, the different categories of arrived information can be prioritized in dissimilar manners and thus it is probable that some of the information which actually contains warnings for potential problems can be overlooked or missed.

Political / power filter

This is perhaps the most important and influencing element throughout the process which leads to actions taken based on received information from the project. Levagnon and Hodgson (2014) in their work point towards the fact that the international development projects have over time moved towards a potential contribution of a critical perspective which focuses on issues of power.

The information which passes the two first filters should be evaluated by the decision makers. This includes information which has been, in the first stage, recognized as necessary for the project and in the second stage, regarded as useful and relevant. This filter is strongly influenced by the fact that who is included in and who is excluded from the decision making process. Based on Hofstede's cultural dimensions, in countries where there is large power distance among members of the project organization, it will be less likely that all the necessary information pass through the two first filters. Eventually the third filter will be also influenced by this aspect.

The diversity of cultural backgrounds within the involving partners in an international projects and the complexity caused by the heterogeneous stakeholders with conflicting interests and high number of interactions can establish barriers against effective actions towards possible EW signs of problems.

The strength of this filter is also affected by the level of power of the main decision makers in the project. Anderson and Galinsky (2006) believe that the sense of power increases optimism in perceiving risks and thus lead to more risky behavior. They also state that powerful people might be so focused on the payoffs and have no focus on the consequences of their actions, and more optimistic that they can get away with a range of actions, that their becomes more risky and more likely to violate social and ethical norms. This can be also a source for overlooking information about EW signs of problems which in case of actualization, can result to undesired consequences for the project.

4.5.2 Empirical study results

The empirical data, gathered through interviews and document analysis, consisted of background interviews with members of the project management team, information on identified EW signs of possible problems throughout the project and the preventive actions which were taken. It also included the challenges the project management team faced for identifying and acting toward EW signs, due to specific characteristics of an international project.

According to the interviews, the project management team was able to identify some of the EW signs of potential problems which were likely to occur while the project was running.

The potential problems, their warning signals and the ideal response to them are listed in Table 4.13. As it is presented in this Table, EW signs of specific problems were identified and their ideal responses were recognized. It was interesting to analyze the data presented in order to determine if: 1) these problems had been the only existing problems within the past three years within the project, 2) the identified warning signs which had been responded to.

According to the interviews, although problem 3 had been rather clear for all the project management team members and the response seemed logical and consistent, this action was never taken. This was due to the fact that the responsible persons in power did not tend to recognize this issue as a problem and act upon it. In fact, this information could not pass the political/power filter to be actualized.

Table 4.13 Problems, EW signs and responses in the project

Potential problem	EW sign	Ideal Response
1. Lump-sum budgeting causing cost related problems	Lack of experience of allocated project manager by P1 with international projects	Breaking budget by quality manager and project coordinator
2. Delays in reaching key milestones	Lack of effective communication among partners Delay in delivering tasks	Face to face meetings with conflicting partners and clarifying the importance of the milestones
3. Dissatisfaction of partners which would result to them stepping out of the project	Lack of competence of critical staff Lack of effective communication among project manager and technical staff	Changes in the staff
4. Not achieving the project final goal	Lack of common understanding of the project main goal	Strict follow up by project management team, clarifying the main project goal to all the partners
5. Lack of common understanding of the project goal and the deliverables	Difference in cultural background	Arrangement of Social events to include and make strong relations between partners. Including a non-local member in the project management team

It is also worth mentioning that the most severe problems had not been stated in the identified risks' list in the project DOW (Description of Work). The likelihood of occurrence of problem 4, in Table 4.13, had been declared as "low" in the project description. It was apparent that in reality, things had been slightly different. This somehow indicated that no matter how detailed the risk plan was, it was always likely to face unpredicted conditions through the stream of project events. Keeping an open eye on possible EW signs which rise within the project and proactively responding to them can be an effective means for preventing failures. This becomes even more crucial in international projects with much higher level of complexity. Of course the existing filters are elements which make this process more challenging specifically for international projects involved with large amounts of complexity and uncertainties.

4.5.3 Conclusions of Publication VI

Aside from the use of conventional project management methods, observing and interpreting EW signals of future possible problems by project manager, according to their experience and observation conditions and the time available, can to a great extent facilitate proactive management and as a result preventing adverse outcomes.

The example presented in this study revealed that although conventional project management methods are an inevitable part of the project management plan, it is likely that unpredicted problems rise during the project. Paying attention to the EW signals and responding to them at the right time is a support for decision makers to overcome these types of challenges. It also shed light on existing barriers in the process through which information about potential problems is received by a project member until a proper response to it is actualized.

4.6 Barriers against effective responses to early warning signs in projects *(Publication VII)*

In this article the authors tend to better clarify the issues associated with barriers to project managers responding effectively to EW signs as a means to prevent failure. Both process-related aspects and psychological aspects that need to be enhanced to strengthen the project managers' responses have been investigated.

The idea emerged due to the fact that established assessments fail to recognize up EW signs, partly due to technical issues, but mainly due to the minds of the individuals concerned (Williams et al., 2012). However despite the challenges, studies have shown that although assessments are not completely successful in identifying all EW signs, the exercises themselves raise awareness and provide opportunities for critical questions to be raised and discussions. If the exercises are performed early enough, when real options are still available, the assessments may prove to be a powerful tool.

Based on a survey of Norwegian project managers or leaders' approaches to responding to such signs, the study revealed that there are specific barriers to their ability to respond to identified EW signs. Barriers may develop due to organizational factors, such as project managers' optimism bias, the normalization of deviance within an organization, and lack of an outside view. They can also develop due to the complexity of projects. The authors elaborated on Ansoff's management model by clarifying the mentality filter in order to better define the procedure whereby obstructions are created.

4.6.1 Survey findings

The respondents of the survey included mainly project managers or project leaders with an average of 19.5 years of experience who worked in various industries. The respondents generally had a master degree in engineering.

The majority of the respondents worked in three industries: oil and gas, construction, and IT. The next largest percentage worked in the infrastructure and transportation industry (10%). A total of 56% of the respondents were either project leaders or project managers, followed by project members (18%) and members of steering committees (19%). The remaining respondents included, for example, project coordinators, project planners, and project sponsors. Some respondents selected more than one answer from the possible choices of roles within project organization listed in the questionnaire.

In order to gain an overview of the characteristics of project organizations to which the respondents were affiliated, the respondents were asked to evaluate the complexity level of

the current or most recent project in which they had been involved. The evaluation was performed by ranking the complexity level from 1 to 5, where 1 represented the lowest level of complexity and 5 represented highest level (Figure 4.4).

In general, the term complexity in itself is in widespread common usage and each person can be expected to have her or his own understanding of this term (Cooke-Davis et al., 2007). Furthermore project managers understand and use the term complexity in a very broad and diversified way due to the lack of clear distinctions between complex and complicated (Azim et al., 2010). Therefor it cannot be claimed that what has been measured through the survey is the "actual complexity", but rather an evaluation of subjective experiences of the respondents and how they perceive the level of project complexity. Since complexity influences the capability to manage the project, to obtain success, it is more important to understand how the project manager or project organization perceives complexity or finds the project complicated. The intention for this type of evaluation has been to investigate on how the perception of complexity can possibly influence the early warning procedure and to examine the extent to which data regarding possible early warning signs are extracted and identified as early warning signs in complex projects. In other words, we would like to investigate if the more complex the respondents find the projects, the more challenging will be the performance of an effective early warning procedure.

It should be noted that there are tools which can be utilized for evaluation of the complexity level of projects. An example is the Project Complexity and Risk Assessment Tool (PCRA), developed by the Treasury Board of Canada Secretariat in 2013, which is intended to support the Treasury board policy on the management of projects and the standard for project complexity and risk. Using such a tool represents a whole survey of its own which requires excessive time and effort from the respondents. However, we believe this type of tools, besides requiring great amount of time for the respondents, are applicable in situations where the actual complexity of project is under question and not necessarily the perception of complexity.

The same question (i.e. about the complexity level of the respondents' involvement in the current or most recent project) was asked about the 'optimism level' within the project organization, and the same ranking was used (Figure 4.5). Approximately 70% of the respondents ranked the projects as highly complex. In total, 96% of the respondents ranked the optimism level above 3, and 46% ranking it as either 4 or 5, which were interpreted as quite high. The same constraints which applied to self-ranking of projects' complexity level apply to this aspect as well.

In addition, the respondents were asked to evaluate the extent to which the project members could freely express their opinions within the project organization. Using a 5-point scale, 80% of the respondents selected either level 4 or 5, which represented a high level of freedom to express opinions. Only 1% of respondents selected the lowest level, 1.

The respondents were asked to choose one or more methods from a list of methods used systematically within their project. The results are presented in Table 4.14. In some cases, the respondents included more methods than listed options. In addition, a total of 72% of the respondents said that the selected methods had been regularly applied within their project organization, 14% stated that the methods had been used sometimes, and the remaining 24% mentioned that the methods were applied only at particular times.

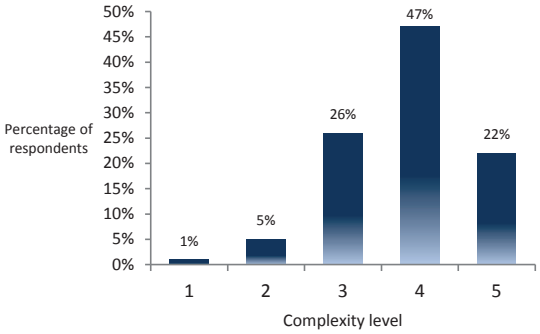

Figure 4.4 Projects' complexity level

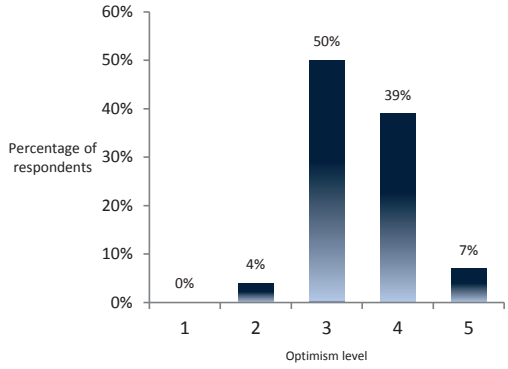

Figure 4.5 Project organizations' optimism level

Afterwards, the respondents were asked to select the phase in which the EW signs of possible problems were identified. The biggest group of responses related to the planning phase and execution phase, respectively accounting for 37% and 49% of the responses. The remaining responses related to either the concept phase or idea phase of the project.
Thereafter, the respondents were asked to rank the most important source for identifying EW signs on a scale of 1 to 5, where 1 represented the least important source and 5 the most important source. The results are presented in Table 4.15.

Table 4.14 Methods applied systematically within the project organizations

Methods	Percentage of respondents	Number of respondents
Project management methods (cost-time-quality)	80%	67
Risk/uncertainty management	73%	62
Brainstorming	31%	26
Performance measurement	15%	13
Stakeholder management	14%	12
Root-cause analysis	14%	12
Maturity assessment	12%	10
Other	11%	9
Health checks	8%	6

Table 4.15 Essential sources for identifying EW signs and their average rankings by respondents

Most important sources for identifying EW signs	Average rank (out of 5)
Gut feelings	3.4
Project assessment methods	3.5
Project management methods	3.8

It was of interest to investigate on the strength of the responses towards EW signs in cases they were identified. Only 35% of the respondents ranked the strength of the responses as either 4 or 5, which represented a rather strong response, while 34% ranked the strength as 3, and the remaining 31% ranked the strength as 1 or 2, which represented a weak response.

The next step in the survey was to investigate the possible reasons for the lack of identification of EW signs. Both the reasons and the percentage of respondents who had selected each reason are presented in Table 4.16. The question was a multiple choice question with the possibility to choose more than one option by each respondent.

The respondents were then asked about the most important reasons for not responding to the EW signs in cases where they were identified. The respondents were given several choices and asked to rank them from 1 to 5, with 1 as the least important reason and 5 as the most important reason. The different options and the average ranking by the respondents are presented in Table 4.17.

Table 4.16 Possible reasons for failure to identify EW signs in the projects

Possible reason for not identifying EW signs	Percentage of respondents	Number of respondents
Lack of effective communication among project members	25%	21
Organization's complexity	25%	21
Over-optimism	21%	18
Unclear strategy	15%	13
Conflict among goal and strategy	12%	10
Other	10%	9

Table 4.17 Reasons for not responding to EW signs and average rankings by respondents

Reasons for not responding to EW signs	Average rank (out of 5)
Over-optimism	3.1
Lack of time to respond	2.9
Lack of effective communication among project members	3.2
Political issues	3.1
Poor management	4.1

As a final step in the survey, the respondents were asked to recommend approaches that would ease the process of identification and response to EW signs of possible problems. With regard to the identification process, the respondents' recommendations could be summarized as belonging to four main groups: active risk management, effective communication, front-end management, and project manager competence. By contrast, the respondents' recommendations for facilitating the response process were rather scattered and not easy to categorize. However the responses included the following aspects: systematic risk monitoring and follow-up, effective use of project learnings, effective risk reporting system, effective governance system and proper understanding of project goals and deliverables.

After compiling an overview of the survey respondents' responses, the next step in the study was to investigate the correlations among different survey results. Table 4.18 shows the correlation matrix.

Knowing that the majority of respondents perceived the complexity level of the projects quite high; the correlation results confirmed that it is very difficult to intuitively infer the behaviour of the whole complex system from the behaviour of the sub-elements (Simon, 1982).

The correlations revealed the significance of project complexity. Such complexity makes discussions more difficult and responses to EW signs of possible problems weaker and less effective. The findings relating to project complexity strengthen the findings from research

conducted by Klakegg et al. (2010) study who conclude that increasing complexity makes it more difficult to detect and interpret signs of potential problems, due to the fact that in complex projects, matters are less well-known and more interconnected and interdependent.

But since the p-value in both mentioned correlations is more than 0.05, it could not strongly indicate that the correlation was credible. This means that it is not necessarily the complexity factor which increases the difficulty level for discussions on EW signs and the strength of responses. In fact the author believes the organizational factors are in general much more influential on the EW procedure than the project specifications.

Results also showed that project complexity level is moderately correlated to importance of gut feelings as a source for identifying EW signs and importance of poor management and political issues as factors influencing the response to EW signs. The first finding is consistent with Klakegg et al.'s (2010) work which indicates that the more complex the project, the more important becomes gut feelings as a source for identifying EW signs.

The latter finding can be explained based on Williams' (2002) study which states that as the complexity and scale of attempted projects increases, the ability to bring these projects to a successful completion dramatically decreases. Also the complexity and dynamics in the environment are hard to foresee and respond to well (Klakegg et al., 2010).

Another influencing factor was the political issues involved with the project. This was perhaps one of the most important issues which affected the EW procedure as Ansoff (1984) in his management model points to political/power issues as one of the main filters against action upon EW signs. This effect can become stronger in complex projects where there is added complexity to the multiplicity of goals (Williams, 2002).

Since the P-value for the correlations mentioned above was less than 0.05, the author assumed that these relationships are credible.

Another of findings was related to the optimism level within the project organization. The survey results showed that the higher the optimism levels within the project organization, the later EW signs were identified. This finding can be explained by the fact that optimism creates a tendency for individuals to exaggerate their talents and abilities and thus misperceive the causes of certain events (Lovallo and Kahneman, 2003). This explanation applies also to another finding from the survey, namely that the higher the level of optimism, the more difficult it was to discuss EW signs of possible problems within the organization. In addition, the findings revealed that the higher the optimism level, the more important "gut feelings" become for identifying of EW signs and conversely the use of project management methods as a source for identifying EW signs. The latter finding can be explained by optimism bias (Flyvberg et al., 2009), which people's tendency to be excessively positive when predicting the outcomes of future planned actions.

A further finding was that the higher the level of optimism, the more important is poor management as an explanation for failure to respond to EW signs. This can be related to the organizational pressure which suppresses the pessimistic opinions while rewarding the optimistic ones (Lovallo and Kahneman, 2003). The findings can also be explained by normalization of deviance (pinto, 2013) which results from optimism bias and causes false

management practices and mistakes to become accepted within the organization. Also Political issues were one of the main reasons reported by the survey respondents as a driver for lack of response to EW signs. According to Chioma (2012), where projects are awarded on political considerations little or no attention is given to the recommendations of project appraisals.

Furthermore, the more open an organization is to employees expressing their opinions, the more effective will be discussions on identified EW signs. According to Martin (1992), by listening carefully to one another's ideas and by responding openly and constructively to one another's concerns, more communication opportunities are created. The practice will lead to more effective discussions on EW signs of possible problems and thus stronger responses to early warning signs. This may also explain another finding from the survey, which revealed that the more difficult it is to discuss EW signs; the weaker will be the responses to them. By contrast, the more effective the discussions on EW signs, the stronger will be the responses to those signs.

The difficulty level for discussing EW signs can also influence the extent to which different reasons for identifying EW signs become important. The survey results show that the more difficult it is to discuss early warning signs, the more important becomes "gut feelings" as the EW identification source. This can be explained by the finding from the study by Klakegg et al. (2010), which reveals that the early warning signs which are identified through gut feelings are mainly related to softer sides of the project, e.g. "lack of culture of openness and good communication", "strained atmosphere", etc. It is expected that project environments which lack the culture of openness, thus facing higher difficulty level for discussing early warning signs, are more likely to be subject to problems regarding the soft side of the project. Therefor it is anticipated that the early warning signs of these types of issues are likely to be identified through gut feelings rather than formal audits/reviews. A further explanation can be that in project environments where results of analysis and systematic methods are difficultly discussed and probably seldom taken seriously, it is more likely that a strong gut feeling regarding certain problems is the only way to bring up the problem within the project organization.

The same logic applies to another finding from the survey which reveals that the more effective the discussions on identified EW signs within projects, the more important becomes the project management methods as sources for identifying EW signs. This can be due to the fact that since the project organization is open for effective discussions on possible EW signs, the results of systematic methods and reviews can be easily discusses , thus can be reliable source for detecting the signals of future problems. Also it is more likely that in such project environments, the problems are less on the soft side, but rather related to hard issues.

The high level of effectiveness of discussions on EW signs positively correlates to the level of importance of "lack of time to respond" as the main barriers for not responding to EW signs. The authors believe this can be justified by stating that if the project team is efficient and healthy enough to reach a point where the EW signs are detected and effectively discussed within the project organization, the barrier against responding to EW signs is most

likely to be “shortage of time” rather than other aspects such as lack of communication or poor management. “Lack of enough time to respond” has also been ranked as the most important barrier against responses to EW signs in cases where the level of activeness of project participants in analyzing the results of project assessment methods is high. This can also be explained by the above arguments regarding high performance of the project team.

The last correlation found among the questioned variables within the survey indicates that the more important is “project assessments” as a source for identifying EW signs, the more important is “over-optimism” as the main reason for not responding to EW signs. It can be interpreted that by use of project assessment methods, the trends and numbers are in place and the reason for objecting to them and neglecting the results can be the over-optimism of the decision makers who believe that they are less at risk of experiencing a negative event, despite the available information regarding possible future problems.

The p-values in all the correlations mentioned above were less than 0.05, proving the credibility of the interrelationships.

Table 4.18 Correlation matrix of the questioned variables within the survey

Variables	Project complexity	Optimism level in project organization	Possibility to freely express opinions within the project organization	Difficulty level for discussing EW signs	Effectiveness of discussions on identified EW signs	Stage of EW identification	Frequency of use of systematic EW identification approaches	Level of activeness in analysis of results of the application of approaches	Importance of different sources for identifying EW signs	Importance of different reasons for not responding to EW signs	Strength of responses to EW signs
Q5. Project complexity	1.00	0.014	0.058	0.2 P-value (0.09)	-0.17	0.013	0.1	0.075	0.22[1] P-value (0.04)	0.3[2] P-value (0.01)	-0.2 P-value (0.08)
Q6. Optimism level in project organization	0.014	1.00	0.04	-0.07	0.04	-0.2 P-value (0.08)	-0.1	0.04	0.21[3] P-value (0.05)	0.2[4] P-value (0.04)	0.21 P-value (0.08)
Q7. Possibility to freely express opinions within the project organization	0.058	0.04	1.00	0.05	0.3 P-value (0.01)	0.13	-0.03	0.09	0.16	-0.2[5] P-value (0.09)	0.3 P-value (0.004)
Q14. Difficulty level for discussing EW signs	0.2 P-value (0.09)	-0.07	0.05	1.00	-0.2 P-value(0.06)	0.01	-0.03	0.09	0.38[6] P-value (0)	0.2[7] P-value (0.07)	-0.3 P-value (0.004)
Q15. Effectiveness of discussions on identified EW signs	-0.17	0.04	0.3 P-value (0.01)	0.3 P-value (0.01)	1.00	0.02	0.11	0.075	0.22[8] P-value (0.04)	0.33[9] P-value (0.002)	0.4[2] P-value (0.0001)
Q13. Stage of EW identification	0.013	-0.2 P-value (0.08)	0.13	0.01	0.02	1.00	0.13	0.12	0.09	0.1	0.1
Q9. Frequency of use of systematic EW identification approaches	0.1	-0.1	-0.03	-0.03	0.11	0.13	1.00	0.18	0.17	0.14	-0.17
Q10. Level of activeness in analysis of results of the application of approaches	0.075	0.04	0.09	0.09	0.075	0.12	0.18	1.00	0.2[10] P-value (0.06)	0.23[11] P-value (0.03)	0
Q16. Importance of different sources for identifying EW signs	0.22[1] P-value (0.04)	0.21[3] P-value (0.05)	0.16	0.38[6] P-value (0)	0.22[8] P-value (0.04)	0.09	0.17	0.2[10] P-value (0.06)	1.00	0.28[12] P-value (0.009)	0.17
Q20. Importance of different reasons for not responding to EW signs	0.3[2] P-value (0.01)	0.2[4] P-value (0.04)	-0.2[5] P-value (0.09)	0.2[7] P-value (0.07)	0.33[9] P-value (0.002)	0.1	0.14	0.23[11] P-value (0.03)	0.28[12] P-value (0.009)	1.00	0.1
Q18. Strength of responses to EW signs	-0.2 P-value (0.08)	0.21 P-value (0.08)	0.3 P-value (0.004)	-0.3 P-value (0.004)	0.4[2] P-value (0.0001)	0.1	-0.17	0	0.17	0.1	1.00

[1] Gut feelings; [2] Political issues, poor management; [3] Gut feelings; [4] Poor management; [5] Over-optimism, lack of communication among project members ; [6] Gut feelings; [7] Not enough time to respond ; [8] Project management methods; [9] Not enough time to respond; [10] Project management methods, project assessment methods; [11] Not enough time to respond; [12] Project assessment methods ~ Over-optimism

4.6.2 Why identification of early warning signs doesn't always result in effective responses?

The findings from the survey led us to elaboration on the existing filters defined by Ansoff (1984) as an explanation for possible obstacles against effective responses to EW signs. In Ansoff's model, presented in Figure 2.4 in chapter 2, the receiver evaluates the information from the environment and makes a decision as what to accept and what to eliminate. In the suggested model, presented in Figure 4.6, the observer and the decision maker are treated as separate units. This is where another filter is added to the procedure which the author named it as the "*observer mentality filter*".

The idea behind this emerged in two stages. The first stage was through reviewing the literature on areas where the decision maker responsible for taking actions is not necessarily the person who observes the warning signs. One such area is risk and safety, and a clear example is the Space Shuttle Columbia disaster, when NASA engineers had spotted something unexpectedly wrong but higher ranking NASA staff failed to act upon the engineers' information in time (Rose, 2003). Although, in this case, the information did pass the observer mentality filter, it is probable that other cases observers could hold back information from the decision makers. Such cases could be due to organizations' over-optimism, which according to Lovallo and Kahneman (2003) results in suppressing opinions that are perceived as pessimistic.

The second stage was during the examination of the survey findings, adding further possible explanations for why signals don't result in suitable actions. One possible explanation is that in an organization that does not encourage employees expressing their opinions, perceived EW signs might not be discussed and thus not acted upon. Another finding is that lack of effective communication among project members could also result in lack of effective response to EW signs.

It is probable that in certain situations specific warning signs of possible problems will be observed by project members who have no authority regarding decision making. The amount of data transferred to the decision makers depends on the culture of openness and level of effective communication within an organization. The author considers that the strength of this filter and the organizational culture of openness are interdependent.

The survey investigated the extent to which project members felt free to express their opinions within the project organization. The question targeted the openness of the channel through which the project members could freely talk to higher ranking project members.

The author considered that in order to ensure the realization of an appropriate action towards an EW sign, it is crucial to enhance the flow of information through all the filters shown in Figure 4.6. In order for information to pass the surveillance filter, it is necessary to enhance the methods that allow enough data to be gathered from the environment to monitor all essential areas that may contain potential problems.

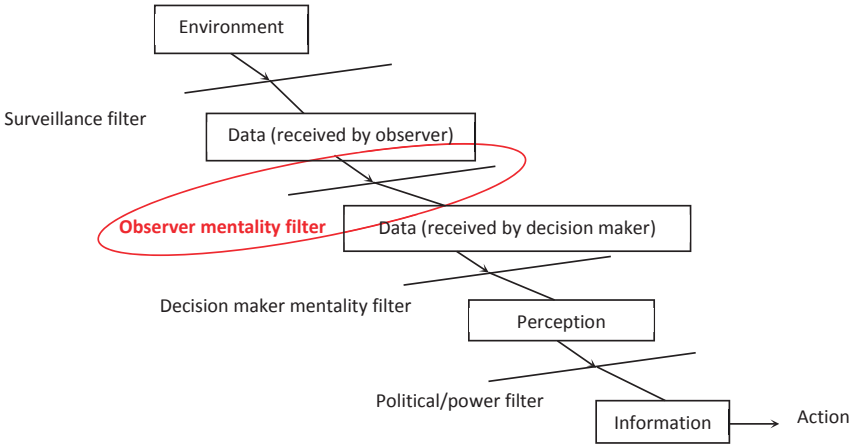

Figure 4.6 Filters to prohibit actions in response to EW signs, adapted from Ansoff's management model (Ansoff, 1984)

In order for the information gathered from a project environment to pass through the *observer mentality filter,* it is crucial to enhance communication between the observer and the decision maker. As in the case of NASA's Challenger project (Rose, 2003), there may be cases where the decision makers ignore the information transferred to them by the observers of the EW sign of a problem. It is also probable that observers will tend not to transfer such information to decision makers, and this may be due to flaws in the communication system within a project organization. In such cases, optimism bias or any other type of bias can act as an obstacle to the proper flow of information. According to Flyvbjerg (2013), the outside view tends to reduce the level of optimism bias, but it can also help to mitigate any type of bias, including strategic bias. The outside view prevents such biases by cutting directly to empirical outcomes and building conclusions about future events on those outcomes. Another reason for biases can be the normalization of deviance within an organization, where unaccepted issues become accepted through time, thus resulting in undesired events. Pinto (2013) suggests that remediation through project governance and reflection through organizational learning may be solutions for overcoming this type of problem. It is worth mentioning that informal communication among project members can also be a driver for better flow of information between observers and decision makers, and is referred to in the literature as intra-organizational social capital (Bartsch et al., 2013).

After the information has passed the surveillance filter, it is the decision maker's mentality filter which should be passed. At this point, the receiver will evaluate the received information and make a decision as what to accept and what to eliminate as unnecessary, unrealistic, or irrelevant. At this point too, it is very important that the decision maker or makers take realistic decisions by avoiding underestimations of the risks of actions and

overestimations of the benefits. Taking an outside view has been suggested as a solution to the risk of optimism bias, strategic misinterpretation, and illusions in decision making (Lovallo and Kahneman, 2003; Flyvbjerg, 2012; Pinto, 2013), which are some of the many reasons why wrong decisions are made rather than decisions based on a rational weighting of the benefits, losses, and probabilities of undesired consequences.

The strength of the *political/power filter*, which determines the type of information permitted to influence a decision-making process, is very much influenced by the political pressure exerted by project different stakeholders. It is thus crucial for decision makers to understand the importance and dynamics of power and politics, and to analyse both the political behaviour of project stakeholders and the political context within the project organization. This would allow the development of appropriate strategies for managing politics at the project level and at the upper management level. According to Pinto (2000), power and politics are a necessary part of project management and it is crucial for project managers to learn to use them to their advantage by increasing the likelihood of successfully managed projects. It is thus important for project managers to learn to use politics in an effective and positive manner. Choosing the most effective stakeholder response strategy through the interactions of multiple project network actors can enable decision makers to deal better with political pressures that may lead to the lack of appropriate responses to EW signs of potential problems in projects (Aaltonen and Sivonen, 2009).

Finally the element of "short time available" has been mentioned as an important factor which can negatively influence the response to early warning signs. It is thus important for managers to take this element into consideration from the very early stages of the project and throughout the whole project.

4.6.3 Conclusions of Publication VII

This article provided empirical evidences which showed that there are barriers to project managers identifying and acting upon EW signs in projects. The key findings of this study show that organizational factors such as complexity, level of optimism, a culture of openness, and the degree of effective communication within project organization strongly influence the EW procedure as a whole. Based on the empirical study and findings from literature search, an elaboration was made on Ansoff's management model by clarifying the mentality filter in order to better define the procedure whereby obstructions are created. It applies especially to large and complex projects where there are various interdependent units working under the umbrella of one project organization.

In the course of this article, the authors endeavored to answer the research questions presented in the Introduction. In the following, the conclusions regarding each question are presented in turn.

What are the main barriers to responding to identified EW signs? (Q1)

Through the literature study the authors obtained information on possible aspects that can be interpreted as sources of lack of responses to EW signs in projects. Examples of the sources include over-optimism, the normalization of deviance, and illusion in decision making. Some of the acquired information was then used in a survey as an input for the respondents.

The results of the survey revealed that elements such as over-optimism, poor management, and political issues can greatly contribute to the lack of effective responses to EW signs of possible problems.

What is the role of organizational factors in effectiveness of the responses? (Q2)

Both the findings from the literature and the survey results revealed that organizational factors such as complexity, level of optimism within project organization, and the level of openness for discussing identified EW signs within the organization have been indicated as factors that can influence the EW response procedure. An additional filter to Ansoff's management model was introduced in order to clarify possible obstacles to the effective flow of information and thus enable responsible parties to take appropriate actions in response to identified EW signs.

What approaches allows project managers to enhance the procedure of responding to identified EW signs? (Q3)

Various literature sources that discuss possible elements that can be interpreted as barriers to responses to EW signs also suggest solutions for enhancing the flow of information within project organizations, thus resulting in more effective actions in response to EW signs. The approaches include taking an outside view, choosing the most effective stakeholder response strategy, creating social capital, improving project manager key competences and applying approaches which encourage more interactions among the project organization.

4.7 Summary of publications

Table 4.19 presents a summary of the seven publications included in this dissertation. The Table lists academic contributions and industrial implications of each publication.

The next chapter will cover a more detailed discussion on the contributions to research and practical implications of the key findings of the dissertation, followed by clarification of the research limitations and the validity and reliability of the research results.

Table 4.19 Summary of individual publications

Publications	Academic contributions	Industrial implications
Publication I	Provides an overview of the full extent of EW detection approaches, which are directly or indirectly addressed in the literature. Categorizes different EW sources according to various aspects. Analyses the strengths and weaknesses of each approach and the factors which influence their predictive power.	Increases managers' understanding of strengths and weaknesses of different EW identification approach in order to make better decisions on the choice of the suitable approach.
Publication II	Explains how a PMS can be utilized as an EW system for avoiding failure. Analyses the published assessments of a failed project, the LAS, in order to illustrate the feasible problems pertaining to a real case and its consequences. Provides a conceptual performance measurement framework, using the main problems in the project phase as a reference for addressing the dimensions of performance to be measured, objects to be controlled, and the indicators.	Highlights the need for paying attention to EW signs of possible future problems in order to avoid failure. Enhances manager's capabilities to understand the approaches which can be utilized in order to proactively manage projects.
Publication III	Explains how a PMS can be utilized as a source of data for an EW approach signaling that a project is about to experience problems at some stage in the future. Suggests that detection of EW signals in projects can be better enabled through the application of a PMS with properly defined KPIs. Based on the case study results indicates that utilization of this tool can positively affect the overall success of the project.	Highlights the need to pay attention to the KPIs in projects. Emphasizes the need to continuously monitor the trends. Enhances manager's capabilities to detect EW signs of possible future problems.
Publication IV	Evaluates the level of efficiency of the PHC tool as a source of data for an EW approach signaling that a project is about to experience problems in the future. Explains that although the application of the PHC tool can to a certain extent contribute to identification of EW signs in projects, but the level of effectiveness of this tool is dependent on several factors such as complexity level of the project, experience of project managers, etc.	Enhances manager's capabilities to detect EW signs of possible future problems by utilizing the PHC tool. Emphasizes that managers need to understand that utilization of a single approach can have different outcomes in different projects with different characteristics.

Publication V	Suggests that it can help to introduce new insights to adding EW identification as part of the management process in the front-end stage of projects. Analyses on the possible EW signs which can be detected in early stage of the Norwegian HSR project and presents how this can contribute to a more effective decision making process for the project.	Highlights the importance of having an open eye on the possible EW signs of potential future problems in the early stages of projects.
Publication VI	Scrutinizes the EW identification process as part of the management system in international projects and the possible obstacles which exist within this procedure. Clarifies the mentioned aspects by using a real ongoing international project as an example.	Highlight the challenges involved with the process of effectively responding to EW signs of potential problems in international projects.
Publication VII	Investigates project and project organization specifications that influence the effectiveness of responses to EW signs in projects based on a survey of Norwegian project managers or leaders' approaches to responding to such signs. Presents that there are specific barriers against effective response to identified EW signs. These Barriers may develop due to organizational factors, such as project managers' optimism bias, the normalization of deviance within an organization, and lack of an outside view. Elaborates on Ansoff's management model by clarifying the mentality filter in order to better define the procedure whereby obstructions are created.	The findings of the study show that organizational factors such as complexity, level of optimism within project organization, and the level of openness for discussing identified EW signs within the organization are influencing factors on the EW procedure, which managers need to consider. Emphasizes that managers need to understand the importance of flow of information within the project organization in order to avoid actualizing of potential problems.

Chapter 5

5. Discussion

From studies of the history of projects that have resulted in either failure or remarkable deviations from their goals, it is clear that projects do not result in total failure in a relatively short period of time. Projects largely fail for non-technical reasons such as issues of negotiation, team capabilities, and communication (Walley, 2013). Such problems are sadly common among projects and improving success rates is one of management's greatest challenges. It's estimated that project failures cost the global economy hundreds of billions of dollars annually. According to Standish Group's Chaos Report, the annual cost of project failure, only within the IT industry, is estimated to be 8.9% of any country's gross domestic product (GDP) (The Standish Group International, 2013).

