Early Warning Signs in hospital construction projects

A qualitative research on identifying and stimulating acting on EWS

in a Dutch hospital construction project

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TU Delft

Master Thesis

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"Learn to see. Realise that everything is connected to everything else"

Leonardo Da Vinci, architect, artist and scientist

Colophon

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PREFACE

With pleasure I present my graduation thesis, the result of my research on Early Warning Signs in hospital construction projects. This research is the final assignment of the master program “Management in the Built Environment” of the faculty of Architecture, Urbanism & Building Sciences at Delft University of Technology. In the MBE domain Design and Construction Management (DCM) the scientific quest for finding answers to the questions why complex (construction) projects tend to turn out to be more expensive and take much longer to build than predicted is a dominant theme in (research on) project management. With my research on Early Warning Signs (EWS) I hope to provide more insight in how recognising and acting on EWS may help improve project management in complex construction projects so that the goals and results that are hoped for can be achieved more easily.

In my research, I could combine my personal interest in the project management of complex projects and healthcare. Healthcare and the management of complex projects meet each other in the building of hospitals. Dutch hospital construction is important for society and a challenging undertaking as these projects tend to turn into a struggle because project goals are not always met, budgets are overrun and delays in planning are the rule rather than the exception. The complexity and the involvement of many stakeholders make it hard to keep such projects in control. Project failure is often linked to the hard sides of project management, but both literature and the experience of professionals indicate that soft factors and skills, such as negotiation, team capabilities and communication also influence the outcome of a project. These people-centered aspects can make the difference in a project. It puzzles me that tools and methods are predominantly aimed at the hard sides of project management and that soft factors and people skills tend to receive less attention.

The concept of EWS fascinates me since my minor in the Bachelor phase of my studies. I noticed how EWS had a positive effect on the communication and cooperation in a project team of a complex infrastructure project. For my final thesis I am grateful to have been given the opportunity to explore EWS in a hospital construction project. During the journey of my graduation I was supported and inspired by excellent supervisors, both at TU Delft and at AT Osborne.

First of all, many thanks go to Louis Lousberg and Marian Bosch-Rekveldt from Delft University of Technology. They kept challenging and encouraging me and their support and sincere feedback were of great value to me. The scientific part of this thesis certainly benefited from their expertise and guidance.

Also, I would like to thank my mentors at AT Osborne, Jeroen Brinkman and Laurens Lancee for their support. They made my research a valuable experience by introducing me to the hospital case and their network. I really enjoyed working with them and I learned a lot from our discussions about the (management) of the project.

In addition I would like to thank the members of the project team that participated in the interviews of the case study and the members of the expert panel for sharing their views and insights with me. The case study and the expert panel showed me that in project management *people* management is important. I really enjoyed working on the case and with the expert panel where scientific theory and practice came together.

Finally, I thank my friends and family for their never ending support. They kept stimulating and encouraging me especially during the more turbulent part of my graduation time. Special thanks go to my mom, Karin van Helmond, who I often used as my testing audience.

I hope you enjoy reading this thesis!

Yara Bergers,

Delft,

April 2024

ABSTRACT

In Dutch hospital construction projects, the project goals are not always met, budgets are overrun, delays in planning, and the progress of the projects do not proceed the way that is expected. The complexity of the hospital construction projects influence the possible outcome of the projects, since complexity makes it harder to keep the project in control and to accomplish the goals of the project. Project failure is often linked to these hard sides of project management, but especially the soft factors and skills, such as negotiation, team capabilities and communication also appear to influence the outcome of a project.

A wide range of signs can indicate possible problems such as delays or exceeding the budget long before they actually occur: these are the so-called Early Warning Signs (EWS). EWS are indicators for potential negative future developments. The signs consist mostly of soft signals which grow stronger over time. When EWS occur in a project, they are mostly process-related, linked to human behaviour and 'gut-feeling'. Some research is performed on the subject, but the ability to identify and act on these EWS is in its early stages. Research on EWS and the response to EWS mainly focuses on the infrastructure construction sector. EWS-Research related to hospital construction projects is lacking. Hospital construction projects in most cases consist of a combination of the renovation and rebuilding of existing hospital buildings and new developments. This research wants to make an attempt to fill the research gap and aims to answer the following research question:

"Which Early Warning Signs can be identified in Dutch hospital construction projects, and how can acting on Early Warning Signs be stimulated to mitigate possible problems?"

The exploratory research is split into two sections; a theoretical study and an empirical study are conducted. The theoretical study consists of a literature review. The findings of the theoretical study are explored in practice in the empirical study, which consists of a case study, including semi-structured interviews, and an expert panel.

The findings in this study show that EWS appear in hospital construction projects and that they are related to human factors, such as gut feeling, communication and culture. Project management can benefit from taking EWS into account: identifying and responding to EWS can have a positive effect on the process of hospital construction.

Before responding to EWS, they must first be identified and barriers must be minimised. To stimulate acting on EWS, there must be *awareness* of which barriers can occur in hospital construction projects.

Nine categories of EWS in hospital construction projects are found: 1) Infeasible project goal, 2) Postponing decision making, 3) Diminishing cooperation, 4) Unfit team composition, 5) Lack of communication, 6) Lack of quality of documents, 7) Deteriorating connection with internal stakeholders, 8) Excessive workload, and 9) Resistance of external stakeholders.

Eight barriers are found that may prevent recognising or acting on EWS in hospital construction projects: 1) Inadequate management style, 2) Uncertainty avoidance, 3) Effects of board/politics, 4) Optimism bias, 5) Lack of time for reflection, 6) Underestimated project complexity, 7) Deteriorating relationship with contractors, and 8) Fragmentation.

To minimise possible problems in a hospital construction project, the three most impactful barriers can be managed by incorporating possible solutions regarding proactive and reactive approaches applying both soft and hard aspects of project management.

SUMMARY

Introduction

Hospital construction projects are becoming more complex to manage, which is related to advanced technology, intricate designs, and the diverse and often opposite interests of stakeholders. In Dutch hospital construction projects, the project goals are not always met, budgets are overrun, delays in planning, and the progress of the projects do not proceed the way that is expected. Hospital construction projects in most cases consist of a combination of the renovation and rebuilding of existing hospital buildings and new developments. The complexity of the hospital construction projects influence the possible outcome of the projects, since complexity makes it harder to keep the project in control and to accomplish the goals of the project. Project failure is often linked to the hard sides of project management, but especially the soft factors and skills, such as negotiation, team capabilities and communication appear to also influence the outcome of a project.

A wide range of signs can indicate possible problems such as delays or exceeding the budget long before they actually occur: these are the so-called Early Warning Signs (EWS). EWS are indicators for potential negative future developments. The signs consist mostly of soft signals which grow stronger over time. When EWS occur in a project, they are mostly process-related, linked to human behaviour and 'gut-feeling'. Some research is performed on the subject, but the ability to identify and act on these EWS is in its early stages. Research on EWS and the response to EWS mainly focuses on other sectors, most of them in the field of Infrastructure projects. EWS-Research related to hospital (re)construction projects is lacking. This research wants to make an attempt to fill the gap and aims to answer the following research question:

"Which Early Warning Signs can be identified in Dutch hospital construction projects, and how can acting on Early Warning Signs be stimulated to mitigate possible problems?"

Methodology

This research is an *exploratory* research, since the aim of this research is to get a better understanding of how the identification and responses on EWS can be stimulated in hospital construction projects and how barriers can be minimised. This research is also a *qualitative* study since it makes use of the non-numerical data of case studies and semi-structured interviews. The research on EWS is limited, especially related to hospital construction projects. So observations are needed to create understanding. These observations are supported by literature research. The research is split into two sections: first a theoretical study, including a literature reviews, is done, and after that an empirical study is conducted. In this empirical study the EWS and barriers that can occur while acting on EWS are explored in a case study of a hospital reconstruction project. The findings are evaluated with experts and possible solutions from practice are incorporated as the experts have a wide range of knowledge in the field of (managing) complex hospital projects.

The research framework (Figure 1) illustrates the approach of this research.

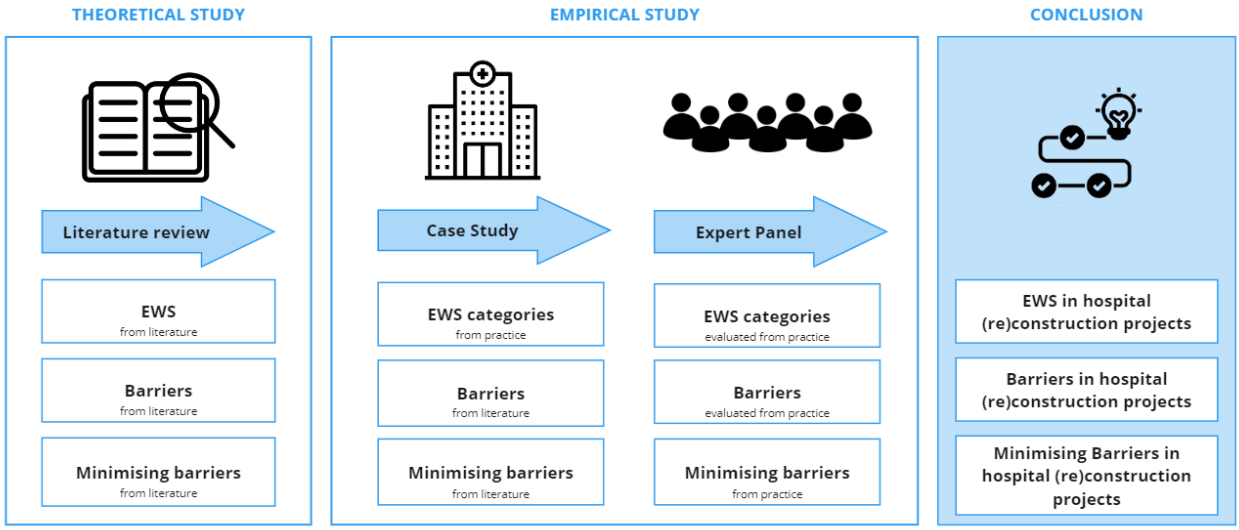

Figure 1 - Research framework

Research findings

In the literature review an overview of EWS categories is found, and possible barriers that occur while acting on EWS. These EWS categories and barriers were used as the theoretical basis for the empirical study. EWS categories and barriers from literature where explored in practice by a case study and evaluated with an expert panel. The EWS categories and barriers are evaluated and explored in the case study and the expert panel. The findings of the case study and expert panel resulted in a set of EWS categories and barriers for hospital construction projects that are linked to the literature findings but are adapted to hospital projects. The EWS categories and barriers are also ranked on their impact. The findings are shown in Figure 2.

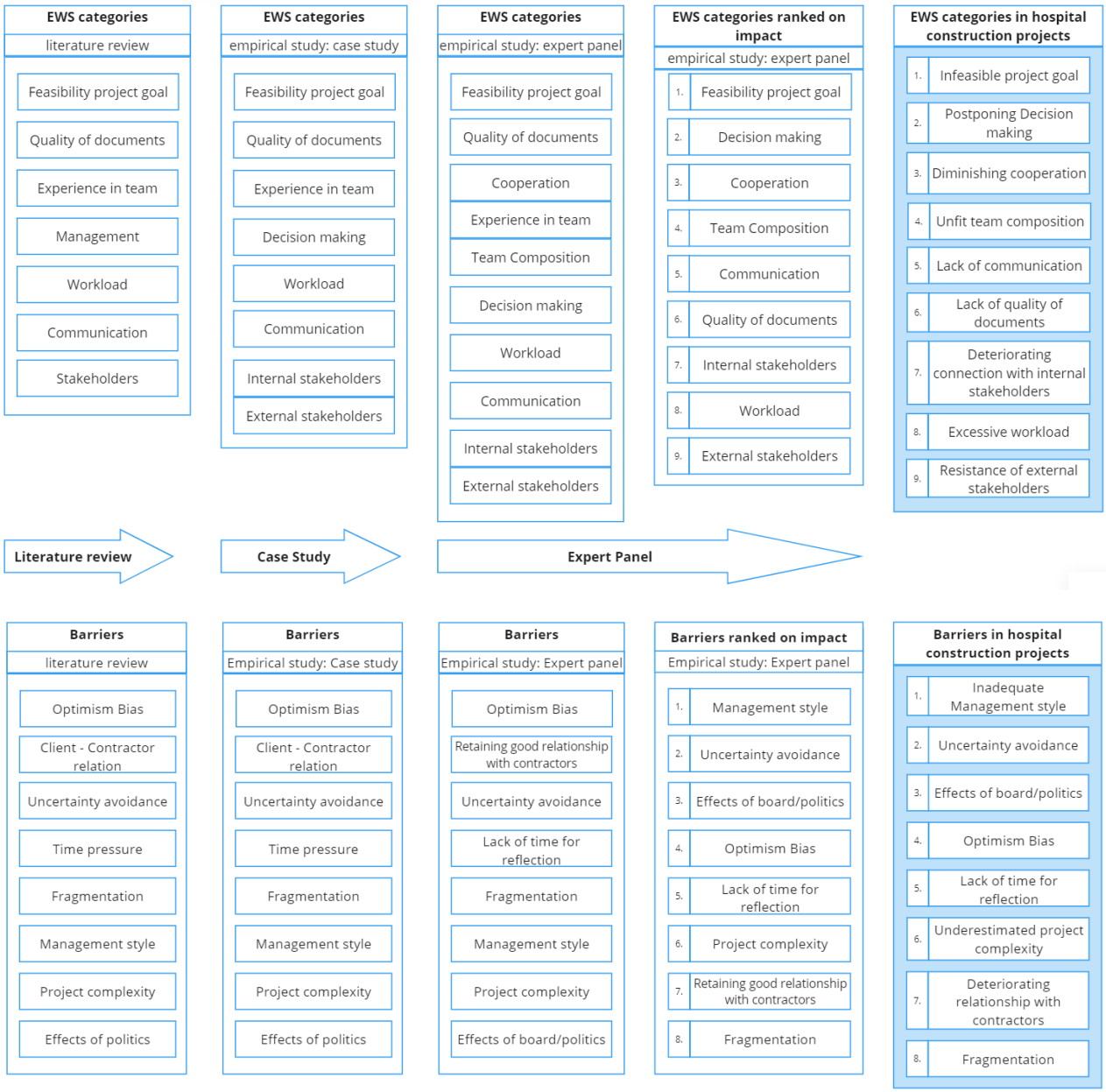

Figure 2 - Research findings EWS and Barriers in hospital construction projects

In the expert panel possible solutions to minimise the effect of the top three most impactful barriers where discussed. Possible solutions are divided into proactive and reactive approaches, with a distinction made in a soft or hard signals as shown in Figure 3. The experts emphasised that combinations of these possible solutions are needed to minimise the barriers have on not acting on EWS in hospital construction projects.

		Management style	Uncertainty avoidance	Effects of board/politics
Proactive	Hard	Training/Coaching for PM	Propose solutions related to planning and budget	Setting frameworks
		Create cooperation document including shared expectations	Create mutual agreements	Show alternatives of changed requirements linked to now vs later and best vs good
			Create escalation protocol	Create escalation protocol
				Present dilemmas and consequenses instead of saying no
	Soft	Characters in the team	Focus on EWS	Stimulate informal meetings
		Create safe ambiance team	Create safe ambiance team	Accept friction, keep discussing, and keep in mind what is best for the project
		One on one meetings	One on one meetings	Stimulate interactions
		Stimulate informal meetings	Understand different interests	
Reactive	Hard	Organise risk management sessions	Organise risk management sessions	Show influence of EWS on project outlines: Money, Quality, Time
		Introduce a contract manager, risk manager, and a "vice-project manager"	Introduce contract management	Clarify consequences and who is responsible
		Escalate to higher management	Execute Review or Audit	
		Change PM		
	Soft	Reflect on regular basis	Reflect on regular basis	Create clarity why pressure is increased
		Discuss Management Style	Organise Team evaluations	Stimulate transparancy
			Stimulate transparancy	

Figure 3 - Findings minimising barriers from expert panel

Conclusion

In hospital construction projects, Early Warning Signs (EWS) are indicators for potential negative future developments. To stimulate acting on EWS, there must be *awareness* of EWS and which barriers can occur. This awareness is related to human aspects as human behaviour and gut-feeling. In project teams EWS are often neglected as the primary focus is on the hard project management aspects. This study shows that by focusing on soft people centered aspects, recognising and acting upon EWS can have a positive effect on managing hospital construction projects.

Nine categories of EWS in hospital construction projects are found: 1) Infeasible project goal, 2) Postponing decision making, 3) Diminishing cooperation, 4) Unfit team composition, 5) Lack of communication, 6) Lack of quality of documents, 7) Deteriorating connection with internal stakeholders, 8) Excessive workload, and 9) Resistance of external stakeholders.

Eight barriers are found that may prevent recognising or acting on EWS in hospital construction projects: 1) Inadequate management style, 2) Uncertainty avoidance, 3) Effects of board/politics, 4) Optimism bias, 5) Lack of time for reflection, 6) Underestimated project complexity, 7) Deteriorating relationship with contractors, and 8) Fragmentation.

To minimise possible problems in a hospital construction project, the three most impactful barriers can be managed by incorporating possible solutions regarding proactive and reactive approaches applying both soft and hard aspects of project management.

Recommendations

Finally several suggestions for future research and recommendations in practice are presented.

Regarding applicability and validation more in-depth research on EWS and barriers that occur while acting on EWS in hospital (re)construction projects is needed, as well as new research on academic hospitals and other sectors. As barriers can prevent acting on EWS, it is interesting to do more research on minimising and breaking down barriers.

In daily practice the awareness of EWS need to be improved by paying attention to soft signals and a more people-centred approach in project management. From an early stage in the project it is recommended to make time for reflection, invest in project start-ups and follow-ups, pay special attention to team composition, quality of documentation, and decision making.

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INTRODUCTION

1. INTRODUCTION

In this chapter, first the research context is explained, followed by the problem statement, then the relevance of this research is discussed, and finally the thesis structure is presented.

1.1 RESEARCH CONTEXT

The context of this research entails the (re)construction of Dutch hospital real estate. Real estate projects are becoming more complex to manage, which is related to advanced technology, intricate designs, and the diverse and often opposite interests of stakeholders (Winch, 2010; Wally, 2013). This is especially the case in the context of hospital construction projects, since there is a need for technical innovations and complex organisational structures (van der Zwart & van der Voordt, 2015; Wally, 2013). Also, the construction of hospitals is further aggravated by its inherent complexity, as the demand for healthcare persists unabated during renovation periods, making any disruption to the daily care services highly undesirable (Lin et al., 2018). Hospital construction projects sometimes comprise the building of a complete new hospital setting, but in most cases the project is a combination of the renovation and rebuilding of existing hospital buildings and new developments (Veuger, 2015). In this study no distinction is made between a complete new construction and partly rebuilding as this kind of projects are always complex, have great impact on the environment and involve multiple stakeholders.

In the project organisation of hospital constructions, a great number of stakeholders are involved which contributes to the rising complexity of such projects. Wally (2013) describes the importance of managing stakeholders in hospital constructions. The complexity of hospital construction projects has a huge influence on the possible outcomes of these projects, since complexity makes it harder to keep the project itself - and the goals of the project under control (Luo et al., 2017; Larsen et al., 2022) In order to meet the increasing and changing demand for health care in this ageing society, the need for fit for purpose construction of Dutch hospitals is adamant (Van der Zwart, 2014). To be able to construct hospitals, the project teams involved have to consider various challenges already at early stage of the project, so that big problems can be anticipated and prevented. A few examples of such problems are cost overruns, delays in a project, or failing of a project, which does not happen overnight (Kerzner, 2014). Specific signs can indicate these problems in an early stage in any real estate (re)construction project; those signs are called Early Warning Signs (EWS). Often these signs are process-related, a soft signal or a signal based on ‘gut feeling’ (Haji-Kazemi, 2015; Williams et al., 2012; Nikander, 2002). The high complexity of real estate (re)construction projects makes it difficult to detect and interpret these EWS (Williams et al., 2012). Because of the rising complexity, the urge to detect and respond to EWS is important. As hospital construction projects specifically are characterised by high complexity, it is important to detect, interpret, and act upon EWS.
Most research on Early Warning Signs is done in the sector of infrastructure and civil engineering projects, and only little research on EWS is done in the hospital real estate sector. To fill this gap EWS, the identification of EWS, and the barriers to responding to EWS in hospital construction projects are explored, and recommendations to stimulate responding to these barriers are given in this research. Barriers are all the possible filters or obstacles that can cloud EWS and prevent or delay project members from acting.

1.1.1 Hospital construction projects

The organisational structure of a hospital is rather complex, since high numbers of stakeholders are involved (Van der Zwart, 2014). Therefore, the (re)build of an hospital becomes a challenge. Real estate projects are becoming more challenging to manage because of the diverse interests of these stakeholders (Winch, 2010). Wally (2013) describes the importance of managing the stakeholders in health care projects.

Table 1 gives an overview of the different stakeholders of an hospital organisation, with a division between internal and external stakeholders.

Table 1: Stakeholders in a hospital organization (Van der Zwart, 2014)

Stakeholders in an hospital organization	
Internal	External
Patients	National government
Medical staff	Ministry of Health, Welfare and Sports
Healthcare professionals	Municipality
Pharmacy	Health insurance
Facility management	Dutch council for public healthcare
ICT	Banks
Hospital board	National institute for Health and Environment
Steering committee	Inspectorate of civil health
	General practitioners
	Elderly homes
	Citizens
	Patient organizations

Within the internal stakeholders, the direct end-users of the hospital real estate are included. Because of the close relation between the building and the way the end-users are used to work in the building, the behaviour of the end-users is directly influenced by the construction of the building. This creates challenging behavioural situations to deal with during the (re)build of a hospital and makes the project such a complex task (Walley, 2013).

Besides the organisational complexity, the change in rules and regulations also contributes to the complexity of hospital construction projects. The regulations of the Dutch hospital sector have been changed in 2008 and since then the sector is in a transition to meet these new regulations (Van der Zwart & Van der Voordt, 2015; Van Reedt Dortland, 2013). One of the biggest changes is that hospitals are now responsible for the reimbursement of their investments in real estate, whereas before this was financed and regulated by the Dutch government. Before 2008, in the old system, there used to be a centrally directed budget for investments in the healthcare real estate (Van der Zwart, 2014). This system was changed in 2012 into a regulated market system to keep healthcare affordable and of high quality. Because of this change, the hospitals got the opportunity and the freedom to make their own autonomous decisions concerning their investment and the optimisation of their own real estate (Van der Zwart, 2014). At the same time the risks related to these investments shifted to the healthcare organisations and became their own responsibility. The financial risks and the need for competitive advantage increased (Van der Zwart, 2014). In this changing environment, the hospitals have to weigh their investments in real estate against investments into other sectors of the hospital, such as ICT or human resources. Overall, the real estate of hospitals in the Netherlands is aging, both technically and functionally (Van der Zwart, 2014). On top of that, the health care sector has to deal with various trends, such as the ageing society, higher levels of chronic disease and disability, medical technological developments, and the rising needs and expectations of patients (Van Reedt Dortland, 2013). The complexity of the hospital construction projects keeps rising because of these various factors (Wally, 2013; Larsen et al., 2022).