One approach towards improving the success rate is to attempt to detect possible signs of project failure during the early stages of a project, in order to take the necessary corrective measures. The detection of the EW signs is a major challenge for project managers, who have to respond to them in order to prevent any undesirable outcomes. Although it has not been proven that identification of EW signals is a guarantee against project failure, there are a number of literature resources that consider paying attention to the signals and efforts to respond to them contribute to project success (Nikander, 2002; CII, 2006; Klakegg et al., 2010).

This dissertation has endeavoured to deal with this issue and shed light on possible approaches for improving the success rate of projects through the implementation of the EW procedure within projects. The aim of this chapter is to outline the key contributions of the dissertation to the project management literature particularly within the field of EW in projects. Knowing that earlier research on the application of EW procedure in practice is limited, this chapter highlights the empirical findings which complement and adds new knowledge to the existing theory. In addition, the practical contributions of the research strands included in this dissertation will be presented. Having presented the findings of each

individual publication in chapter 4, this chapter aims to synthesise those findings on a higher and more overall level. The chapter finishes with a discussion on the validity and reliability of the overall research results and on the limitations of the dissertation.

5.1 Theoretical contributions of the individual publications

The key objective of this dissertation was to develop a better understanding of the EW phenomenon, possible approaches for identifying EW signs and barriers against effective responses to these signs in practice. Based on existing literature on the mentioned elements, the dissertation examines questions concerning how this concept is perceived within the field of project management, how possible EW identification approaches are utilized in practice and how they contribute to better management of projects. In addition, the dissertation considers questions dealing with the reason why in spite of application of EW identification tools, in many cases these signs are ignored and no suitable actions are taken towards them.

The dissertation contributes to three main strands of research. First, it provides insight into possible project management approaches which can be utilized as EW identification tools. This is followed by a thorough and detailed analysis on these approaches in order to categorize them based on the type of data that can be gathered by implementing the specific approach, the type of analysis required, the focus point, the source of data and finally, the particular phase in which the approach can be utilized as an EW identification approach. Second, it explains how application of EW identification approaches as part of the management system can result in avoiding undesired events. In addition it scrutinizes specific approaches in order to better clarify the utilization procedure within projects. Third it investigates project and project organization specifications that influence the effectiveness of responses to EW signs in projects and explains specific barriers against effective response to identified EW signs.

Through studying existing literature on this topic and other literature sources that the author found relevant to this aspect and also through collection and analysis of empirical data, this dissertation brings new insights to the current literature on utilization of EW identification approaches in projects with the aim to better predict potential problems and proactively manage conditions which lead to undesired outcomes. In addition it provides new insights into specifications of the project members, project organizations and project environments which can influence the effectiveness of timely and suitable responses to EW signals in projects. This has been done by endeavouring to bridge the research gaps earlier mentioned in chapter 2 (See Figure 2.8). In other words, knowing that the research gaps are missing elements in the existing literature, the theoretical contribution of this dissertation is bridging the gaps between the existing literatures within the field of project management, in particular EW signs. Figure 5.1 presents which individual publication has been developed to bridge the different research gaps.

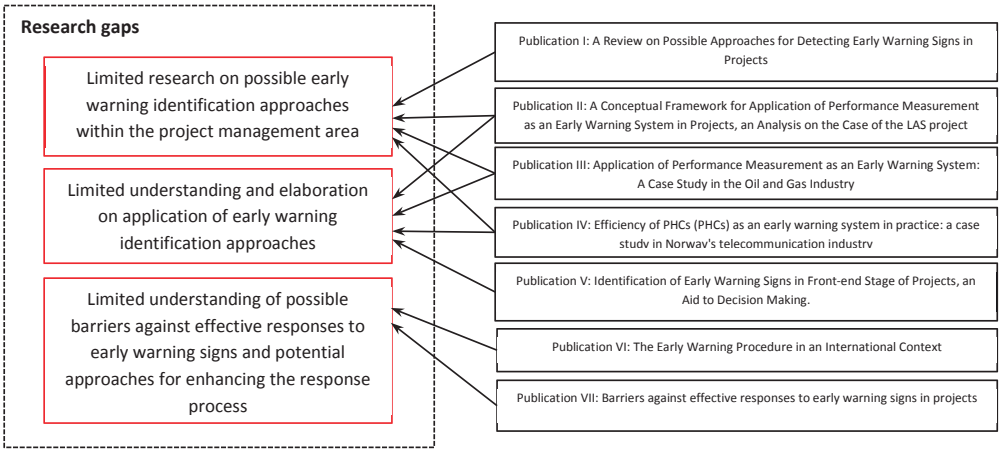

Figure 5.1 Overview of how individual publications relate to the research gaps

Following, the detailed theoretical contributions of the individual publications to the above mentioned research strands which address the three main categories of research gaps are explained.

5.1.1 Theoretical contributions to bridging research gap 1

The limited research on possible EW identification approaches within the project management area called for a comprehensive research on the possible approaches and how they can contribute to proactive management of projects.

Publication I contributes to bridging this gap by presenting an overview of the full extent of EW detection approaches, which are directly or indirectly addressed in the literature and analysing the strengths and weaknesses of each approach. The author has found no other source which summarizes this information in one piece of work. This work provides a new insight into how EW signs of potential problems within the project can be taken into the picture and considered as critical aspects, by applying the existing project management tools and techniques. This study can also be a starting point for carrying out this research towards expanding the possible EW identification approaches and elaborating on the existing ones in order to examine their utility as an aid for better managing projects.

Having introduced the possible approaches which can be applied for identifying EW signs, *publications II, III, IV* contributed to bridging the first research gap by thoroughly explaining two specific EW identification approaches; performance measurement and PHC, and scrutinizing the characteristics of each approach and the steps which have to be followed in order to obtain the particular data signalling that a project is about to experience some problems at some stage in the future. In addition, their effectiveness as an EW identification approach was examined, revealing the strengths and limitations of each approach in practice.

5.1.2 Theoretical contributions to bridging research gap 2

Limited elaboration on application of EW identification approaches in practice, demands for further research on the utilization of these approaches in real life projects.

The case studies carried out in the course of studies which led to development of *publications II, III, IV* contributed to bridging the second research gap by explaining how the application of certain EW identification approaches (performance measurement and project health check) in different projects from various industries (Oil and gas, telecommunications and transportation) can actually result to awareness against potential problems and taking actions against them in order to avoid undesired consequences. As mentioned earlier in chapter 4, different methodologies were applied for obtaining the empirical data including interviews, post-mortem analysis and document analysis. The results shed light on how each approach can be utilized as a source of data and how effective it application can be in different projects.

In *Publications V*, although the focus is not on a specific approach but rather on including the procedure in the management process in early stages of projects, the publication does contribute to bridging the gap. This is done through providing insight into how considering EW signs of potential problems in front-end stage of projects can aid project managers in the decision making process and the concept selection phase of projects. As mentioned earlier the study was done based on the data obtained from a real railway project in its initial stages.

5.1.3 Theoretical contributions to bridging research gap 3

The third gap in research within the field of EW signs in projects is the limited understanding towards possible barriers against effective responses to EW signs and potential approaches for enhancing the response process.

Publication VI contributes to bridging this gap by discussing the possible obstacles against effective responses to identified EW signs in projects. A case of an ongoing international project has been used as an example to better clarify the exact barriers which are likely to exist. This aspect is further scrutinized in *Publication VII*, where the study endeavours to investigate project and project organization specifications which influence the effectiveness of responses to EW signs in projects. This is done based on the survey which has been described in detail in section 4.6. The study also elaborates on the filter model developed by Ansoff (1984) (See Figure 4.6) in order to better clarify how each filter acts as an obstacle against the flow of information which leads to actions towards the identified EW signs. By investigating on elements which can negatively influence the EW response process within projects, this publication brings awareness towards aspects which require more consideration in order to avoid situations which lead to weak or no actions towards EW signs of potential problems. Examples are the level which project participants are free to express their opinions, the extent to which their opinion is taken into consideration while making critical decisions, the optimism level within the project organization, etc.

5.2 Practical contributions of the individual publications

The concept of EW signs is according to Nikander (2002) closely related to human factors and how the receiver perceives and processes a signal after receiving it. The interpretation and processing of the message is wholly dependent on the receiver (Wiio, 1989). The earlier discussions, in section 4.6, on the filter model (Figure 4.6) and the project and project organizational factors which affect the strength of those filters reveal that identifying and acting towards EW signs of potential problems within projects more than anything relies on behavioural patterns and organization's structural issues which establish the context within which the EW procedure is efficiently implemented. In other words, it is all about sharing knowledge and information between "the observers" of possible EW signals and "the decision makers" which actually aims for an action. Considerable amount of research has confirmed the relationship between organizational culture and knowledge sharing behaviours (Wiewiora et al., 2013). The findings in publication VII also show that the optimism level within a project organization and the level to which project participants can freely express their opinion impacts the flow of information within the project organization and thus the effectiveness of the responses to EW signs of potential problems.

In addition to the theoretical contributions, this dissertation endeavours to offer support and guidance for managers concerning increasing the success rate of their projects by providing new insights into implementing EW identification approaches in practice and their impact on project's outcome. In addition it provides new insights into barriers which should be overcome in order to take efficient actions towards EW signs of possible problems in order to avoid undesired outcomes.

Publication I equips managers with a better understanding of possible practical EW identification approaches and the strengths and weaknesses of each approach in order to make better decisions on which approach to choose in different projects. It also suggests that the choice of the EW identification approach in a given project is up to the discretion of the project management team, in order to exploit as many EW signs as possible and timely enough to be able to take preventive actions. The choice of the most effective approach is also strongly dependent on the type of project, organizational culture, and the project environment. In addition to the overview of the full extent of EW identification approaches, the article provides industrial experiences of the authors which refer to the results obtained from implementation of typical "assessment-based" approaches compared with some findings of a more "gut feeling" based type in real projects.

The key managerial message is that the managers should keep an open eye for signals which indicate possible future problems within the focus area of different project management tools and techniques. Apart from considering the technical managerial aspect, managers should also consider the social dimension of projects which refers to the dynamics and complexities of the human side of the project. In other words, EW signs of potential problems can be detected via two channels; 1) systematically applied project management tools and techniques and 2) gut feelings of project stakeholders. These two aspects are complementary and lack of a dual view will result to shortcomings in capturing the wide range of possible EW signs of potential problems within projects (See Figure 5.2).

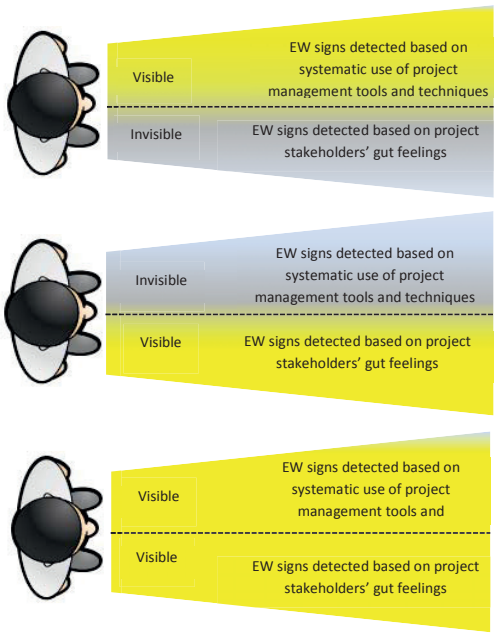

Figure 5.2 Different perspectives towards EW signs in projects

Publications II and III deal with the application of performance measurement as an EW identification approach in two projects one having been defined as a case of a total failure (LAS) and the other one (Tyrihans) being evaluated by the project owners as a successful case. They both highlighted the need for paying attention to the KPIs in projects and emphasized the need for continuous monitoring of the trends in order to pick up the signals which indicate that a problem is likely to happen in the future.

These two publications adopt different perspectives; one referring to the actions which could have been taken in order to identify EW signs of potential problems and thus avoid failure and the other referring to the actions which were actually taken in order to proactively manage the project and lead it towards success. However they both carry the same managerial message specifying that problems don't develop overnight and there is a possibility to detect the EW signs of problems which may result to project failure. Performance measurement has been recommended as a useful and practical tool which can aid project managers in monitoring a wide range of project aspects giving an overall view of the project. Figure 5.3 illustrates the process which should be followed in order to identify and act upon EW signs of potential problems by applying the performance measurement approach.

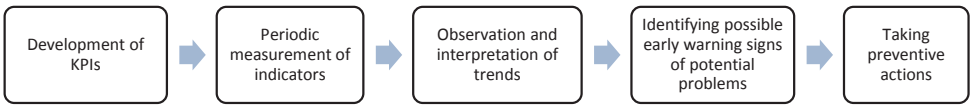

Figure 5.3 The process of applying performance measurement to identify EW signs

Publication V provides information on how the implementation of PHC can aid project managers in identifying EW signs of potential problems. By providing evidence on dissimilar results of utilization of this tool in two real life case projects, it indicates that managers need to realize that utilization of a single approach can have different outcomes in different projects with unlike characteristics. The key managerial message is that there are many that influence the level of efficiency of a certain EW identification approach in practice. Examples are project complexity level and level of communication and dialogue within the project organization. The PHC tool should be customized to specific industries and types of projects in order to perform efficiently and be able to capture relevant information for project managers. Another message is that it is often the application of several different approaches which provides the essential information required by managers in order to take the proper action at the right time. As in the case of the MOVE projects, the application of the health check "only" acted as confirmation of what had already been identified through the use of other approaches, such as risk management, stakeholder management, change management, and progress follow-ups. Figure 5.4 illustrates the suggested process for obtaining information on possible EW signs through the use of PHC tool.

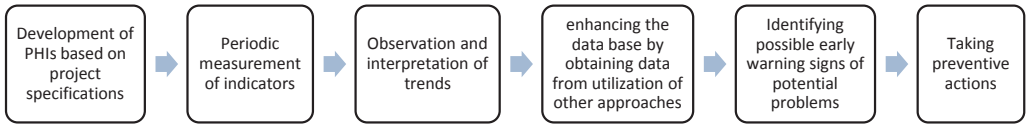

Figure 5.4 The process of applying PHC to identify EW signs

Publication V provides evidence that although EW signs of a vast group of problems are not possible to be identified in the front-end stage, but the ones which are possible to be detected, can highly contribute to making major decisions such as level of feasibility of the project at the first place and the extent to which its objectives can be met. The key managerial message is that identification of EW signs in the front-end stage can give more insights for the managers to choosing the right concept and making more effective decisions. Although the uncertainty is at its highest level, the possible EW signs which may be detected can predict, in many ways, the project's future conditions. Both the low cost of changes and the rather large amount of available time for taking preventive/corrective actions can be a great aid for making the right decisions.

Publication VI discusses the complexity, dynamism and risks involved with international projects and the obstacles which may exist against effective flow of information regarding possible EW signs of potential problems within these types of projects. The real life project which has been mentioned as an example, illustrates the reality of the existing barriers against effective response to EW signs of potential problems within these projects. The key managerial message is that managers should be aware of the existence of stronger barriers against the flow of information due to the complexity, dynamism and risks involved with these types of projects and should proactively manage these situations in order to avoid

failure. Managers should attempt for enhancing the flow of information through better communication and dialogue and transparency of relationships.

Publication VII advances the research on possible barriers against effective responses to EW signs in projects by investigating project and project organizational factors which may influence the effectiveness of responses to EW signs within project organizations and the approaches which allow project managers to enhance the response procedure. Of managerial interest is the notion that project and project organizational characteristics may have a crucial impact on how the EW signs of potential problems are perceived, the information regarding them transferred to the decision makers and finally acted upon. Organizational factors such as complexity, level of optimism within the project organization, and the level of openness for discussing identified EW signs within the organization have been indicated as factors that can influence the EW response procedure. The key managerial message is that project managers should be aware of the possible filters against effective actions towards EW signs of problems and attempt for enhancing the flow of information through these filters and thus take preventive actions towards the warning signals. The findings also highlight the managerial need to take into account the role of "observers" (See Figure 4.6) within the project organization, which can any member of project team or project stakeholders. The practical contributions of the seven individual publications can be classified into three main categories (See Figure 5.5).

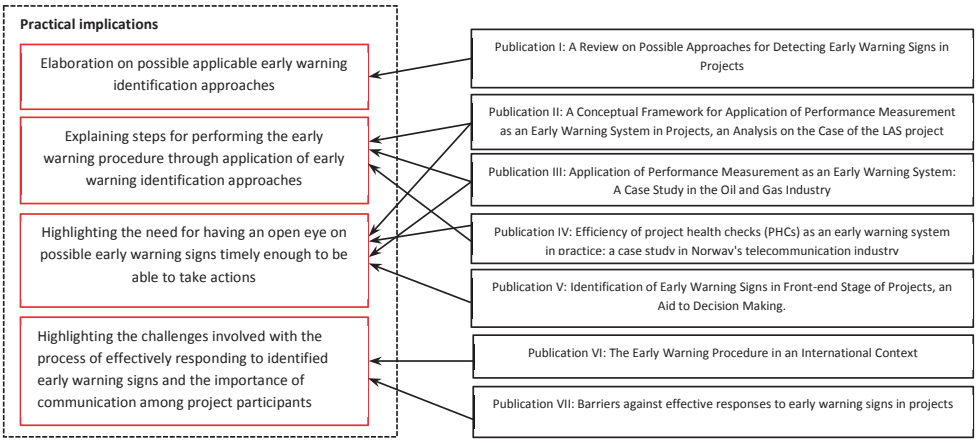

Figure 5.5 Practical contributions of the individual publications

5.3 Synthesis and overall contributions

Having explained the theoretical and practical contributions of the individual publications, this section will endeavour to provide a bigger picture of how the dissertation as a whole contributes to both research and practice. The collective Figures and Tables presented in this section are tended to be the first attempts for modelling the overall findings of this research which can be used as a solid base for further research and investigation within this area.

5.3.1 The early warning procedure developed based on research findings

Figure 5.6 presents the EW procedure which has been designed based on the findings from the individual publications. The initial idea for development of the model stems from Nikander‘s (2002) decision support model (See Figure 2.3). The findings from each publication contributed to clarification of different stages of the model. The main stages within the procedure include:

1. Observations in order to detect possible EW signs of potential future problems

This is done through application of tools or simply having an open eye on what’s going on within the project and trusting the messages the gut feelings provide. In this stage the *surveillance filter* passes on the data which has been chosen to be measured. At this point the project manager/owner should initially decide on the criteria to measure. This is the stage where the KPIs (in case of application of performance measurement as an EW identification approach, in Publication III) or the PHIs (in case of application of PHC, in Publication IV) as an EW identification approach) are chosen. In case of application of other approaches, mentioned in section 2.2, the criterion should be chosen based on the type of input the method requires.
For example, in case of the earned value method, the criteria to measure will be the planned cost and the actual cost spent at the measurement point of time.
The flaw occurs when the chosen criteria lack specific areas which are sources of problems

2. Evaluation of the information gathered via application of methods and the information perceived through gut feelings

This is done through scrutinizing and interpretation of the results of application of systematic methods and rethinking of the information based on gut feelings in order to conclude if there are any indications of EW signs. At this stage the trends, numbers or any other type of data which is retrieved via the application of EW identification approaches are analyzed in order to assess the level of seriousness of possible warning signs provided by the data. In case, the gut feelings are the source of the EW sign, it should be discussed internally among project team or externally among project stakeholders, based on the conditions, in order to assess its level of importance.

3. Transfer of information to the decision maker

In this stage the observer decides on what type of information is necessary or relevant to pass further on to the next level. This is the stage where the *observer mentality filter* passes on the information which he/she feels necessary to share. Many of the factors which were discussed in publication VII influence this stage. Examples are the power distance within the project organization, the level to which project participants are free to express their opinion, etc. The flaw occurs in situations where the observer notices an indication of an EW sign, but due to certain barriers is not able to transfer the information further in the procedure.

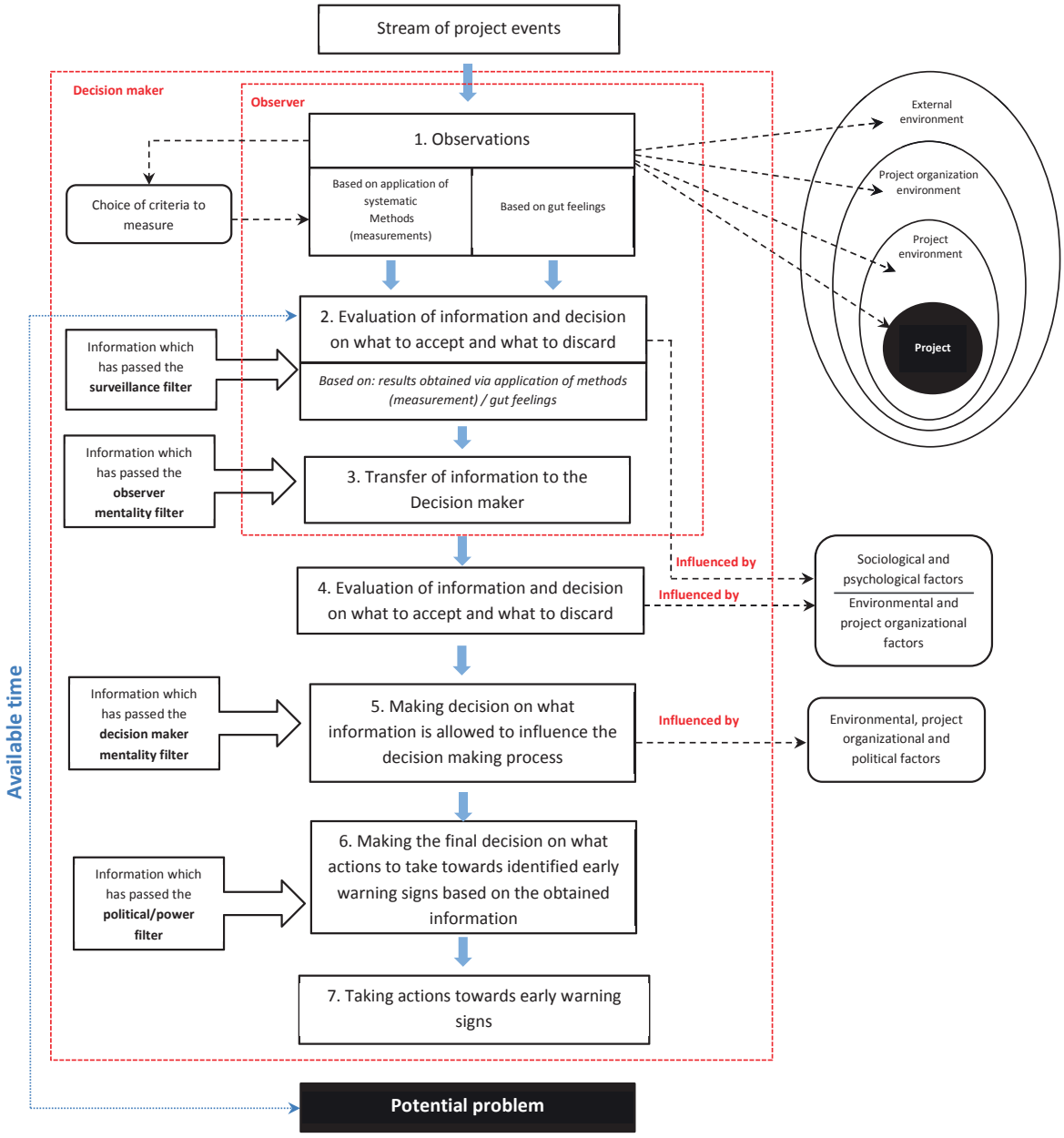

Figure 5.6 The developed EW procedure

4. Evaluation of the information received from the observer and making decisions on what to accept or what to discard due to being unnecessary or irrelevant

In case, the information regarding a possible EW sign passes through the observer mentality filter, it is then the decision maker's role to re-evaluate the conditions in order to assess its relevance and impact on the project. At this stage the decision maker mentality filter passes on the information he/she feels necessary or relevant to move further on in the procedure. In

fact, the same condition which has been identified as a possible EW signs will be seen from two different perspectives. It is probable that a condition which seems to be an EW sign by a project member (observer) is not recognized the same by the decision maker. The flaw occurs in situations where the decision maker neglects a signal which actually indicates a potential problem.

5. Evaluation of information regarding accepted elements as EW signs and deciding which one is allowed to influence the decision making process

At this stage the *political/power filter* passes on the information which feeds the decision making process. This stage is perhaps the most influencing stage within the EW procedure. At this point, the decision maker should take into account all the underlying conditions within the project, project organization and project environment which establish the base for making decisions on possible actions to be taken within the project. At this stage, the project stakeholders' demands and requirements should carefully be taken into consideration. The flaw occurs in situations where different stakeholders' interests are not aligned and there is a lack of a common view towards a certain incident or condition which has been identified as an EW sign. In other words, an EW sign, although having been considered as relevant or necessary to consider, is neglected or overseen due to political/power issues within the project organization thus resulting in actualization of the potential problem.

6. Making the final decision on what actions to be taken towards the identified EW signs

The decision on specific actions which should be taken towards the EW signs is made at this stage. Decisions such as allocating new resources, change of plans, adding staff, reallocation of resources, emergency meetings, workshops, training programs for the project team, etc.

7. Taking the actions in order to avoid actualization of potential problems

This is the final stage where the planned actions are actually taken within the project /project organization. An important factor throughout the discussed process is the "time available" between the point where the EW is identified and the point where an action is actually taken as a response to the identified EW signs. According to Nikander (2002), the crucial factor in choosing responses is the amount of time estimated to be available before the issue reaches its full impact. When time is insufficient, even weak signals should be reacted to.

According to Ansoff (1984), the response strategy differs by variation of the time between the point where the first indication is made and the time where the full impact is reached. For example in situations where the estimated development speed is slow, there is enough time for "normal responses". On the contrary, in situations where the responding is already too late when the first weak signals are detected, the situation requires "crisis management".

This dissertation argues that the available time can be extended, to a large extent, by applying EW identification approaches within the project. The sooner the indications of potential future problems are identified, the more time will be available for arrangement of the underlying conditions which lead to taking suitable actions in order to prevent the problem from actualizing. This was discussed in publications III and IV, where the

application of performance measurement and PHC as EW identification tools throughout the whole project life cycle, contributed to early identification of EW signs and thus reacting to them timely enough.

In addition, the available time can be expanded by having an open eye on possible EW signs of potential future problems in early stages of the project. It is noteworthy that, as mentioned in publication V, although EW signs of a vast group of problems are not possible to be identified in the front-end stage, but the ones which are possible to be detected, can highly contribute to making major decisions such as level of feasibility of the project at the first place and the extent to which its objectives can be met.

Nevertheless, as already discussed within the publications and the earlier sections in this chapter, there are many more factors besides the available time which influence the EW procedure and the responses. These will be discussed in the following section.

5.3.2 Influencing Factors at each stage of the procedure and suggestions for remediation

Figure 5.7 illustrates the EW procedure emphasizing on the point where the filters against flow of information have the most impact.

The information which establishes the base for taking the action/response towards the identified EW signs has passed all the filters mentioned in the Figure. The factors which influence the strength of each filter will directly affect the effectiveness of the response.

Based on the survey results in Publication VII, there are certain factors which have a direct impact on the effectiveness of the responses. The factors include: 1) Project complexity, 2) Difficulty level for discussing EW signs and 3) Effectiveness of discussions on identified EW signs (See Table 4.18). The factors which influence the mentioned elements and thus influence the strength of responses to EW signs include: 1) Optimism level in project organization, 2) possibility to freely express opinions within the project organization 3) political issues and 4) poor management.

These factors are mostly consistent with the aspects mentioned in Table 2.3 in section 2.3, which are the main elements that could be interpreted as such within the project management literature. The elements include:

1. Over optimism / optimism bias
2. Normalization of deviance
3. Culture of uncertainty avoidance
4. Illusion in decision making
5. Time pressure
6. Effects of politics
7. Project complexity

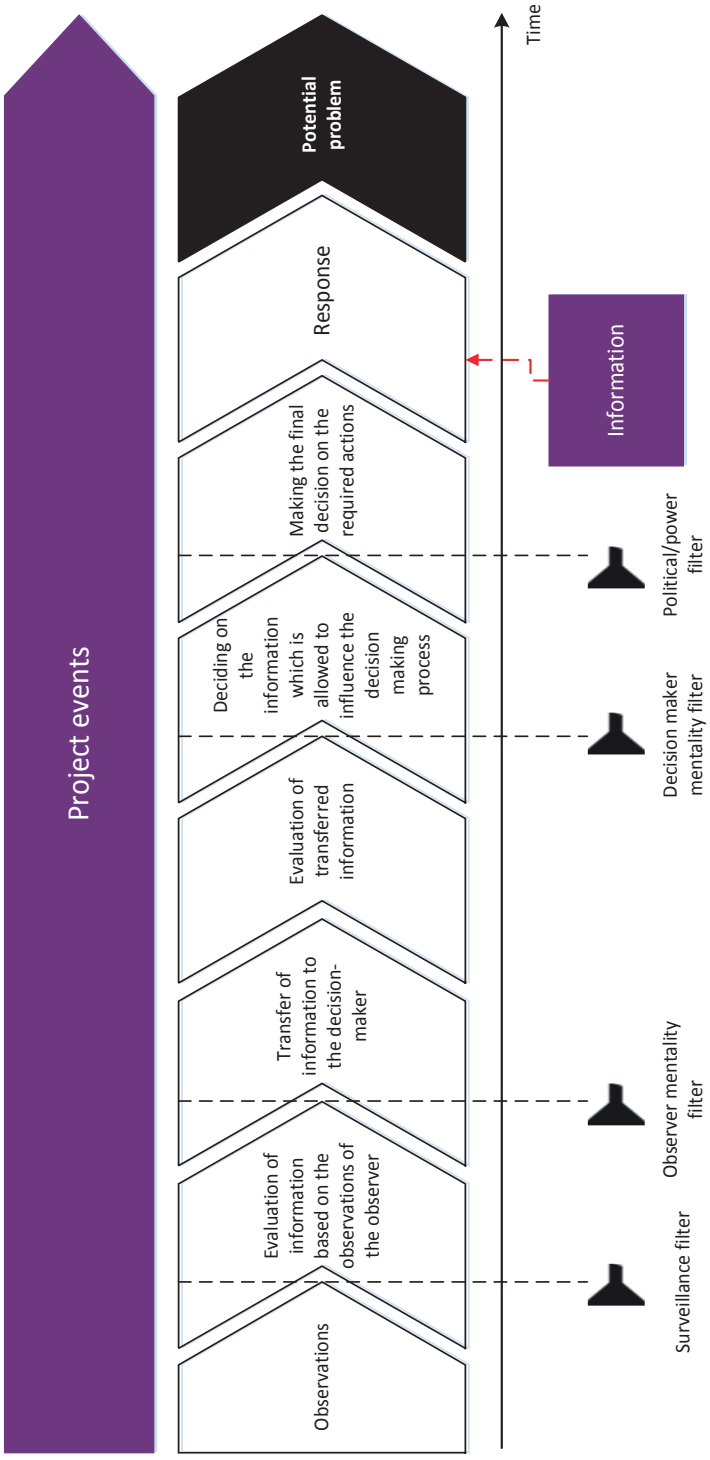

Figure 5.7 The EW procedure and the possible filters against flow of information

Based on the findings from the survey and the existing literature, Figure 5.8 illustrates the underlying aspects which lead to lack of effective responses to EW signs. The elements in the inner circle are influenced by the elements mentioned in the outer circle and they altogether alter the final EW response.

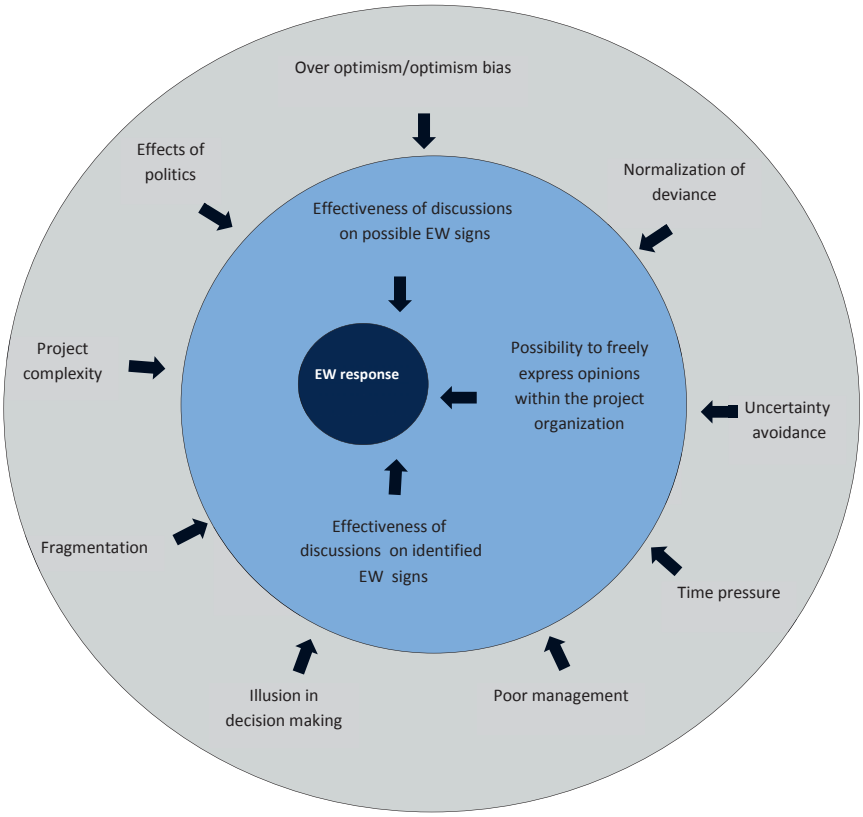

Figure 5.8 Influencing factors on the EW response

However the main challenge lies where researchers or practitioners should scrutinize why and how these factors influence the procedure as such and how each of the filters illustrated in Figure 5.7 are affected by these factors. Table 5.1 presents the primary reasons mentioned in the outer circle, alongside a brief description of how each element can possibly influence the different filters within the EW procedure. It is possible that some of these elements have no or little effect on certain filters. For example the author has not found any effect on the illusion is decision making on the surveillance filter.