1.2 RESEARCH GAP

In construction projects difficulties like delays, shortcomings on the budget, and lack of quality are likely to occur (Herz & Krezdorn, 2021). Over time the complexity of construction projects has grown and the complexity makes it harder to keep the project and the goals in control (Luo et al., 2017). The project goals are not always met and the progress of the projects is not proceeding as expected. Project failure is often linked to these hard aspects (budget, planning, risks) of project management, but Wally (2013) discussed that construction projects are not only influenced by the hard side. Especially the soft factors and skills, such as negotiation, team capabilities and the communication influence the outcomes of a project. Different signs can indicate big problems such as major delays or exceeding the budget before they occur. These signs are called Early Warning Signs (EWS). When EWS occur in a project, they are mostly process-related, linked to human behaviour and 'gut-feeling' (Nikander, 2002; Flyvbjerg, 2013; Haji-Kazemi & Andersen, 2014; Wijtenburg, 2018). The sooner these signs are recognised, the more opportunity there is to fix them (Kerzner, 2014). In complex projects, different project assessments are carried out that could help to identify and act on EWS, but previous research shows that the ability to identify and act on these EWS is not always present (Haji-Kazemi & Andersen, 2014; Wijtenburg, 2018). Therefore, additional research focusses on finding the main barriers in responding on and strengthening the response to EWS. However, these researches are mainly related to infrastructure projects (Wijtenburg, 2018; Stolk, 2022). Research on EWS related to hospital construction projects is missing as can be concluded from the limited number of research and research papers. This indicates a research gap. Appendix A *Research Scopus* shows there is almost no research related to EWS and hospital construction projects. The ability to identify and act on EWS is not yet met in Dutch hospital construction projects, and therefore this researches focusses on enhancing the knowledge on EWS in this sector, and stimulating the response on EWS.

1.3 RESEARCH QUESTIONS

There is a gap in knowledge about which EWS occur in hospital construction projects, how they can be identified, and how acting on EWS can be stimulated. In contributing to closing the gap the following **research question** is formulated:

"Which Early Warning Signs can be identified in Dutch hospital construction projects, and how can acting on these EWS be stimulated to mitigate possible problems?"

In order to answer the main question, four **sub-questions** are formulated:

1. What are Early Warning Signs and how can they be identified?
2. What barriers occur while acting on EWS and how can these barriers be minimised?
3. Which EWS and which barriers occur while acting on EWS in hospital construction projects?
4. How can the barriers in hospital construction projects be minimised?

1.4 RESEARCH GOAL

The goal of this research is to explore which Early Warning Signs occur in hospital construction projects, how the EWS are identified, which barriers influence the response on these EWS, and how these barriers can be mitigated. Expanding the knowledge on EWS and how the response to them can be stimulated can lead to a more effective EWS procedure within hospital construction projects. This contributes to the aim of improving the chances on meeting project goals.

To achieve these goals, this thesis generates the following deliverables:

1. A literature review on the subject of EWS, the identification of EWS, and the barriers that occur while responding to these EWS. The literature review will provide knowledge about the data present. From the data an overview is created for the empirical study.
2. A case analysis of EWS and responses in a hospital construction project. The purpose of doing a case study is to challenge and complement the scientific research with practical experiences.
3. To give insight in and come up with recommendations on improving and stimulating the responsiveness to EWS in hospital construction projects. An expert panel is consulted and included in the evaluation of this process.

1.5 RELEVANCE

This research expands the knowledge and sheds light on identifying EWS and the response to them in hospital construction projects. In doing so, it contributes to the existing knowledge and literature. As suggested by Haji-Kazami & Andersen (2014) and Wijtenburg (2018), additional studies can investigate the barriers in responding to EWS related to other sectors. Also, Larsen et al. (2022) shows that there is an interest in researching EWS in hospital projects in other countries such as Norway.
Apart from this, there is a need for better knowledge on EWS in daily practice. This research is conducted in accordance with AT Osborne. AT Osborne is a consultancy firm specialised in managing and advising on complex construction projects. The firm keeps investing in building up more knowledge on project control. This research contributes to expanding knowledge on EWS and project control.

1.6 THESIS STRUCTURE

Figure 4 shows the structure of this thesis. It starts with an introduction, where the research context, research gap and questions, the goal of the thesis, and the relevance are introduced. Chapter two continues with the research method applied in this thesis. In chapter three the literature review is discussed. Chapter 4 and 5 show the empirical study, which consists of a case study with semi-structured interviews in chapter 4, and an expert panel in chapter 5. The discussion is presented in chapter 6. Chapter 7 contains the conclusions of this research and the answers to the research questions. Lastly, chapter 8 gives recommendations for further research.

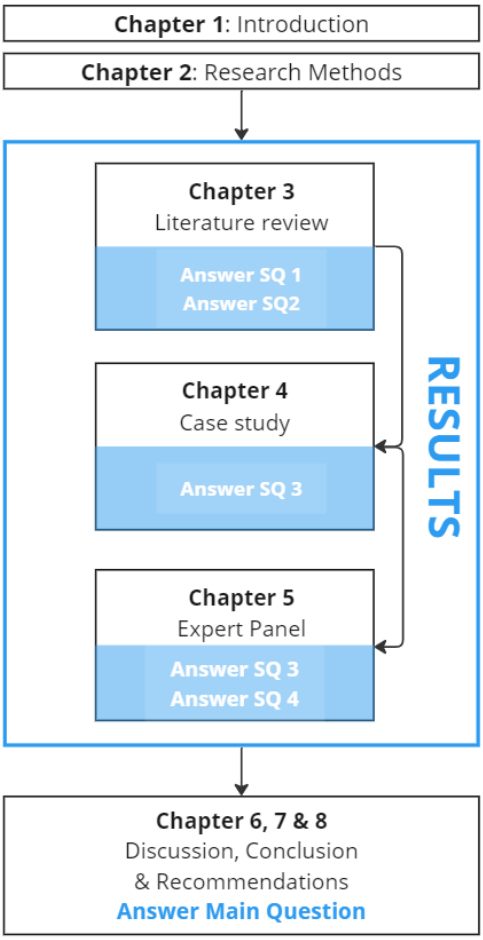

Figure 4 - Thesis structure

RESEARCH METHOD

2. RESEARCH METHOD

This research is an *exploratory* research, since the aim of this research is to get a better understanding of how the identification and responses on Early Warning Signs can be stimulated in hospital (re)construction projects and how barriers can be mitigated. This research is also a *qualitative* study since it makes use of the non-numerical data of case studies and semi-structured interviews. The data are used to gain knowledge, give more insight to develop and modify theories and to understand experiences (Maxwell, 2008). In this research, both the *inductive* and *deductive* approach described by Blaikie & Priest (2019) are used. The research on EWS is limited, especially related to hospital (re)construction projects. So observations are needed to create understanding. These observations are supported by literature research. The base is created in the theoretical part of the research, which includes the literature review. As shown in Figure 5, the research is split into two sections. First a theoretical study is done, and after that an empirical study is conducted. The findings of the theoretical study are explored in practice in the empirical study. These findings are evaluated with experts. In the expert panel, possible solutions from practice are also discussed. From these results conclusions and recommendations are drawn.

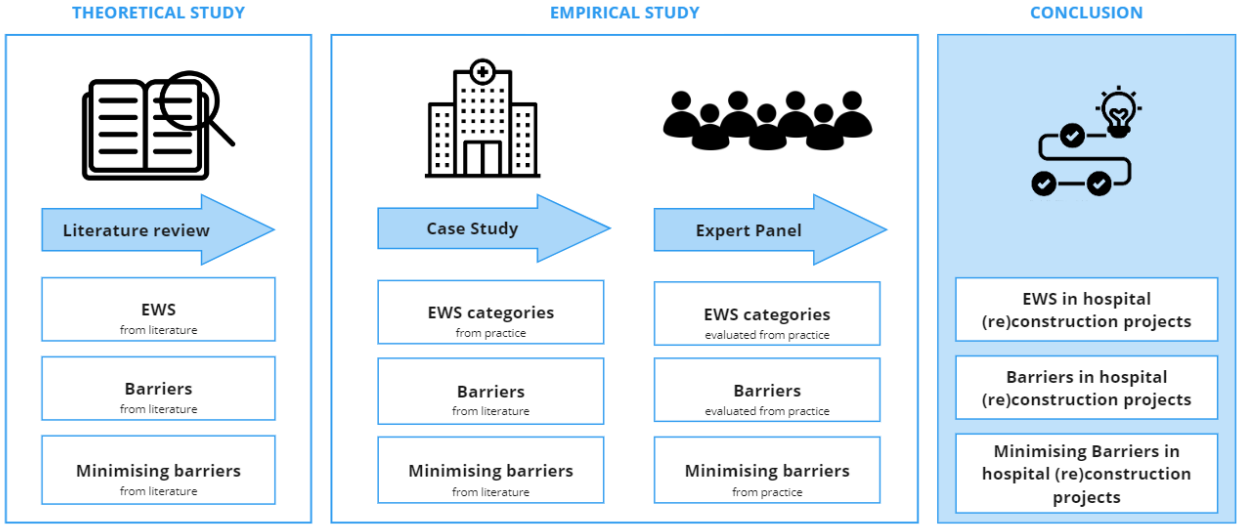

Figure 5 - Research framework

2.1 THEORETICAL STUDY

The first part of this research consists of a theoretical study. In this study, literature about EWS is addressed to give an overview of important EWS, identification methods and barriers that occur while acting on EWS. The gained knowledge from the literature review is used to review the research questions and main ideas. In this manner the literature review is an ongoing component in this research (Bryman, 2016).

By conducting the literature research, the scope of the research is determined. During the literature review, various definitions and findings are collected from scientific journals, scientific reports, and books. Relevant articles are collected in the library of the TU Delft, the Repository of the TU Delft, Google Scholar, and Scopus. Keywords for the literature search were composed, since different names or terms are used related to EWS and hospitals. Search terms related to Early Warning Signs are: 'EW signs', 'Early warning signals', 'warning signs', 'weak signals', 'weak signs', 'responding on EWS', 'barriers in responding on EWS', and 'early warning identification'.
Search terms related to the hospital construction are: 'hospital', 'hospital construction', 'hospital reconstruction' 'hospital real estate', 'hospital building', 'healthcare construction', 'healthcare reconstruction', 'healthcare real estate', and 'healthcare'.

2.2 EMPIRICAL STUDY

After the theoretical study, an empirical research is conducted. In this part, the data retrieved in the empirical study are used to further explore the findings of the theoretical study. The data of the empirical study are retrieved from a case study, semi-structured interviews, and an expert panel.

2.2.1 CASE STUDY

After the theoretical study, the existing data from the literature are summarised. The case study focuses on understanding which EWS can be identified and which barriers occur in a hospital construction project. The case study focusses on the contemporary phenomenon within a real-life context, where the subject is analysed within its context (Yin, 2018). For this research, an in-depth single case study design is used to explore theoretical concepts and to get a deeper understanding of the subject (Gustafsson, 2017). In-depth data selection involves different sources of information in the case (Gustafsson, 2017). To achieve these different sources of data, semi-structured interviews are held with various members of the project team. By using multiple sources, the triangulation of the information is taken into account. In this way, this study aims to resolve the potential disadvantages of the qualitative approach and a single case study, such as subjectivity (Gaya et al., 2016). Also, within the time frame of this research, one case can be studied holistically and in-depth at the same time. This way the case study is better suited to help give an answer to the research questions (Gaya et al., 2016). This can lead to a deeper understanding of the case and its subject (Gustafsson, 2017).

2.2.2 SEMI-STRUCTURED INTERVIEWS

To collect data, the semi-structured interviewing are used. Semi-structured interviews allow some flexibility to learn more about critical areas that are not assessed in the interview set-up (Yin, 2018). The goal of the interviews is to obtain an understanding on which EWS occur in hospital construction projects, which barriers occur and how these barriers can be mitigated. The interviews are conducted with different employees and managers from the project organisation. Apart from the interviews, available project documents are analysed to strengthen the validity.
An interview protocol is created which includes the interview questions and the set-up of the interview. During the interview data is collected by a sound recording device and the notes taken by the interviewer. To validate the data, a transcript of the interview is made and a comprehensive summary is send to the interviewees for a review.

2.2.3 EXPERT PANEL

An expert panel is used to evaluate the EWS and the barriers that show up while acting on EWS in hospital construction projects. Also, information is gathered on how barriers occur while acting on EWS in hospital construction projects and how they can be mitigated. By evaluating the outcomes of the literature review, the case study regarding the categorisation of EWS, and the barriers occurring while acting on EWS, the possibility of coincidence is minimised. Also, the expert panel is asked to advise on possible ways to minimise the barriers in responding to EWS based on their collective and personal experience.

2.3 TRIANGULATION

In this research, the identification of EWS and possible barriers in responding to EWS in hospital construction projects, is looked at from three perspectives: from the literature, in practice through a case study, and by employing an expert panel. In this way the results from one perspective can be explored and evaluated from another perspective. The data collection in this study is done by using three different sources: documents, semi-structured interviews, and an expert panel. Figure 2 shows the triangulation of data where the evaluation of the research is assured through the use of several methods and sources to collect the data on the same topic (Yin 2018).

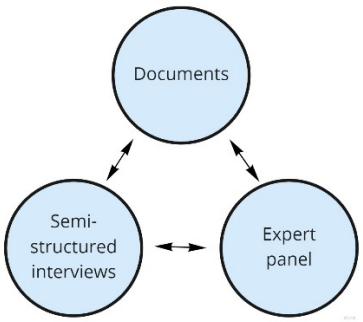

Figure 6 - Triangulation (Yin, 2018).

2.4 ETHICAL CONSIDERATIONS

In this research the FAIR guiding principles Findability, Accessibility, Interoperability, and Reusability of Wilkinson et al. (2016) is used. The scientific data gathered in this research meet the requirements in the following way:

- Findability: this MSC thesis is uploaded on the educational repository of the TU Delft and can be downloaded freely.
- Accessibility: If (raw) data that are not included in the final document, they can be accessed by contacting the author. Important note is that sensitive information will not be shared (not in the final document nor via contact) without permission of the people involved. Before any set of data is used, explicit approval of the participants in the interviews and expert panels is requested. This ensures a safe environment for the interviews and discussions. Also, all cases and participants are made anonymous.
- Interoperability: At the end of the MSc thesis, a list of all used references is included. Also, the thesis is written in formal, accessible English.
- Reusability: The data used in this research meets the domain-relevant community standards and are described with a detailed provenance.

LITERATURE REVIEW

3. LITERATURE REVIEW

This chapter shows the literature review on the phenomenon of Early Warning Signs, how they can be identified, what barriers can occur while acting on EWS, and how these barriers can be minimised.

3.1 EARLY WARNING SIGNS

In this section, the phenomenon of EWS is introduced by looking at existing literature. Also, how EWS can be identified is discussed.

3.1.1 Definition

The concept of Early Warning Signs is used in different and various sectors, for instance in Medicine, Information Technology (IT), and project management. Related to corporate strategic management, the idea was introduced by Ansoff (1975), who discussed that unexpected situations in firms and organisations are indicated by 'weak signals'. Ansoff indicates that weak signals act as warning signs for strategic discontinuities. These signals grow stronger and become more specific in time. Continuing on this concept, Nikander (2002) researched early warnings in project management.
Definition of Early Warning stated by Nikander (2002, pg 49):

"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."

This definition is adopted in this research, since it is the most accepted definition in project management (Wijtenburg, 2018). In contrast to the definition of Nikander (2002), this research focuses on *negative* issues in EWS in hospital construction projects because negative issues can have large impact on the desired project results.

3.1.2 Characteristics of EWS

In literature, different terminology is used regarding EWS: weak and strong signals, soft and hard signs, and leading and lagging indicators. To analyse EWS, these different concepts are discussed below.

Weak and strong signals
Ansoff (1975) describes that signals grow stronger over time. A signal can start weak and develop over time into a strong signal. When a signal is stronger, a more precise response can be formed (Nikander, 2002). Holopainen & Toivonen (2012) describe that when a weak signal appears in a project, the information can be hard to interpret. Over time the information becomes more clear, which means that the outcome of the threat also becomes more clear. However, responding on an weak signal in an early phase of the project can highly benefit the project. In this early phase change costs are still low and there is relatively more time to take proper actions (Wijtenburg, 2018).

Soft and hard signals
Haji-Kazemi et al. (2015) makes a distinction between soft and hard EWS. Williams et al. (2012) mentioned that most EWS have a soft character. A soft signal relates to human and organisational aspects, such as gut feeling, employee satisfaction, trust in the team, culture, and stakeholder relations (Williams et al., 2012;

Haji-Kazemi et al., 2015). A hard signal relates to data, such as project-planning and an overview of the costs (Haji-Kazemi et al., 2015). Traditionally, in construction projects mainly the hard signals are monitored to express the progress of the project. It can be argued that identifying and responding to soft signals can solve problems in an earlier phase in the project (Wijtenburg, 2018).

Leading and lagging indicators

Williams et al. (2012) describe that in a construction project, mostly the hard signals are employed to understand the progress of the project. These indicators give information on past activities of events (Haji-Kazemi et al., 2015). The consequences of an activity can for example be expressed in money or delay. Therefore these indicators function as lagging indicators. According to Haji-Kazemi et al. (2015) lagging indicators are useful for learning since they provide information, but they cannot to be used as a tool for EWS.

However, there are also leading indicators which present themselves before an issue happens, for example employee satisfaction (Haji-Kazemi et al., 2015). Leading indicators can provide relevant information and indicate a more proactive approach in the management of a project (Larsen et al., 2022; Wijtenburg, 2018). Larsen et al. (2022) mentioned that EWS are a type of performance indicators to enhance focus on the project. They represent a proactive approach for responding to strategic surprises. There is certainly a need for proactive management in construction projects (Haji-Kazemi et al., 2015), but current project management methods do not include leading indicators (Wijtenburg, 2018).

3.1.3 Early Warning Signs from literature

In literature, a variety of EWS are indicated and divisions in kinds and categories of EWS are given. For example EWS derived from assessment (hard side) and EWS derived from gut feeling (soft side). This shows the complexity of identifying EWS. This section presents examples of EWS in projects within the divisions of categories shown in literature. This gives an indication of what EWS can be expected.

So far the most comprehensive list of EWS from literature is composed by Nikander and Eloranta (2001). They name 68 EWS and show a categorisation of 11 different groups of EWS, see table 2. The list is based on literature research in the industrial construction sector, interviews with professionals, and case studies.

Table 2 – Early Warnings groups (Nikander and Eloranta, 2001)

Early Warnings
Gut feelings
Personnel, project group
Project manager, management
Project planning
Project control and reporting
Working within the project
Communication
Expressed by parties
Documents
Differences and deficiencies in project culture
External source

Williams et al. (2012) researched EWS in complex projects by doing a literature review, by analysing guidelines, interviews, and case studies. They looked at construction industries, energy, oil and gas, telecommunications, and ICT in the countries Australia, Norway, and the United Kingdom. This research gives an overview of EWS in different stages of a project, with a division between EWS known through assessment and EWS known through gut feeling. Table 3 shows the most important categories of EWS, where the difference between process-related and people-related EWS is taken into account.

Table 3 – Most important EWS, Williams et al. (2012)

EWS	
Process-related	**People-related**
Quality of information and documentation produced	Sponsor with unclear expectations and role
Main risks identified	Leadership issues
Location decisions and complications from such	Culture, whether specific conditions exist that will make cultural aspects a factor
Relevance of the proposed solution compared with needs	Missing competence in the project team
Whether guidelines for early phase assessments and 'behaviour' where followed	
The need for development of new technology	

Larsen et al. (2022) researched EWS in the front-end phase of hospital real estate projects. They identified 62 challenges and established four different categories of EWS, shown in table 4 below. Hard and soft issues are taken into account while creating these categories. They discuss the need for further research on EWS and its terminology.

Table 4 – EWS Categories, Larsen et al. (2022).

Early Warning Signs Categories
Structure and Tools
Context and frame factors
Management
Relational factors and properties

AT Osborne researched soft signals related to project recovery to support the process of a complex project towards an intended end-result (AT Osborne, 2021). Project recovery offers wise guidance and real-world practices for saving troubled projects (Kerzner, 2013). AT Osborne considers identifying and acting on EWS as a valuable approach in project recovery. Their research shows the following ten themes of Early Warning Signs, see table 5.

Table 5 – Themes of Early Warning Signs, AT Osborne (2021). Freely translated.

Early Warning Signs Themes
Trust within the team
Safety to express opinions
Atmosphere within the team
Cooperation between colleagues
Workload
Time and attention for reflection
Feasibility of the project goal
Clarity of the strategy
Relation with environment
Support base of the environment

3.1.4 Identification of EWS

As discussed in the previous section, it is important to interpret EWS in an early stage of a construction project since it gives an indication of what is going to happen in the future. However, little existing literature deals with EWS in projects and project management explicitly (Nikander, 2002; Klakegg et al., 2010; Haji-Kazemi, 2015; Wijtenburg, 2018). There is some literature about project management which include possible ways to identify EWS. Williams et al. (2012) divides the identification of EWS in two groups: EWS identified through assessment, and EWS identified based on gut-feeling. Identification methods of EWS described in literature mostly focus on the hard side, for example documentation or contractual obligations (Williams et al., 2012). Haji-Kazemi et al. (2013) describe identification of hard EWS through hard factors, such as risk/uncertainty management and project assessment. Project assessments include all sorts of audits, or reviews that are applied in a project (Wijtenburg, 2018).

The importance of identifying EWS through gut-feeling is described by Haji-Kazemi (2015). Identification of soft and leading EWS signs can be difficult, since some of these EWS cannot be found through assessment (Williams et al., 2012; Klakegg et al., 2010). Identifying softer EWS can be done by listening to the environment 'with an ear to the ground' (Nikander, 2002). It is important that everyone in the organisation is aware of the detection of EWS, not only higher management. In a workplace, the culture can suppress the expression of soft EWS (Williams et al., 2012). This makes informal elements an important factor in identifying softer EWS, for instance, through unofficial interorganisational moments, such as talks around the coffee table (Holopainen & Toivonen, 2012). Other ways to interpret soft signals are through stakeholder engagement tools and employee feedback surveys (Williams et al., 2012). To identify soft EWS, AT Osborne makes use of the Project Barometer which all members of the team fill in (AT Osborne, 2021). The Project Barometer includes all 10 EWS themes mentioned above.

Although methods to identify EWS mostly focus on hard factors, at the same time the softer aspects such as the culture of the organisation and communication are important to identify EWS. Approaches based on identification through gut-feeling are limited because of the lack of awareness in the projects, and the experience in practice (Wijtenburg, 2018).