It is noteworthy that the information presented in the following Table is not 100% empirically deduced but rather offers a collective synthesis of the whole research based on the accumulated wisdom obtained in the course of this research.

It should be stated that the mentioned elements in Table 5.1, are not the only possible barriers against effective responses to EW signs. The author believes that certain types of cognitive biases, which are tendencies to think in certain manners, can have also have a

negative effect on suitable responses to EW signs. Although cognitive biases are often studied within the field of psychology and investigation on these issues goes further than the scope of this study, the author would like to briefly refer to other possible explanations for ineffective response to EW signs. In addition, discussions on these aspects develop fertile areas for further research within the area of EW signs in projects.

An example of a relevant cognitive bias is the *selective perception* process which is the process of screening out the information that one finds uncomfortable or contradictory with one's beliefs (Griffin, 2013). This is in fact where the mentality filters reject passing the information which is contradictory with the observer or decision maker's beliefs. The *base rate neglect* which is the tendency to ignore generic information and focusing on specific information (Baron, 1994) can affect both the surveillance filter and the mentality filters within the EW procedure. The surveillance filter can be affected due to ignoring areas which can be fertile for possible EW signs of future problems and the mentality filters can be influenced by setting too much focus on analyzing the information related to a certain area and neglecting the other areas which might be sources of EW signs. The *focusing effect* which is the tendency to place more importance on one aspect than the others (Kahneman et al., 2006) has to a certain extent the same effect on the procedure. Another cognitive bias which can lead to serious negative outcomes within projects in the *normalcy bias*, which is the tendency to refuse planning or reacting to a disaster which has never happened before (Baron, 1994). This can be the source for neglecting the possible EW signs which indicate that an unfamiliar negative aspect is about to occur.

Having discussed the possible barriers to responding to EW signs in projects, the next step is to deliberate on possible approaches for improvements in order to lessen the negative affect of these aspects on the effectiveness of responses to EW signs. Some of the suggested solutions were presented in publication VII. Figure 5.9 summarizes the possible remedies for improving the EW procedure as a whole, based on findings from the literature review and the empirical data obtained in the course of this study. It is also based on the analysis on possible ways that each element can influence the filters against flow of information within the EW procedure, which was presented in Table 5.1.

The next section presents a self-evaluation of the quality of research within this dissertation.

Table 5.1 Primary elements which affect the filters within the EW procedure

Primary influencing elements	Surveillance filter	Observer mentality filter	Decision maker mentality filter	Political/power filter
Over optimism / optimism bias	Overlooking areas which have a potential for mistakes and miscalculations due to optimism bias	Resistance towards expressing indications of negative issues due to the culture which suppresses pessimistic opinions	Resistance towards taking possible EW signs into consideration due to overestimation of managerial skills and abilities to overcome the shortcomings	Overlooking potential problems and miscalculations due to denial of EW signs by the project owners/responsibles
Normalization of deviance	Potential areas for future problems are viewed as a normal part of organizational processes thus not monitored	Deviance is unrecognized due to assuming that it's a normal occurrence	Resistance towards taking possible EW signs into consideration due to the fact that perception of errors is reduced to normal occurrences	Overlooking the potential for catastrophe and thus actions, due to earlier decisions which resulted to invisible or indiscernible negative effects
Uncertainty avoidance	Potential areas for problems are monitored based on formalized policies and procedures ; thus missing the gut feeling- based EW signs	The observer prefers what he/she already knows and avoids the unfamiliar (the EW signs probably often stem from the unfamiliar condition)	The decision maker prefers what he/she already knows and avoids the unfamiliar (the EW signs probably often stem from the unfamiliar condition)	Resistance towards change and actions against possible EW signs due to avoidance of the unknown or unpredicTable conditions
Time pressure	Lack of enough time to observe all the possible EW signs	The observer might avoid transferring the information on indications of EW signs due to the fact that it might be too late	The decision maker might ignore EW signs due to the fact that it might be too late to prevent the problem	Resistance towards actions due to short time for response. There might be need for crisis management
Poor management	Lack of correct choice of criteria to measure and tools applied in order to capture the indications of EW signs	Resistance towards transferring the possible identified EW signs due to Lack of (Regular) communication/Meetings among the project team	Lack of enough information regarding the EW signs due to ineffective commination among the project team	Resistance towards actions due to lack of knowledge regarding the potential problem

Fragmentation	Potential areas for future problems can be missed due to lack of knowledge sharing on similar type of project within the project organization	-	-	-
Illusion in decision making	-	-	Resistance towards considering possible EW signs into the decision making process due to overestimation of benefits and underestimation of mistakes	Lack of a concrete action towards possible EW signs due to ignorance towards possible risky events
Project complexity	EW signs may be missed due to uncertainty regarding objectives to be achieved and difficulty in managing and keeping track of the large number of interconnected tasks and activities	Lack of transfer of information due to lack of effective communication among the many project stakeholders which can be a source of complexity	Lack of ability to reach a concrete decision based on various views of different stakeholders towards what can be an EW sign (Large number of stakeholders which is a source of complexity)	Lack of ability to take concrete actions towards a possible EW signs due to different interest of stakeholders possibly caused by shifting environmental and strategic directions which are generally outside the direct control of the project
Effects of politics	-	-	Lack of ability to take a possible EW signs into the decision making process due to political pressure for implementing a solution which may require ignoring the EW sign of potential problems	Lack of ability to take concrete actions towards possible EW signs due to political pressure (exerted by the project owners) to implement a given solution which may be contradictory to the suitable preventive action

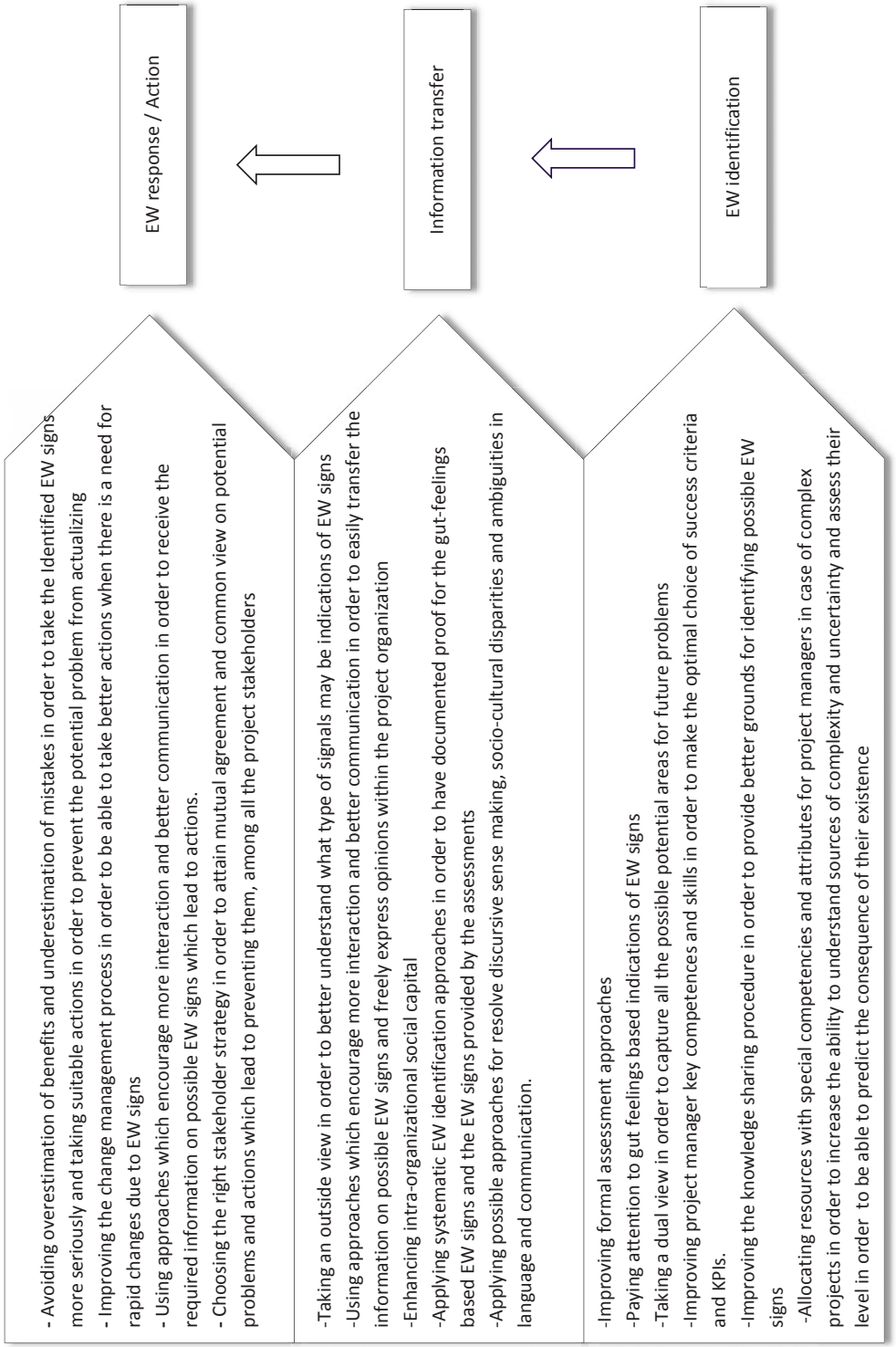

Figure 5.9 Overall remedies for improvement of the EW procedure

5.4 Quality of the research

According to Patton (2002), validity and reliability are two factors which any qualitative researcher should be concerned about while designing a study, analyzing results and judging the quality of the study. These concepts and the approaches towards generating valid and reliable research results have been described in detail in section 3.6. Having discussed the main findings and the theoretical and practical contributions of this dissertation, in this section, the validity and reliability of the research results based on the criteria for judging the quality in research (Yin, 2012) , mentioned in section 3.6, will be deliberated.

Construct validity pursues to measure the degree to which the study actually investigates what it claims to investigate (Denzin and Lincoln, 1994). Various measures have been suggested in order to ensure construct validity (See Figure 3.11). The first is the use of multiple sources of evidence and data collection strategies. Publication I implied a narrative literature review strategy which forms the basis for carrying on the research towards development of the later publications. Publication II utilized a post-mortem analysis approach. Furthermore in publication III also interviews were performed. In publications IV, V and VI interviews were conducted individuals from various hierarchical and functional organizational positions. In addition some of the interviewees were interviewed more than once. Publication VII, which was the last piece of the research work, utilizes a survey approach which endeavors to capture a bigger picture of what has been identified through previous publications in order to reach to a concrete conclusion. Another principle to follow in assessing construct validity is to establish a chain of evidence which refers to allowing the reader to reconstruct how the research proceeded from the initial questions to the final conclusions. The chain of evidence in all the publications was maintained by focusing on presentation of both the research motive and the basis for the conclusions. In fact it was ensured to maintain a "storyline" which is a requirement for any PhD dissertation (Phillips and Pugh, 2010). Finally, obtaining verification of the case study reports by inviting the informants to review them is an important tactic in improving construct validity. With regard to publications III, IV, V and VI, the empirical findings were sent to the company representatives to confirm the contents. The feedbacks they provided was later discussed with them. In case of publication II, since the case was a historical project executed quite long time before this research took place, it was not feasible to discuss the findings with project representatives. However, the findings were discussed with practitioners who had experience with projects within similar context.

Internal validity is to be ensured for explanatory or causal studies so it cannot be tested for the exploratory survey done within this study. However the case studies were explanatory case studies which their results should be tested for internal validity. Tactics to deal with internal validity include addressing rival explanations, the use of logical models, conducting explanation building, and pattern-matching exercises (Yin, 2012). These are all required to ensure that the conclusions made in the dissertation accurately reflect what has been studied and that the results of qualitative research are credible or believable from the perspective of the participant in the research. In publications II, III, IV, V and VI internal validity was enhanced by formulating a clear research framework to demonstrate associations with

variables and results. It is noteworthy that there were some limitations regard the internal validity of the results which will be discussed in the next section.

External validity deals with the degree to which the findings and conclusions of the study can be generalized beyond the immediate case study. In general limited external validity is considered as a weakness of the case study method and is the main reason why multiple case studies are advocated (Johnston et al., 1999). Yin (2012) suggests the utilization of theory in single case studies and replication logic in multiple case studies in order to ensure external validity. Since the case studies in Publications II, III, IV and V have all been done in order to fulfill one research objective; it is reasonable to claim that the replication logic has been applied. This has been done by choosing the case projects from various industries within different organizational contexts. Theory has been utilized in publication VI which is a single case study. It is worth mentioning once again that in this study, external validity has not been the main objective. The intention has rather been to enhance understanding on the concept of EW in projects and elaborate on the efficiency of application of EW identification approaches in practice. Furthermore, the existence of possible barriers against responding to EW signs has been scrutinized. The latter issue can vary in different project contexts due to it being heavily dependent on human factors.

Reliability addresses the consistency and repeatability of the research procedures applied in a case study (Yin, 2012). Using case study protocols and development of case study data bases are tactics suggested by Yin (2012) in order to enhance reliability of research results. In this dissertation, case study questions, hypotheses and propositions were documented and a sound theoretical framework was developed for the case studies presented in publications II, III, IV, V and VI. When applicable, the case study protocol was also discussed with selected company representatives before the data collection started. In addition, a triangulation, which is also a typical strategy which improves the reliability of research findings (Golafshani, 2003), was carried out by applying various research methods including narrative literature review (publication I), case study and survey (Publication VI) in order to strengthen the research results.

5.5 Research limitations

This dissertation has several limitations with regard to the interpretation of the research results. Both case study and survey approaches have their own limitations. The restraints regards performing case studies include the lack of generalizability of the findings beyond the immediate case context. Small sample size, the respondents' biases of any type and the subjectivity of the responses are examples of constraints involved with the utilization of the survey approach.

In this dissertation, the generalizability challenge regarding the case study results was addressed through performing case studies among projects from various industries and in different phases. Yet, the number of cases can be considered low since it never reached the saturation point. In addition, the projects were mainly located in Norway so it may be debated that generalizing the results to projects performed in other countries with different organizational and business cultures is low. These limitations were due to constraints in

access to more case projects within international contexts and also due to time constraints involved with PhD research. However, the author believes that due to common characteristics of projects and project organizations worldwide, the main concepts developed in the course of this study can be applicable to other project contexts as well.

The generalizability and reliability challenges regarding the survey results was addressed through choosing the survey respondents among project participants working within a wide range of industries and project organizations in order to capture a big picture of how the concept of EW signs in projects is perceived and what may be the obstacles against effective responses towards them. Yet, it can be debated that since the results are strongly influenced by biased mentality of respondents, they are only applicable to projects performed in Norwegian project environments. Although the results would be much more generalizable if the respondents were from different countries, however, the author believes that due to common characteristics of human beings and projects worldwide, there is no reason that the findings cannot be applicable to other projects in different contexts.

In general if there had been a possibility for a truly longitudinal research setting, the application of EW identification approaches could have been evaluated more substantively within larger number of project industries and countries. The same applies to the survey results, which could have been strengthened by having a wider range of respondents from different countries and larger number of industries. The next chapter presents suggestions on how the mentioned limitations can be overcome through future research.

Chapter 6

6. Conclusions and further work

This section takes a final perspective on the contributions on this PhD dissertation and points out the suggested areas for further research within this area.

6.1 Overall conclusions

The overall objective of this dissertation was to develop a better understanding of the EW phenomenon, possible approaches for identifying EW signs and barriers against effective responses to these signs in practice. The aim was to gain and present in-depth knowledge of the subject, thorough knowledge of different research methods and a good understanding of the practical application.

Three main research questions were formulated in order to fulfil the research goal. The research questions speculate how EW detection approaches have been addressed in the existing project management literature, how the utilization of these approaches contributes to overall project performance and what may be the possible obstacles against effective responses to identified EW signs in practice. In the following, the research questions will be answered based on the research findings and the further analysis on the findings, presented in chapter 5.

Research question 1: How are early warning detection approaches addressed in the existing literature?

This question was answered based on the studies which led to development of publication I. The initial literature studies, carried out by the author, revealed that the concept of EW signs was underrepresented in the literature. The overall picture of what the literature already contained on this topic showed that although the importance of detecting EW signs is emphasized as a means for avoiding the full impact of potential problems, not many sources directly point to systematic approaches which can be applied in order to identify EW signs within projects. However, research within the project management literature revealed that

there are other possible approaches which can be applied as a means for arriving to EW identification of possible future problems within projects.

The approaches which have been directly mentioned in the literature as EW identification systems include risk management, EVM, project success/failure factors and project assessments.

A broad range of the project management literature points to EW signals through the treatment of risk management as one important part of the field's toolbox. Various authors have mentioned terms such as 'risk symptoms' and the 'occurrence of symptoms and issues.' According to Nikander (2002), since EW refers to a problem that may arise in the future, the relation between the EW phenomenon and risk management is rather obvious.

EVM is mentioned to be another approach that provides triggers or EW signals. This was done based on a set of metrics that measure and evaluate the general health of a project.

Another large body of literature in the project management field deals with so-called project success factors, or sometimes their inverse, project pitfalls. There is much literature outlining ways to ensure that success factors are promoted or pitfalls avoided. The recommendations range from specific tools like project planning and stakeholder analysis to good advice about communication, leadership, and other soft management skills. Paying attention to these signs, earlier in the project, increase the probability of successful outcomes.

Various project assessments have also been discussed as a way to identify areas that should be addressed by EW monitoring. Project assessments go by many names, some of which are project reviews, PHCs, benchmarking, post project evaluation and project audits (Klakegg et al., 2010). Assessments can take place during the project initiation stage and up to the project mandate stage, when the go/no go decision is made and even post-project completion.

The approaches which have been indirectly referred to in the literature as EW identification systems include stakeholder analysis, brainstorming, maturity measurement, extrapolation from earlier projects, cause and effect analysis, gut feelings, and interface management.

One of the sources that don't directly refer to the EW concept, although is quite related to its identification throughout the project, is stakeholder analysis. A number of models outline the process of undertaking a stakeholder analysis, but they have clear similarities, which include activities to identify the project's existing and presumed future stakeholders; gain a better understanding of their needs and expectations toward the project and its outcomes; and anticipate their strategies and actions. Irrespective of which approach is used, the outcome of a stakeholder analysis will be some level of insight into what stakeholders the project has to relate to and what they expect from the project and how they might react if they don't achieve this. The issues emerging from such an analysis can clearly be utilized to identify EW signs.

Brainstorming, in particular based on the project team's knowledge of prior projects and their problems, can also be a source of EW signs. Although brainstorming in its most basic form is a very simple technique, there are more advanced varieties as well. Stroebe et al.

(1992) identified three processes that derailed brainstorming efforts; free riding, evaluation apprehension, and blocking. Issues arising from the brainstorming effort can then feed a process to identify EW signs.

The data that EW is built on should indicate pending problems as far in advance as possible. An approach of possible relevance is that of maturity measurement. This is a type of measurement that represents an even earlier warning than events; the maturity of the organization to undertake the project that it has been mandated to do. The key idea is that it might be possible to assess how mature (i.e., how qualified) an organization is to run projects, and thus very early, even before the project starts, determine whether it seems likely that the project will run smoothly or end up in trouble.

To extrapolate from earlier projects is a way of using the experience gained, but the validity for the current situation must of course always be ensured first. The project management literature has numerous references to how experience from earlier projects is used in order to identify EW signs. A somewhat different approach has been used by Kappelman et al. (2007) and Klakegg et al. (2010), in which experience from earlier projects is used as a basis for discussions with project management experts, in order to get their qualified assessments of the relative importance of the EW signs.

Another concept that is indirectly related to EWs in projects is the cause and effect analysis approach. The author believes that since this topic focuses on causes and origins of issues, it is closely related to the success and failure factors in projects. Nikander (2002) provided a model indicating that problems, their causes and EWs are connected through a chain.

In addition to the EWS that can be identified through project assessments, another category of signs can be "gut feeling" signs. Such a “gut feeling” will usually be closely related to the tacit knowledge of the recipient of the signals. Paying attention to these signal aids project managers to read some of the - sometimes even critical - signs about the state/condition of a project.

The last approach is interface management which serves as a natural checkpoint for managers in order to monitor performance and thus prevent problems from falling into a snowball process. The main objective of this process is to facilitate agreements with other stakeholders regarding roles and responsibilities, timing for providing interface information, and identification of critical interfaces early in the project through a structured process. The overall goal for the process is early identification of issues that have the potential to impact cost or schedule. This is done in order to minimize or to remove this impact, and also to promote clear, accurate, timely, and consistent communication with other organizations.

Research question 2: How can the utilization of early warning identification approaches improve project performance in practice?

The first research question tends to investigate on possible EW identification approaches and briefly discusses how each approach can be applied as an EW system (See Figure 4.1). The second research question takes a further step by investigating on application of these approaches and the effect of it on projects' overall performance. In order to do this, two specific approaches; performance measurement and PHC, were scrutinized and applied to both a published case project and real ongoing life projects.

Two of the seven publications within this dissertation focus on performance measurement as an EW identification tool. Both articles explain how a PMS can be utilized as an EW signal for avoiding failure. However different approaches have been taken for performing these two studies.

Publication II carried out the study by analysing the published assessments of a project, executed in 1992, the LAS, which failed to fulfil its goals. The authors had basically no connections to this project. The rationale behind this selection was not to offer criticism relating to this specific project's performance but to learn constructively from it and move towards a better practice. In contrast, Publication III carried out the study by performing a combination of action research and a case study supplemented by a post-mortem analysis after project close-out on the Tyrihans project which was executed during years 2005 and 2011.

In publication II, a statement was made that, with application of a PMS in the project phase of the LAS project, chaos and perhaps total failure in the operational phase could have been prevented. Also, a conceptual PMS was proposed, using the main problems in the project phase as a reference for addressing the dimensions of performance to be measured, objects to be controlled, and the indicators. The overall aim was to increase understanding of the concept of EW signs in projects and offer a possible approach, which can assist project managers in taking timely preventive actions in order to avoid undesired outcomes. The author suggested that a PMS might have been used as an EW system in this project thus resulting to prevention of failure. The suggested system followed the framework presented in Figure 4.2. Each element of the framework was adapted to the specific condition and aspect in the LAS project. The main problems that occurred in the project phase were used as a reference for addressing the dimension of performance, the objects to be controlled, the indicators of measured elements, and the suitable process of measurement.

In Publication III, The main objective was to describe how implementing a PMS can contribute to the identification of EW signs in a project and outline the possible areas for improvement, thus resulting in better performance of the project. It was also of interest to investigate how KPIs in projects, which are an important component of the information needed to explain a company's progress towards its stated goals, can be developed, implemented and used, and which effects it might produce for the project. This was done through carrying out a combination of action research and semi-structured interviews and document analysis supplemented by a post-mortem analysis for the Tyrihans project. A PMS including eight KPIs was developed and tested on the Tyrihans project. The results

showed that Performance measurement of EW indicators is a direct response to the need for managing project performance in a proactive rather than a reactive manner. The leading indicators can actively contribute to taking proactive action to prevent imminent problems. Lagging indicators, on the other hand, provide information about issues after the fact and can represent a basis for learning, but not as a tool for EW. In the case project, according to neutral measurements of success and the project management team, EW based on performance measurement contributed very positively to the success of the project. This did not prove that use of a PMS can guarantee success in any type of project, but represented a promising result.

In terms of practical implications, the authors proved that it is possible to define performance indicators capable of providing EW. Furthermore, it was shown that the data required to feed a PMS based on these indicators can be collected mostly from existing registers or through simple surveys. As such, this case study research tried to prove an inspiration to other projects to test the EW procedure. By providing detailed insight into the performance indicators applied, it would be also possible for other projects to copy or modify these. Finally, the process applied in the case project to develop and implement the system could be replicated by other companies.

Publication IV, explained how effective the utilization of PHC can be as a source of data for an EW approach signalling that a project is about to experience problems at some stage in the future. This was based on the assumption that application of PHC due to its systematic nature for managing all project variables in different phases can minimize the risk of project failure. Two case projects from the telecommunication industry which had implemented the PHC system were investigated in order to observe how the use of this approach can help indicate EW signs which arise in projects and specify the area in which the problem is about to occur, thus result to better managing the project in order to gain satisfactory overall performance.

The results of the case studies showed that in practice the PHC tool does not always offer novel information about a project's status. Rather the health check acts as a trigger for further investigation into corrective actions that could be taken to prevent possible future problems. Although gut feelings were recognized as the most important source of EW, the PHC results were perceived as confirmation of this awareness. The results show that the tool can be employed to prove the need for corrective actions. The results also reveal that it is not always easy to demand that changes should be made based only health check diagnoses. There is always resistance against acceptance that undesired events are forthcoming. The results of a PHC can serve as additional proof to substantiate the need for change.

The results of the second case study (Case 2) were slightly different from what was concluded from the first case. According to the interviewee, in this particular case the application of the health check had "only" acted as confirmation of what had already been identified through the use of other approaches, such as risk management, stakeholder management, change management, and progress follow-ups. Thus, the results obtained from the health check were a consequence of the foreseen problematic situation and not a predictor of it.

Looking at the two cases, it was apparent that although the projects were performed within the same company and using the same methodology, the results obtained from the application of the health check tool differed in some aspects. We believe that this was at least in part due to the different characteristics of the projects.

The findings from this study suggest that the PHC tool can, under specific circumstances, be helpful to project managers for identifying EW signs of problems. However, there are also many factors that influence its level of efficiency at different points in time. The tool also seems to require modifications in certain areas of a project. The strength of the tool lies in its focus on soft issues such as communication and dialogue, conflict handling, and interactions within the project. Since Projects largely fail for non-technical, therefore a focus on soft issues is to a great extent a contributing factor to project success.

Although performance measurement and PHC are the only tools applied and tested in practice in the course of this study, however it seems that a common output of all EW identification approaches is the data on specific areas which are of importance to projects' success. This information which is extracted from the project itself, the project environment, the project organization environment and the external environment (See Figure 5.6), serve as the initial input to the EW procedure which if performed effectively can lead to prevention of possible future problems, thus contributing to better overall project performance. In fact, the outcome of these approaches acts as the data which has passed the first filter (the surveillance filter) within the EW procedure.

Of course, conducting an effective EW procedure requires the information to flow through all the existing filters (See Figure 5.7). The third research question deals with the possible obstacles against effective flow of information throughout the EW procedure and the remedies for enhancing the process.

Research question 3: What are the possible barriers against effectively responding to early warning signs and how to enhance responses to EW signs in projects?

This question was mainly addressed in publication VII, where the issues associated with barriers against effectively responding to EW signs, as a means to prevent failure, were better clarified. Both process-related and psychological aspects that need to be enhanced to strengthen the project managers' responses were investigated.

Based on the survey results in Publication VII, there are certain factors which have a direct impact on the effectiveness of the responses. The factors include: 1) Project complexity, 2) Difficulty level for discussing EW signs and 3) Effectiveness of discussions on identified EW sign (See Table 4.18). The factors which influence the mentioned elements and thus influence the strength of responses to EW signs include: 1) Optimism level in project organization, 2) possibility to freely express opinions within the project organization 3) political issues and 4) poor management.

These factors are mostly consistent with the aspects mentioned in Table 2.3 in section 2.3, which are the main elements that could be interpreted as such within the project management literature. The elements include:

1. Over optimism / optimism bias

2. Normalization of deviance
3. Culture of uncertainty avoidance
4. Illusion in decision making
5. Time pressure
6. Effects of politics
7. Project complexity

Based on empirical study and findings from literature search, an elaboration was made on Ansoff's management model by clarifying the mentality filter in order to better define the procedure whereby obstructions are created. It applies especially to large and complex projects where there are various interdependent units working under the umbrella of one project organization. In the suggested model, presented in Figure 4.6, the observer and the decision maker are treated as separate units. This is where another filter is added to the procedure which the author named it as the "observer mentality filter". It is probable that in certain situations specific warning signs of possible problems will be observed by project members who have no authority regarding decision making. This is where the observer should decide whether to transfer or not transfer the information to the decision makers within the project organization. The author believes that this filter is developed due to organizational factors such as lack of effective communication among project members, which was discussed in detail in the previous chapter.

In order to ensure the realization of an appropriate action towards an EW sign, it is crucial to enhance the flow of information through all the filters (See Figure 4.6). In order for information to pass the surveillance filter, it is necessary to enhance the methods that allow enough data to be gathered from the environment to monitor all essential areas that may contain potential problems. In order for the information gathered from a project environment to pass through the observer mentality filter, it is crucial to enhance communication between the observer and the decision maker. The information will pass the decision maker mentality filter if the decision maker or makers take realistic decisions by avoiding underestimations of the risks of actions and overestimations of the benefits. Finally, the flow of information through the political/power filter can be facilitated if decision makers perfectly understand the importance and dynamics of power and politics, and analyse both the political behaviour of project stakeholders and the political context within the project organization.

Various literature sources that discuss possible elements that can be interpreted as barriers to responses to EW signs also suggest solutions for enhancing the flow of information within project organizations, thus resulting in more effective actions in response to EW signs. The approaches include taking an outside view, choosing the most effective stakeholder response strategy, creating social capital, improving project manager key competences and applying approaches which encourage more interactions among the project organization.

Besides the suggested solutions which were presented in publication VII, the author developed a set of remedies for improving the EW procedure as a whole, based on findings from the literature review and the empirical data obtained in the course of this study (See Figure 5.9). It was also based on the analysis on possible ways that each element can

influence the filters against flow of information within the EW procedure, which was presented in Table 5.1. The remedies are categorized to three main categories which cover suggestions for improvement of three main steps within the EW procedure including EW identification, information transfer and EW response.

6.2 Further work

This study provides enhanced understanding of the EW phenomenon, EW identification approaches, their application in practice and barriers against effectively responding to them in projects. However, since research on this topic is in its early stages, further research is still required to provide more empirical evidence and theorizing on this important subject. This dissertation has established the basis for further future studies within this area.

Publication I addresses the possible early warning identification approaches directly or indirectly mentioned within the project management literature. In addition, an analysis of the strengths and weaknesses of each approach and their application in different contexts is performed. However, the analyses are mainly based on the authors' perception and understanding of the approaches and not drawn from practical implementation of the methods. There for, more research is needed to reach a concrete statement on the level of usefulness of each approach and its strengths and weaknesses in practice. This may be done by testing as many as possible approaches in different case projects or through having project managers put them to use and report their experiences.

Publication II explains how a PMS can be utilized as an EW system for avoiding failure by analysing the published assessments of a project, executed in 1992, the LAS project, which failed to fulfil its goals. A statement was made that, with application of a PMS in the project phase of the LAS project, chaos and perhaps total failure in the operational phase could have been prevented. However, it is always easy to suggest remedies after the disaster has happened. Further research is needed to apply the suggested framework in a real life project and observe and analyse the outcomes and its influence on the overall project performance. Also it is of interest to conduct further research on the specific stage in the project in which the process of early warning detection should begin in order to prevent a series of problems in the following stages.

Publication III describes how implementing a PMS can contribute to the identification of EW signs in a project and outline the possible areas for improvement by carrying out a combination of action research and semi-structured interviews and document analysis supplemented by a post-mortem analysis for the Tyrihans project. In the future, broader investigations of such systems should be carried out. Testing this approach in different projects, in various organizations and environments, can provide further insight into the potential of the approach and how such a system should be designed and used.

Publication IV explains how effective the utilization of PHC can be as a source of data for an EW approach signalling that a project is about to experience problems at some stage in the future. Two case projects from the telecommunication industry which have implemented the PHC system were investigated in order to observe how the use of this approach can help indicate EW signs which arise in projects and specify the area in which the problem is about

to occur. Areas for further research on this topic include performing action research and thus modifying the PHC tool while it is being implemented, in order to observe closely the shortfalls and examine the level of validity and reliability of results. It is also of interest to test the tool in other industries, in order to explore its efficiency as an early warning system.

Publication V suggests that it can help to introduce new insights to adding EW identification as part of the management process in the front-end stage of projects. This is due to the fact that most of the critical decisions are made in the front-end stage of projects due to high level of uncertainty in this stage (both negative and positive uncertainty). A case study on the Norwegian HSR project, which was in its front-end stage at the time the study took place, was done in order to better illustrate the key points of the research. However, the project did not proceed to further stages while this study was being done. Therefor further research is needed in order to test how identification of early warning signs in the front end stage of projects can practically influence the overall performance of projects. This can be done by following up a real case and evaluating its performance in all its stages.

Publication VI endeavours to scrutinize the EW identification process as part of the management system in international projects and the possible obstacles which exist within this procedure. An ongoing international R&D project including 5 different countries and 15 partners from both academia and industry sectors was used as an example for better clarifying the concepts. Fertile areas for future research include investigation on filters which can restrict the processing and responding to signals and messages obtained on possible future problems within projects.

Publication VII tends to better clarify the issues associated with barriers to project managers responding effectively to EW signs as a means to prevent failure. Both process-related aspects and psychological aspects that need to be enhanced to strengthen the project managers' responses have been investigated. This was done through both literature studies and a survey of Norwegian project managers or leaders' approaches to responding to such signs. Further studies that investigate more thoroughly the conditions under which each of the filters are created and the approaches that can ease the information flow through those filters are likely to be of great interest in the near future. It is of interest to conduct surveys among multi-national projects in order to improve the generalizability and validity of the results.

Finally the results of the study emphasize the need to understand how application of EW procedure can positively influence the projects' overall performance and guide managers towards better proactive management of projects. Based on the overall findings and the results of the analysis of research results, suggestions for further research include:

1. Conducting a more detailed examination of real life projects in different industries within different countries in order to scrutinize the real challenges, limitations and obstructions towards effectively carrying out the EW procedure.
2. Performing action research; implementation of various EW identification approaches in real life projects in order to examine its influence on projects' overall performance.

3. Performing action research; implementation of suggested remedies for enhancement of the EW procedure in order to examine the effectiveness of the remedies in practice.
4. Investigation on possible cognitive biases which cause inefficiencies in the EW procedure within project organizations.

Acronyms

CII	Construction Industry Institute
DVAS	Discrete Visual Analogue Scale
EVM	Earned Value Management
EW	Early Warning
GDP	Gross Domestic Product
GHG	Green House Gases
HSR	High Speed Railway
IFaCOM	Intelligent Fault Correction and self-Optimizing Manufacturing systems
KPI	Key Performance Indicator
LAS	London Ambulance Service
LTE	Long Term Evolution
MOVE	Mobile Office – Virtual Exchange
NASA	National Aeronautics and Space Administration
PHC	Project Health Check
PHI	Project Health Indicator
PMBOK	Project Management Body of Knowledge
PMS	Performance Measurement System
R&D	Research and Development
SMART	Strategic Measurement and Reporting Technique

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PART II: INDIVIDUAL PUBLICATIONS

I

Publication I.