3.2 Barriers to identifying and responding to EWS

This section focuses on barriers that prevent identifying and responding to EWS. Despite different methods to identify EWS, the ability to identify and act on them can still be difficult (Williams et al., 2012; Haji-Kazemi, 2015). The barriers that occur in the process of identifying EWS, are explained through the filters in management information (section 3.2.1). There are also barriers that prevent acting on an identified EWS (section 3.2.2). Lastly, possible solutions to minimise the barriers are discussed in section 3.2.3.

3.2.1 Barriers to identifying EWS

Haji-Kazemi et al. (2015) describe what different filters an EWS need to pass before the sign reaches the organisation and can act on the EWS, see Figure 7. In the process of identifying an EWS, the filters can restrict or ease the flow of the information. These filters are based on the theory of Ansoff (1984), and extended by Haji-Kazemi et al. (2015) in terms of project management. The filters are the *surveillance filter, the observer mentality filter, the decision maker mentality filter, and the political/power filter*. The surveillance filter is the first stage where information is processed, so it is represented by which information is needed and what identification methods are used in a project. The observer mentality filter and the decision maker mentality filter are more sociological and psychological. By the observer mentality filter the observer evaluates the information and makes a decision what information is necessary and what information can be eliminated. The amount of data that is given to the decision maker, depends on the culture of the organization and how effective the communication is (Haji-Kazemi et al., 2015). In the decision maker mentality filter the receiver of the information evaluates the received information, and makes a decision on what information can be eliminated, and what information is essential. The final filter, the political/power filter, is used by decision-makers to determine to what extent the information influences the decision-making process.
The strength of the described filters in the process of identifying and acting upon an EWS determines in what way the response is effective or not (Haji-Kazemi, 2015; Wijtenburg, 2018).

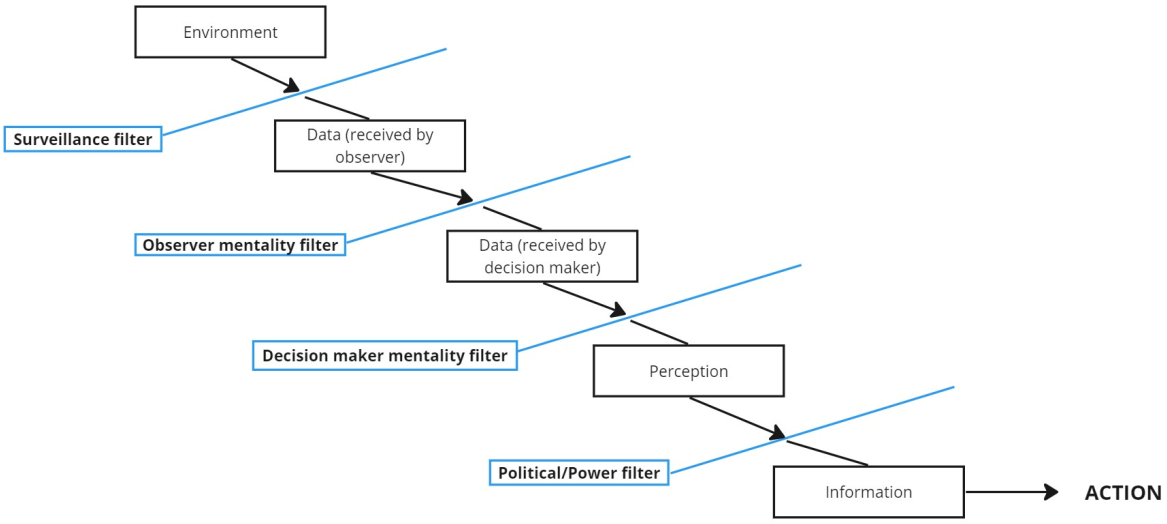

Figure 7 - Filters in Management information in the process of identifying EWS (Haji-Kazemi et al., 2015)

3.2.2 Barriers to responding to EWS

Besides the difficulties that occur while identifying EWS, the ability to actually act on EWS is also a struggle (Wijtenburg, 2018; Haji-Kazemi, 2015; Williams et al., 2012). Different potential barriers to acting on EWS are described in literature. Williams et al. (2012) identified the following barriers: struggle to understand risk and uncertainty in a project, complexity, and tacit knowledge and interaction. Haji-Kazemi (2015) researched the barriers based on the identified barriers of Williams et al. (2012) in different fields related to project management. The outcomes of the research of Haji-Kazemi (2015) are used by Wijtenburg in his research. Wijtenburg (2018) shows the overview of the 8 most important potential barriers to responding to EWS in infrastructure construction projects in Table 6.

Table 6 - Barriers that occur while responding to EWS in infrastructure construction projects (Wijtenburg, 2018)

Barriers *(Wijtenburg, 2018)*
Optimism Bias
Client - Contractor relation
Uncertainty avoidance
Time pressure
Fragmentation
Management style
Project complexity
Effects of politics

Optimism Bias
In construction management, optimism is a known factor (Wijtenburg, 2018; Winch, 2010). Optimism bias implies that potential benefits of the project are overestimated, while on the other hand the cost are underestimated (Flyvbjerg, 2003; Wijtenburg, 2018). Optimism bias can function as a barrier while identifying EWS (Williams et al., 2012).

Client-contractor relation
In the relationship between the client and the contractor, trust plays an important role (Wijtenburg, 2018). In the project, the actors can have different perception of the project status, difference in satisfaction of the relationship, and a different experience in project outcome (Wijtenburg, 2018; Pinto, 2014). This can lead to a more rival dynamics between the parties, which can imply withholding information and information asymmetry (Pinto, 2014; Winch; 2010). Wijtenburg (2018) says that with these possible dynamics between the client and contractor, it is likely that EWS are missed or misinterpreted.

Uncertainty avoidance
Related to construction management, when there is a project culture with high uncertainty avoidance, it is possible that the team members are too focussed on the rules and procedures (Wijtenburg, 2018). This can lead to missing the EWS that gut-feeling can identify. It is also possible that when an EWS is detected, the team member feels threatened by the uncertainty that such a sign can bring (Wijtenburg, 2018). If that is the case, it is likely that the team member rejects or neglects these signs.

Time pressure
Williams et al. (2012) shows that too much time pressure limits the time for reflection: reflecting on the progress and decisions, and looking ahead in the project. A bit of pressure on the schedule can stimulate the project team to perform, but too much time pressure eliminates this possible benefit and causes negative effects (Wijtenburg, 2018). When there is less time to reflect, it can lead to higher chances of missing or neglecting possible EWS.

Fragmentation
In a project there is fragmentation if knowledge is not transferred in the project, and between projects and the organisation (Wijtenburg et al., 2018). When a construction project is considered big, the organisation of such project has a great number of people involved. Often different teams in the project are formed. This can limit the learning within the organisation. This is also the case with knowledge from previous projects, since there is an unique project-based environment (Wijtenburg, 2018). This also can have a negative effect on EWS.

Management style
The leadership style of the project manager has an influence on project performance (Wijtenburg, 2018). A certain style of leadership cannot be considered better or worse in management, but the difference in style has influence on how EWS are dealt with in a project. Wijtenburg (2018) states that it is not investigated which management/leadership style is best related to acting on EWS, but that a culture of open communication is very important for the handling of EWS.

Project complexity
Complexity in the context of a project is researched and described by many authors (Bosch-Rekveldt et al., 2011; Wijtenburg, 2018). In engineering projects, Bosch-Rekveldt et al. (2011) developed a framework for project complexity looking at three elements: Technical, Organizational, and Environmental complexity (the TOE-framework). In hospital construction projects, especially the complexity of the organisation is distinguished (Van der Zwart & Van der Voordt, 2015). Williams et al. (2012) stated that complexity in a project has an important role in preventing identifying and acting on EWS. Haji-Kazemi (2015) shows that project complexity makes gut feeling approaches for identifying EWS more important, and that it makes discussing EWS more difficult, which weakens the responses on the EWS.

Effects of politics
Political effects can be used as a pressure to implement certain agendas or solutions and therefore influence a project (Williams et al., 2012). Wijtenburg (2018) states that in projects top-down political pressure influences the decision making, and therefore also affect the decision making whether or not to act on EWS (Haji-Kazemi, 2015).

3.2.3 Minimising the effect of barriers in responding on EWS

Literature studies do not provide a clear means or method to overcome or minimise the effect of barriers (Haji-Kazemi et al., 2015; Wijtenburg, 2018). In the following paragraph several suggestions are done to soften the effect of barriers.

Optimism Bias
To mitigate the optimism bias, Flyvbjerg (2013) suggests that an outside view must be used throughout the project. An outside view can prevent optimism bias by focussing on the empirical outcomes and using those outcomes to generate conclusions about future events (Haji-Kazemi et al., 2015). Wijtenburg (2018) states that this can be done by challenging the project by internal and external reviews.

Client-contractor relation
A negative client-contractor relation can be improved by ensuring a healthy client-contractor relation based on transparent communication (Wijtenburg, 2018). This can be ensured by setting a good example by the project organisation in open communication, so that the same can be expected from the other parties involved. Pinto (2014) states that transparency is important to assure that all actors understand the standards and are willing to contribute to make the project a success. Differences in interests should therefore also be discussed explicitly, and differences should be challenged by questioning and not judgement (Wijtenburg, 2018).

Uncertainty avoidance
Minimising the negative effects of uncertainty avoidance can be done by tracking and discussing EWS (soft and hard) explicitly (Wijtenburg, 2018). It is important that this is done from the start of a project and on a regular basis. A culture of open communication and trust is essential for sharing EWS. Wijtenburg (2018) notes that to avoid ignoring EWS due to uncertainties, a way to track EWS explicitly needs to be created, focussed on the soft aspects.

Time pressure
To minimise the negative effects of time pressure, Haji-Kazemi et al. (2015) states that it is important for managers to take focus on this element from early stages in the project, and keep focussing on in throughout the whole project. To avoid the negative elements of the time pressure, sufficient and effective time for reflection must be ensured. Klakegg et al. (2010) advise to minimise the negative effect of time pressure on decision making on EWS by ensuring transparency. This can be done by creating multiple communication lines to the decision makers (Wijtenburg, 2018).

Fragmentation
Fragmentation in projects can be avoided by stimulating communication with colleagues within the project, as well as with colleagues outside the project. It is important that an culture of openness is created, that stimulates communication between colleagues in the organisation. In this way information can be shared efficiently (Haji-Kazemi et al., 2015).

Management style

A bottom up management approach can help to overcome possible negative effects of management style. At the same time being decisive and transparent in decision making is important (Wijtenburg, 2018). To avoid indecisiveness, organising critical thinking by internal challenge stimulates sharing EWS. Ensuring that there is enough capacity in the project team to follow up on the EWS is needed.

Project complexity

In order to minimise the negative effects of project complexity, the project should invest in gut-feeling approaches to detect EWS (Williams et al., 2012). Starting from the beginning of a project these approaches must be incorporated and used on a regular basis. Informal communication and interaction should be stimulated in order to reveal patterns of unknowns (Klakegg et al., 2010).

Effects of politics

To minimise the negative effects of politics, an effective stakeholder response strategy must be chosen to better deal with political pressures (Haji-Kazemi, 2015). It is important that the accountability is placed on the higher management and politics, and that the communication to higher levels is established (Wijtenburg, 2018).

3.3 Key findings Literature review

This section presents the key findings of the conducted literature study on EWS, the identification of EWS, the barriers that can occur while acting on EWS, and the possible means to minimise the barriers.

3.3.1 Early Warning Signs

Early Warning Signs are indicators for potential negative future developments. The characteristics of these signs are that they are leading indicators, consisting of mostly soft signals, and grow stronger over time. Taking EWS into account, and responding to them can have a positive effect on the process and outcome of (construction) projects.

To be able to explore EWS in hospital construction projects, in this study a classification of EWS categories is made (figure 4). These categories are based on the 4 relevant research studies on EWS described by Nikander and Eloranta (2001), Williams et al. (2012), Larsen et al. (2022), and AT Osborne (2021).

EWS categories from literature				Classification of EWS categories
Nikander & Eloranta, 2001	Williams et al. 2012	Larsen et al. 2022	AT Osborne 2021 (Freely translated)	
Project planning Project control and reporting	Main risks identified	Context and frame factors	Feasibility of the project goal	→ Feasibility project goal
Documents	Quality of information+ documentation produced Need for development of new technology	Structure and Tools	Clarity of the strategy	→ Quality of documents
Gut feelings Personnel, project group	Culture		Trust within the team	→ Experience in team
Differences and deficiencies in project culture	Missing competence in the project team		Atmosphere within the team	
Project manager, management	Relevance of the proposed solution compared with needs Leadership issues	Management	Safety to express opinions	→ Management
Working within the project	Whether guidelines for early phase assessment and 'behaviour' where followed		Workload Time for attention and reflection	→ Workload
Communication			Cooperation between colleagues	→ Communication
Expressed by parties External source	Location decisions and complications for such Sponsor with unclear expectations and role	Relational factors and properties	Relation with environment Support base of the environment	→ Stakeholders

Figure 8 - Classification of EWS categories

Identification of EWS is not straightforward. Literature shows that methods to identify EWS tend to focus on hard factors, but Haji-Kazemi (2015) stress the fact that especially the soft aspects must be taken into account. However, approaches based on identification through gut-feeling are limited because of the lack of awareness in projects, and experience in practice (Wijtenburg, 2018).

3.3.2 Barriers

In literature, no clear method or approach to minimise or overcome the effect of barriers can be found. However, several suggestions are made to soften the effect of to the barriers described.

Before a project organisation can *identify* EWS, different filters can obscure the identification of the signs. Haji-Kazemi et al. (2015) introduced the *surveillance filter, the observer mentality filter, the decision maker mentality filter, and the political/power filter.* Being aware of this filters is the first step in recognising EWS and acting on them.

Wijtenburg (2018) shows the 8 most important potential barriers to *responding* to EWS in infrastructure construction projects. Figure 9 shows the barriers identified by Wijtenburg (2018) and the possible response from literature to minimising them. In this study these identified barriers are also used to explore possible barriers that can occur while acting on EWS in hospital construction projects.

Barriers *(Wijtenburg, 2018)*	**Minimising Barriers** *(Literature study)*
Optimism Bias	- Outside view on project (by internal and external reviews) (Flyvbjerg, 3013; Wijtenburg, 2018)
Client - Contractor relation	- Transparant communication (Pinto, 2014) - Project organisation should lead by example (Wijtenburg, 2018)
Uncertainty avoidance	- Tracking soft EWS explicitly - Discussing EWS on regular basis (Wijtenburg, 2018)
Time pressure	- Secure transparancy in decision making (Klakegg et al., 2010) - Ensuring sufficient ime for reflection (Wijtenburg, 2018)
Fragmentation	- Facilitate sharing information both inside and outside the project (Wijtenburg, 2018)
Management style	- Apply bottom-up management style (Wijtenburg, 2018) - Organise critical thinking and capacity (Wijtenburg, 2018)
Project complexity	- Stimulate interactions throughout the project to reveal unknowns (Klakegg et al., 2010)
Effects of politics	- Ensuring accountability and communication to higher management and policits (Wijtenburg, 2018)

Figure 9 – Barriers and minimising barriers from literature

CASE STUDY

4. CASE STUDY

This chapter contains the results of the case study conducted on a large hospital reconstruction project. Section 4.1 describes the approach of the case study. After that the results of the case study are presented in 4.2. In section 4.3 conclusions are drawn.

4.1 CASE STUDY APPROACH

The approach of the case study applied in this research is discussed in this section. The goal of the case study is motivated, how the data collection is designed, how the case is selected, and what the interview design entails.

4.1.1 Goal of the Case study

The goal of the case study is to investigate which EWS occur in hospital (re)construction projects, and how barriers interfere in responding to these EWS.

4.1.2 Data Collection

The EWS and barriers in responding to these EWS found in the literature study, are researched in a current project in the hospital real estate sector. The data are collected through project document analysis and semi-structured interviews. The document analysis gives a clear indication of the hospital context, the organisational context, and the progress of the project. By using semi-structured interviews, flexibility is obtained within a guiding structure with boundaries. The questions asked in the interviews were carefully prepared. Special attention was given to the fact that the interviewees were at ease during the interview. As EWS are related to soft project aspects such as human behaviour, it was important that the participants in the interviews felt free to share their information.

Privacy and confidentiality are important issues. The project has a long history and is still under construction. Therefore, the case in this research is described in an anonymous way, as are the interviewees that participated in this study. Information obtained by the research is sensitive. At the same time, participants are keen to learn how the findings on EWS can be incorporated in the final stage of the project.

The findings from the interviews are linked to EWS, filters and barriers as described in the literature. In this way, it can be established how EWS, and the possible filters and barriers manifest themselves in a complex hospital project.

4.1.3 Selection of the case

Table 7 shows the criteria for the case selection.

Table 7 - Criteria Case selection

Case selection		
Number	**Aspect**	**Criteria**
1.	Industry	The project is an hospital (re)construction project
2.	Location	The project is located in the Netherlands
3.	Phase	The project is in the building phase or finished
4.	Characteristic	The task of the project is considered complex

A large-scale hospital (re)construction project met all the criteria. The hospital project is a combination of renovation of older buildings and new developments. The project team was willing to fully participate in the study. Not only did they share relevant project-documentation, (former) members of the project team also participated in the interviews. As the project is still under development and the (political) context is sensitive, special attention had to be paid to confidentiality. Anonymity of the information and the interviewees had to be assured.

4.1.4 Interview design

Semi-structured interviews are used in this case study to collect data. An interview guide was made beforehand (*Appendix B*). This guide provides structure and sets boundaries, while still maintaining necessary flexibility in the interviews. Each interview lasted one hour and the conversations were recorded and transcribed. A summary of this transcript was shared with the interviewees for approval.

Each interview starts with introducing the concept of EWS. After that the hospital project and the function of the interviewee within the project is discussed. Each participant is asked to name big events and key-moments in the project. The interview questions were specifically designed to enable participants to come up with both hard and soft EWS, possible filters that occur while identifying EWS, and barriers that can prevent acting on EWS. The participants are asked to link specific moments in the project to (hard or soft) signals that could possibly have indicated those events, and how a response was or was not formed to those signals.

4.2 CASE STUDY RESULTS

This chapter contains the results of the case study. First, the case is introduced including the various roles of the participants in the interviews. The results and findings are discussed and conclusions regarding EWS and barriers in hospital (re)construction are presented.

4.2.1 Case introduction

Context of the hospital project

The hospital needed a large-scale renovation, so the initial plan was to create a new building. This plan originates from 2008. However, the plan could not be executed in the original form, so changes were made. In 2016, an adapted plan was delivered in which the hospital is partly renovated and new parts are constructed in different phases. An investigation was done which departments were most in need of renovation. At the same time the volume of the project got rescaled and the scope and design were diminished. The new project was divided in three building phases (Figure 10). The first phase started in 2020 and focuses on the renovation part of the project, the building of the basement, and the build of the acute care unit (intensive care and complex care). The second phase and third phase include the construction of the offices, diagnostics and outpatient clinics, and operating theatres.

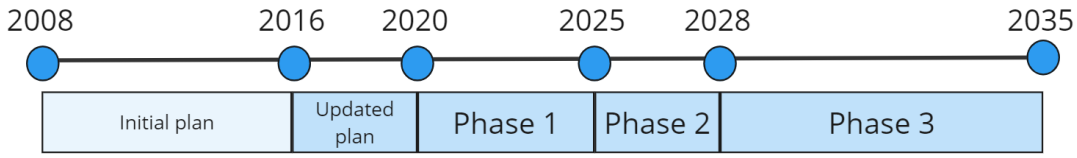

Figure 10 - Hospital case study timeline

The simplified organogram of the organisation of the project is shown in Figure 11.

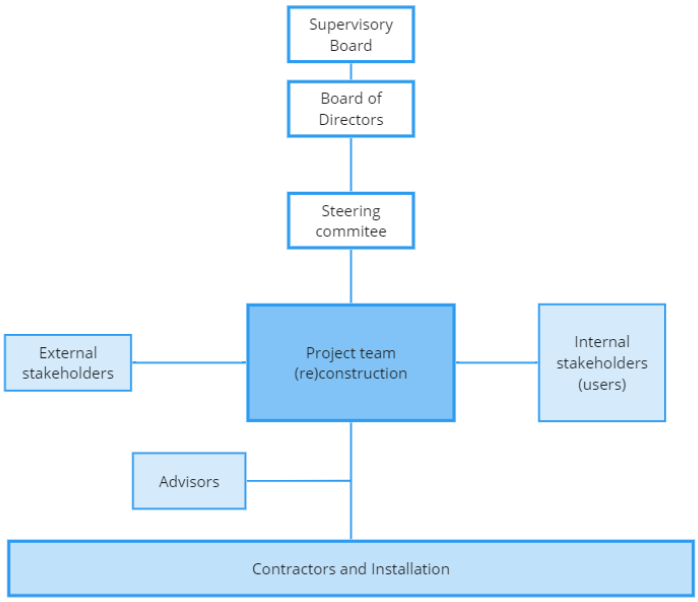

Figure 11 - Simplified organogram hospital case

Participants in the interviews

Eight interviews were held in the period of November 2023 – January 2024. Table 8 shows the different roles of the participants that were interviewed. The interviews were held in Dutch, so also the Dutch translation of the roles is added.

Table 8 - Roles of participants interviews case study

Participants interviews case study		
Participants	**Role**	**Role (translated)**
Interviewee 1 (i1)	Risk manager	Risico manager
Interviewee 2 (i2)	Support Building manager and stakeholder manager	Ondersteuning Bouw coördinator en omgevingsmanager
Interviewee 3 (i3)	Procurement coordinator	Coördinator inkoop
Interviewee 4 (i4)	Real estate advisor	Huisvestingsadviseur
Interviewee 5 (i5)	Construction supervisor	Directievoerder
Interviewee 6 (i6)	Facility Manager	Facilitair manager
Interviewee 7 (i7)	Project manager	Projectmanager
Interviewee 8 (i8)	Project director	Projectdirecteur

The timeline (Figure 12) shows when the interviewees were/are involved in the project.