Haji-Kazemi, Sara; Andersen, Bjørn; Krane, Hans Petter, 2013.

A review on possible approaches for detecting early warning signs in projects

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PAPERS

A Review on Possible Approaches for Detecting Early Warning Signs in Projects

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ABSTRACT

In this paper, we attempt to provide an overview of the full extent of early warning detection approaches, which are directly or indirectly addressed in the literature. These approaches can aid project managers in taking corrective actions timely enough for preventing failures. The study is based on a review of the current literature within the field of early warning in project management and our own experiences gained from practice. An analysis of the strengths and weaknesses of each approach and their applications in different contexts are also performed. We conclude that the choice of the most effective approach is arguably dependent on the type of project, organizational culture, and the project environment.

KEYWORDS: early warning signs; detection approaches; strengths; weaknesses; project management

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INTRODUCTION

Despite the improvements in the utilization of project management tools and techniques in recent years, quite a significant number of projects still fail. An approach to avoiding this is to attempt detecting possible project failures at the early stages of a project in order to take the necessary corrective measures. In retrospect, we are quite often able to point out a number of the most likely factors contributing to the project's failure, and we can also see a number of signs of this failure. Those signals, with the benefit of hindsight, often appear obvious and it is hardly possible to understand why they were not taken into consideration at the time.

The concept of early warning signs (EWS) is underrepresented in the literature. Apart from a few key works (Ansoff, 1975; Nikander, 2002; Klakegg et al., 2010), which will be discussed further in the literature chapter, not much work has been done on EWS within the project management research literature. We consider this an area that should be looked into more closely; we hope this paper contributes to this area.

The aim of this paper is to create a conceptual understanding of the extent of approaches available for identifying early warning signs. This will be done through reviewing the current literature within the field, looking into studies of industrial practice, and also building upon our own experiences in various forms, both through advising and supervising project management teams and through observations and studies of projects. We extract possible approaches for EWS from the literature and practical experience, and make a thorough discussion of their strengths and weaknesses. The main research questions to be answered in this paper are (1) What approaches exist for detecting early warning signs and how can they be categorized; and (2) What are the strengths and weaknesses of different EWS detection approaches under different circumstances? This approach to the research stems from previous exploratory investigations into the area, strongly indicating that there are obvious gaps in the literature regarding the field of early warning signs.

The work presented here is partly based on review of the literature, again based on a post-positivist view of such studies saying that, on the one hand we aim to be as unbiased and neutral as possible; on the other hand, however, we also acknowledge the influence from our world view on our research.

In the next part of the research, we draw on our heavy involvement in a number of early warning case studies over the last five years. This work has to some extent taken the form of action research, by mainly taking a constructionist stance, which means that the phenomena we observe are interpreted as social constructions not being independent from the people related to them. We should also remark that we acknowledge that our research is well positioned within an objectivist tradition.

It should also be noted that the combination of the two main parts—literature studies and our own experience—has given us opportunities for triangulation (i.e., evaluating to what extent findings from the first is underpinning or confirming the latter or if it is possible to see that they are in any respect conflicting). Based on the results from those two basic parts of our research, we then discuss the findings and draw a set of tentative conclusions.

The Concept of Early Warning as Presented in the Literature

The general idea of early warning is a broad concept and applies to almost any area where it is important to obtain indications as early as possible of some development in the future, usually of a negative nature. The concept of early warning in a management context was first discussed by Ansoff in 1975. This was later developed for a project context by Nikander (2002) in his doctoral dissertation. Ansoff stated that strategic surprises, for example the oil crisis in the early 1970s, do not appear out of the blue; it is possible to predict their occurrence by the aid of signs that are called "weak signals." A weak signal was defined by him as ". . . imprecise early indications about impending impactful events . . . all that is known (of them) is that some threats and opportunities will undoubtedly arise, but their shape and nature and source are not yet known" (Ansoff & McDonnell, 1990, p. 20). The main idea is thus that even unexpected discontinuities are indicated by some warning signals; there have been some doubts and criticism of this theory, however. For example, Webb (1987) claimed such messages or information about the future could not be obtained and that Ansoff's work had no earlier foundation to confirm the claims of such weak signals. He believed that these signals only provide weak knowledge of the final threat or opportunity. Ashley (1989) turned the discussion around, saying that such discontinuities are only seen after they have occurred, and possible pre-indicators of their arrival are only identified with the benefit of hindsight. Makridakis and Heáu (1987) stated that the concept of weak signals had remained a purely academic idea, and Åberg (1993) stated that weak signals are usually so vague that they are easily missed. On the other hand, however, several other authors have described the same core idea using slightly different terms; for example, symptoms, early indicators, soft forms of information, and early warnings (Juran, 1995; King, 1987; Mintzberg, 1994). Leidecker and Bruno (1987) and Pinto and Slevin (1988) have also performed some studies that can be regarded as research in support of the existence of weak signals.

Expanding the view beyond management literature, the belief in early warnings seems more profound. Whereas detecting minor behavioral changes in competing industrial enterprises that eventually lead to the introduction of profoundly new technologies can be challenging, identifying physical changes, such as the formation of a low pressure system or an increased concentration of a certain type of algae could be easier. Not surprisingly, there is an abundance of articles, reports, and web pages dedicated to or dealing with early warning signs in many different sectors. In the next section, we will review some of these when looking into specific approaches to the identification of early warning signs.

Early Warning Detection Approaches Mentioned Directly in Project Management Literature

According to Nikander (2002), which is consistent with our own findings, very little existing literature deals explicitly with the early warning in projects and project management; however, the project management literature does include some statements that are possible to interpret as examples of early warnings. For example, Kerzner (1994), Cleland (1994), and Zeitoun and Oberlender (1993) have pointed to this phenomenon in their studies (Nikander, 2002). The approaches we will discuss in this section include risk management, earned value management, and project assessments.

A broad range of the project management literature points to early warning signals through the treatment of *risk management* as one important part of the field's toolbox. The body of work on risk management is too large to review here, so it is sufficient to say that various authors have mentioned terms such as "risk symptoms" and the "occurrence of symptoms and issues." According to Nikander (2002), because early warning refers to a problem that may arise in the future, the relation between the early warning phenomenon and risk management is rather obvious. Kappelman et al. (2007) also link these two concepts by stating that early warning signs provide an indication of evident risks and thereby an assessment of a project's exposition to future problems and failure.

An example of research done on the link between risk and early warning is the work done by Niwa (1989), outlining an approach based on the use of computer-based expert systems. The concept of risk alarms was introduced and intended to be advance warning of emerging problems.

Earned value management (*EVM*) is mentioned to be another approach that provides triggers or early warning signals (Fleming & Koppelman, 2000).

According to Vanhoucke (2012), the earned value management system relies on a set of metrics that measure and evaluate the general health of a project. Kim et al. (2003) also refer to this approach by stating that EVM is perceived as being a good forecasting or early warning tool that enables project managers to plan and control projects proactively. In addition, there are other authors who have referred to this method without directly using the early warning term, but emphasize its usefulness as a tool that enhances proactive problem solving (Anbari, 2003; Brandon & Daniel, 1998; Lipke, Zwikael, Henderson, & Anbari, 2009; Vanhoucke, 2012). Lipke et al. (2009) mention this method as a predicting tool for a project's final outcome. They claim that it can actually start predicting the outcome as soon as 10% of the project is completed, thereby giving project managers enough time to take timely action in case of negative predictions.

Various *project assessments* have also been discussed as a way to identify areas that should be addressed by early warning monitoring. Project assessments go by many names, some of which are project reviews, project health checks, benchmarking, post project evaluation, and project audits (Klakegg et al., 2010). Assessments can take place during the project initiation stage and up to the project mandate stage, when the go/no-go decision is made and even post-project completion. There is much literature on the stage gate approach and how it aims to preempt potential problems that make a project nonviable (Cooper et al., 1997; Cooper, 2005; OGC, 2007); however, as Flyvbjerg et al. (2003) caution, overoptimistic assessments of benefits and underestimates of problems and risks can subvert this process as a way of flagging risk that may result in an unsustainable project.

As mentioned earlier on, the concept of early warning signs has been underrepresented in the literature. It is not easy to find specific approaches for the detection of early warning signs and responding to them. Looking at the overall picture of what the literature already contains on this topic, we see that the importance of detecting early warning signs is emphasized as a means for avoiding the full impact of problems, but there is still a great deal to be found out on how to detect these signs and how to act upon them. We believe there are many fields in which this topic is alluded to without using the exact term of "early warning." We therefore investigate further into such fields and try to extract the useful information in order to make a statement on how early warnings can be detected in a systematic way. This will be presented in the following section.

Overlooked Possible Early Warning Detection Approaches

The overlooked approaches, which we will review in this section, include stakeholder analysis, brainstorming, maturity measurement, extrapolation from earlier projects, cause and effect analysis, gut feelings, and interface management.

One of the sources that does not directly refer to the early warning concept, although quite related to its identification throughout the project, is *stakeholder analysis*. Every single project is "surrounded" by entities that directly or indirectly participate in or influence the design, execution, and effects of the project. These are commonly termed *stakeholders*, defined by Project Management Institute as (PMI, 2000, p. 16):

> Individuals and organizations who are actively involved in the project, or whose interests may be positively or negatively affected as a result of project execution or successful project completion.

There are a number of models proposed that outline the process of undertaking a stakeholder analysis, (for example, Cleland, 1986; Karlsen, 2002; Savage et al., 1991) but they have clear similarities, which include activities to identify the project's existing and presumed future stakeholders; gain a better understanding of their needs and expectations toward the project and its outcomes; and anticipate their strategies and actions. Irrespective of which approach is used, the outcome of a stakeholder analysis will be some level of insight into what stakeholders the project has to relate to and what they expect from the project and how they might react if they don't achieve this. The issues emerging from such an analysis can clearly be utilized to identify early warning signs.

Brainstorming, in particular based on the project team's knowledge of prior projects and their problems, can also be a source of early warning signs. Although brainstorming in its most basic form is a very simple technique, there are more advanced varieties as well. The technique has its roots in work in advertising as early as 1939 (Osborn, 1953). Rules were defined to aid brainstorming, but there are also doubts about its effectiveness. Stroebe et al. (1992) identified three processes that derailed brainstorming efforts; free riding, evaluation apprehension, and blocking. Issues arising from the brainstorming effort can then feed a process to identify early warning signs.

The data that early warning is built on should indicate pending problems as far in advance as possible. An approach of possible relevance is that of *maturity measurement*. This is a type of measurement that represents an even earlier warning than events; the maturity of the organization to undertake the project that it has been mandated to do. The key idea is that it might be possible to assess how mature (i.e., how qualified) an organization is to run projects, and thus very early, even before the project starts, determine whether it seems likely that the project will run smoothly or end up in trouble. Andersen and Jessen (2003) discussed the term and pointed to the dictionary definition of maturity; having reached a state of full natural or maximum development. This definition fits products and organizations alike,

although it might be argued that organizations never reach a state of full maturity. Maturity models have also been extensively used as an improvement tool, where organizations conduct self-assessments (Ahern et al., 2004). If such maturity assessments reveal areas of lower maturity, it is natural to consider these targets for early warning monitoring.

To *extrapolate from earlier projects* is a way of using the experience gained, but the validity for the current situation must of course always be ensured first. The project management literature has numerous references to how experience from earlier projects is used in order to identify early warning signs. See, for example, Pinto and Slevin (1988), Kerzner (1987), Pinto and Prescott (1988), and the IMEC study (Miller & Lessard, 2000). A somewhat different approach has been used by Kappelman et al. (2007) and Klakegg et al. (2010), in which experience from earlier projects is used as a basis for discussions with project management experts, in order to get their qualified assessments of the relative importance of the early warning signs.

Another concept that is indirectly related to early warnings in projects is the *cause and effect analysis* approach. We believe that because this topic focuses on causes and origins of issues, it is closely related to the success and failure factors in projects. Nikander (2002) provided a model indicating that problems, their causes and early warnings are connected through a chain. There are other sources, which although not mentioning the term "early warning" directly, refer to cause and effect analysis and root cause analysis approaches for the identification of risks in advance in order to prevent future problems (Leszak et al., 2000; Ohatka & Fukazawa, 2009; Parker & Skitmore, 2005; Sambasivan & Soon, 2007; Williams et al., 2012).

In addition to the EWS that can be identified through project assessments, another category of signs can be *"gut feeling"* signs. These signs are described by Nikander and Eloranta (2001) through the statement: "anticipatory feelings are the least easy to detect, identify and interpret, intuitive feeling" (p. 387). Klakegg et al. (2010) make a very simple categorization of EWS, where they are either identified through assessments or they are based on "gut feeling" (Table 1). Such a "gut feeling" will usually be closely related to the tacit knowledge of the recipient of the signals. Whitty (2010) showed the importance of emotions as an expression of knowledge, and also the use of body language as such an expression, and exemplified the importance of reading body language in a project setting in order to read some of the—sometimes even critical—signs about the state/condition of a project.

The last approach we will refer to is *interface management*, described by Cleland and Morris (1988) as an element that serves as a natural checkpoint for managers in order to monitor performance and thus prevent problems from falling into a snowball process. Calgar and Connolly (2007) defined it as a means for the development of effective communication and information exchange among project participants. The main objective of this process is to facilitate agreements with other stakeholders regarding roles and responsibilities, timing for providing interface information, and identification of critical interfaces early in the project through a structured process. The overall goal for the process is early identification of issues that have the potential to impact cost or schedule. This is done in order to minimize or to remove this impact, and also to promote clear, accurate, timely, and consistent communication with other

Through Assessments	Based on "Gut Feelings"
The numbers or information missing	Lack of culture of openness and good communication between the actors
Assessments not performed/ documentation not completed	Strained atmosphere
Plans and reports delayed or unclear	Evaluating the reality of needs
Contract obligations not fulfilled	Inconsistent arguments about agendas
Milestones/activity definitions unclear or missing	Changes in positions over time
Lack of an implemented governance framework	Uneasy comments and body language
	Stating uncertainty, unwillingness to conclude
	What kind of information is willing to be shared
	How questions are asked and answered
	Making reservations
	Lack of showing trust in the project organization

Table 1: Additional important early warning signs from case studies (Klakegg et al., 2010).

organizations for exchanging interface information. Voss (2012) emphasized the importance of clear interfaces among project participants as a vital part of the project portfolio management process. Findings about interfaces among components or actors can be sources of early warning.

In the next section we will briefly discuss several case studies that the authors have been involved in, with the aim of identifying how early warning signs were detected in these cases, which specific signs were found, and how these signs were used in performing these real-life cases.

Industrial Experiences on Application of Early Warning Detection Approaches

Through our involvement in case studies performed as part of various research activities, here we present the summary of our findings as examples of implementation of some early warning detection approaches in real-life cases.

A study of a selection of eight cases from different industries (both the public and private sectors) with varying degrees of complexity, in three countries, was done in order to investigate the most important early warning signs that were detected by the project teams, the approaches that were implemented for performing this task, and also to assess the level of usefulness of the early warning detection systems. The analysis process of these cases was not very easy due to the different range of projects, which varied in size, complexity, and task uniqueness. According to our findings, the approaches used for detecting these signals were mainly project assessment tools and "gut feelings." Many of the experts involved in the case projects pointed out that many early warning signs are of a less measurable nature and thus depend on more "gut feeling" approaches.

In general, the case studies suggested further possibilities for the detection of early warning signs, many of which consisted of soft atmospheric or "feeling" issues, such as introducing the existence of a culture of openness and effective communication among actors, as an aid to detection of early warning signs. In addition, there were suggestions on more reliance on personal "antennas" than on systematic analyses and other assessments.

Table 1 shows some of the main findings from typical "assessment-based" approaches compared with some findings of a more "gut feeling" based type. From the table we can see that by using a formal assessment and looking for indications of issues such as the ones mentioned in the left column of the table, it is rather unlikely to be able to detect the types of indications mentioned in the right column, unless being very much aware of their potential as early warning signs.

For answering the question about how useful the used approaches for detecting early warning signs are, we can conclude from the findings of the case studies that early warning signs may be identified via assessment methods, and in this respect, assessments are considered to be successful, but in the studied cases, this knowledge did not always lead to actions for dealing with them. This can lead to the conclusion that assessments, no matter how successful they are in the identification of relevant issues, can be a waste of time and effort. Some experiences, however, showed that the exercises themselves were most important due to their allowance of crucial questions to be raised early.

In addition, it was revealed that dialogue and organizational culture play key roles in detecting early warning signs, and this confirms the need for "gut feeling" approaches that can detect signals that are not easily covered by formal approaches. Generally, comparing the two approaches, we can conclude that "gut feeling" approaches are limited in the way that there is no awareness as to what to look for, but this is also its strength because there are no preoccupations with looking for specific indicators. This provides the opportunity for detecting any type of early warning sign.

It is part of future plans to perform case studies on other possible approaches for detecting early warning signs and to evaluate their usefulness, strengths, and weaknesses in practice.

Analysis of Possible Early Warning Detection Approaches

As stated earlier, we have not been able to locate a systematic and coherent documentation of where projects can turn for information that allows identifying issues and potential problems that could be worth tracking, through the use of early warning signs. This section of the paper discusses a wide range of sources for such issues and analyzes them in order to clarify how each approach can be used as an early warning source (the approaches are shown in Figure 1). Note that the following sources come from both literature studies and experiences we have gained through various industrial case studies; there is no direct link between these sources and the specific cases mentioned in this paper.

The purpose of outlining this spectrum of possible sources is to systematize currently fragmented knowledge. We also hope to inspire academicians as well as practitioners in terms of where projects can look for issues that can be developed into early warning signs. After a few years of close study and contact with the channels mentioned, we have come to realize that projects have an extensive range of tools available when looking for issues that could become future problems. Some of these are obvious; others are more obscure and have gradually emerged as useful sources that can be tapped into. The same way we have sometimes been surprised at the variety of possible early warning sign sources, we hope this overview will expand others' views as well.

The following section discusses all the various sources we have deemed

A Review on Possible Approaches for Detecting Early Warning Signs in Projects

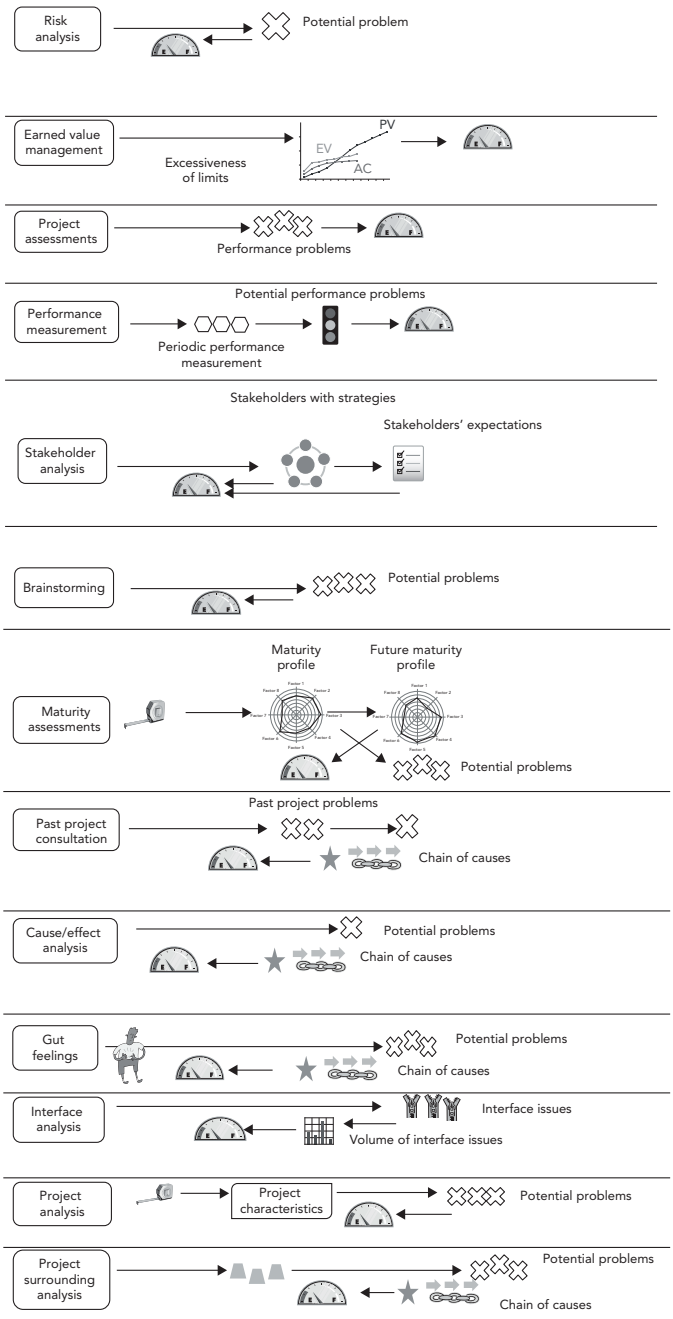

Figure 1: Categorization of different early warning sources according to various aspects.

useful to include as separate entities (some of the list entries could be construed as collective terms for a group of similar sources or variants of the same type of source). For each source discussed, an example is given of how early warning could arise through the use of the source (please notice that these examples are not taken directly from real-life cases, but are fictional illustrations of how each source could work).

Analysis of Sources Directly Mentioned in Literature as Early Warning Detection Approaches

Risk analysis results are probably the most obvious source of them all. Risks identified as part of a risk analysis exercise must be handled in some way by the project, typically by assigning responsibilities within the project team for monitoring the situation and taking action as needed. This monitoring can lead to identification of risks that represent issues for which early warning signs can be developed. For example, if an identified risk is increasing contractor prices, early warning monitoring can consist of periodically reviewing the market conditions. Relevant risk analyses can be undertaken specifically for the project in question by the project owner organization for a larger portfolio; and results from previous projects can also be used, to the extent previous projects are similar to the current one.

Earned value management is primarily focused on keeping track of time and cost-related issues in a project. This is done by periodical measurements of project progress over time, both in terms of cost and time, and presenting a comparison between the key parameters of the earned value method: planned value (PV), actual cost (AC), and earned value (EV). By periodically measuring these parameters and assessing the amount of excessiveness, an early warning sign emanates from serious deviations; of course it should be noted that it is a prerequisite to define the limits in advance in order to establish a baseline for comparison.

A project assessment is a somewhat imprecise term by which we mean various types of reviews/audits/status checks the project is subject to, which could reveal issues to be aware of in the future. Examples of such assessments are pre-sanctioning assessments (e.g., based on CII's PDRI [Project Definition Rating Index]), evaluations or reviews done during execution (e.g., stage-gate assessments, internal or external review board evaluations, etc.), and many other types of evaluations undertaken for different purposes. Common for these is that the primary purpose is not to feed early warning efforts, but they will typically reveal issues that are often relevant to monitor on a more continuous basis. For example, an external project evaluation after year 1 points to conflicting goal interpretations among involved stakeholders, an observation that can be used to focus early warning measurements on goal alignment. It should also be noted that so-called "health-checks" can be construed as one such project assessment, but one that is very closely linked to the concept of early warning.

Performance measurement is a common label for various efforts to periodically collect "performance" data about the project, but that are not primarily aimed at early warning purposes. For example, all projects track incurred costs, most projects are mandated by authorities to measure health and safety issues, and schedule monitoring is ingrained in all project management. Such measurements are undertaken as part of project administration and control efforts, but can easily be used as a basis for identifying early warning signs. If periodic measurements indicate construction site safety issues, this is a development that should be analyzed in an early warning light in terms of the future consequences of such issues. It should also be noted that performance measurement is also a specific tool for collecting data required to look for early warning signs.

Analysis of Sources Indirectly Mentioned in Literature as Early Warning Detection Approaches

Stakeholder analysis insights are a fairly obvious source; most projects undertake more or less formalized and extensive stakeholder analyses that create insights relevant to exploit for early warning issues. Stakeholders can, by definition, influence the project, and how they actually come to influence it depends on how well their needs and expectations toward the project are fulfilled and the strategies they pursue. The stakeholder analyses aim to uncover such needs and expectations and likely behavior of the stakeholders, and can clearly be converted to early warning signs. For example, if an environmentally focused NGO's assessment of a project and subsequent actions depend on the extent of depletion of natural resources in an area, monitoring the depletion rate can give early indicators of future negative behavior by the stakeholder.

Brainstorming based on the project team's insight is arguably the most frequently used source for early warning signs, where the project team simply builds on its collective insight into the project and its surroundings to come up with possible future problems. Such exercises can be more or less structured, ranging from "lunch break talks" to facilitated brainstorming sessions. The outcome from such brainstorming can also vary considerably, from loosely described "uneasiness," to well-defined potential problems approaching risk factors resulting from risk analyses. The more structured the brainstorming approach, the more similar to traditional risk analysis sessions such an exercise can be, but the main difference lies in their uses; risk analyses create risk factors that will be further analyzed and handled specifically, whereas potential problem brainstorming serves to give rise to early warning signs directly. For example: a project to build a new hospital identifies the development of new PET-scanning technology as a potential problem if the new

machines require more power than what the infrastructure under design is dimensioned for. This situation can be kept under control by postponing the design decision and staying in touch with research environments leading the PET-scanning development.

Maturity assessments, which could be viewed as a specific subset of project characteristics analysis, focus on assessing the maturity of various aspects of a project and its context. By use of tools, such as CII's PDRI, the maturity of the project organization, or the "quality" of the project methodologies in use by the project organization are assessed—all of these typically produce "maturity profiles" that show areas of weakness. Such areas of weakness are obvious indications that the project could run into problems relating to the lack of skills or methodologies revealed. Early warning signs can then be based on monitoring the development of these areas as the project progresses and possibly indications that these weaknesses may lead to specific problems. An example illustrates both approaches: a maturity assessment of a project team undertaken early on in the project reveals low levels of maturity for the areas of supplier management and procurement as well as project close-out and handover to operations. The lack of procurement expertise can easily harm the project as it progresses through engineering and into the procurement and construction phases, warranting updated maturity measurements to see whether the team is being strengthened. Close-out and handover are specific events, but represent culminations of a string of preparations and events leading up to them (e.g., preparation of technical documentation, development of operations and maintenance manuals, training of operational personnel, and so forth). Early warning signs can be linked to these activities to ensure satisfactory progress early enough.

Previous projects, both inside the organization and in the public domain, are other obvious sources of ideas for problems the project can encounter. Most relevant are typically similar projects, but also seemingly very different projects can have characteristics that coincide with the project in question and offer learning points. The purpose is to tap into knowledge about things that have caused problems in these projects and therefore can indicate relevant issues also in the incumbent project. Such knowledge from other projects can be found in available documentation (e.g., public domain descriptions, lessons learned reports, post mortems, interviews with people who were involved, formal databases, and the experiences of people in the current project who were also parts of relevant past projects). Like the interface approach, this is also a two-stage exercise: first, problems that have occurred in past projects must be found; and second, causes or triggers of the problems must be identified to allow developing early warning signs (thus, knowledge from previous projects can be used as input to a cause-and-effect analysis). For example: a railroad infrastructure project learns from similar past projects that a key supplier of signaling system components has been prone to delivering immature technology, causing delays in getting the total signaling system to work properly. From this knowledge, some causes appear: insufficiently stringent requirements specifications, lack of dialogue with the supplier, certain "maverick" people lead the supplier's team, and so forth, and these can then be monitored through suitable indicators/observations.

Cause-and-effect analysis and root cause analysis are well-known techniques from the quality management field and can be applied in an early warning context. The principle idea is that issues that arise from brainstorming are usually undesirable "end states," but determining early warning signs that indicate progress toward these end states can be difficult. By applying these techniques, one tries to nest backward through cause-and-effect chains to identify triggers that, early on, set in motion chains of events eventually leading to the end states. For early warning, the project can then monitor for the occurrence of these triggers. For example: the project team of a complex technology infrastructure project identifies a loosely defined problem of substandard performance of technical components of the system to be built. Looking for paths that could create this problem, a root cause analysis uncovers a chain of events where substandard performance is caused by a supplier delivering an unsuitable component, due to unclear requirements specifications, caused by poorly defined goals, ultimately triggered by poor understanding of the stakeholder's needs. Thus, early warning monitoring could focus on the degree to which stakeholder needs have been mapped and understood.

"Gut feeling" is not a scientific term, but it seems to be quite prevalent in projects when looking for potential future problems. This is closely linked to brainstorming, where gut feelings and instinctual responses of project team members involved in such exercises represent an important source of brainstorming ideas. As such, gut feeling probably does not deserve labeling as a source of its own, but we find it important to mention that, in many cases, it is the most used "inspirational well" that develops into early warning signs. As mentioned earlier, the results of the case studies done show that many experts involved with case projects believe that many early warning signs are less measurable and depend more on gut feeling approaches. They believe that many early warning signs are only possible to be detected by reliance on personal intuition rather than systematic analyses. These gut feeling ideas can then form the basis for defining early warning signs that can alert project management about a development toward the occurrence of these potential problems. For example: A

geologist on a project team has doubts, albeit unfounded in terms of evidence, that the rock conditions of a tunnel site might be difficult. The hesitation is caused by long experience and conditions of similar sites encountered in the past. Extreme reactions on the part of the project can be extremes of either canceling the whole project or moving the location of the tunnel on one hand and, on the other hand, simply ignoring the input. A better approach would be to implement a procedure for obtaining rock samples ahead of the tunnel progress to allow detection and handling of difficult conditions.

Interface analysis is an approach that builds on the fact that many project problems appear in the "white space" at interfaces between technical systems, disciplines of people, actors, and so forth. Such interface "hot spots" can therefore represent a potentially powerful source of early warning signs. Extracting such signs can be done in many different ways; from less structured reviews of technical, human, contractual, and similar types of interfaces to applying more specific analysis techniques, such as FMEA (Failure Modes and Effects Analysis) and related variants, fault trees, and so forth. Having identified potentially problematic interfaces, early warning signs of development of these interfaces into real problems must be found. This latter task can often be more difficult than finding interface hot spots, and some projects settle for monitoring the volume of unresolved interface issues as an early warning sign itself. The thinking behind this approach is that several trends could be alarming (e.g., the total volume of interface issues increases and the project seems unable to resolve them or, after an initial growth face, no new interface issues are identified, a possible sign that people underreport and issues remain hidden).

Project characteristics analysis is a rather ambiguous term. By this term we endeavor to point to various assessments that projects are frequently subjected to in order to determine certain characteristics (e.g., degree of complexity, degree of physical distribution, degree of novelty, and so forth). In some cases, there are more specific "tools" available (e.g., team measurement instruments), and for other characteristics sets of indicators have been developed (e.g., project complexity or degree of distribution of a project team). For many factors the assessment is a matter of qualitative discussion. Irrespective of which characteristic the project is analyzed against, for projects that are determined to have certain characteristics, these can be sources of early warning signs. For example, a project determined to being heavily dependent on the development of new technology should be subjected to close monitoring of innovation progress, whereas a heavily distributed project team could monitor aspects, such as extent and quality of communication, goal alignment, and so forth.

External factors are yet another example of issues that could come up through risk analysis, stakeholder, analysis, which we include as a final item, because external factors represent a specific type of issues with a range of sources external to the project. Such issues are typically uncovered through some kind of analysis looking into aspects like the political/regulatory climate surrounding the project, market/financial issues, climate/weather where this is relevant, organizational issues, and so forth. In all cases, triggers of problems originate outside the project, sometimes completely outside its sphere of influence; in other cases, with influence from the project. Keeping a watch for such external factors and problems they could cause is a natural part of an early warning approach. An example of such an external factor is the price development in the contractor market. Cost estimates for a project are based on current prices at the time of estimation, possibly adjusted for projected changes ahead, but significant deviations can occur in the period from estimation until the project is ready to start tendering for bids, thus influencing the costs. Monitoring price levels or, better yet drivers of price levels in the forms of larger projects gearing up for tendering, are a natural response from the project.

Figure 1 represents the EWS sources discussed, and contains a small diagram per source to illustrate the mechanisms at play for each source. We do not claim this list of various sources to be exhaustive, but believe it covers a much broader range than what might be readily apparent from previous publications on the topic. It is also obvious that not all of these sources for early warning signs are "unique" singular items; rather, many of them are similar or interlinked in how they can lead to the identification of early warning signs. The next section of the paper will therefore analyze the various sources to provide a better understanding of their natures, pros and cons, and how they can best be applied and possibly combined.

Analysis of Strengths and Weaknesses of Sources for Identification of Issues

To summarize some main facts regarding the sources for early warning signs, we have compiled Table 2. For each of the EWS sources, a categorization has been done of the types of data used, the data sources that will typically be used, and what kind of analysis is performed. Furthermore, the table provides a classification of the kinds of issues that are focused on in the process and shows in which project phase that each of the EWS sources will typically be useful. The information in the table is provided on a very broad and general basis, and should therefore be used with great care and a good portion of critical judgment in any specific situation.

Followed by Table 2, the most typical and/or common strengths and weaknesses for each of the EWS sources are summarized in Table 3, which also pinpoints the most important factors that the predictive power of each of them depends on.