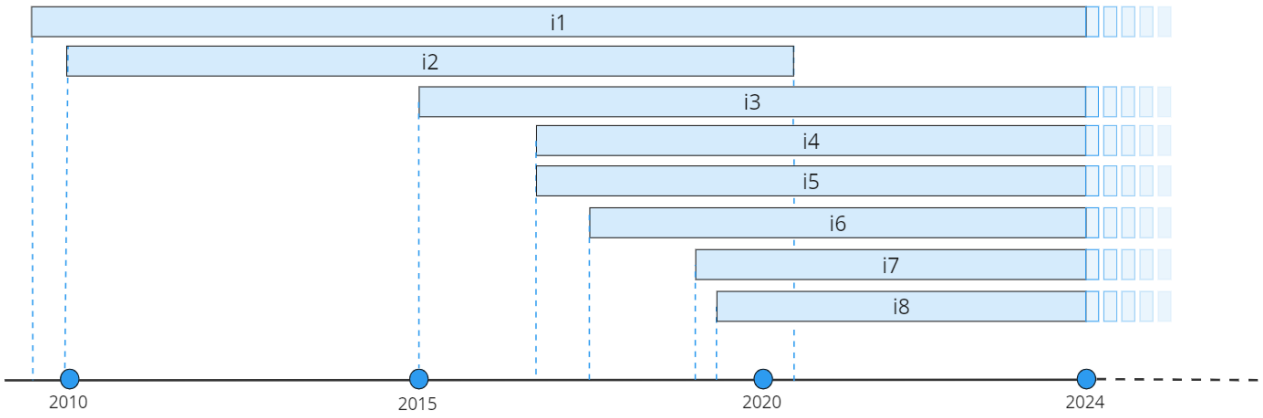

Figure 12 - Timeline of involvement of interviewees

4.2.2 Early Warning Signs in hospital reconstruction project

Several EWS were identified in the hospital reconstruction project by looking at the project documents and from the interviews. The overview of all EWS found in the case is presented in *Appendix C*. The overview of the anonymised EWS found in the case is presented in

Table 9. The highlighted blue numbers represent soft EWS, the other numbers refer to hard EWS. Table 9 shows that 12/21 EWS found in the hospital case can be categorised as soft, so relating to human behaviour, communication and gut feeling. The other 9/21 EWS can be categorised as hard signals, representing the traditional way of project management such as risk management, project and financial planning.

Table 9 - EWS hospital case

	Early Warning Sign	Description	Period	Submitted by # interviewees
1	Discussion about contract form	In the team there was a division in view on which form of contract would be best for the project	Initial plan	2 of 8
2	No experience in team with chosen contract form	No team member worked with this contract form before	Initial plan	2 of 8
3	Project plan not accepted by users	The users did not agree with the organisational changes as a result of the project plan	Initial plan	3 of 8
4	Mainly steering on the financial aspects	Mainly the financial side of the project was considered in the decision making	Initial plan	1 of 8
5	Plan was not feasible	Project scope did not match with budget	Initial plan	4 of 8
6	Documents not complete	Some documents needed for contract where missing or not finished	Initial plan	2 of 8
7	Connection project and internal organisation is lacking	The internal organisation was not intertwined in the project	Initial plan	2 of 8
8	High pressure to create project ambitions	In a short period of time the ambitions of the project needed to come together in a document	Updated plan	1 of 8
9	Challenge to understand needs of different stakeholders	Since a high number of stakeholders are involved, with all a different expertise, it is a challenge to understand each other totally	Updated plan	3 of 8
10	Changes in scope discussed to match budget	The client and project team discussed the possible changes and budget to meet the project goal and plan	Updated plan	2 of 8
11	Environment more critical about project plan then expected	No to little discussion possible with local groups about how the deal with the trees in the project area	Updated plan	1 of 8
12	Worries about quality of documents discussed	The documents are based on the initial plan, but there are worries in the team if the designs will fit the updated plan	Updated plan	3 of 8
13	Unclarity about role description and responsibilities	Some responsibilities where not discussed per role and therefore not taken	Updated plan	3 of 8
14	Users skeptical about feasibility revised plan	After the initial plan where the users felt not heard, the users where not sure if the revised plan would work	Updated plan	3 of 8
15	Documents are not integral designed and contain some inconsistencies	Parties worked on the documents in different time frames and despite checks there are some inconsistencies in the documents	Updated plan and Phase 1	3 of 8
16	Worries about cooperation between parties	Some team members expressed their worries about the cooperation between different parties involved	Updated plan and Phase 1	4 of 8
17	Postponing making decisions	Due to innovations and fast lead time some decisions are postponed	Updated plan and Phase 1	5 of 8
18	Worries about financial feasibility	Due to changes in the project, some team members worried about the budget	Phase 1	4 of 8
19	Colleagues and stakeholders are difficult to reach	Before deadlines, some colleagues would not pick up their phones or respond on the email	Phase 1	2 of 8
20	Little time for reflection	In busy times the focus shifts to dealing with current issues and not reflecting on previous situations	Phase 1	4 of 8
21	Planning not feasible	Due to delay and unforeseen events the planning is not feasible and up-to-date anymore	Phase 1	5 of 8

All EWS from the literature study (Table 10) were recognised in the interviews.

Table 10 - EWS categories named in case study interviews

EWS categories	Named in interviews
Stakeholders	8/8 interviews
Workload	8/8 interviews
Feasibility project goal	7/8 interviews
Quality of documents	7/8 interviews
Experience in team	6/8 interviews
Management	5/8 interviews
Communication	4/8 interviews

From the interviews it is notable that six interviewees stressed that the complexity related to hospital project is linked to the high number of (internal) stakeholders and the hierarchy in the hospital organisation. Also the big influence of the users on the project is named by all of them.

> *"A feature of a hospital construction project is the high number of stakeholders, for example the nurses, doctors and managers."*
> *(Interviewee 4, 2023)*

One of the participants of the interviews stressed the fact that some delays were linked to the EWS categories cooperation and communication.

> *"Looking back at which signals were shown before a deadline was passed, different signals showed that cooperation was under pressure. Communication between team members [also the communication with the contractor] deteriorated and not all shared information was complete."*
> *(Interviewee 6, 2023)*

In this case study, the EWS regarding decision making, internal stakeholders, and coordination with users appeared to be key topics.

4.2.3 Barriers occurring while acting on EWS in hospital reconstruction project

All barriers that can occur while acting on EWS from the literature study (Table 11) were recognised in the interviews. The barrier 'Time pressure' was named most in the interviews, often in relation with other factors. For example, one interviewee mentioned that time pressure had a negative effect on the risk management sessions and therefore the follow up on the risks was less effective.

Table 11 - Barriers named in case study interviews

Barriers	Named in interviews
Time pressure	5/8 interviews
Client - Contractor relation	4/8 interviews
Fragmentation	4/8 interviews
Project complexity	4/8 interviews
Optimism Bias	3/8 interviews
Management style	3/8 interviews
Effects of politics	3/8 interviews
Uncertainty avoidance	2/8 interviews

In the interviews the difficulty of recognising an EWS was also stressed by some interviewees. It was named that often team members do not know where they can express an EWS or gut feeling. Another factor was that when an EWS is expressed, it is not always well-received or understood by the recipient. In addition from the answers of the interviewees the filters of Haji-Kazemi (2015) described in section 3.2.1 also played a role in the hospital case.

4.3 KEY FINDINGS CASE STUDY

This section presents the key findings of the case study. First the categorisation of EWS is shown. Then the barriers that can occur while identifying and acting on EWS are presented.

Early Warning Signs in a hospital reconstruction project

In the hospital case all EWS that were mentioned in literature, were recognised by the interviewees. However, by exploring the hospital case, it became clear that some adjustments specific for the hospital reconstruction project can be made. Figure 13 shows the adjustments (highlighted) made based on the interviews.

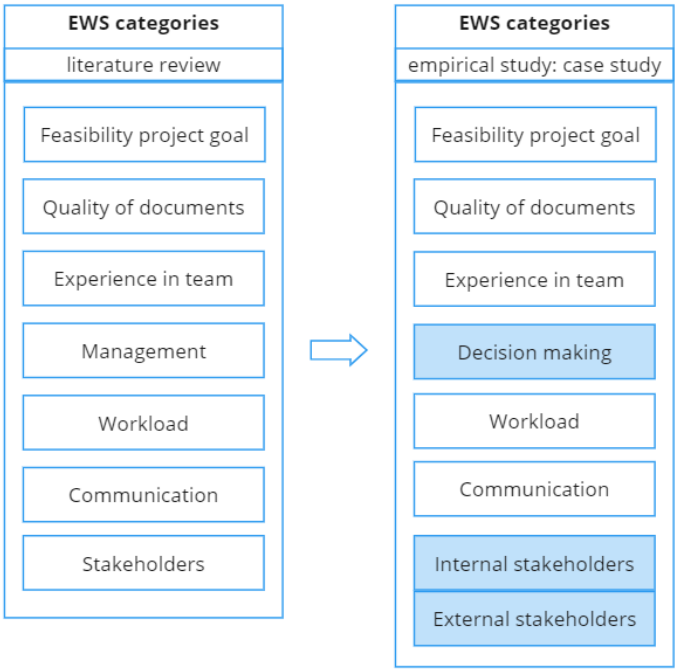

Figure 13 - EWS categories from literature to case results

It was found that the category 'management' from the literature review is redefined into 'decision making'. Participants of the interviews mentioned that postponing (critical) decision making by the management had a negative influence on the project. Project members experienced uncertainty and were worried by the delays that occurred because the management were keeping options open too long.

> *"By postponing making a decision about the layout of the operating room, the contractor already placed the beams. When finally a decision was made, the final layout cannot be realised in the room without making changes in the structure or design."*
> *(Interviewee 3, 2023)*

> *"Some decisions were postponed to a later phase of the project, however, in some cases the decision making about the issues did not take place at all. This led to disappointments and irritations for some team members."*
> *(Interviewee 6, 2024)*

Continuing on the different categories of EWS in the hospital reconstruction project, the interviewees highlighted that in hospital projects a division has to be made between different stakeholders. The users (internal stakeholders) have a big influence on the project, while other parties (for example the local residents) have far less influence. Therefore the EWS category 'Stakeholders' is divided into 'Internal Stakeholders' and 'External Stakeholders'.

"An interesting element in a hospital construction project is that not always the client is the one that is the boss or influences the project. This is the case because a hospital project has to deal with partnerships (Dutch: maatschappen), doctors, and specialists. These internal stakeholders have great influence on the project."
(Interviewee 7, 2024)

"During the creation of the ambition document [in the phase of the updated plan] extra attention was paid to involve the doctors and nurses, to ensure that they were on board with the updated plan. Especially because these stakeholders disagreed with the initial plan."
(Interviewee 4, 2023)

Barriers occurring while acting on EWS in a hospital reconstruction project

For the case study the input from the theoretical study was used and explored in practice. In the case all barriers that can occur while acting on EWS were recognised. The barriers recognised in the hospital reconstruction project appear to be the same barriers as found in the literature review (see Figure 14).

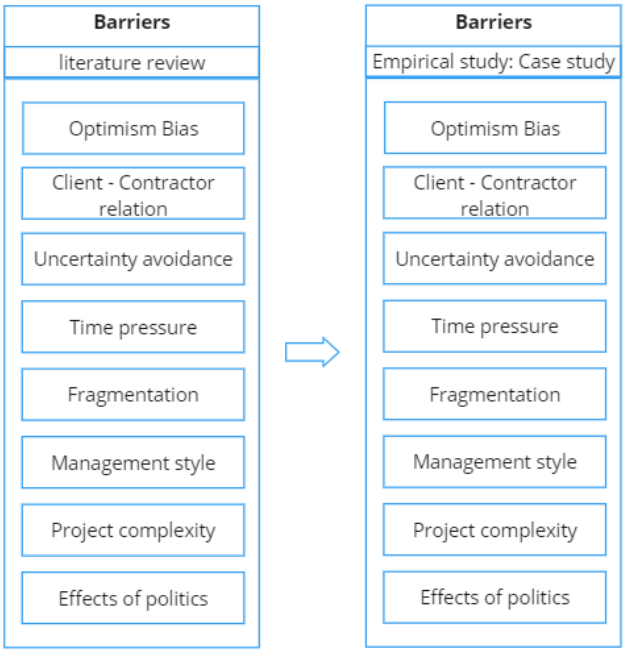

Figure 14 - Barriers occurring while acting on EWS from literature to case results

The participants of the interviews not only recognised the different barriers, but also explained that in some cases that not one barrier occurred, but that several barriers occurred at the same time and were connected.