EWS Source	Type of Data[a]	Type of Analysis	Focus/Type of Issues	Data Sources	Project Phase
Risk analysis	Hard and soft, qualitative and quantitative analyses	Structured process blending; qualitative and quantitative analyses	Significant external/ internal, strategic/operational threats	The project team, contextual data, previous projects	All phases, at decision gates/other milestones
Stakeholder analysis	Hard and soft, qualitative analysis	Structured process of qualitative analysis	Potential external and internal stakeholder issues	The project team, contextual data, stakeholders, previous projects	All phases, but front-end/early phase bias
Project assessments	Hard and soft, qualitative and quantitative	Snapshot analysis of project status	Internal and external problems	Internal and external project data	All phases
Performance measurement	Hard and soft, qualitative and quantitative analyses	Continuous analysis of project performance	Trends indicating internal and external problems	Internal and external project data	All phases
Brainstorming from team insight	Soft, qualitative analysis	Creative exercise	Potential internal and external problems	Individual participant judgment, previous projects	All phases, but front-end/early phase bias
Cause-and-effect/ root cause risk analysis	Hard and soft, qualitative and quantitative analyses, qualitative bias	Structured process, applying different analysis tools, often combined with creative insights	Sources of internal and external problems	Any source of data about the problem being analyzed	All phases
Interface analysis	Hard and soft, qualitative and quantitative analyses	Identification and resolution of nonclarified interfaces	Avoidance of problems at nonclarified interfaces	Project team knowledge, project documentation	All phases
Extrapolation from previous projects	Hard and soft, qualitative and quantitative analyses	Creative exercise	External and internal problems encountered in previous projects	Risk analyses, project documentation, close-out reports, interviews, experience	Front-end/early phase
Project characteristics	Hard and soft, qualitative and quantitative analyses	Classification of characteristics, benchmarking with baseline/other projects	Identification of singular characteristics and specific requirements stemming from these	Project documentation, project team knowledge	Front-end/early phase
Maturity assessment	Soft, qualitative and quantitative analyses	Questionnaire-based measurement of the maturity of the project and/or project organization	Identification of weaknesses in the project and/or project organization	Individual project team member assessments	All phases, but front-end/early phase bias
Earned value management	Hard and soft, quantitative analysis	Calculation of earned value	Shortcomings in value creation	Resource consumption data, assessment of task completion	Project execution

EWS Source	Type of Dataa	Type of Analysis	Focus/Type of Issues	Data Sources	Project Phase
"Gut feeling"	Soft, qualitative analysis	Creative exercise	Potential internal and external problems	Individual participant judgment, previous projects	All phases
External factors	Hard and soft, qualitative and quantitative analyses	Identification and analysis of external factors	External factors that could negatively influence the project	Contextual data	All phases

[a]"Hard issue" or "formal dimension" refers to technical managerial aspects, which consist of formal integrative mechanisms through tools and techniques, and "soft issue" or "social dimension" refers to the dynamics and complexities of the human side of the project (Mustaffa & Bowles, 2005).

Table 2: Categorization of different early warning sources according to various aspects.

EWS Source	Strengths	Weaknesses	Predictive Power Dependent on
Risk analysis	Easy to perform the underlying analysis because it is a structured method; everyone can contribute; generally little need for collecting additional data	Quality of the analysis outcome dependent on the selection and insights of the participants; propensity to focus on concrete; often technical risks and overlook less tangible issues; danger of not updating the analysis to capture dynamics of risk issues	Type of project where technical/immediate risks are of importance for project success
Stakeholder analysis	Easy to perform the underlying analysis because it is a structured method; encourages the project to consider broader issues	Quality of the analysis outcome dependent on the selection and insights of the participants, easy to overlook stakeholders not encountered in previous projects or downplay the importance of some stakeholders, danger of not updating the analysis to capture dynamics of stakeholders	Whether the analysis identified the right stakeholders and their future behavior and the complexity of the stakeholder situation
Project assessments	Wide selection of project assessment tools available, which covers many aspects and gives longitudinal insight if repeated at certain intervals	Give only one snapshot assessment if performed only once, usually a need for collecting additional data, requires knowledge about the method The results not always lead to actions for dealing with the identified early warning signals (according to case study results)	The choice of assessment method and the frequency of analysis
Performance measurement	Provides continuously updated data that encourage frequent analysis; continuous data allows keeping track of developments, puts focus on issues covered by measurements	Often a need for collecting extensive amounts of data; for some issues not easy to find relevant data, risk of overlooking issues not covered by the measurements (black swans)	The choice of performance indicators

(*Continued on next page*)

Table 3: (Continued)

EWS Source	Strengths	Weaknesses	Predictive Power Dependent on
Brainstorming from team insight	Easy to perform because it is a "simple" analysis; no limitation on issues that could come up; everyone can contribute and generally little need for collecting additional data	Based solely on previous experience, risk of overlooking issues outside the contributors' mindsets, danger that some people can dominate the exercise	The team's experience
Cause-and-effect/root cause analysis	Looks for early triggers of undesired events or developments, uncovers relationships between triggers leading up to events	More complicated analysis because it requires creative backtracking from undesired event, relies on different analysis methods; typically a need for collecting additional data	The identification of undesired developments/events and the interpretation of the connections along the chain of cause-and-effect
Interface analysis	Looks for issues in the "white space" of the project that might otherwise go unidentified	Provides only a first indication of potential issues, but gives no method for monitoring these issues	People looking for interface issues and transparency about the project, the complexity of the project
Extrapolation from previous projects	Relevant source of issues in cases of similar projects, sources for this knowledge often found internally in the organization	Danger of indiscriminately applying findings from previous projects, often relies on tacit knowledge	Similarity of projects and their conditions
Extrapolation from previous projects	Relevant source of issues in cases of similar projects, sources for this knowledge often found internally in the organization	Danger of indiscriminately applying findings from previous projects, often relies on tacit knowledge	Similarity of projects and their conditions
Project characteristics	Counters the tendency to assume that all projects face the same issues; provides a basis for benchmarking against relevant other projects	Specific analysis method or checklist does not exist	The accuracy of the characteristics profile developed
Maturity assessment	Analyzes underlying factors influencing project success, focuses on issues not covered by any of the other sources	Doubts about the accuracy of the measurements, relies on subjective assessments by individuals; must collect large amounts of data	The accuracy of the measurements and the correlation between maturity profile and project success
Earned value management	Easy to generate frequent measurements; uses partly objective data	Uses partly subjective assessments of completion, targets only the issues of cost and performed work	The accuracy of the subjective assessment of completion
"Gut feeling"	Independent of analysis methods with a specific focus; can capture issues otherwise overlooked; detects issues that are not easily covered by formal approaches; not preoccupied with looking for specific indicators (according to case study results)	Can be difficult to prove validity of issues; no awareness as to what to look for (according to case study results)	The experience and background of people involved; the persuasive power of the person identifying an issue and the openness of the rest of the team
External factors	Looks at the whole context of the project; could capture issues otherwise overlooked	Focuses on issues that can be difficult to predict the developments of, if only analysis undertaken; risks overlooking internal factors	The correlation between the external factors and project success

Table 3: Strengths and weaknesses of different early warning sources.

First of all, we must once again remind the reader about the obvious fact that projects are very different, and that the singular conditions must be analyzed in every single case. The conditions and settings may differ so much that there are in fact no single and definitive favorites or one most promising source for identifying early warning signs. Nonetheless, we would like to point to some of those sources, which we believe are quite promising. Performance measurement seems to offer some quite promising toolsets that, when wisely applied, may prove to be useful as sources for EWS. Also, we consider that maturity assessments may offer potentially valuable indicators of possible weak areas for the project. We also believe that by analyzing suitable project characteristics, we can have a simple early sign of possible project challenges. It should be emphasized that this will most likely have to be used in combination with other EWS.

Conclusions

In this paper, we have explored to which degree there exist various possible approaches for identifying early warning signs in projects, many of which are not mentioned directly as an early warning source in the literature. The choice of the right approach is of course very much dependent on the project itself, the project organization, and the project context. We have endeavored to categorize the various early warning identification approaches. This has been done based on the type of data that can be gathered by implementing the specific approach, the type of analysis required, the focus point, the source of data, and finally, the particular phase in which the approach can be used as an early warning source. The results show that each approach has its own strengths and weaknesses. The choice of approach in a given project will be up to the discretion of the project management team, in order to exploit as many early warning signs as possible and timely enough to be able to take preventive actions. The choice of the most effective approach is for sure dependent on the type of project, organizational culture, and the project environment.

We have also briefly described our findings from several case studies on the use of early warning detection approaches which we have been involved in. Our findings are based on practical experiences from the implementation of various methods in real life cases.

We would like to move our future research forward as follows:

- Trying to test as many approaches as possible in different cases in order to reach a concrete statement on the level of usefulness of each approach and its strengths and weaknesses in practice. We would like to do this through introducing the possible early warning approaches in various case projects or having project managers put them to use and reporting their experiences.
- Having identified the possible early warning identification approaches, we would like to show how various sources can be combined to gain the most advantages with the least effort.
- Gathering this information we would like to evaluate how the implementation of an early warning system contributes to overall project performance and its success. ■

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II

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A Conceptual Framework for Application of Performance Measurement as an Early Warning System in Projects, an Analysis on the Case of the London Ambulance Service Project

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A Conceptual Framework for Application of Performance Measurement as an Early Warning System in Projects: An Analysis on the Case of the London Ambulance Service Project

By Sara Haji-Kazemi, Bjørn Andersen, and Hans Petter Krane

Abstract

This study presents an overview of the concept of early warning signs in projects and explains how a performance measurement system can be utilized as an early warning signal for avoiding failure. An analysis will be done on the published assessments of a project, the London Ambulance Service, which failed to fulfill its goals. This analysis has been performed in order to illustrate the feasible problems pertaining to a real case and its consequences. The rationale behind this selection is not to offer criticism relating to this specific project's performance but to learn constructively from it and move towards a better practice. A statement has been made that, with application of a performance measurement system in the project phase, chaos and perhaps total failure in the operational phase could have been prevented. Also, a conceptual performance measurement system has been proposed, using the main problems in the project phase as a reference for addressing the dimensions of performance to be measured, objects to be controlled, and the indicators. The overall aim of this paper is to increase understanding of the concept of early warning signs in projects and offer a possible approach, which can assist project managers in taking timely preventive actions in order to avoid undesired outcomes.

Keywords: performance measurement; project failure; early warning signs; conceptual framework; London Ambulance Service

Introduction

Despite the improvement of project management practice in recent years, there is still a considerable rate of project failure. Many authors have looked into this subject and various responses to this problem have been developed. In their research, Sauser et al. (2009) found that the root cause of failure in projects is often managerial rather than technical. Some of the main managerial failure factors are mentioned to be inadequate project risk analysis and weak definition of scope (Yeo, 2002; Kutsch & Hall, 2005). Of course, there are many more factors that might result in project failure, but the question is how one might approach the issues that lead to project failure? Is it possible to prevent these situations or will these factors inevitably result in project deficiencies? The challenge, according to Sauser et al. (2009), is that while studying a project's success or failure it is important to realize that factors that work well in one specific situation may not work in another, or, in other words: "one size does not fit all." Thus, one is required to choose the correct appropriate management style to help predict the success or failure of projects.

The ability to react to unforeseeable events and take proactive actions by detecting the early warning signs, in addition to early identification of problems, can assist in preventing potential causes of failure in projects. It is clear that the higher the risk of upcoming events, the more crucial it becomes to be able to predict and take actions accordingly in order to decrease the threat of failure. There is a need for more careful planning, close monitoring, and strict control of large, high-risk projects (Couillard, 1995). Identification of early warning signs and relating them to the appropriate project problems and their causes can contribute positively to the prevention of undesired consequences. Consequently, it is important to start applying this knowledge and actively start implementing actions aimed at lessening the threats, and the sooner the better (Nikander & Eloranta, 2001).

There are many different project assessment tools that can be utilized as early warning systems. Examples are project reviews, project health checks, benchmarking, post-project evaluations, and project audits (Klakegg et al., 2011). The research objective of this study is to describe the functionality of performance measurement systems in projects as early warnings with the aim of preventing undesired outcomes and to test whether the use of this principle is feasible in actual projects.

Research Methodology

In order to achieve the research objective, a brief literature review has been done on the concept of performance measurement and how it can be used as an early warning system in projects. Although many authors have written about the concept of performance measurement (Kaplan, 1990; Maskell, 1991; Rolstadås, 1995; Folan & Browne, 2005; Jafari, 2007; Vittorio et al, 2008; Almahmoud et al., 2011), not much is said about its linkage to early warning signs in projects and how this tool can be utilized as an early warning system. The rationale for focusing on this tool is that it is recommended in the literature (Andersen & Fagerhaug, 2002; Nikander, 2002) as a useful prediction method.

Throughout this paper, we have mainly used the results of the work done by Andersen and Fagerhaug (2002) on designs and application of performance measurement systems and the performance measurement framework developed by Vittorio and Frattini (2009). This is followed by an analysis based on the work performed by Finkelstein and Dowell (1996) on the problems that drove the case of the London Ambulance Service to total failure. Benefiting from knowledge relating to the project conditions and the problems that landed the project in specific circumstances, a conceptual performance measurement framework is proposed to better illustrate possibilities for how this project could have been carried out differently.

Performance Measurement as an Early Warning System

Projects do not experience trouble overnight. Usually, they proceed from "green," to "yellow," to "red," and during this process early warning signs can indicate if a project is on its way to failing or if urgent changes are needed (Kerzner, 2011). According to Kerzner (2011), the earlier the warning signs are discovered, the more opportunities for recovery exist. Successful identification of the early warning signs specifies if a project can achieve its objectives according to the original requirements with minor changes, if it can be repaired by implementing major changes, or if it should be terminated.

Andersen and Fagerhaug (2002) state that the earliest warnings originate from monitoring the basic knowledge development inside the organization and that these often emerge a year or two ahead of when the real problems make themselves apparent. Some of the typical early warning signs in projects, according to Kerzner (2011), include: different opinions on a project's purpose and objectives; unhappy stakeholders and steering committee members; delayed decisions, resulting in missed deadlines; unrealistic expectations; poor change control processes; and so forth. We believe that the reason why a performance measurement system can be used as an early warning is that it will aid project managers in taking preventive actions by providing a clear view towards oncoming matters rather than looking backwards. Having a proper performance measurement system in place can serve as a tool for detecting these signs in order to assist project managers in implementing the appropriate actions. According to Spitzer (2007), performance measurement creates the basis for effective management, thus offering a method of implementing strategies and policies in an organization, in addition to improving decision-making and problem solving. In addition, Andersen and Fagerhaug (2002) specifically highlight the usefulness of performance measurement as an early warning system. In the next section, the process of designing a performance measurement system will be described.

Design of a Performance Measurement System

The first important issue that should be considered by project managers when attempting to measure a project's performance is to design a system that fits the context in which it will be used. The design of this system should be clearly in alignment with the project's environment. The environment is, according to Vittorio et al. (2007), defined as: (1) critical objectives of the project, (2) organizational and managerial practices adopted for the project process, and (3) characteristics of the project's tasks that are going to be internally taken. An appropriate definition of the standards against which to measure performance is necessary to ensure that the measurement system provides useful indications capable of correcting the course of action.

In fact, there is a need for a proper "benchmark" to be in place in order to use it as a reference (Vittorio et al., 2007).

According to Andersen and Fagerhaug (2002), there are two performance measurement system design approaches: A top-down cascading method and a bottom-up design process. The rationale for the top-down approach, which perhaps constitutes the most widespread approach, is that top management knows best which strategy to follow, which objectives to strive for, and what aspects of performance to measure. The bottom-up approach, on the other hand, is based on personal responsibility and is well suited for designing a performance measurement system that every member of the organization feels ownership of, can relate to, and generally view as useful. Considering the advantages and disadvantages of these approaches, the authors encourage a combined approach, where the top-down and bottom-up approaches meet somewhere in the middle. This ensures both that the organization's guiding star, its strategy, will define the boundaries for the performance measurement system and simultaneously encourage ownership and use of the system by allowing the users to define the details of the system themselves. The process of designing a performance measurement system includes (Andersen & Fagerhaug, 2002):

1. Understanding and mapping business structures and processes
2. Developing business performance priorities
3. Understanding the current performance measurement system
4. Developing performance indicators
5. Decide how to collect required data
6. Designing, reporting, and performance data presentation format
7. Testing and adjusting the performance measurement system
8. Implementing the performance measurement system

According to Andersen and Fagerhaug (2002), steps 1 and 2 are more complex than necessary, and step 3 can even be eliminated in small organizations. Steps 5 and 6 can be simplified and merged for projects in which a mass of performance data is not required. This is also applicable to steps 7 and 8. However, because the aim of this study is to design a performance measurement system for projects in general, which also include complex and high-risk projects, it would be appropriate to approach each and every step dependently when designing a performance measurement system. But it should also be taken into account that in large, complex project organizations such a process might not be able to capture the complex web of objectives, links between units, and so on. In these cases, it is recommended to apply the system design process to the independent tasks and units and then try to aggregate upward.

We have decided to use the model designed by Vittorio and Frattini (2009), which is a framework for designing a performance measurement system for new product development projects, as our framework. Also, the steps are clearly illustrated in a graphic model and are easy to understand. The suggested framework is illustrated in Figure 1. Each element of this framework, which will be described in this paper, matches each step of the design instructions suggested by Andersen and Fagerhaug (2002). The specific step that matches each element is also illustrated in Figure 1. The main aspects of this framework, as depicted below, are objectives, dimensions of performance, control objects, indicators, and the process of measurement. The objectives of measurement are to create a loop of never-ending improvement; the main objectives mentioned by Andersen and Fagerhaug (2002) are presented in the framework.

The choice of objectives and the structure of the system influence the dimensions along which measurement is undertaken. Several authors suggest that these dimensions can be brought back to "the balanced scorecard approach." (Kaplan & Norton, 1996; Vittorio & Frattini, 2009) Consequently, performance should be measured taking into account the financial perspective, customer perspective, innovation and learning perspective, and the business process perspective. The control objects in this framework are a set of objects whose performance should be kept under control. The objects that should be kept under control during the

project are project teams, the functional department under which the project team performs, individuals, and the stakeholders. The indicators can be either qualitative or quantitative. For example, project time and cost can be measured by quantities, whereas the measure of quality of communication must be presented qualitatively. Of course, the choice of indicators to be employed should be consistent with the objective against which project performance is measured (Vittorio & Frattini, 2009).

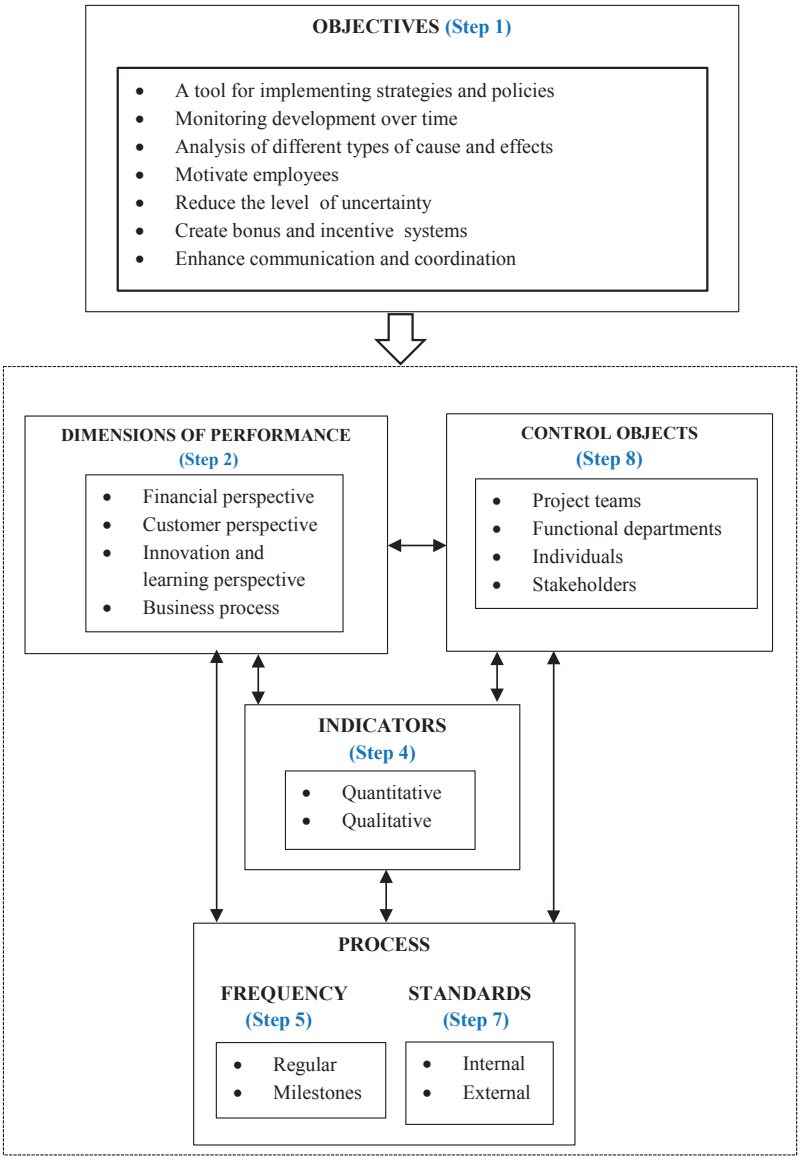

Figure 1: PMS framework (adapted from Vittorio & Frattini, 2009)

The measurement frequency can be chosen to be regularly, for example on a monthly or weekly basis, or at specific milestones. This choice will depend on the PMS objectives, the dimensions of performance, and the control objects. In some cases, a new project might prove similar to previous ones, for which a performance record is available. In this case, we believe that standards can be used as a reference in order to prevent the re-currence of previous risks and mistakes.

Having designed the main framework for measuring project performance, there is a need for clarifying the constitutive elements of the measurement system and describe which dimensions of performance should be monitored by the PMS, which indicators should be used to monitor each performance dimension and identify which organization level are being monitored, and also the indicators associated with each of these. In order to accomplish this, an objective must first be identified and the above-mentioned steps will then be followed according to this specific objective.

In the next section, the case of the London Ambulance Service project, which turned out to be a failure, will be subjected to analysis. The reason why this published case study has been chosen is that this project, mentioned by Williams (2002), is an example of a highly complex project, reputed to having experienced a disastrous outcome due to lack of appropriate management. We would like to discuss this case in order to identify which measures could have been undertaken differently in order to prevent the project's failure. Note that, in addition to this, the information published on this case is clear, detailed, precise, and the causes of failure, management conditions, and other important aspects needed for analyzing a case are provided in the published literature pertaining to this specific case.

London Ambulance Service (LAS): A Case of Total Failure

This section includes a brief overview of the case of the London Ambulance Service based on studies by Finkelstein and Dowell (1996) and Dalcher (1999). The reason we have chosen to analyze this case is that this project, according to Williams (2002), was a highly complex, long-duration project and experienced a number of serious problems during the operation phase. The purpose of this study is to discuss how this project could have been managed differently and in a more effective way.

The London Ambulance Service is referred to as the largest ambulance service in the world, covering an area of over 600 square miles and a population of approximately 7 million people. The service was divided into two sections: one providing routine patient transport and the other an accident and emergency service. In 1990, the LAS decided to commission the development of a computerized dispatch system in order to improve its performance. Prior to this, the service used manual methods for controlling the dispatch of ambulances. The details of a call were noted on paper and sent to a central collection point. The communication with ambulances before dispatch was done by telephone and once the ambulance was dispatched, via radio.

A requirements specification was prepared and an invitation to tender for the development was issued in February 1991. Many companies responded, although many commented that the proposed implementation date of January 1992 made the time scale very tight. Nevertheless, a supplier who offered to meet the deadline was chosen. Note that this supplier didn't have enough experience to carry out this kind of system. Price was a major factor in selecting the winning bid.

During the development of the new system (project phase) many problems occurred, including:

1. The delivery of software was frequently late
2. There was no proper project management
3. None of the people involved in the project had experience with PRINCE, the project management methodology that had been adopted for the development
4. Software developers made ad-hoc changes to the software in order to achieve user satisfaction
5. The users were not adequately trained and were skeptical about the benefits of the system

Due to the above-mentioned problems, the implementation of the system was pushed back until late 1992, but it became evident that many problems were still unresolved.

The computerized dispatch system went live at 7:00 a.m. on 26 October 1992. At the time of start-up, when there were few calls to deal with, the system worked satisfactorily and the staff was capable of managing the

tasks, but as the number of calls increased, it became clear that there were major problems riddling the system. The problems that showed up in the operational phase included:

1. The system failed to eliminate duplicate calls, so sometimes more than one ambulance attended a scene.
2. The tracking of ambulances did not work properly.
3. Ambulance crews were confused about how to apply their status reporting system. This resulted in the system failing to produce a true picture of the ambulance fleet's status, thus making inappropriate allocations of ambulances to incident sites.
4. The delays caused people at incident sites to call again and consequently increase the load on the system.

Eventually, it became clear that the system failed to handle the amount of calls and consequently lost control of its fleet. On the same day this fact was established, the service reverted to a semi-manual system, using only part of the original software (i.e., the one for taking incoming calls). This functionality also failed several weeks later due to a program error, and the system was then completely abandoned.

The failure of this system attracted a great amount of media attention and there were allegations that approximately 20 people had possibly died as a result of the delays of up to 3 hours in ambulances arriving at incident sites. Later inquiries, however, stated that there was no evidence of deaths occurring due to the ambulance delays. The following aspects were identified as the main causes of system failure:

1. Neither the system nor the user was properly prepared for the implementation of the system.
2. The system contained design flaws.
3. There was an unrealistic reliance on correct information about ambulance location.
4. The project timescale had been too short.
5. The software was incomplete and effectively untested.
6. The implementation approach was 'high risk' and inappropriate and unjustified assumptions were made during the specification process.
7. There was a lack of consultation with users and clients in the development process, with immediate consequences for their "ownership" of the resulting system.
8. The poor fit of the system with the organizational structure of the ambulance service
9. Poorly designed user interfaces
10. Lack of robustness and straightforward "bugs" and errors

In the next section, a performance measurement system will be proposed for this project, indicating that if this system had been applied as an early warning system, perhaps many of the problems, and consequently serious failure, could have been avoided.

What Could Have Been Done Differently?

In the case of the London Ambulance Service it is clear that some issues could have been handled differently, and certain early warning signs could have been detected in advance to prevent encountering serious problems in the end. Many studies have been done on the case of the London Ambulance Service and analyses carried out to determine the reasons why this project ended in such a disaster (Hougham, 1996; Beynon-Davis, 1999; Dalcher, 1999; Fitzgerald & Russo, 2005). We would like to analyze this case from a management point of view and discuss how the application of a performance measurement system in the project phase of the London Ambulance Service could have contributed to preventing chaos and perhaps total failure in the operational phase.

In his study, Kerzner (2011) introduces a list of typical early warning signs in projects and indicates that the sooner early warning signs are detected, the more opportunities exist for recovery and for improving the possibility for successful projects. According to the case descriptions in the previous section, the specific

problems in the operational phase can be matched to one of the typical early warning signs introduced by Kerzner (2011) (Table 1).

We would like to suggest that a performance measurement system might have been used as an early warning system in this project. The suggested system follows the framework presented in Figure 1. Each element of the framework is adapted to the specific condition and aspect in the LAS project. In order to do this, the main problems that occurred in the project phase will be used as a reference for addressing the dimension of performance, the objects to be controlled, the indicators of measured elements, and the suitable process of measurement. The system's components are presented in Table 2.

Table 1: Problems in the project phase as early warning signs.

Specific problem in the operational phase	Early warning sign
Software frequently late	Delayed decisions resulting in missed deadlines
Ad-hoc changes by software developers to achieve user satisfaction	Poor change control process
Users not adequately trained and skeptical about the benefits of the system	Different opinions on project's purpose and objectives
Short time scale	Unrealistic expectations
Software not tested	Technical failure
Lack of consultation with the users and clients	Failure in progress reporting, poor morale
Unjustified assumptions in the specification process	Unrealistic expectations

In this model, the dimension of performance that should have been measured to prevent problems in the operational phase of the project is mentioned. Each problem is related to one of the following areas, which are the components of the balanced scorecard:

1. Financial issues such as operating income, return on investment, and economic added value
2. Learning and growth issues such as employee satisfaction, employee retention, skills, and so forth
3. Customer issues such as customer satisfaction and customer retention
4. Internal business issues such as cost, throughput, and quality

Table 2: Components of the suggested PMS.

Problems in project phase	Dimension of performance	Control objects	Indicators
Software frequently late	Service delivery on time (business process)	Project team	Percentage of project concluded on time (earned value)
No proper project management	Project management effectiveness (business process)	Project team	Value of schedule variance and cost variance
No experience with PRINCE (project management methodology adapted for development) for people involved	Capability of applying selected project management methodology (learning and growth)	Project team	Project performance during first month
Ad-hoc changes by software developers to achieve user satisfaction	Level of changes in the software (customer)	Project team	Percentage of customer satisfaction
Users not adequately trained and skeptical about the benefits of the system	Capability of clarifying goals of the project for users and level of training (learning and growth)	Individuals	Number of positive users in the beginning of the project
Short time scale	Level of proper planning (business process)	Functional department /project team	Percentage of project concluded on time according to the initial estimations
Software not tested	Quality of software performance (business process)	Project team	Percentage of "bugs" and errors
Lack of consultation with the users and	Quality of communication with customers (customer)	Customer/project team	Percentage of client satisfaction through the development stage

clients			
Unjustified assumptions in the specification process	Level of justification and reality of estimations (business process)	Functional department	Percentage of achievements according to the assumptions at each decision gate

In the proposed model, the dimension of performance for each aspect is matched to the area in which it fits. For example, "lack of consultation with users and clients in the development process" was a problem that occurred due to lack of a measurement system for customer satisfaction during the process.

The control objects, the objects whose performance should be kept under control, are set for each issue. For example, "too short project time scale" could be improved by controlling the project team's performance, their improvement during a specific period of time, and the estimates they would have made to identify the right finishing time of the specific tasks they were responsible for. The frequencies of measurement, which can be on specific milestones or regularly throughout the project, are identified according to each aspect. For example, in the case of a "too short project time scale," if the project teams' performance had been measured regularly, comparing the planned work to be done with the actual work done (earned value method), the flaws could have been identified in advance.

Since the project team was not sufficiently experienced in developing this specific kind of system, there were no internal standards for use as a reference; however, any general software development standard that defines and establishes the routine process for software development can be used as a reference in order to prevent common risks and mistakes.

Having applied this model, the problems in the operational phase could have been overcome to some extent or even totally prevented. An example of the problems in the operational phase is the failure of the system to eliminate duplicate calls and, as a result, dispatch ambulances to a scene more than once. According to the suggested performance measurement model, if the percentage of "bugs" and errors were measured, the software problems could have been identified in advance and, as a result, the above-mentioned errors could have been prevented in the operational phase. Each of the aspects mentioned in Table 2, in case they were noticed and acted upon, could have contributed to the prevention of the major problems that led the project to total failure.

Also, the level of customer satisfaction could have been evaluated during the project in order to identify their expectations in advance, thus avoiding surprising and unwanted events.

Discussion and Conclusions

Projects do not go from "totally perfect" to "totally disastrous" overnight. There are always specific signs that indicate that there will be a problem ahead. The sooner these signs are detected by the management team, the more possibilities exist for taking preventive actions. Some of the project assessment tools that are used in projects as early warning systems have been mentioned in this paper. Performance measurement is one of the tools that can assist project managers in the early identification of early warning signs. The example of the London Ambulance Service was chosen to better illustrate the problem and the possible solutions to it. In this specific IT project, the problems were clearly identified by looking back at what had already happened. This provided a good knowledge base for indicating what should have been measured, consequently identifying the early warnings, and which measures could have been implemented in a different manner.

It should be mentioned that we are fully aware of the fact that it is easy to look back on history and state what could have been done differently. We believe that the real challenge is to identify the early warning signs while the project is running and to be able to detect them early enough to take the right actions. As mentioned earlier, one size does not fit all, and this is not a general framework that can be utilized in all cases. There is a

need for more enhanced awareness of project conditions, thus enabling project management to choose the appropriate indicators and measurement dimensions.

We would like to also emphasize that because this framework has not been tested in this specific project, there is no guarantee that an application of this framework could have definitely prevented failure. We should take into account that, in some cases the early warning signs are in fact sensed, but nothing is done about them. Here is when we should consider the human side, which can very much influence the process of detecting early warning signs. According to Holmes (2001), the London Ambulance Service organization had the culture of "fear of failure," according to which senior management was continually under pressure to succeed. This could cause avoidance of even observing the early warning signs, let alone taking proactive actions to respond to them. Klakegg et al. (2011) also discuss the problem pertaining to why project assessment methods are not capable of identifying early warning signs in projects. They mention and discuss three particular areas that can contribute to this problem, including: complexity, understanding of risk, and interpersonal affects. Some of these issues are identified in the analysis done by Holmes (2002) on the case of the London Ambulance Service. For example, the London Ambulance Service organization had a history of severely problematical industrial relations between management and the ambulance crew. As a result, consultation with the ambulance crew during system validation was avoided. We conclude that not only was a systematic approach not applied to detecting the early warning signs in this project, but there was also a culture of ignorance, which led the project to such failure. Further studies will be carried out on how to detect the early warning signs in real ongoing projects and the human and organizational factors that should be considered in order for an early warning system to be effective.

Another interesting point is to identify at what stage in the project life cycle it is possible to detect the early warning signs. In the previous section it was mentioned that the supplier chosen to handle the London Ambulance Service project didn't have enough experience to carry out this kind of system and that the price was a major factor in selecting the winning bid. Looking at the bigger picture, it is somehow possible to see these two issues as early warnings that the allocated tasks will not be carried out with the prerequisite quality. We would like to conduct further research on the specific stage in the project in which the process of early warning detection should begin in order to prevent a series of problems in the following stages.

In this paper we hope we demonstrated a basic description of the concept of early warning signs in projects and how performance measurement can be utilized as one of the tools which, if applied as part of the management system, can help project managers to not only detect the early warning signs of oncoming problems, but also enable them to take preventive actions on time in order to avoid adverse outcomes.

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III

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Identification of Early Warning Signs in Front-End Stage of Projects, an Aid to Effective Decision Making

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Abstract

Most of the critical decisions are made in the front-end stage of projects. This is due to high level of uncertainty in this stage (both negative and positive uncertainty) and at the same time the high potential for corrective actions and reducing consequences of possible negative impacts. On the other hand the prerequisites of a project's success include those aspects which should be in order and those matters that need to be attended to in the initial phases of the project. At this stage, attempting to detect early warning signals of possible future problems can be an aid to making the right decisions and ensuring the existence of crucial requirements. The earlier the warning signals are identified, the more time will be available for taking appropriate corrective actions before the negative consequences of a problem show up. This article suggests that it can help to introduce new insights to adding early warning identification as part of the management process in the front-end stage of projects. A case study on the Norwegian High Speed Railway project, which is currently in its front-end stage, is done in order to better illustrate the key points of this research. This will be done through an analysis on the possible early warning signs which can be detected in this stage and showing how this can contribute to a more effective decision making process for the project.

Keywords: Early warning; project front-end stage; uncertainty; decision making

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1. Introduction

One of the most important phases of a project is the front-end phase, which is when the project exists only conceptually, before it is planned or implemented. It includes the entire set of activities from decision on the initial concept to the final decision for financing the project (Williams & Samset, 2010). In this stage resources should be expended without guarantee of return. The best project management practice is needed in this period to ensure that resources are spent as effectively as possible in order to provide highest likelihood of return (Morgan, 2002). At this point the complete project should have come together as one integrated whole, building the best fit with it market, environment, community and the corporate strategy of its sponsor (Morgan, 1987). Front-end decision making for projects according to Samset (2010) is very important since the need to "do the right project" is just as important as to "do the project right". During this phase, it is essential to have a broad perspective on the project and its features which are relevant for various stakeholders. It is also very important to take into account the uncertainty involved with the project's objectives and strategic framework. When it comes to large-scale public projects, with high level of complexity and risk, it is very important to spend enough time and effort on the front-end phase since the costs of changes are very high. Jergeas (2008), in his study states that the solution to preventing cost-over runs in large capital oil sand construction projects is having more focus on the front end planning phase.

It is obvious that due to the high level of uncertainty in this stage, it is not easy to identify early warning signs of potential problems which may arise during the project. But attempting to select the right approaches for indicating the early warning signs of possible problems will be a highly effective aid to project managers for making the right decisions, thus avoiding undesired events later in the project.

The objective of this paper is to examine how identification of early warning signs in the front-end phase of projects can contribute to a more effective decision making process. It suggests that adding early warning identification as part of the management process, in the front end stage, can help in having better insights towards the future of the project. A real case of a project, in its front-end phase, in the railway industry will be used as an example to better illustrate the main goal of this study.

The paper is structured around several main issues. The first concerns the phenomenon of early warning and different approaches for early warning detection being discussed. Secondly, the case on Norwegian high speed train will be briefly discussed and analyzed. An investigation on possible early warning signs that can be detected will be performed. Lastly the effects of early warning identification in project's front-end phase on the decision making process will be discussed.

2. Early Warnings in Projects at the Front-end Stage

The general idea of early warning is a broad concept. It applies to almost any area where it is important to obtain indications as early as possible of some development that in the future will become clearer, usually of a negative nature. The concept of early warning in a management context was first discussed by Ansoff in 1975 and was later supported by Nikander (2002) in his doctoral dissertation. Ansoff stated that strategic surprises do not appear out of the blue, it is possible to predict their occurrence by the aid of signs which are called weak signals. A weak signal was defined by him as "…imprecise early indications about impending impactful events…all that is known is that some threats and opportunities will undoubtedly arise, but their shape and nature and source are not yet known" (Ansoff, 1984).

In Nikander's words (2002), "an early warning is an observation, a signal, a message or some other item that is or can be seen as an expression, an indication, a proof, or a sign of the existence of some future or incipient positive or negative issue. It is a signal, omen, or indication of future developments". In his study he devises a preliminary model illustrating the character of the early warnings observations.

This model sees project events as a time-bound consecutive stream of events. At a given moment, information about this stream can be obtained (e.g. early warnings of potential future project problems). This information is processed and responses are required in order to influence the flow of the project. A crucial factor in choosing a response appears to be, according to Ansoff, time available for responses before the potential problem significantly impacts the project.

Not much has been mentioned in the literature about the exact time the early warning sign identification should start in the project life cycle. We believe that in case early warning signals are identified in the front-end stage of a project, the available time will be rather long enough for project managers to take the right actions in the subsequent stages of project. For example in case some warning signals related to cost and time limitation are identified in the front-end stage, budget estimating in the initiation phase can be done more accurately. In addition, it can be a guide to planning deliverables, baseline schedule and baseline budgets in the planning stage. Identification of early warning signs related to technical issues, can aid the responsible persons to make better decisions on risk management and production of key variables in the execution phase. Of course the challenge lies in the possibility of detecting the early warning signs and their level of reliability.

According to Nikander (2002), very little literature exists that deals explicitly with early warning in projects and project management. But the project management literature does include some statements which directly or indirectly refer to this concept and its identification approaches (See Table 1).

Table 1. Categorization of sources of early warning signs in projects

Early warning sources directly discussed in the literature	Potential Early warning sources in-directly discussed in literature
Risk analysis (Niwa (1989); Nikander (2002))	Stakeholder analysis (Savage *et al.* (1991); Cleland (1986))
Project success / failure models (Pinto & Slevin (1988); Miller & Lessard (2000))	Cause / effect analysis (Parker & Skitmore, (2005); Sambasivan & Soon (2007); Klakegg *et al.* (2010))
Project assessment methods (Cooper (2005); Miller & Lessard (2000); Klakegg *et al.* (2010))	Maturity assessment (Andersen & Jessen, 2003; Ahern *et al.* (2004); Jachimowics (2003); Kerzner (2001))
Earned value management (Vanhoucke (2010))	Interface analysis (Cleland & Morris (1988); Voss (2012))
Decision support model of early warnings (Nikander & Eloranta, 2001)	Extrapolation from previous projects (Pinto & Slevin (1988); Miller & Lessard (2000); Kappelman *et al.* (2007); Klakegg *et al.* (2010))
	Gut feelings (Nikander & Eloranta (2001); Klakegg *et al.* (2010); Whitty (2010))

The choice of the right approach is very much dependent on the project itself, the project organization and the project context. Detailed description of each approach is out of this paper's scope. In the next section, the case of the Norwegian high speed railway project, which is in its front-end stage, will be introduced and subjected to analysis. The reason this case has been chosen is that it is an example of a complex project, involving a great number of stakeholders which can highly influence the project in all its phases. We would like to discuss this case in order to identify what are the possible problems that may arise during the project and what are the possible early warnings signs that can be identified in the project's current stage. We would like to discuss how these findings can potentially aid the project responsibles to a more effective decision making process later on. Note that, due to the public being one of the main stakeholders in this project, the information published on this case is clear, detailed and precise. Our findings are based on a document analysis on published assessments of the feasibility study on this project in addition to semi-structured interviews with the project manager of the feasibility study project.

3. Identification of Early Warnings in a Project in its Front-end Phase , A case study

As mentioned earlier, the front-end of a project is basically defined as the period from when an idea is conceived to where the decision to finance the project is actually made. This is the point where the complete project should have come together as one integrated whole, building the best fit with it market, environment, community and the corporate strategy of its sponsor (Morgan, 1987). We would like to utilize in this study the framework designed by Samset (2010) for strategy analysis which leads us to a clear picture of the probable consequences of a choosing specific solution. This approach applies a simplified framework for identification of the most important elements of a project. It presents an overall picture of the project strategy and the main uncertainty factors which can influence the project implementation. Determination of the most important uncertainties leads us to identification of the most probable problems that may rise in the project and guide us to attempt for detecting the early warning signs of those specific events. In the next two sections, a brief description of the case project will be performed followed by introducing the potential problems, based on the uncertainty elements, and their possible early warning signals

3.1. A case of a project in its initial phase (HSR Project)

The Norwegian high-speed railway project which is one of the major investment projects intended to be carried out for the first time in Norway has absorbed lots of attention from public and media in the recent years (2010-2012). Since many stakeholders are involved with this project, there are a variety of opinions on whether it should or should not be executed.

The feasibility study project for the Norwegian high-speed railway was given its mandate by the Norwegian Rail Administration (Jernbaneverket) in February 2010, with a total budget of 50 million Norwegian kroners and was intended to be carried out in order to provide recommendations on long-term strategies that will form the basis of long distance passenger traffic in Norway and for exploring opportunities for building high speed railways in southern Norway.

The final report was published in February 2012 concluding that it is possible to build and operate high-speed trains in Norway and it has a large endpoint and future market. Although the development costs are significant for all options, they vary greatly according to the length of tunnels in different section. Corporate economy is positive for most of the routes but social economy is negative for all sections. From the environmental point of view, it is concluded that the number of years to achieve CO_2 emissions balance varies greatly with the length of tunnels of the different sections. The study has shown that 30-40% of traffic on the routes is known along the way traffic, i.e. passengers who drive between endpoints. A possible realization of the high speed railway will shorten travel time for the population in regions and districts between the major cities in a significant way. In case of realization it should be performed in a way that people living between major cities can also benefit from it.

The concluding remarks consist of analysis on specific factors including technical feasibility, investment, market conditions, socio- economics, business, environment and safety. In the next section we will analyze the case and try to point out to possible early warning signs of potential problems which may come up in later stages of the project. This will be based on the information provided in the final assessment published by the Norwegian Rail Administration.

3.2. Uncertainty elements of the HSR project

Having studied the published reports on the Norwegian high-speed rail project, we have extracted the uncertainties involved with different aspects in the project in order to identify the potential problems

which may rise during the project. a total of 53 uncertainty elements have been identified in various aspects such as technical feasibility, climate factors, travel time, market, safety and security, development costs and environmental issues (See Table 2).

Table 2. Uncertainty elements in Norwegian High Speed Railway Project

Category	Uncertainty elements
- Technical feasibility - Climate factors	1. Suspension bridge over the Hardangerfjørd with a length of 1.6 km in Oslo-Bergen rout is feasible
	2. 2 tube tunnel under Hardangerjøkuln in Oslo – Bergen rout
	3. 2 tube tunnel under Boknafjørd with a length of 51 km in Stavanger-Haugesund rout is feasible
	4. Underground portion of over 50% in Oslo-Trondheim rout is feasible
	5. Establishing technological standards alongside the rapid development of international practice is feasible
	6. Climate change is not so vast to require new technological solutions
	7. The need for compatibility to Swedish lines does not require completely new, out of the scope technological solutions
	8. Land wasting are detected early enough
	9. Bed rocks are in good conditions so the rails can be built on them
	10. Diagnosing in advance probability of water leakage in places where tunnels are intended to be constructed
- Travel time - Market - Safety & Security - Business - Development costs	11. Travel time is approximately 3,5 hours in all corridors in order to make replacement of flights beneficial
	12. Number of passengers is adequate in all the routes
	13. The investment pays back in good time
	14. Socio economic value is positive
	15. Cost of the project is reasonable and worth the service its providing
	16. Development of labor market is satisfactory due to easier means of transportation between towns and large cities
	17. Community acceptance is satisfactory
	18. The HSR can operate safely under harsh climate of Norway
	19. Distribution of population over time is relevant to the need of HSR
	20. Travel duration is convenient and pleasant for passengers
	21. Business travellers needs over time is still in alignment with the need for HSR in specific routes
	22. Number of people working and living in different areas is relevant to the need of HSR
	23. Employment growth in different areas is relevant to the need for HSR
	24. Public reaction to public funding required for construction of HSR is positive
	25. Passengers perception of use of HSR is positive
	26. Inflations and change of interest rates does not affect the project costs in a negative way
	27. World economy will not change in a manner which can negatively affect the project
	28. Government policy does not turn negative against the project
	29. Road improvements and new technologies does not decrease the public interest in HSR
	30. Changes in legislations during HSR development and construction does not stop the project
	31. Change in EU policies does not affect the project costs and scope (For example immigration laws preventing use of foreign contractors from outside EEU)
	32. Communities in Norway approve the plans

Category	Uncertainty elements
	33. Low rate of level crossing accidents
	34. Low rate of tunnel accidents
	35. Few fatalities during the construction phase (less than 11 fatalities per year for the total railway net)
	36. few accidents due to collision with wild animals crossing the rail lines
	37. less than 2 accidents per 10 years with local people living near the railway area
	38. No successful terroristic accidents
	39. No serious accidents due to fire
	40. No serious accidents due to violence and sabotage actions
	41. No detonation accidents in the tunnels
	42. No bombing accidents near the rail lines
Environmental issues	43. Transfer of air traffic and road traffic to HSR is significant
	44. Environmental balance is achieved in good time
	45. Intervention effects on natural environment, cultural heritage, landscape, natural resources and society is not too high
	46. Amount of CO_2 emission due to tunnelling is acceptable
	47. Amount of CO_2 emission while the HSR in operation is acceptable
	48. Amount of noise produced by HSR is not disturbing for people living in the area surrounding the places where train passes
	49. Amount of GHG emission per unit of traffic is acceptable
	50. Amount of GHG is decreased due to high volume of traffic transferred from air
	51. Public reaction to environmental effects from construction of HSR is positive
	52. The HSR is more environmental friendly than air transport
	53. New technologies such as hybrid cars, low hazard fuels for air planes etc. do not replace this solution

Assuming that all the uncertainty elements in the above table are more risk- oriented rather than opportunity oriented, we will continue our discussions taking into account these elements as risk elements of the project (According to Chapman and Ward (2003) the negative side of uncertainty is considered as risk). We can interpret that each of the uncertainties mentioned in table 2 as potential problems in case of occurrence on the negative side. The main purpose of the Norwegian HSR project is mentioned to be an environmental friendly solution for transportation despite the huge amount of development costs. The question will be now what can be the early warning signs to these risks in the front end stage of the project? It is also a challenge to identify early warning signs of which category of problems can mainly be determined in this stage. The analysis will be done in the following section. In this section we would like to try to point out to the possible early warning signs of problems which can be identified in the front-end stage of the project. Each category of problems will be analysed separately.

Problems related to technical feasibility and climate factors

In the report containing summary of phase 2 works (Norwegian high speed rail assessment 2010-2012, Summary of phase 2 works, Jernbaneverket, 26.02.2011) it is mentioned that when new high-speed railway lines are planned, robust and reliable infrastructure should always be the main goal. This includes bridges, tunnels and protecting embankments in places where the surrounding nature and climatic conditions are particularly demanding. In a few cases though, it is not technically or economically possible to build such infrastructure. In these cases an early warning system (EWS) could be an option. EWSs are built to monitor the ground conditions, and give warnings as early as possible when land

wasting happens. This can give the railway operator a few valuable seconds to protect the running of trains on the railway line. In most cases the train can be stopped on prepared stopping points before it runs into the problem area. In some rare cases, the train will not be able stop at all, but should at least be able to slow down the speed to reduce the damage to equipment and injuries to people.

Although the concept of early warning has been mentioned in this report, approached for detection of these signs in the front-end stage of the project are not pointed out. We believe that the early warning signs of technical and climate oriented problems cannot be detected before the planning phase starts. This project has been estimated to start earliest in year 2017. It is obvious that factors such as conditions of bed rocks, amount of land wasting and climate factors cannot be predicted now and detection of early warning signs related to this issues should be done shortly before execution of the project. Results of the assessment also show that there is the risk that some unknown problems arise, which cannot be foreseen before the execution starts.

Problems related to Travel time, Market, Safety & Security, Business and Development costs

The results of the assessments show negative socio-economic values (Konklusjoner og oppsummering av arbeidet I fase 3, 2012). This can strongly affect the decision of the political parties which should make the final agreement in order for this project to be executed. There may be arguments on ways for better use of public funding which includes education, elderly health care, etc. Also it is important to point out that the result of the feasibility study show that it takes 60 years for investment payback which proves the project is almost never economically viable. This can be an early warning sign for the project not reaching its goals.

The high amount of underground portion of the project is also a great weakness. Despite its huge development costs, in case of accidents can cause to sever deadly consequences. This can be another early warning to causing problems such as inadequate number of passengers in all the routes due to inconvenient and unpleasant travel time for passengers.

According to the interview done by the project manager of the feasibility study project, an SPA analysis was made by Atkins Consultant Company by distributing questionnaires to 10000 people among those who either travel or intend to travel within the planned train routes. 3100 out of 10000 gave positive answers. The main uncertainty is we never know what will be the real number of people intending to use this technology when it comes to practice. Learning from other similar project can be good help in estimating how credible the result of these questionnaires is. Same type of analysis has been done in France but it turns out that 8 out of 10 HSR trains in France have fewer passengers than estimated. We believe this can also be another early warning sign for lack of adequate number of travellers in all the routes.

The final assessments of the feasibility study show that in case the travel time is approximately 3.5 hours in all corridors, replacement of flights becomes a beneficial option for travellers. But according to another SPA done by Atkins Consultant Company, 70% to 80% of passengers will prefer this train to airplane only in case the travel time is 3 hours. If the travel time increases to 3.5 hours, half of the people will go back to taking planes as their first priority. This is also an early warning sign of lack of interest of public towards the high speed railway.

Despite the mentioned issues above, we believe that other problems such as changes in legislations during HSR development and stopping the project, changes in EU policies negatively affecting the project costs and scope and changes in world economy in a manner which can negatively affect the project, are issues which should be considered in the planning phase in order to detect the possible early warning sign of their occurrence. Although looking at trends may help, but the uncertainty level in these cases is so high that the information extracted from the historical trends will not be reliable for making any decisions.

Problems related to environmental issues

As the main purpose of the Norwegian HSR project is mentioned to be an environmental friendly solution for transportation despite the huge amount of development costs, the problems related to environmental issues are of great importance. In case of environmental friendliness, although the results of the feasibility study show that in 60 years the CO_2 emission caused by HSR will be less compared to other transportation means altogether (Flights, cars, classic rails and coaches), we believe this can only be acceptable in case HSR will be the one and only means of transportation which is far from the truth. Also Since in some routes more than 50% of the railway will be installed underground; there will be a huge amount of environmental hazards due to the construction of tunnels. These can be considered an early warning signs to problems such as negative public reaction to environmental effects from construction of HSR and more importantly the authorities' opinion in approving this project in the first place.

Having discussed the possible early warning signs of some of the problems which may rise during the project, we will explain in the next section, how the identification of these signals can be an aid to decision making for project responsibles.

4. How identification of early warning signs can be an aid to decision making

According to Nikander (2002), two stages of assessing the future are included in early warning utilization. First the severity, likelihood of materialization and time available of the potential problems should be analysed, based on the view point of the evaluator, and second the decision maker should examine the impact of the planned responses on the project, and the reactions, and responses of the various project parties and /or outsiders in the situation at hand. Nikander (2002) suggests a decision support model of early warnings, including 6 stages, which will be briefly described here. The first stage is detecting the early warning signs. In the second stage, the observer interprets the signs in order to decide whether it is an early warning sign or should be rejected due to its insignificancy. In the third stage, the observer tries to determine the significance of the information provided by early warning signs for the project.in the fourth stage the observer attempts to identify the problem (risk) that has emerged as well as its causes based on the information provided by the early warning sign and other aspects such as project's situation and environment. The fifth stage includes an assessment on the time available for taking the right actions. This is explored along with recognition of risks. The question in this stage is how much time is available for the responses requires by the problem and the level of urgency of the situation. This stage is also highly influenced by the project situation and environment. Finally at the last stage it is necessary to decide which responses are required towards the situation.

Regarding the utilization of the decision support model of early warnings, this question may arise how the steps introduced in this model are related to the general risk management process. It is also possible to wonder about the differences between early warning sign detection and conducting a risk analysis in the beginning of the project. According to Nikander (2002), although the decision support model has clear characteristics of risk management, the contents of risk management analyses are broader than those made possible by information provided by the early warning approach. In fact early warnings can give advance notice of arising risks, but they do not provide information about the probability of occurrence of these risks on the project. Based on this, authors believe that utilization of this model in the front end stage of projects can provide a clear view towards many possible problems which may arise in the future. Although the early warning signs of many risks are not possible to be detected in the front-end stage of the project, e.g. mainly technical issues, but the ones which can be detected provide a strong basis for decision making due to the adequate available time prior to the occurrence of the real problem and thus providing a high possibility for assessing the possible responses which can be taken in order to see if the project will or will not reach its purposes under the realized situation.

In case of the Norwegian HSR project, identification of early warning signs related to important aspects of the project such as market conditions, environmental effects and different stakeholders' opinion about the project can highly assist the main decision makers of this project in order to first investigate if the project shall start at the first place and to what level the project's objectives will be met in case of execution. Table 3 presents an example of the actions which may be taken in case of Norwegian HSR project, following the 6 step procedure which was defined above. We Believe that although the final results of the Norwegian HSR project feasibility study claim that this project is fully feasible, the early warning signs of several serious problems which were discussed in the previous section, have been overlooked and the probability of the project not reaching its goals , in case of execution, should be taken under consideration.

Table 3. Decision support model steps for an environmental issue in Norwegian HSR project

Decision support model Steps	Example from case of Norwegian HSR project
Detection of EW signs	50% of routes are underground
Interpretation of signs in order to approve or reject it as an EW signs	A serious EW signs due to high CO_2 emissions it will cause
Determination of the significance of information provided by the EW signs, for the project	Highly important due to its contradiction with the main purpose of the project : an environmental friendly means of transportation
Identification of the possible problems (risk) as well as its cause based on the information provided by EW signs	Hazardous environmental effects caused by construction of tunnels. Main cause is large amount of mountains and rocks in the defined routes.
Assessment of time available for taking the right action	Prior to the start of planning phase
Decision on responses required towards the situation	Possible alternative routes / alternative means of transportation

5. Conclusions and areas for further research

In this article we have clarified the link between early warning identification and decision making in the front-end stage of projects. The case of Norwegian High speed railway was used as an example of a real project in its front end stage. We endeavored to identify the possible problems and their early warning signs based on the knowledge extracted from the document analysis done on the published assessments of the feasibility study on this project alongside semi structured interviews with the project manager of the feasibility study. Our findings show that although early warning signs of a vast group of problems are not possible to be identified in the front-end stage, but the ones which are possible to be detected, can highly contribute to making major decisions such as level of feasibility of the project at the first place and the extent to which its objectives can be met.

We may conclude that in general, identification of early warning signs in the front-end stage can give more insights for the managers to choosing the right concept and making more effective decisions. Although the uncertainty is at its highest level, the possible early warning signs which may be detected can predict, in many ways, the project's future conditions. Note that both the low cost of changes and the rather large amount of available time for taking preventive/corrective actions can be a great aid for making the right decisions.

We plan to move forward our future research by testing how identification of early warning signs in the front end stage of projects can practically influence the overall performance of projects. This can be done on following up a real case and evaluating its performance in all its stages.

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The early warning procedure in an international context

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The Early Warning Procedure in an International Context

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Abstract

The globalized business and organizational environment is creating a growing need for project managers that can operate in a variety of cultural and socio-economic settings and are capable of handling the complexities that arise while working in an international context. It is of course a very important aspect to be considered by project managers to identify the early warning signs of problems timely enough to take preventive actions in order to avoid undesired consequences. This act can be more challenging when performed in an international context which in nature is more complex. In this study we endeavor to scrutinize the early warning identification process as part of the management system in international projects and the possible obstacles which exist within this procedure. A real ongoing international R&D project will be used as an example to help us better clarifies the concept.

Selection and peer-review under responsibility of the IPMA.

Keywords : International projects; project management; early warning signs; filters; preventive actions

1. Introduction

Delivering new products and solutions successfully to the market is vital for many organizations but it is also a very complex and difficult task (Balachandra & Friar, 1997). Although carrying out these type of projects, in an international context, has a remarkable impact on the development of technological potential and international competitiveness for organizations all over the world (Wortmann, 1989), these projects have a high probability of failure. This high probability derives from the fact that not only international projects are usually highly complex and are likely to face many challenges regarding various areas, but the nature of R&D projects is complex too. The combination of these creates many more challenges for the project managers which need to be dealt with and puts the project in a quite vulnerable situation. The areas which make international projects complex can be physical distance, language barriers, cultural differences, etc. While the planning phase of international projects does not considerably differ from planning of local projects, project controlling, project organization and project communication present extra challenges for the management of international projects.

Due to vulnerability and complexity of these types of projects it is ever more crucial for project managers to be able to adapt to the project context and enhance their ability to react to unforeseeable events. Treatment of international project as a standard project, lack of sensitivity to local cultures and ignoring the project context are examples of causes of failure of international projects.

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Von Zedtwitz et al. (2004) in their work on global R&D projects state that although there are no unique solutions for challenges of global innovation, the management has to however make a choice on how to perform the project in order to face fewer threats of failure.

This article presents an overview on the concept of early warning signs and argues on how identifying and acting upon these signs timely enough can aid project managers in better coping with the upraising challenges and preventing as many problems as possible. We will also scrutinize the possible barriers against identification and response towards early warning signs in international projects due to the specific characteristics of these types of projects. An ongoing international R&D project including 5 different countries and 15 partners from both academia and industry sectors will be used as an example to aid us in better clarifying the concepts. This project will be looked at from the point of view of the single partner which carries out the management and coordination responsibility within the project. The research objective of this study is to explain the importance of awareness of project managers of possible future problems and their actions in order to prevent undesired consequences.

2. Literature Review

2.1. Concept of Early Warning in Projects

The general idea of early warning is a broad concept. It applies to almost any area where it is important to obtain indications as early as possible of some development in the future, usually of a negative nature. The concept of early warning in a management context was first discussed by Ansoff in 1975 and was later supported by Nikander (2002). A weak signal was defined by Ansoff as "…imprecise early indications about impending impactful events…all that is known is that some threats and opportunities will undoubtedly arise, but their shape and nature and source are not yet known" (Ansoff, 1990).

In Nikander's words (2002), "an early warning is an observation, a signal, a message or some other item that is or can be seen as an expression, an indication, a proof, or a sign of the existence of some future or incipient positive or negative issue. It is a signal, omen, or indication of future developments". In his study he devises a preliminary model illustrating the character of the early warnings observations (See figure 1). This model sees project events as a time-bound consecutive stream of events. At a given moment, information about this stream can be obtained (e.g. early warnings of potential future project problems). This information is processed and responses are required in order to influence the flow of the project. A crucial factor in choosing a response appears to be, according to Ansoff, time available for responses before the potential problem significantly impacts the project.

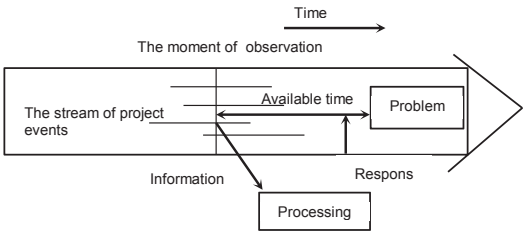

Figure 1. Preliminary Model Illustrating the Character of the Phenomenon of Early Warning (Nikander, 2002)

Not much has been mentioned in the literature about the exact time the early warning sign identification should start in the project life cycle. According to Lewis (1993), the prerequisites of project success are the things that must be in order before the project is initiated. We believe that in case early warning signals are identified in the early stage of a project, the available time will be rather long enough for project managers to take the right actions in the subsequent stages of project. For example in case some warning signals related to cost and time limitation are identified in the early stage, budget estimating in the initiation phase can be done more accurately. Identification of early warning signs related to technical issues, can aid the responsible persons to make better

decisions on risk management and production of key variables in the execution phase. Of course the challenge lies in the possibility of detecting the early warning signs and their level of reliability.

Nikander (2002) in his works points out to findings by Ansoff (1990) on possible filters which a message or piece of information should go through before arriving to the firm from the environment of that firm. We assume this piece of information is the one mentioned in figure 1. These filters can either restrict or ease the processing of information.

Three main filters are mentioned by Ansoff including the surveillance filter, the mentality filter and the political/power filter (see figure 2). The first stage requires the company/ project/ organization to choose what kind of information is needed and what type of techniques should be employed to procure it. The mentality filter is in character sociological and psychological. The receiver at this point evaluates the arrived information and makes the decision on what to accept and what to eliminate due to being unnecessary, unrealistic or irrelevant. The last filter is used especially by the decision maker and determines what type of information is permitted to influence the decision making process.

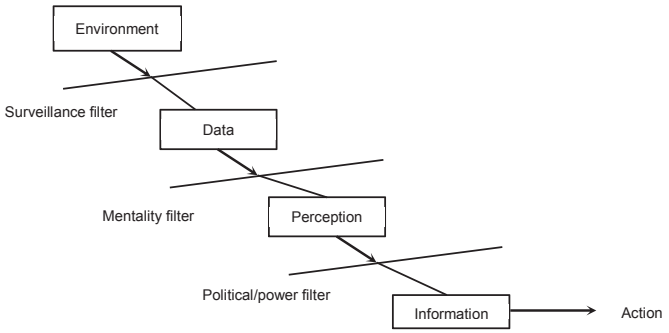

Figure 2.Management information (Ansoff (1990) in Nikander, 2002)

The approaches for identifying the early warning signs are also important to consider and may vary greatly in different projects and situations. The approaches for identifying the early warning signs are also important to consider and may vary greatly in different projects and situations. According to Nikander (2002), which is consistent with our own findings, very little literature exists that deals explicitly with techniques for obtaining information from the environment. But the project management literature does include some statements which directly or indirectly refer to this concept and its identification approaches (See table 1).

Table 1. Categorization of Sources of Early warning signs in projects.

Early warning sources directly discussed in the literature	Potential Early warning sources in-directly discussed in literature
Risk analysis (Niwa (1989) ; Nikander (2002))	Stakeholder analysis (Savage et at (1991); Cleland (1994))
Project success / failure models (Pinto &Slevin (1988); Lewis (1993), Miller & Lessard (2000))	Cause / effect analysis (Leszak et al. (2000); Parker & Skitmore, (2005); Sambasivan & Soon (2007) ; Ohatka & Fukazawa (2009); Klakegg et al. (2010))
Project assessment methods (Cooper et al. (1997); Cooper (2005); Wateridge (2002); Jaafari (2007); Miller& Lessard (2000); Klakegg et al. (2010))	Maturity assessment (Andersen and Jessen ,2003; Ahern et al. (2004); Cooke-Davies & Arzymanow (2003); Ibbs & Kwak (2000), Kerzner (2001))

2.2. International project management

According to Lientz and Rea (2003), international projects are different from local projects due to various factors such as cultural and social differences among participants from different countries, language and dialect variations, Legal, regulatory, and reporting requirements, time zone differences, etc. While there are many benefits to performing international projects, the growth of these types of projects has come at a cost. Surveys reveal that the probability of failure in international projects is higher than standard single country projects. One of the main drivers is the higher level of complexity of international projects (Lientz and Rea, 2003). Koster (2010) summarizes the major characteristics of international projects in a way that anyone can understand at by a glance (See Figure 3).

Due to complexity, diversity and high risk of failure, there are certain steps which should be taken for performing an international project. The following are suggested by Lientz and Rea (2002):

- Strategy selection
- Definition of project purpose and scope
- Development of vision and benefits resulting from the project
- Identification of roles and responsibilities
- Performance of an analysis on potential issues
- Determination of resource management
- Establishment of a way for addressing communications

The main focus of this research is the 5th step where potential issues which can impact the project are identified at the start. This act will lead to discussions on how issues will be identified, tracked and resolved. In other words, this step can be interpreted as the early warning procedure introduced by Nikander (2002) where the signals of possible future problems are first identified and the information obtained, after passing the filters presented in figure 2, leads to relevant actions for preventing the problem.

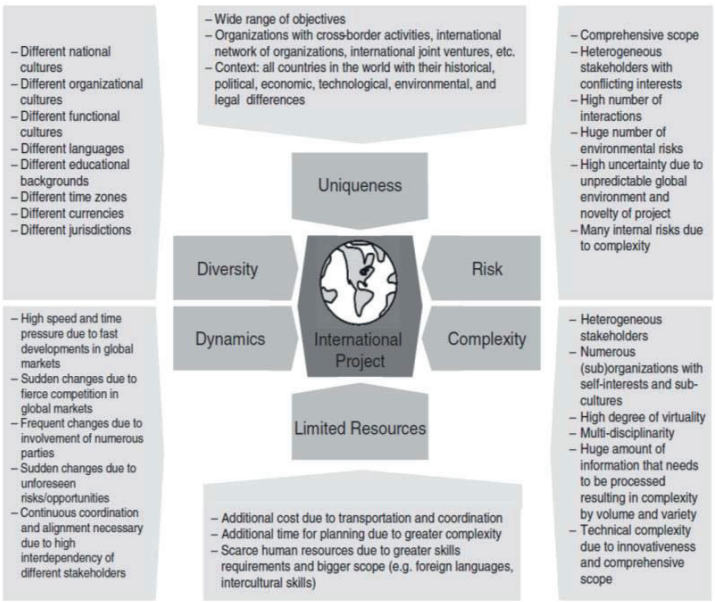

Figure 3. Characteristics of international projects (Koster, 2010)

2.3. Possible obstacles against effective response to early warning signs in international projects

According to Lientz and Rea (2003) there are certain "stumbling blocks" which may result in international project failure. These include: Treatment of the international project as a standard project, Failure to clarify and communicate goals, Failure to take self-interest into account, Lack of sensitivity to local cultures, Ignoring context, Customer dissatisfaction, Excessive management attention and time overrun. But problems of any type and scale are not developed over night. Ansoff (1975) states that even unexpected discontinuities are indicated by some warning signals. The challenge lies in detecting these signs timely enough to be able to prevent the undesired outcome.

But although there are many early warning identification approaches which exist and are applied in many cases (Haji-kazemi et al., 2013) there are still failures occurring. According to Williams et al. (2012), "we are not very good at picking early warning signs". In their study they point out problems related to three main areas: understanding of project risk and uncertainty, project complexity and detection of people's tacit knowledge and comprehending their way for responding and interacting. They also state that established assessments fail to pick up early warning signs. The reason is partly due to technical issues, but mainly found within the minds of individuals.

Hofstede (1984) states that the nature of management skills is such that they are culturally specific, meaning that a management technique or philosophy which is appropriate in one national culture is not necessarily appropriate in another. Taking into account the cultural side of management presupposes an understanding of the way people's minds can be programmed differently by their different life experiences. Patterns and models of behavior between subordinates and superiors, among colleagues, and towards clients in the work situation have been set outside the work situation.

According to Grisham (2010), project teams must adapt to the international context and local practices, language, time zones, resources, laws, politics, etc. when embarking on projects which are conducted within multiple countries and cultures. Figure 2 represents the main three existing filters which can influence the effectiveness of the early warning procedure. We believe these filters can act differently in different project environments. Hereby we would like to discuss the possible features of these filters in an international context where involves high level of complexity, dynamics and diversity (See figure 3).

Surveillance filter

At this stage, the project organization should choose what kind of information is needed and what kind of techniques should be employed to procure it. This is where the project organization should in fact decide on the specific success criteria to measure and monitor within the project. The specific approach for obtaining the data should be then chosen based on possible resources. This data can be actually a base for identifying early warning signs for potential problems in the future.

International projects involve heterogeneous stakeholders with conflicting interest and high number of interactions. Also they are mainly multi-disciplinary projects associated with huge amount of information that needs to be processed resulting in complexity by volume and variety. Another influencing factor is the different organizational cultures within the project which results to having different points of view toward the project. It is very likely that a success criterion which is important and critical for one organization is not necessarily crucial for others as well. These characteristics can form a challenging situation where the project organizations due to their different views towards the project's goals and their varied interests may not reach a concrete decision on what type of data to look for and the approaches for obtaining them.

Mentality filter

This filter is in character sociological and psychological. Receiver of information evaluates the arrived information and decides what to accept and what to discard due to it being unnecessary, unrealistic, useless or irrelevant. International projects include a wide range of objectives and a broad and comprehensive scope. They involve many internal risks due to high complexity and high level of uncertainty due to unpredictable global environment and novelty of the project. The information which the receiver obtains as a result of project assessments methods or via gut feelings (Klakegg et al., 2010) can have totally different level of importance for different receivers. It is also dependent on the perception of the project's goal by of each party. If different parties

have different understanding of the goal, the different categories of arrived information can be prioritized in dissimilar manners and thus it is probable that some of the information which actually contains warnings for potential problems can be overlooked or missed.

Political / power filter

This filter is used specially by the decision maker. It determines what information is allowed to influence the decision making. This is perhaps the most important and influencing element throughout the process which leads to actions taken based on received information from the project. Levagnon and Hodgson (2014) in their work point towards the fact that the international development projects have over time moved towards a potential contribution of a critical perspective which focuses on issues of power.

The information which passes the two first filters should be evaluated by the decision makers. This includes information which has been, in the first stage, recognized as necessary for the project and in the second stage, regarded as useful and relevant. This filter is strongly influenced by the fact that who is included in and who is excluded from the decision making process. Based on Hofstede's cultural dimensions, in countries where there is large power distance among members of the project organization, it will be less likely that all the necessary information pass through the two first filters. Eventually the third filter will be also influenced by this aspect.

The diversity of cultural backgrounds within the involving partners in an international projects and the complexity caused by the heterogeneous stakeholders with conflicting interests and high number of interactions can establish barriers against effective actions towards possible early warning signs of problems.

The strength of this filter is also affected by the level of power of the main decision makers in the project. Anderson and Galinsky (2005) believe that the sense of power increases optimism in perceiving risks and thus lead to more risky behavior. They also state that powerful people might be so focused on the payoffs and have no focus on the consequences of their actions, and more optimistic that they can get away with a range of actions, that their becomes more risky and more likely to violate social and ethical norms. This can be also a source for overlooking information about early warning signs of problems which in case of actualization, can result to undesired consequences for the project.

3. Research methodology

As mentioned earlier, in this study we would like to investigate on the relationship between implementing the early warning procedure and better management of international R&D projects. Also we would like to investigate on possible obstacles which exist throughout the early warning procedure. In order to achieve the research objective, we will build our discussions mainly based on Ansoff's management information model (Figure 2) and Koster's model for international projects (Figure 3) in order to outline the challenges involved with timely identification and reacting upon potential problems within international projects.

The ongoing international R&D project which we will use an example of a real life case consists of 15 partners from 5 different countries. Due to confidentiality of information, we will point to the countries as C1, C2 …C5 and the partners as P1, P2…P15 throughout the work. The empirical results are based on analysis of available project documents and semi-structured interviews with members of the project management team. The analysis focuses mainly on approaches used for identifying and responding to early warning signs of future problem throughout the project and scrutinizes the impact of implementing the early warning procedure on effective prevention of future problems. The data obtained from available project documents includes detailed definition of project concept and objectives, information on project participants and their roles and responsibilities and the management structure and procedures. The interview data consists of background interviews with members of the project management team, information on identified early warning signs of possible problems throughout the project and the preventive actions which were taken. It also includes the challenges the project management team faced due to specific characteristics of an international project.

It is crucial to mention that the empirical study has its limitations due to the fact that authors base their findings based on data obtained from one work package among the 10 existing work packages. Although this specific work package is the project management unit which should in principal have quite an extensive over view on the project as a whole, it is very important to get insights from other partners as well. Also since the project is still not over,

there are still potential problems which may come up or actualize in the future which are not considered in our study.

The research follows an inductive reasoning approach, concluding that the approach can contribute to better management of other similar projects as well. Of course the authors are fully aware of the fact that these types of results are not always logically valid and it is not always accurate to assume that a general principle is correct.

4. Example of a real life international project

The main project objective is to improve industry's ability to produce high quality products more efficiently and with fewer faults. The project was established as an initiative from P1, responsible for management of coordination of the project, and has 15 partners from 5 countries. The project budget is 10+ million Euros and the duration is estimated to be 3.5 years. The project is right now in its third year.

The project consists of 10 work packages. Work packages 1 to 6 are the research and technology development work packages which are planned as vertical activities to develop results to be applied and demonstrated in different applications. The estimated workload of the project equivalents to 76 people working full time within the total project duration.

As mentioned earlier, the main focus of this study will be on work package 10, including project management related activities. This work package only covers legal, administrative and financial management of the project. Scientific coordination, scientific quality assessment/management, research risk management and other research and technology development related activities are covered by the corresponding scientific work packages.

The management structure which is based on experiences from coordination of several international projects consists of various interdependent elements including management of project according to approved plans, monitoring and performance of project control, implementation of procedures for quality management and administrative review process of deliverables, implementation of risk management procedures and implementation of tools to establish a basis for efficient and easy communication within the project.

The project management work package is also devoted to risk management in order to prevent and mitigate the possible risky events. Risks issues in this case range from technical to organizational or communicational problems.

The project management team considers risk management as a dynamic activity and the loop “risk identification-risk evaluation-definition of contingency plan” is to be carried out for the whole duration of the project. Risk are evaluated and analyzed according to their likelihood and seriousness. A risk matrix is developed categorizing the likelihood of risks as low, medium and high and the seriousness of them as, low, medium, high and extreme. From this, a priority list for actions is developed.

Such analysis aids to identify the most significant risks and therefor those need careful management. The resulting grades of risk help the project team to focus on dealing with the most important risks, once evaluated and prioritized, and to mitigate them. A list of identified risks have been developed for the case project by the project management team and categorized based on the probability of occurrence and the level seriousness of them. Also the relevant actions to be taken in order to prevent or manage the risks have been listed. Both technical and managerial risks are considered.

It should be noted that what we are considering through this study is not the risks themselves but the signals which indicate that the risky event is about to occur. In addition, the actions towards those signals are going to be discussed. Early warning responses can in many conditions be different from risk responses.

5. Empirical study results

As mentioned earlier the empirical data, gathered through interviews and document analysis, consists of background interviews with members of the project management team, information on identified early warning signs of possible problems throughout the project and the preventive actions which were taken. It also includes the challenges the project management team faced for identifying and acting toward early warning signs, due to specific characteristics of an international project.

According to the interviews, the project management team was able to identify some of the early warning signs of potential problems which were likely to occur while the project was running.

"One of the very first warnings rose in very early stage of the project when we began estimating and allocating the project budget" stated the quality manager of the project. The problem initiated due to the fact that the project owner and the partner responsible for management of the project (P1) had different perceptions on who is the actual project manager in the project. This caused a chaotic situation were roles and responsibilities were rather mixed. Since the project manager allocated by the project organization did not have sufficient experience with large scale international projects, the splitting of budget was not done properly. In case the budget didn't become broken upon each and every work package, the project would have ended up with a lump-sum budget. Knowing that the project was estimated to require a resource of 900 person month (equivalent to 76 persons working full time), a lump-sum budget would have resulted to serious cost-related problems for the project which in the worst case would have resulted to cutting the budget by the project owner.

Another early warning sign was identified was the lack of communication and common understanding among two specific partners which carried out interdependent tasks within the project which would have caused to delays in delivering specific tasks allocated to them. The project being a fast-track project with strict milestones and deadlines, did not tolerate any delays. The warning in this case was actually transferred to the project management team by a third partner who had previous experience working with one of the conflicting partners. The problem was getting far more serious up to the point where the conflicting partners were to be suspended by the project owner. The project management team then set up several face to face meetings with the conflicting partners and tried to explain the importance of allocating the right tasks to the right persons and enhancing dialogue and communication among interdependent partners.

Sometime after the project start up, one of the key responsible members within the project was changed. The new member did not have enough understanding of the project and his competent did not fully cover the project area. This change caused to frustration for some of the partners. This was identified as an early warning for partners leaving the project in case their requirements continued to be abandoned. The project management team believed that changing the member would be the best solution.

Another main challenge which the project management team faced from the very beginning of the project was the fact that different partners had different perceptions of the project goal. This was mainly due to the different nature of academia and industry and their interests and goals. This was sensed by the project management team and considered as a warning sign for not achieving the final goal. They then took action by performing strong follow up on deliverables of the project by each partner and reminding the main goal of the project to the participants. The different cultural backgrounds are a common challenge in international project and this project was definitely not an exception. The project management team, having sufficient experience with these types of projects, performed proactive management by arranging social events in order to enhance the relationship and communication among partners. Including a non-local member to the project management team with similar cultural background as several partners of the project was also an effective act in order to prevent future problems.

The potential problems, their warning signals and the ideal response to them are listed in table 2. As it is presented in this table, early warning signs of specific problems have been identified and their ideal responses are recognized. But it is interesting to analyze the data presented in order to determine if: 1) these problems have been the only existing problems within the past three years within the project, 2) the warning signs which have been identified have been responded to.

As already mentioned before, authors have only gathered the data from one of the partners involved in the project. We believe that having had contact with the other parties involved in the project, would have shed light on other possible problems within the project. This can be a possible explanation for existence of a surveillance filter which does not allow all the data reach the decision makers which in this case is the project management team. Another assumption is that the data on possible problems within the project is actually received by the project management team but perceived as irrelevant or useless (existence of a mentality filter).

Also, according to the interviews, although problem 3 has been rather clear for all the project management team members and the response seemed logical and consistent, this action was never taken. This was due to the fact that

the responsible persons in power did not tend to recognize this issue as a problem and act upon it. In fact, this information could not pass the political/power filter to be actualized.

Table 2. Problems, early warning signs and responses in the project

Potential problem	Early warning sign	Ideal Response
Lump-sum budgeting causing cost related problems	Lack of experience of allocated project manager by P1 with international projects	Breaking budget by quality manager and project coordinator
Delays in reaching key milestones	Lack of effective communication among partners Delay in delivering tasks	Face to face meetings with conflicting partners and clarifying the importance of the milestones
Dissatisfaction of partners which would result to them stepping out of the project	Lack of competence of critical staff Lack of effective communication among project manager and technical staff	Changes in the staff
Not achieving the project final goal	Lack of common understanding of the project main goal	Strict follow up by project management team, clarifying the main project goal to all the partners
Lack of common understanding of the project goal and the deliverables	Difference in cultural background	Arrangement of Social events to include and make strong relations between partners. Including a non-local member in the project management team

It is also worth mentioning that the most severe problems had not been stated in the identified risks' list in the project DOW (Description of Work). The likelihood of occurrence of problem 4, in table 2, has been declared as "low" in the project description. We can see that in reality, things have been slightly different. This somehow indicates that no matter how detailed the risk plan is, it is always likely to face unpredicted conditions through the stream of project events. Keeping an open eye on possible early warning signs which rise within the project and proactively responding to them can be an effective means for preventing failures. This becomes even more crucial in international projects with much higher level of complexity. Of course the existing filters are elements which make this process more challenging specifically for international projects involved with large amounts of complexity and uncertainties.

6. Conclusions and future research

The complexity, dynamism and risks involved with international R&D projects and the turbulent environment which they are performed in, creates a situation where failing in any way becomes extremely costly for project owners. Traditional project management methods may be unable to fully capture the unforeseeable events and provide insights in to appropriate responses and thus their application can lead to unwanted consequences.

Aside from the use of conventional project management methods, observing and interpreting early warning signals of future possible problems by project manager, according to their experience and observation conditions and the time available, can to a great extent facilitate proactive management and as a result preventing adverse outcomes.

The example presented in this study reveals that although conventional project management methods are an inevitable part of the project management plan, it is likely that unpredicted problems rise during the project. Paying attention to the early warning signals and responding to them at the right time is a support for decision makers to overcome these types of challenges. It also sheds light on existing barriers in the process through which information about potential problems is received by a project member until a proper response to it is actualized.

Fertile areas for future research include investigation on filters which can restrict the processing and responding to signals and messages obtained on possible future problems within the project.

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VII

Barriers against effective responses to early warning signs in projects

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Abstract

It is a major challenge for project organizations to react sufficiently quickly to identified early warning signs of project problems in order to avoid the occurrence of those problems. This article investigates project and project organization specifications that influence the effectiveness of responses to early warning signs in projects. Based on a survey of Norwegian project managers or leaders' approaches to responding to such signs, this study reveals that there are specific barriers to their ability to respond to identified early warning signs. Barriers may develop due to organizational factors, such as project managers' optimism bias, the normalization of deviance within an organization, and the lack of an outside view. They can also develop due to projects' complexity. The authors elaborate on Ansoff's management model by clarifying the mentality filter in order to better define the procedure whereby obstructions are created.

Keywords: Early warning signs, organizational factors, response, filter, barriers

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1. Introduction

The concept of 'early warning' is not new. The idea was first discussed by Ansoff (1975), who argued that even unexpected discontinuities are indicated by some warning signs. However, the concept of early warning is generally underrepresented in project management literature. Nevertheless, according to Nikander (2002), the project management literature includes some statements that may be interpreted as including examples of early warnings.

Some of the approaches that have been mentioned in the literature as early warning sources include risk analyses, stakeholder analyses, performance measurements, and project health checks. The sources imply that the approaches can aid project managers or organizations in taking timely actions in response to indicators of poor performance and thus increase the likelihood of project success (Kerzner, 1994; Kappelman, 2007; Vanhoucke, 2012).

Although the above-mentioned methods are applied in many cases, project failures still occur. According to Williams et al. (2012), 'we are not very good at picking early warning signs.' They highlight problems related to three main areas: understanding project risk and uncertainty, understanding project complexity, and the detection of people's tacit knowledge and comprehending their ways of responding and interacting. Williams et al. also state that established assessments fail to recognize early warning signs, partly due to technical issues, but mainly due to the minds of the individuals concerned. Despite the challenges, studies have shown that although assessments are not

completely successful in identifying all early warning signs, the exercises themselves raise awareness and provide opportunities for critical questions to be raised and discussed. If the exercises are performed early enough, when real options are still available, the assessments may prove to be a powerful tool. Further, Williams et al. (2012) state that although formal methods are useful for identifying early warning signs in the aspects they are designed to consider, informal 'gut feeling' approaches are a possible means for identifying signs without having a specific focus or issue in mind.

When applying early warning identification approaches, both formal assessments and informal 'gut feeling' approaches lead to essential information that, according to Nikander's (2002) model, needs to be processed in order to evaluate the level of seriousness of the identified signs. After processing the information, it is necessary to respond to prevent real problems from occurring.

Although there is evidence that it is possible to detect early warning signs in projects and despite the existence of the necessary information, in many cases the appropriate response is missing from project managers. This may be due to many reasons, such as time pressure, a tendency for optimism, and the effects of politics (Williams et al., 2012), over-optimism, lack of tolerance of warnings, and lack of an outside view (Lovallo and Kahneman, 2003), or the 'normalization of deviance' (Pinto, 2013).

Through our research we sought to understand better the issues associated with barriers to project managers responding effectively to early warning signs as a means to prevent failure. We investigated both process-related aspects and psychological aspects that need to be enhanced to strengthen the project managers' responses. We started with a literature review of aspects of early warning, including the phenomenon of early warnings in projects, the early warning procedure, and organizational aspects that can be interpreted as possible obstacles to effective responses to early warning signs of problems. This led to our understanding of the project managers' approaches undertaken on the basis of the information they obtained on the status of their respective projects throughout the project's life cycle, and we examined the conditions under which early warning signs were neglected, with undesirable consequences. Thereafter, we conducted a survey among experienced project managers and leaders from various industries in Norway in order to examine in detail the main factors affecting the process of project managers reacting to identified early warning signs in projects. Our study focused on addressing the following research questions:

Q1. What are the main barriers to project managers responding to identified early warning signs?

Q2. What are the organizational and project-specific issues that influence the effectiveness of the responses to identified early warning signs?

Q3. What approaches enable project managers to enhance the process of responding to identified early warning signs?

From our literature review and the findings from the empirical study, we discuss in this article both a set of conditions under which early warning signs are less likely to be acted upon and the possible

approaches that may enhance the process of taking actions under those specific conditions. Thereafter, we present out conclusions and brief suggestions for future research.

2. Literature review

2.1 The early warning phenomenon

The generic idea of early warning is a wide concept. It applies to almost any activity, sector, or area where it has value for obtaining indications as early as possible of some development that in the future will become clearer, typically indications of a negative nature.

The debate on early warning in a management context was initiated by Ansoff (1975). His core idea was that even unexpected discontinuities are heralded by some warning signs. The suggestion is supported by Nikander (2002), who deals extensively with literature on the concept of early warning signs in his doctoral dissertation: 'an early warning is an observation, a sign, a message or some other item that is or can be seen as an expression, an indication, a proof, or a sign of the existence of some future or incipient positive or negative issue. It is a sign, omen, or indication of future developments'.

Nikander (2002) points to findings by Ansoff and McDonnell (1990) on possible filters that a message or piece of information from a firm's environment should pass through before arriving at that firm. Such filters can either restrict or ease the processing of information. Nikander (2002) cites Ansoff's three main filters: the *surveillance* filter, the *mentality* filter, and the *political/power* filter (Figure 1). The first stage in processing information, exemplified by the surveillance filter, requires a company, project, or organization to choose what kind of information is needed and what type of techniques should be employed to procure it. The mentality filter is sociological and psychological in character, and at this point a receiver evaluates the received information and decides what to accept and what to eliminate as unnecessary, unrealistic, or irrelevant. The third and final filter in the process, the political/power filter, is used especially by decision makers and determines what type of information is permitted to influence the decision-making process.

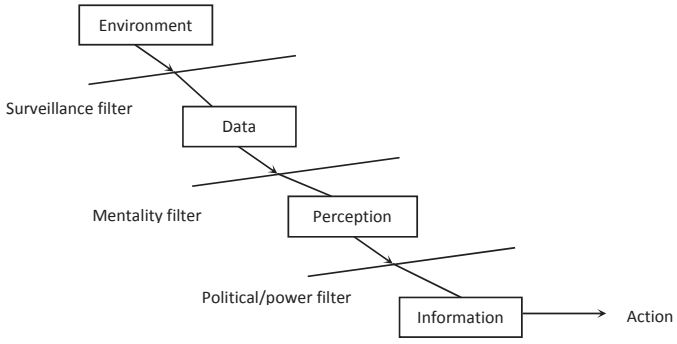


Figure 1. Management information (Ansoff, 1984, cited in Nikander, 2002)

According to Nikander (2002), with whom our previous findings are consistent, very little literature to date deals explicitly with early warning in projects and project management. However, project management literature includes some statements that directly or indirectly refer to the concept of early warning and approaches to its identification. Table 1 presents a brief description of other literature sources which can be interpreted as early warning sources.

Table 1. Early warning identification sources reported in published sources

	Source	Description
Early warning sources directly discussed in the literature	Risk analysis (Nikander, 2002; Niwa, 1989)	Since early warning refers to a problem that may arise in the future, the relation between the early warning phenomenon and risk management is rather obvious.(Nikander, 2002) Early warning signs provide an indication of evident risks and thereby an assessment of a project's exposure to future problems and failure. (Kappelman, 2007) The concept of risk alarms are meant to be advance warnings of emerging problems.(Niwa, 1989)
	Project assessment methods (Cooper, 2005; Cooper et al., 1997; Jaafari, 2007; Klakegg et al., 2010; Miller and Lessard, 2000; Wateridge, 2002)	Project assessments, which go by many names, some of which are project reviews, project health checks, benchmarking, post project evaluation and project audits (Klakegg et al., 2010), have been discussed as a way to identify areas that should be addressed by early warning monitoring. There is abundance of literature on the stage gate approach and how it aims to preempt potential problems that make a project non-viable (Cooper et al., 1997; Cooper, 2005)
	Earned value management (Kim et al., 2003; Vanhoucke, 2012)	An approach that provides triggers or early warning signals (Fleming & Koppelman, 2000). Earned value management is perceived as being a good forecasting or an early warning tool that enables project managers to plan and control projects proactively (Kim et al., 2003)
Potential early warning sources indirectly discussed in the literature	Stakeholder analysis (Cleland, 1986; Savage et al., 1991)	There are a number of models proposed that outline the process of undertaking a stakeholder analysis, (for example, Savage et al., 1991; Cleland, 1986; Karlsen, 2002) but they have clear similarities, which include activities to identify the project's existing and presumed future stakeholders; gain a better understanding of their needs and expectations toward the project and its outcomes; and anticipate their strategies and actions. The outcome of a stakeholder analysis will be some level of insight into what stakeholders the project has to relate to and what they expect from the project and how

		they might react if they don't achieve this. The issues emerging from such an analysis can clearly be utilized to identify early warning signs.
	Cause/effect analysis (Klakegg et al., 2010; Leszak et al., 2000; Ohatka and Fukazaw, 2009; Parker and Skitmore, 2005; Sambasivan and Soon, 2007)	Since this topic focuses on causes and origins of issues, it is closely related to the success and failure factors in projects. Nikander (2002) provides a model indicating that problems, their causes and early warnings are connected through a chain. There are other sources which, although not mentioning the term "early warning" directly, refer to cause and effect analysis and root cause analysis approaches for the identification of risks in advance in order to prevent future problems (Leszak et al., 2000; Parker & Skitmore, 2005; Sambasivan & Soon, 2007; Ohatka & Fukazawa, 2009; Williams et al., 2012).
	Maturity assessment (Ahern et al., 2004; Andersen and Jessen, 2003; Cooke-Davies and Arzymanow, 2003; Kerzner, 2001)	The key idea is that it might be possible to assess how mature (i.e., how qualified) an organization is to run projects, and thus very early, even before the project starts, determine whether it seems likely that the project will run smoothly or end up in trouble. Andersen and Jessen (2003) refer to this term as having reached a state of full natural or maximum development. This definition fits product and organizations alike, although it might be argued that organizations never reach a state of full maturity. Maturity models have also been extensively used as an improvement tool, where organizations conduct self-assessments (Ahern et al., 2004). If such maturity assessments reveal areas of lower maturity, it is natural to consider these targets for early warning monitoring.
	Interface management (Calgar and Connolly, 2007; Voss, 2012)	This process is described by Cleland and Morris (1988) as an element that serves as a natural checkpoint for managers in order to monitor performance and thus prevent problems from falling into a snowball process. The main objective of this process is to facilitate agreements with other stakeholders regarding roles and responsibilities, timing for providing interface information, and identification of critical interfaces early in the project through a structured process. The overall goal for the process is early identification of issues that have the potential to impact cost or schedule. This is done in order to minimize or to remove this impact, and also to promote clear, accurate, timely, and consistent communication with other organizations for exchanging interface information
	Extrapolation from earlier projects (Kappelman et al.,	This approach is a way of using previous experience gained, but the validity for the current situation must of course always be ensured first. The project management

	2007; Kerzner, 1987; Klakegg et al., 2010; Miller and Lessard, 2000; Pinto and Slevin, 1988)	literature has numerous references to how experience from earlier projects is used in order to identify early warning signs. See, for example, Pinto and Slevin (1988), Kerzner (1987), Pinto and Prescott (1988) and the IMEC study (Miller & Lessard, 2000). A somewhat different approach has been used by Kappelman et al. (2007) and Klakegg et al. (2010), in which experience from earlier projects is used as a basis for discussions with project management experts, in order to get their qualified assessments of the relative importance of the early warning signs.
	Gut feelings (Nikander and Eloranta, 2001; Klakegg et al., 2010; Whitty, 2010) Project health checks (Construction Industry Institute, 2006; Jaafari, 2007; Wateridge, 2002)	These signs are described by Nikander and Eloranta (2001) through the statement: "anticipatory feelings are the least easy to detect, identify and interpret, intuitive feeling" (p. 387). Klakegg et al. (2010) make a very simple categorization of early warning signs, where they are either identified through assessments or they are based on "gut feeling". Such a "gut feeling" will usually be closely related to the tacit knowledge of the recipient of the signals. Whitty (2010) showed the importance of emotions as an expression of knowledge, and also the use of body language as such an expression, and exemplified the importance of reading body language in a project setting in order to read some of the—sometimes even critical—-signs about the state/condition of a project.
	Brainstorming (Osborn, 1953; Stroebe, 1992)	The brainstorming technique has its roots in work in advertising as early as 1939 (Osborn, 1953). Stroebe et al. (1992) identified three processes that detailed brainstorming efforts; free riding, evaluation apprehension, and blocking. Issues arising from the brainstorming effort can then feed a process to identify early warning signs.

Although there are different ways for structuring the early warning system in different types of projects (Klakegg et al., 2010), the function of the governance framework that looks for early warning signs in projects is common among all types of projects within different industries. This can be explained by the following considerations stated by Nikander (2002): 1) the early warning phenomenon has a risk related character, 2) the studies of communication is familiar with early warnings and 3) the project management literature contains references to the phenomenon. However the choice of the specific approach and what to measure is very much dependent on the project itself, the project's organization, and the project's context.

The main focus of this article is the three filters and the type of information that passes through them or is blocked by them. We aim to identify how and why these virtual filters exist and how they influence project managers' final action or response given to the acquired information.

2.2 Obstacles to identifying and acting upon early warning signs

In our earlier research we have examined the available literature to identify possible sources of early warning signs within projects (Haji-kazemi et al., 2013). Some sources are directly mentioned in the literature and some are indirectly mentioned as possible approaches to identifying early warning signs of future problems. We use the same approach in this article to find possible barriers to project managers' responses to early warning signs within projects. We have found very few references besides Williams et al.'s (2012) work , which briefly refers to possible reasons for lack of responses to early warning signs within projects, directly mentioning the obstacles to responses to such signs. Although Ansoff's management model discusses the possible filters, it does not explain why these filters are created. We therefore conducted a study of different fields relevant to project management in order to find possible reasons that may contribute to the formation of the filters.

The approach we took was to investigate concepts closely related to the early warning concept. A thorough literature study of all the areas which deal with the early warning phenomenon was carried out in order to identify the fields which are most relevant to the project management area. We found that the closest concepts are 'forecasting' and 'prediction', due to the fact that early warning signs of problems are identified on the basis of predictions and assumptions of future. Within the sources pointing to these concepts, we chose the ones which discussed possible drivers for making irrational or false decisions.

According to Lovallo and Kahneman (2003), high numbers of business failures are not mainly due to rational choices that later become inappropriate, but rather as a result of faulty decision making, which occurs when decisions are based on *delusional optimism* rather than on rational weighting of gains, losses, and probabilities. In the former case, the benefits are overestimated, the costs underestimated, and potential problems and miscalculations are overlooked.

Wu (2012) claims that business failure prediction methods are generally important and purposeful due to the possibility for corporate managers to apply failure prediction methods to develop early warning systems for possible business failure and thus take proper actions to prevent such failures. Moreover, also sponsors and financial institutions can utilize the methods to enable better decision-making processes.

In order to improve the accuracy of forecasts, Lovallo and Kahneman (2003) suggest the application of two distinct modes of forecasting: the inside view and the outside view. The forecasts prepared by an internal project team focus closely on the case objective and the obstacles to its completion, and are characteristically extremely optimistic. By contrast, the outside view completely neglects the project's details and rather examines the experiences of a class of similar projects, draws up a rough distribution of outcomes for this reference class, and then positions the current project within that distribution, and the result is much more accurate than that obtained using the inside view (Flyvberg, 2013; Lovallo and Kahneman, 2003). It should be noted that optimism should be promoted

to keep employees motivated. The innate optimism of professional project managers allows them to deal effectively with the contradictory characteristics of their work environment (Dolfi and Andrews, 2007), but at the same time the decision makers should generate realistic forecasts (Lovallo and Kahneman, 2003).

Another view is that the optimism bias is one of several results of negative dynamics caused by the *normalization of deviance* within project organizations (Pinto, 2013). The concept of the normalization of deviance was initially published by sociologist Diana Vaughan (1996), based on a study of the NASA culture prior to the Space Shuttle Challenger disaster, and suggests that *the unexpected becomes expected, which in turn becomes accepted.* Social normalization of deviance means that people within an organization become used to a given deviant behaviour to the extent that they no longer consider it deviant, although such behaviours far exceed their own elementary safety rules. The concept also represents a cultural attitude that deliberately creates conditions under which mistakes are made, and as a result it provides a perfect environment for corporate or project misbehaviour. Problems appear when actions and attitudes such as organizational conflict become culturally embedded and destructive but remain viewed as a normal part of organizational processes without questioning the assumptions driving them. Pinto (2013) categorizes three main types of such behaviours: (1) project proposals and strategic misrepresentation, (2) client/contractor relationships and planning, and (3) scheduling dynamics. In order to resolve these issues Pinto (2013) suggests both remediation through project governance and reflection through organizational learning. The challenges related to these actions should not be overlooked. For example, organizational learning often faces challenges due to the unique nature of project-based work, which develops barriers and limits that prevent or slow down the transfer and use of knowledge obtained from earlier projects (Bartsch et al., 2013). A study by Bartsch et al. (2002) shows that project managers' *intra-organizational social capital* enhances organizational-level learning and can contribute to lowering the likelihood of undesired outcomes.

Anderson and Galinsky (2006) have a rather distinctive opinion on the source of optimism, stating that a sense of power increases the level of optimism in perceiving risks and thus leads to more risky behaviour. They also state that powerful people might be highly focused on the payoffs, lose sight of the possible consequences of their actions, and become increasingly optimistic that they can get away with a range of actions to the extent that their behaviour becomes more risky and they are more likely to violate social and ethical norms.

Another aspect which we believe is likely to act as a barrier against effective actions towards early warning signs of potential problems is the complexity involved with projects. There is an abundance of literature on the concept of project complexity (Baccarini, 1996; Williams, 2002; Jaafari, 2003; Cooke-Davis et al., 2007; Bosch-Rekveldt et al., 2011; Giezen, 2012 and Davis and Mckenzie, 2014) According to Klakkeg et al. (2010), it seems reasonable and quite well documented that increasing level of complexity makes it more burdensome to discover and interpret signals. In these

projects early warning signs are sometimes unknown unknowns and due to this fact may not appear relevant until too late. Klakegg et al. (2010) in their study recommend several approaches which can aid project managers to overcome this barrier.

Table 2 summarizes the possible barriers to project managers' responses to early warning signs and suggested solutions as reported in various publications.

Table 2. Possible barriers to project managers' responses to early warning signs and suggested solutions

Reference	Barrier	Description	Solution
Lovallo and Kahneman (2003)	Over-optimism	Benefits are overestimated, costs underestimated, and the potential for problems and miscalculations are overlooked	Adopting a dual view (inside and outside view)
Pinto (2013)	Normalization of deviance	The unexpected becomes expected, which becomes accepted.	Remediation through project governance and reflection through organizational learning
Bartsch et al. (2013)	Fragmentation	Projects hinder organizational learning	Intra-organizational social capital
Hofstede (1984)	Culture of uncertainty avoidance	The extent to which the members of a culture feel threatened by ambiguous or unknown situations.	–
Aaltonen and Sivonen (2009)	'Avoidance' and 'dismissal' stakeholder response strategies	Choosing a strategy whereby a focal organization loosens its attachments to stakeholder-related claims and tries to guard and shield itself from the claims Choosing a strategy by which a focal organization ignores demands and pressures posed by stakeholders	Choosing the most effective strategy through the interaction of multiple project network actors
Flyvbjerg (2013)	Systematic fallacy (illusion) in decision making	Causes people to underestimate the costs, completion times, and risks of planned actions, whereas they overestimate the benefits of the same action Stems from actors taking an 'inside view', focusing on the constituents of the specific planned action rather than on the	Taking an 'outside view' on planned actions, which consists of using experience from similar ventures already completed, including (a) the average outcome in sets of such ventures, and (b) distributional

		outcomes of similar actions already completed	information about outcomes
Flyvbjerg et al. (2009)	Optimism bias and strategic misrepresentation	Planners and project promoters make decisions based on delusional optimism rather than on a rational weighting of gains, losses, and probabilities Political-economic explanations and strategic misrepresentation account for the systematic underestimation of costs and overestimation of benefits found in data	Taking an outside view
Klakegg et al. (2010)	Time pressure	Difficulties for acting due to lack of time to think ahead and question assumptions	Secure transparency in decision making Install project assurance
	Mismatch in incentives between the organization and individuals	Individuals take their experience to the next project and fail to recognize the need to secure the ability of an organization to learn	
	Tendency to optimism	Trust in a project team's ability to fix the problems and that all will be fine in the end.	
	Effects of politics	Political pressure (exerted by the project owners) to implement a given solution	Improving project manager key competences and skills Improving formal assessment approaches
	Project complexity	A situation involved with flux and unpredictability and large amount of unknown unknowns	Using approaches which encourage more interactions so that patterns can emerge

3. Methodology

The methodology used in our study followed an inductive reasoning approach based on a survey. In common with other types of field study, this type of research can contribute to the advancement of scientific knowledge in different ways (Forza, 2009). According to Pinsonneault and Kraemer (1993), survey research is a quantitative method that requires standardized information about the topics being

studied and the subjects studied might be individuals, groups, organizations, they might also be projects, applications, or systems. Correspondingly, researchers often differentiate between exploratory, explanatory, and descriptive survey research (Filippini, 1997; Malhotra and Grover, 1998 cited in Forza, 2009; Pinsonneault and Kraemer, 1993). The survey research design adopted in this study was a combination of exploratory and explanatory research. An exploratory research design is performed in the early stages of investigation and research on a phenomenon and used when the researcher's aim is to obtain preliminary insight into a subject. While an *explanatory* survey research design is performed when knowledge of a phenomenon has been articulated in a theoretical form using well-defined concepts, models and propositions (Forza, 2009).

As mentioned in section 2.1, in general there is deficiency of literature on the phenomenon of early warning in projects and the early warning procedure as a whole. The main research within this area has been done by Nikander (2002) and Klakegg et al. (2010). Further, with the exception of Klakegg et al. (2010), we have found very few sources that directly indicate the main reasons for project managers to overlook the early warning signs of problems within projects. So there is a need for exploratory research in order to investigate on possible barriers against an effective early warning procedure. However, during the research for our study, both literature studies and our semi-structured interviews, we identified certain elements which can be interpreted as possible barriers against identification and thus the lack of response to early warning signs of problems, based on which, a survey was conducted within industrial and academic organizations in Norway during the spring of 2014. Nevertheless, although the survey tends to test the research findings, since the theory is not concrete and well defined, it is hard to state that the survey is completely explanatory, but is rather a combination of exploratory and explanatory research.

The data was collected via a questionnaire designed especially for the study and based on an analysis of literature studies and our semi-structured interviews. The respondents included members of the "Project Norway" association, which is a national arena for the exchange of experiences, building networks and providing an external reference to the member organization's own project expertise. It is a research-based collaboration with Norwegian project-based organizations in the public and private sector. It should be noted that although the results are directly applicable to the Norwegian project context, we see no reason why the results shouldn't be applied to other projects in other countries as well.

The questionnaires were sent to the respondents via email, directing them to a web site to provide their answers. The target population of the survey included a wide representation of project-based organizations without any expressed interest in our study topic. The questionnaire was sent to approximately 350 potential project manager respondents for whom we had valid email addresses. We received completed questionnaires from 86 respondents. This gives a return rate of approximately 24%.

Our survey was designed in three main parts. The required data and the types of questions in each section are presented in table 3.

Table 3. The contents of the questionnaire

Section	Required data	Type of question
1	Q1. Industry which they worked in	Multiple Choice
	Q2. Year of experience	Open ended
	Q3. Working title	Open ended
2	Q4. Role in the project	Multiple Choice
	Q5. Complexity level of the project	DVAS (1-5)
	Q6. Optimism level within the project organization	DVAS (1-5)
	Q7. Possibility for all project participants to express their opinion	DVAS (1-5)
	Q8. Methods systematically used in the project	Multiple choice
	Q9. Frequency of use of systematic methods	Multiple choice
	Q10. Level of activeness in analysis of methods	DVAS (1-5)
	Q11. Most important problems experiences within the project	Open ended
	Q12. Identified EW signs of those problems	Open ended
	Q13. EW identification stage	The Rating Scale
	Q14. Difficulty level for discussing EW signs	DVAS (1-5)
	Q15. Level of effectiveness of discussions on identified EW signs	DVAS (1-5)
	Q16. Importance of different sources for identifying EW signs	Rank Order Scaling
	Q17. Action taken against identified EW signs	Open ended
	Q18. Strength of responses to identified EW signs	DVAS (1-5)
	Q19. Reasons for not identifying EW signs	Multiple choice
	Q20. Importance of reasons for not responding to EW signs	Rank Order Scaling
3	Q21. Recommendations for improving the EW identification process	Open ended
	Q22. Recommendations for improving the EW response procedure	Open ended

The authors were aware that the use of discrete visual analogue scales (DVAS) questions within the survey can influence the results in a subjective manner. They were also aware that this scale is uni-dimensional and only gives 5 options of choice, so the space between each choice cannot possibly be equidistant. However, the tool was chosen to be used first of all due to the fact that the scale is suitable for measurement of attitudes, beliefs and opinions and second of all it is the most universal method for survey collection, therefore easily understood, easily quantifiable and subjective to computation of some mathematical analysis.

Our analysis covered frequency analysis of responses and the correlation among the characteristics of the projects and project organization with the approaches taken by project managers in order to respond to the identified early warning signs. This focus was chosen because our earlier research had revealed that the main challenge in responding to warning signs does not tend to lie in the early identification process but rather in response and reaction to the signs. In many projects, identified early warning signs are overlooked and consequently problems occur at a later stage. We found a number of explanations for the main obstacles to responses to early warning signs and the conditions that negatively influence the response process.

Following the analysis we evaluated the correlation among the obstacles to responses to early warning signs and other characteristics of the projects and project managers covered in the questionnaire survey. This was done through several internal workshops with participation of the authors in order to thoroughly discuss and interpret the survey results based on both finding from the literature and the authors' own experiences. The aim was to perform a data triangulation which tends to strengthen the research results.

By using exploratory research, we were able to define the existence and strength of the relationships between specific project characteristics and factors related to the projects' early warning procedure. The values of the correlation factors for the projects' characteristics and the factors related to the projects' early warning procedure showed an adequate correlation among several of the variables.

Our literature research on correlation factors revealed different opinions on the categorization of correlation factors according to their strength. For example, Field (2005) states that when estimating the intensity of relationships between two variables, a partial correlation coefficient (r) below ± 0.3 shows a small effect, the correlation coefficient between ± 0.3 and ± 0.5 shows medium effect, and a correlation coefficient above ± 0.5 shows a strong effect. However, according to Shortell (2001) there is no rule for determining whether the size of a correlation coefficient is considered strong, moderate, or weak. Further, the interpretation of a coefficient partly depends on the topic of study. For example, in studies related to human's mental life, we rarely see correlations above 0.6. Rather, correlations above 0.4 are generally considered to be relatively strong, correlations between 0.2 and 0.4 are considered moderate, and those below 0.2 are considered weak. When items that are more easily countable are studied, we can expect higher correlations. In our case, since the variables included human issues, the level of precision in the responses received was not very high, whereas the level of subjectivity was quite high. We therefore expected the correlation factors to be lower, and consequently considered the categorization as a base for the analysis of the correlations.

It is also important to calculate the p-value for each correlation. In general, the smaller the p-value, the more evidence that we have against our null hypothesis. According to Cleophas et al. (2009) a p-value < 0.05 is generally used to indicate a significant difference from the null hypothesis while a

p-value > 0.05 is most likely to indicate no difference from the null hypothesis. The results will be analysed in the following sections.

4. Survey results

4.1 Summary of the survey responses

The results of the survey showed that our respondents included mainly project managers or project leaders with an average of 19.5 years of experience who worked in various industries. The respondents generally had a master degree in engineering. Figure 2 illustrates the years of experience of the respondents and table 4 presents the percentage of respondents from each industry. This question was a multiple choice question and some of the respondents chose more than one industry.

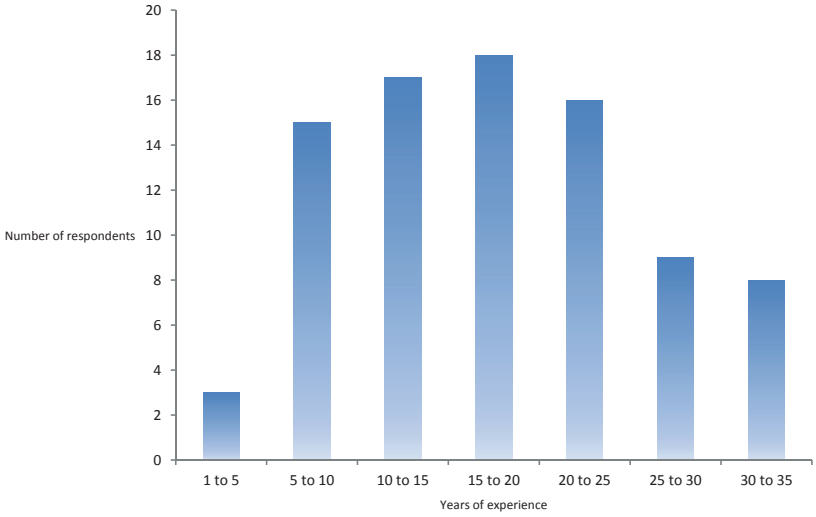


Figure 2. Years of experience of respondents

Table 4. Distribution of the respondents by industry

Industry	Percentage of respondents	Number of respondents
Oil and gas	20%	17
Construction	20%	17
IT	20%	17
Infrastructure and transportation	10%	9
Telecommunication	8%	7
Consultancy/advisory	7%	6
Other	7%	6
Research and higher education	3%	3
Public sector	3%	3
Energy and electricity supply	2%	1

The majority of the respondents worked in three industries: oil and gas, construction, and IT. The next largest percentage worked in the infrastructure and transportation industry (10%). A total of 56% of the respondents were either project leaders or project managers, followed by project members (18%) and members of steering committees (19%). The remaining respondents included, for example, project coordinators, project planners, and project sponsors. Some respondents selected more than one answer from the possible choices of roles within the project organization listed in our questionnaire.

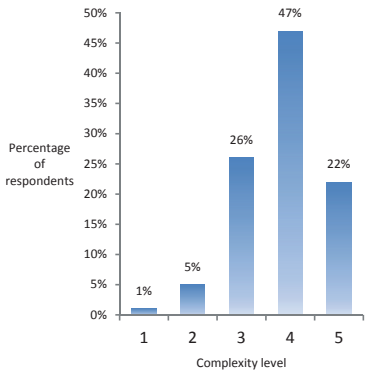
In order for us to gain an overview of the characteristics of the project organizations to which the respondents were affiliated, the respondents were asked to evaluate the complexity level of the current or most recent project in which they had been involved. The respondents were asked: How do you evaluate the complexity level of your projects? Answer based on a scale where 1 stands for lowest and 5 stands for highest level of complexity (Figure 3).

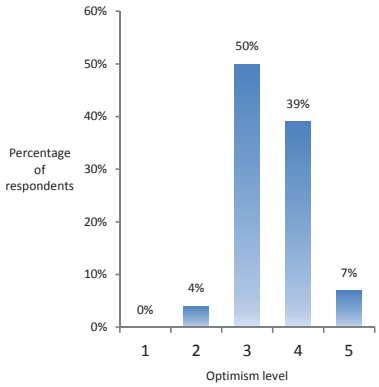
In general, the term complexity in itself is in widespread common usage and each person can be expected to have her or his own understanding of this term (Cooke-Davis et al., 2007). Furthermore project managers understand and use the term complexity in a very broad and diversified way due to the lack of clear distinctions between complex and complicated (Azim et al., 2010). Therefor we cannot claim that what has been measured through survey is the "actual complexity", but rather an evaluation of subjective experiences of the respondents and how they perceive the level of project complexity. Since complexity influences the capability to manage the project, to obtain success, it is more important to understand how the project manager or project organization perceives complexity or finds the project complicated. The intention for this type of evaluation has been to investigate on how the perception of complexity can possibly influence the early warning procedure and to examine the extent to which data regarding possible early warning signs are extracted and identified as early warning signs in complex projects. In other words, we would like to investigate if the more complex the respondents find the projects, the more challenging will be the performance of an effective early warning procedure.

It should be noted that there are tools which can be utilized for evaluation of the complexity level of projects. An example is the Project Complexity and Risk Assessment Tool (PCRA), developed by the Treasury Board of Canada Secretariat in 2013, which is intended to support the Treasury board policy on the management of projects and the standard for project complexity and risk. Using such a tool represents a whole survey of its own which requires excessive time and effort from the respondents. However, we believe this type of tools, besides requiring great amount of time for the respondents, are applicable in situations where the actual complexity of project is under question and not necessarily the perception of complexity.

The same question (i.e. about the complexity level of the respondents' involvement in the current or most recent project) was asked about the 'optimism level' within the project organization, and the same ranking was used (Figure 4). Approximately 70% of the respondents ranked the projects as highly complex. In total, 96% of the respondents ranked the optimism level above 3, and 46%

ranking it as either 4 or 5, which we interpret as quite high. The same constraints that applied to self-





ranking of the projects' complexity level apply to this aspect as well.

Figure 3. The projects' complexity level Figure 4. The project organizations' optimism level

In addition, we asked the respondents to evaluate the extent to which the project members could freely express their opinions within the project organization. Using a 5-point scale, 80% of the respondents selected either level 4 or 5, which represented a high level of freedom to express opinions. Only 1% of the respondents selected the lowest level, 1.

The respondents were asked to choose one or more methods from a list of methods used systematically within their project. The results are presented in Table 5. In some cases, the respondents included other methods than the pre-listed options. In addition, a total of 72% of the respondents said that the selected methods had been regularly applied within their project organization, 14% stated that the methods had been used sometimes, and the remaining 24% mentioned that the methods were applied only at particular times.

Table 5. Methods applied systematically within the project organizations

Method	Percentage of respondents	Number of respondents
Project management methods (cost-time-quality)	80%	67
Risk/uncertainty management	73%	62
Brainstorming	31%	26
Performance measurement	15%	13
Stakeholder management	14%	12
Root-cause analysis	14%	12
Maturity assessment	12%	10
Other	11%	9
Health checks	8%	6

Afterwards, the respondents were asked to select the phase in which the early warning signs of possible problems were identified. The biggest group of responses related to the planning phase and execution phase, respectively accounting for 37% and 49% of the responses. The remaining responses related to either the concept phase or idea phase of the project.

Thereafter, the respondents were asked to rank the most important sources for identifying early warning signs on a scale of 1 to 5, where 1 represented the least important source and 5 the most important source. The results are presented in table 6.

Table 6. Most important sources for identifying early warning signs and their average rankings by respondents

Most important sources for identifying early warning signs	Average rank (out of 5)
Gut feelings	3.4
Project assessment methods	3.5
Project management methods	3.8

We wanted to know the strength of the responses towards early warning signs in cases where they were identified. Only 35% of the respondents ranked the strength of the responses as either 4 or 5, which represented a rather strong response, while 34% ranked the strength as 3, and the remaining 31% ranked the strength as 1 or 2, which represented a weak response.

The next step in our survey was to investigate the possible reasons for the lack of identification of early warning signs. Both the reasons and the percentage of respondents who had selected each reason are presented in Table 7. The question was a multiple choice question with the possibility to choose more than one option by each respondent.

Table 7. Possible reasons for failure to identify early warning signs in the projects

Possible reason for not identifying early warning signs	Percentage of respondents	Number of respondents
Lack of effective communication among project members	25%	21
Organization's complexity	25%	21
Over-optimism	21%	18
Unclear strategy	15%	13
Conflict among goal and strategy	12%	10
Other	10%	9

We then asked the respondents about the most important reasons for not responding to the early warning signs in cases where they were identified. The respondents were given several choices and asked to rank them from 1 to 5, with 1 as the least important reason and 5 as the most important reason. The different options and the average ranking by the respondents are presented in table 8.

Table 8. Reasons for not responding to early warning signs and their average rankings by respondents

Reasons for not responding to early warning signs	Average rank (out of 5)
Over-optimism	3.1
Lack of time to respond	2.9
Lack of effective communication among project members	3.2
Political issues	3.1
Poor management	4.1

As a final step in our survey, the respondents were asked to recommend approaches that would ease the process of identification and response to early warning signs of possible problems. With regard to the identification process, the respondents' recommendations could be summarized as belonging to four main groups: active risk management, effective communication, front-end management, and project manager competence. By contrast, the respondents' recommendations for facilitating the response process were rather scattered and not easy to categorize. However the responses included the following aspects: systematic risk monitoring and follow-up, effective use of project learnings, effective risk reporting system, effective governance system and proper understanding of project goals and deliverables.

4.2 The relationship between the attributes of the projects and project organizations and the factors related to the early warning procedures

After compiling an overview of the survey respondents' responses, the next step in our study was to investigate the correlations among different survey results. Table 9 shows the interdependencies we examined in order to find possible correlations among them. Since the correlations could only be calculated for quantifiable variables, the variables that were not ranked by numbers were scaled to quantities. For example the question on frequency of use of systematic methods within the project was a multiple choice question including the following choices: regularly, sometimes, only on special points of time and other. These elements were quantified respectively as 2, 1 and 0. Although the approach does not necessarily allow for accurate results, it provides insight into the level of interdependency of the variables.

Table 9. Correlation matrix of variables within the survey

Variables	Project complexity	Optimism level in project organization	Possibility to freely express opinions within the project organization	Difficulty level for discussing EW signs	Effectiveness of discussions on identified EW signs	Stage of EW identification	Frequency of use of systematic EW identification approaches	Level of activeness in analysis of results of the application of approaches	Importance of different sources for identifying EW signs	Importance of different reasons for not responding to EW signs	Strength of responses to EW signs
Q5. Project complexity	**1.00**	0.014	0.058	0.2 *P-value (0.09)*	-0.17	0.013	0.1	0.075	**0.22**[1] ***P-value (0.04)***	**0.3**[2] ***P-value (0.01)***	-0.2 *P-value (0.08)*
Q6. Optimism level in project organization	0,014	**1.00**	0.04	-0.07	0.04	-0.2 *P-value (0.08)*	-0.1	0.04	**0.21**[3] ***P-value (0.05)***	**0.2**[4] ***P-value (0.04)***	0.21 *P-value (0.08)*
Q7. Possibility to freely express opinions within the project organization	0.058	0.04	**1.00**	0.05	**0.3** ***P-value (0.01)***	0.13	-0.03	0.09	0.16	-0.2[5] *P-value (0.09)*	**0.3** ***P-value (0.004)***
Q14. Difficulty level for discussing EW signs	0.2 *P-value (0.09)*	-0.07	0.05	**1.00**	-0.2 *P-value(0.06)*	0.01	-0.03	0.09	**0.38**[6] ***P-value (0)***	0.2[7] *P-value (0.07)*	**-0.3** ***P-value (0.004)***
Q15. Effectiveness of discussions on identified EW signs	-0.17	0.04	**0.3** ***P-value (0.01)***	**0.3** ***P-value (0.01)***	**1.00**	0.02	0.11	0.075	**0.22**[8] ***P-value (0.04)***	**0.33**[9] **P-value (0.002)**	**0.42** ***P-value (0.0001)***
Q13. Stage of EW identification	0.013	-0.2 *P-value (0.08)*	0.13	0.01	0.02	**1.00**	0.13	0.12	0.09	0.1	0.1
Q9. Frequency of use of systematic EW identification approaches	0.1	-0.1	-0.03	-0.03	0.11	0.13	**1.00**	0.18	0.17	0.14	-0.17
Q10. Level of activeness in analysis of results of the application of approaches	0.075	0.04	0.09	0.09	0.075	0.12	0.18	**1.00**	0.2[10] *P-value (0.06)*	**0.23**[11] ***P-value (0.03)***	0
Q16. Importance of different sources for identifying EW signs	**0.22**[1] ***P-value (0.04)***	**0.21**[3] ***P-value (0.05)***	0.16	**0.38**[6] ***P-value (0)***	**0.22**[8] ***P-value (0.04)***	0.09	0.17	0.2[10] *P-value (0.06)*	**1.00**	**0.28**[12] ***P-value (0.009)***	0.17
Q20. Importance of different reasons for not responding to EW signs	**0.3**[2] ***P-value (0.01)***	**0.2**[4] **P-value (0.04)**	-0.2[5] *P-value (0.09)*	0.2[7] *P-value (0.07)*	**0.33**[9] **P-value (0.002)**	0.1	0.14	**0.23**[11] ***P-value (0.03)***	**0.28**[12] ***P-value (0.009)***	**1.00**	0.1
Q18. Strength of responses to EW signs	-0.2 *P-value (0.08)*	0.21 *P-value (0.08)*	**0.3** ***P-value (0.004)***	**-0.3** ***P-value (0.004)***	**0.42** ***P-value (0.0001)***	0.1	-0.17	0	0.17	0.1	**1.00**

[1] Gut feelings; [2] Political issues, poor management; [3] Gut feelings; [4] Poor management; [5] Over-optimism, lack of communication among project members ; [6] Gut feelings; [7] Not enough time to respond

[8] Project management methods; [9] Not enough time to respond; [10] Project management methods, project assessment methods; [11] Not enough time to respond; [12] Project assessment methods ~ Over-optimism

The correlation analysis reveals a rather dissatisfactory set of results showing, with only one exception, a moderate correlation among the variables. Knowing that the majority of respondents perceived the complexity level of the projects quite high; the correlation results confirm that it is very difficult to intuitively infer the behaviour of the whole complex system from the behaviour of the sub-elements (Simon, 1982). This is due to interdependence of a large number of elements within a project (structural complexity) and the high level of uncertainty involved within the system. In addition, these results open up for more detailed research on these elements and their interrelationship within the project context.

Discussion

Our study of the literature on the concept of early warning signs in project management revealed gaps with regard to publications on barriers to responses to early warning signs of possible problems, which in turned motivated us to carry out our survey. Two main ideas emerging from this work are: 1) by clarifying the mentality filter in the model we gain a better explanation to why signals do not produce action, 2) With this better explanation we can consider the suggested practices (outside view etc.), and explain why they improve the situation and cause more signals to produce proper action. In the following sections we discuss our findings and how they led to these two ideas.

5.1 Interpretation of survey results

Having examined the correlation factors of the variables used in the survey, we recognized that there were interrelationships among some of them, which are explained below.

The correlations revealed the significance of project complexity. Such complexity makes discussions more difficult and responses to early warning signs of possible problems weaker and less effective. Our findings relating to project complexity strengthen the findings from research conducted by Klakegg et al. (2010) which concluded that increasing complexity makes it more difficult to detect and interpret signs of potential problems. This is due to the fact that in complex projects, matters are less well-known and more interconnected and interdependent. This finding from the survey can also be due to the fact that in complex projects, there is a mixture of hard and soft issues among the early warning signs, which are related to for example attitudes and values, and these are hard to measure or even detect. But since the p-value in both correlations is higher than 0.05, we cannot strongly indicate that the correlation is credible. This means that it is not necessarily the complexity factor which increases the difficulty level for discussions on early warning signs and the strength of responses. In fact we believe the organizational factors are much more influential on the early warning procedure than the project specifications.

Results also show that the project complexity level is moderately correlated to the importance of gut feelings as a source for identifying early warning signs and the importance of poor management and political issues as factors influencing the response to early warning signs. The first finding is consistent with Klakegg et al.'s (2010) work, which indicates that the more complex the project, the

more important gut feelings become as a source for identifying early warning signs. In fact the formal project assessment methods, which are usually dominated by analytical approaches, may not be the right approach in really complex projects.

The latter finding can be explained based on Williams' (2002) study, which states that as the complexity and scale of attempted projects increases, the ability to bring these projects to a successful completion dramatically decreases. Also the complexity and dynamics in the environment are hard to foresee and respond well to (Klakegg et al., 2010). It is probable that this fact may be overlooked by project members and thus be blamed fully on poor management. However we do not claim to minimize the importance of the role of project managers in effectively managing the complexity. It is indeed one of the most important roles of project managers to find approaches for dealing with the complexity involved in their projects. For example Williams (2002) suggests decomposing complex projects into simpler sub-projects or programs of sub-projects.

Another influencing factor is the political issues involved in the project. This is perhaps one of the most important issues which affect the early warning procedure, seen in the way Ansoff (1984) in his management model points to political/power issues as one of the main filters against action upon early warning signs. This effect can become stronger in complex projects where there is added complexity through the multiplicity of goals (Williams, 2002). Thomas and Mengel (2008) also point to the importance of attaining skills in organizational politics in order to successfully manage complex projects. Since the P-value for the correlations mentioned above is less than 0.05, we assume that these relationships are credible.

Our second set of findings is related to the optimism level within the project organization. The survey results showed that the higher the optimism levels within the project organization, the later early warning signs were identified. This finding can be explained by the fact that optimism creates a tendency for individuals to exaggerate their talents and abilities and thus misperceive the causes of certain events (Lovallo and Kahneman, 2003). This explanation applies also to another finding from the survey, namely that the higher the level of optimism, the more difficult it was to discuss early warning signs of possible problems within the organization. In addition, our findings revealed that the higher the optimism level, the more important "gut feelings" become for identifying early warning signs and conversely the use of project management methods as a source for identifying early warning signs. The latter finding can be explained by optimism bias (Flyvberg et al., 2009), i.e., people's tendency to be excessively positive when predicting the outcomes of future planned actions. Due to this phenomenon, experienced people tend to hold the belief that they are capable of handling a project without any additional tool other than their own experience and knowledge, which can be referred to as "gut feelings".

A further finding is that the higher the level of optimism, the more important poor management is as an explanation for failure to responding to early warning signs. This can be related to the organizational pressure which suppresses the pessimistic opinions while rewarding the

optimistic ones (Lovallo and Kahneman, 2003). The findings can also be explained by normalization of deviance (Pinto, 2013), which results from optimism bias and causes false management practices and mistakes to become accepted within the organization. Also political issues were one of the main reasons reported by our respondents as a driver for lack of response to early warning signs. According to Chioma (2012), where projects are awarded on political considerations, little or no attention is given to the recommendations of project appraisals.

Furthermore, the more open an organization is to employees expressing their opinions, the more effective discussions on identified early warning signs will be. According to Martin (1992), by listening carefully to one another's ideas and by responding openly and constructively to one another's concerns, more communication opportunities are created. The practice will lead to more effective discussions on early warning signs of possible problems and thus stronger responses to early warning signs. This may also explain another finding from the survey, which revealed that the more difficult it is to discuss early warning signs, the weaker the responses to them will be. By contrast, the more effective the discussions on early warning signs, the stronger the responses to those signs. The difficulty level for discussing EW signs can also influence the extent to which different reasons for identifying EW signs become important. The survey results show that the more difficult it is to discuss early warning signs, the more important becomes "gut feelings" as the EW identification source. This can be explained by the finding from the study by Klakegg et al. (2010), which reveals that the early warning signs which are identified through gut feelings are mainly related to softer sides of the project, e.g. "lack of culture of openness and good communication", "strained atmosphere", etc. It is expected that project environments which lack the culture of openness, thus facing higher difficulty level for discussing early warning signs, are more likely to be subject to problems regarding the soft side of the project. Therefor it is anticipated that the early warning signs of these types of issues are likely to be identified through gut feelings rather than formal audits/reviews. A further explanation can be that in project environments where results of analysis and systematic methods are difficultly discussed and probably seldom taken seriously, it is more likely that a strong gut feeling regarding certain problems is the only way to bring up the problem within the project organization.

The same logic applies to another finding from the survey which reveals that the more effective the discussions on identified EW signs within projects, the more important becomes the project management methods as sources for identifying EW signs. This can be due to the fact that since the project organization is open for effective discussions on possible EW signs, the results of systematic methods and reviews can be easily discusses , thus can be reliable source for detecting the signals of future problems. Also it is more likely that in such project environments, the problems are less on the soft side, but rather related to hard issues.

The high level of effectiveness of discussions on EW signs positively correlates to the level of importance of "lack of time to respond" as the main barriers for not responding to EW signs. The authors believe this can be justified by stating that if the project team is efficient and healthy enough to

reach a point where the EW signs are detected and effectively discussed within the project organization, the barrier against responding to EW signs is most likely to be "shortage of time" rather than other aspects such as lack of communication or poor management. "Lack of enough time to respond" has also been ranked as the most important barrier against responses to EW signs in cases where the level of activeness of project participants in analysing the results of project assessment methods is high. This can also be explained by the above arguments regarding high performance of the project team.

The last correlation found among the questioned variables within the survey indicates that the more important is "project assessments" as a source for identifying EW signs, the more important is "over-optimism" as the main reason for not responding to EW signs. It can be interpreted that by use of project assessment methods, the trends and numbers are in place and the reason for objecting to them and neglecting the results can be the over-optimism of the decision makers who believe that they are less at risk of experiencing a negative event, despite the available information regarding possible future problems.

The p-values in all the correlations mentioned above were less than 0.05, proving the credibility of the interrelationships.

5.2 Why identification of early warning signs doesn't always result in effective responses?

The findings from the survey led us to elaborating on the filters defined by Ansoff (1984) as an explanation for possible obstacles against effective responses to early warning signs. In Ansoff's model, presented in Figure 2, the receiver evaluates the information from the environment and makes a decision as to what to accept and what to eliminate. In our suggested model, presented in Figure 5, the observer and the decision maker are treated as separate units. This is where another filter is added to the procedure, which we named "*observer mentality filter*". The idea behind this emerged in two stages. The first stage was when we were looking into areas where the decision maker responsible for taking actions is not necessarily the person who observes the warning signs. One such area is risk and safety, and a clear example is the Space Shuttle Columbia disaster, when NASA engineers had spotted something unexpectedly wrong but higher-ranking NASA staff failed to act upon the engineers' information in time (Rose, 2003). Although, in this case, the information did pass the observer mentality filter, it is probable that in other cases, observers could hold back information from the decision makers. Such cases could be due to organizations' over-optimism, which according to Lovallo and Kahneman (2003) results in suppressing opinions that are perceived as pessimistic.

The second stage was during the examination of the survey findings, adding further possible explanations why signals don't result in suitable actions. One possible explanation is that in an organization that does not encourage employees expressing their opinions, perceived early warning signs might not be discussed and thus not acted upon. Another finding is that lack of effective communication among project members could also result in lack of effective response to early warning signs.

It is probable that in certain situations, specific warning signs of possible problems will be observed by project members who have no authority regarding decision making. The amount of data transferred to the decision makers depends on the culture of openness and level of effective communication within an organization. We consider that the strength of this filter and the organizational culture of openness are interdependent.

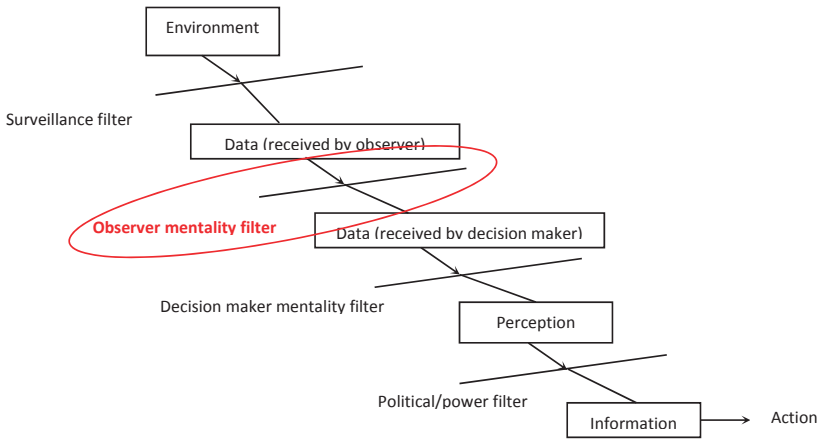


Figure 5. Filters to prohibit actions in response to early warning signs, adapted from Ansoff's management model (Ansoff 1984)

Our survey investigated the extent to which project members felt free to express their opinions within the project organization. The question targeted the openness of the channel through which the project members could freely talk to higher-ranking project members. We consider that in order to ensure the realization of an appropriate action towards an early warning sign, it is crucial to enhance the flow of information through all the filters shown in Figure 5: In order for information to pass the surveillance filter, it is necessary to enhance the methods that allow enough data to be gathered from the environment to monitor all essential areas that may contain potential problems. Suitable utilization of the methods listed in Table 1 may contribute to the aforementioned practice.

In order for information gathered from a project environment to pass through the *observer mentality filter,* it is crucial to enhance communication between the observer and the decision maker. As in the case of NASA's Challenger project (Rose, 2003), there may be cases where the decision makers ignore the information transferred to them by the observers of the early warning sign of a problem. It is also probable that observers will tend not to transfer such information to decision makers, and this may be due to flaws in the communication system within a project organization. In such cases, optimism bias or any other type of bias can act as an obstacle to the proper flow of information. According to Flyvbjerg (2013), the outside view tends to reduce the level of optimism bias, but it can also help to mitigate any type of bias, including strategic bias. The outside view prevents such biases by cutting directly to empirical outcomes and building conclusions about future

events on those outcomes. Another reason for biases can be the normalization of deviance within an organization, where unaccepted issues become accepted through time, thus resulting in undesired events. Pinto (2013) suggests that remediation through project governance and reflection through organizational learning may be solutions for overcoming this type of problem. It is worth mentioning that informal communication among project members can also be a driver for better flow of information between observers and decision makers, and is referred to in the literature as intra-organizational social capital (Bartsch et al., 2013).

After the information has passed the surveillance filter, it is the decision maker's mentality filter that should be passed. At this point, the receiver will evaluate the received information and make a decision as what to accept and what to eliminate as unnecessary, unrealistic, or irrelevant. At this point too, it is very important that the decision maker or makers take realistic decisions by avoiding underestimations of the risks of actions and overestimations of the benefits. Taking an outside view has been suggested as a solution to the risk of optimism bias, strategic misinterpretation, and illusions in decision making (Lovallo and Kahneman, 2003; Flyvbjerg, 2012; Pinto, 2013), which are some of the many reasons why wrong decisions are made rather than decisions based on a rational weighting of the benefits, losses, and probabilities of undesired consequences.

The strength of the *political/power filter*, which determines the type of information permitted to influence a decision-making process, is very much influenced by the political pressure exerted by different project stakeholders. It is thus crucial for decision makers to understand the importance and dynamics of power and politics, and to analyse both the political behaviour of project stakeholders and the political context within the project organization. This would allow the development of appropriate strategies for managing politics at the project level and at the upper management level. According to Pinto (2000), power and politics are a necessary part of project management and it is crucial for project managers to learn to use them to their advantage by increasing the likelihood of successfully managed projects. Choosing the most effective stakeholder response strategy through the interactions of multiple project network actors can enable decision makers to better deal with political pressures that may lead to the lack of appropriate responses to early warning signs of potential problems in projects (Aaltonen and Sivonen, 2009).

Finally the element of "short time available" has been mentioned as an important factor which can negatively influence the response to early warning signs. It is thus important for managers to take this element into consideration from the very early stages of the project and throughout the whole project.

5. Conclusion

In this article we have provided empirical evidence to show that there are barriers to project managers identifying and acting upon early warning signs in projects. The key findings of our study show that organizational factors such as complexity, level of optimism, culture of openness, and the degree of

effective communication within project organizations strongly influence the early warning procedure as a whole. Based on our empirical study and findings from our literature search, we elaborated on Ansoff's management model by clarifying the mentality filter in order to better define the procedure whereby obstructions are created. It applies especially to large and complex projects where there are various interdependent units working under the umbrella of one project organization.

In the course of this article, we have endeavoured to answer the research questions presented in the Introduction. In the following, we present our conclusions regarding each question in turn.

What are the main barriers to responding to identified early warning signs? (Q1) Through the literature study we obtained information on possible aspects that can be interpreted as sources of lack of responses to early warning signs in projects. Examples of the sources include over-optimism, the normalization of deviance, and illusions in decision making. Some of the acquired information was then used in a survey as an input for the respondents. The results of the survey revealed that elements such as over-optimism, poor management, and political issues can greatly contribute to the lack of effective responses to early warning signs of possible problems.

What is the role of organizational factors in effectiveness of the responses? (Q2) Both the findings from the literature and the survey results revealed that organizational factors such as complexity, level of optimism within the project organization, and the level of openness for discussing identified early warning signs within the organization have been indicated as factors that can influence the early warning response procedure. An additional filter to Ansoff's management model was introduced in order to clarify possible obstacles to the effective flow of information and thus enable responsible parties to take appropriate actions in response to identified early warning signs.

What approaches allows project managers to enhance the procedure of responding to identified early warning signs? (Q3). Various literature sources that discuss possible elements that can be interpreted as barriers to responses to early warning signs also suggest solutions for enhancing the flow of information within the project organization, thus resulting in more effective actions being taken. The approaches include taking an outside view, choosing the most effective stakeholder response strategy, and creating social capital.

These findings are quite logical and what would be expected. So the value of this research is that the authors empirically confirm findings which could have intuitively been expected. In addition, the elaboration on Ansoff's management model provides a new perspective to the early warning procedure by taking the observer's role as an important element into consideration.

Further studies that investigate more thoroughly the conditions under which each of the filters are created and the approaches that can ease the information flow through those filters are likely to be of great interest in the near future.

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