> *"A barrier to not respond to an EWS is that team members don't want to be in each other's way. Due to high time pressure discussing issues is postponed or simply do not take place. […] A hospital is a big and complex organisation. Some issues are not discussed with the persons who need to hear about the issues."*
> *(Interviewee 1, 2024)*

> *"Barriers which prevented acting on an EWS were usually of a personal nature, for example pride, sense of honour, and not wanting to fail. But also the belief that the project is executed the way it should played a part."*
> *(Interviewee 7, 2024)*

> *"Regarding the chosen contract form, a specific document were missing. The team missed the necessary knowledge and had no experience with this specific contract form."*
> *(Interviewee 7, 2024)*

Filters occurring in hospital reconstruction project

The participants in the case study recognised the barriers, but also described the filters by Haji-Kazemi et al. (2015). The interviewees mentioned that it can be difficult to recognise an EWS, which relates to the 'Surveillance filter'. It was also mentioned that team members named the EWS, but the other person did not fully understand the named EWS, which relates to the 'Decision maker mentality filter'.

> *"Looking back, some EWS were missed because the signal was not clear for the receiver of the information. The person who informed a colleague about an EWS shared his view, but the colleague did not understand the meaning or importance [of the signal]. This is also related to the different expertise of team members: do employees from the hospital understand what the employees of the construction site mean when talking about certain subjects?"*
> *(Interviewee 4, 2024)*

The hospital case study answered sub question 3 (section 1.3), and also presented useful insights for sharpening the categories for EWS in hospital construction and dealing with the barriers that can occur while acting on EWS. The interviewees indicated that they think that they will think that they will recognise EWS and barriers better if special attention is paid to the concept of EWS in the project team. This not only improves the awareness in the team, but some room can be created for better communication between team members.

EXPERT PANEL

5. EXPERT PANEL

This chapter contains the results of the expert panel. The set-up of the expert panel is discussed in section 5.1. The results are presented in section 5.2. In section 5.3 conclusions are drawn.

5.1 EXPERT PANEL APPROACH

5.1.1 Goal of the expert panel

The goal of the expert panel is to gather expert information in practice about Early Warning Signs in hospital construction projects, the barriers that occur while acting on EWS and finding possible approaches to minimise these barriers.

5.1.2 Expert panel design

The expert panel that participated in this study consists of consultants and managers who have worked and are working on complex projects in the Dutch hospital real estate sector. Their views and information can be considered as reflecting the dominant views on managing complex projects in this sector. Eight experts were asked to join the expert panel, some of them having more than 30 years of experience in Dutch hospital projects. The group of experts is selected carefully, considering different roles and focus areas: managing consultants, project managers with experience in all stages of a project, and consultants (technical, contract management, stakeholder management and project control).

The session of the expert panel started with an overview of the different categories of EWS and the barriers (see Figure 13 and Figure 14) derived from the case study.

First, the experts were asked if they recognise the categories of EWS in practice, and to rank them according to their impact on managing the project and keeping the project in control.

The following step was to look at the barriers that interfere with responding to EWS. The experts were asked if they recognise the barriers in practice and to rank them according to their impact. The barrier that is ranked highest has the biggest influence on not-acting on EWS and therefore has a negative influence on project management.

In the next step, the topic minimising the barriers was discussed. The experts were asked to individually come up with ideas to minimise the top 3 most impactful barriers, write their answers down on sticky notes, which were collected on three posters. Only the top 3 most impactful barriers were evaluated because of the limited time available and the choice to elaborate on 3 topics in detail. Next, the three barriers were divided under the experts and discussed in three groups. Each group presented possible mitigation measures to one of the 3 barriers on the posters.

In Table 12 the findings from the literature review and the case study about EWS are presented into a list of eight EWS categories. As the expert panel was held in Dutch, also the translations are shown.

Table 12 - EWS Categories derived from case study (with translation)

EWS Categories	EWS Categories (translated)
Decision making	Besluitvorming
Communication	Communicatie
Experience in the team	Ervaring in het team
Quality of documents	Kwaliteit van documenten
Feasibility of the project goal	Haalbaarheid van het projectdoel
Workload	Werkdruk
Internal Stakeholders	Interne Stakeholders
External Stakeholders	Externe Stakeholders (omgeving)

In Table 13 the findings from the literature review and case study about the barriers that occur while responding on EWS are presented (also including the Dutch translations).

Table 13 - Barriers that occur while acting on EWS derived from case study (with translations)

Barriers	Barriers (translated)
Optimism Bias	Over Optimisme
Relationship with contractor	Relatie met aannemer
Uncertainty avoidance	Onzekerheid vermijden
Time pressure	Tijdsdruk
Fragmentation	Fragmentatie
Management style	Management stijl
Project complexity	Complexiteit van het project
Effects of politics	Politieke druk

5.2 EXPERT PANEL RESULTS

The expert panel consisting of eight qualified experts came up with several suggestions that can lead to improvements in dealing with EWS and barriers in hospital construction projects.

5.2.1 Categories of Early Warning Signs

The experts where asked if they recognized the categories of EWS in practice. Figure 15 shows that all the eight categories in the literature of EWS were recognised in practice by the experts. There was one category which all the experts recognised, namely 'Decision making' (besluitvorming). According to the experts, postponing a decision, or keeping options open for changes after a decision was made, are common in practice. Two experts suggested two other categories of EWS, namely, 'cooperation' (samenwerking) and 'team composition' (team compositie). These two EWS categories where recognised by the other experts. Difficulties in cooperation can be seen as an EWS in the projects. According to the experts it is important that the team composition in a project team contains a good mix of different characters and skills.

EWS categories	Recognised by experts
Decision making	8/8 experts
Feasibility project goal	7/8 experts
Quality of documents	7/8 experts
Workload	7/8 experts
Internal stakeholders	7/8 experts
Communication	6/8 experts
Experience in team	6/8 experts
External stakeholders	5/8 experts
Team Composition	Recommended by expert
Cooperation	Recommended by expert

Figure 15 - EWS categories recognized by experts

5.2.2 Ranking the EWS on impact

The experts where asked to rank the recognised EWS on their impact in a hospital project in practice. Figure 16 shows the results of the ranking.

Figure 16 - EWS categories ranked on impact

The experts agreed that 'feasibility of the project goal' and 'decision making' have most impact on the project in practice, since not acting on those signs causes immediate problems in the hospital construction project. 'External stakeholders' were ranked the lowest, because of the relatively small area a hospital construction project covers, and therefore there is only a relatively small amount of external stakeholders that is involved in the project.

5.2.3 Barriers

All presented barriers that can occur while responding on EWS were recognised in practice by the experts, as shown in Figure 17. All eight experts recognised the barrier 'Management style': there are different styles a project manager can adopt in managing a project. Besides the barriers that were presented, the experts discussed another factor that influences the barriers they recognised in practice, namely *money*. The experts stated that money actually plays a part in most of the barriers. For example, 'over optimism' about the budget, and the 'pressure from the board' to execute the project within the budget estimations.

Barriers	Recognised by experts
Management style	8/8 experts
Client - Contractor relation	7/8 experts
Optimism Bias	6/8 experts
Time pressure	6/8 experts
Uncertainty avoidance	5/8 experts
Project complexity	5/8 experts
Effects of politics	5/8 experts
Fragmentation	4/8 experts

Figure 17 - Barriers recognised by experts

5.2.4 Ranking of the impact of the barriers

The experts were asked to rank the barriers on their impact on a hospital construction project in practice. Figure 18 shows the results of the ranking. Ranking barriers is useful to prioritise management attention.

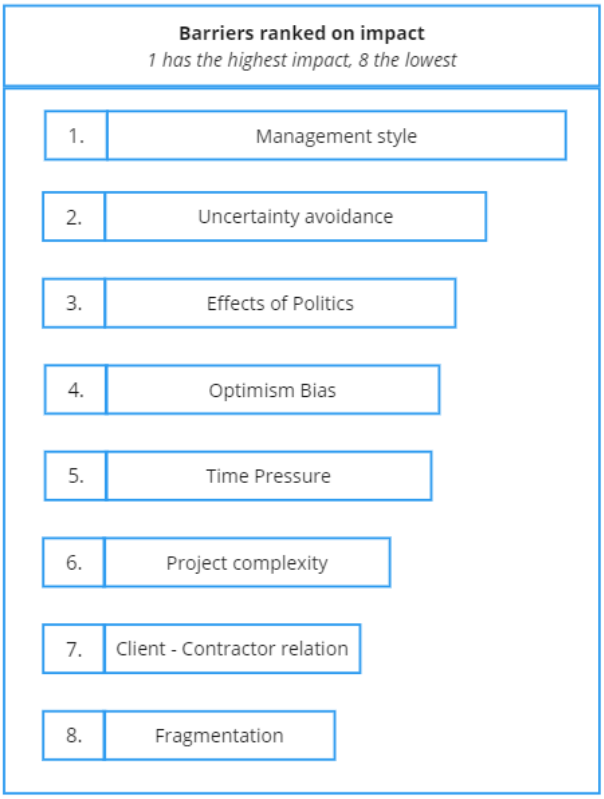

Figure 18 - Barriers ranked on impact

The experts came up with a few suggestions for renaming the barriers. The barrier 'relation with contractor' (relatie met aannemer) is changed to 'Retaining a good relationship with contractors' (behouden van een goede relatie met opdrachtnemers). The second suggestion is to change 'effects of politics' (politieke druk) to 'Effects of the board / politics' (druk van het bestuur / politiek), since hospital construction projects experience more pressure from the board, then from effects of politics. The experts also suggested a clarification of the concept 'workload' (werkdruk). This term can better be replaced by 'Lack of time for reflection'. They stressed the importance of making the term more clear and sharp, and -given that work load is not always a negative issue- , lack of time for reflection is actually the defining principle of where this EWS lies in the ranking of the categories.

5.2.5 Minimising the top three barriers

After looking at the impact of the barriers, the 3 top barriers (Management style, Uncertainty avoidance and Effects of politics) where discussed in dept. First, all experts wrote their ideas on sticky notes for all 3 barriers. For each barrier a poster was created to analyse and discus the ideas of the experts. The experts were divided over the 3 posters and were asked to come up with recommendations to minimise the barrier. The experts were free to use their own explorative approach and were given a clean sheet. The overview of the possible solutions to minimise the top three barriers are shown below. The posters the experts created are included in Appendix D.

1. Management style

The experts described the possible solutions to minimise the barrier Management Style by a step-by-step approach. If possible solutions from step 1 do not work, go further with the possible solutions from step 2, and so forth. This approach takes proactive and reactive solutions into account. Table 14 contains the possible solutions of the experts to minimise the barrier.

Table 14 - Possible solutions barrier Management style

Minimising barrier Management style		
Step 1	Proactive	Get to know the team and recognise how the characters in the team work together
		Create a good ambiance in where people can be vulnerable
		Create a cooperation document and incorporate shared expectations
Step 2	Proactive	Implement assessment on soft aspects (Barometer of AT Osborne) on a regular basis, so team members can lister to each other and discuss dilemmas.
		Create an ambiance where informal meetings can take place between client and project team
		Implement regular one on one meetings with manager and team members
	Reactive	Take time to reflect on a regular basis
		Organise risk management meetings in smaller groups (without PM)
Step 3	Proactive	Invest in training, coaching, and teaching the PM
	Reactive	Discuss management style in team
		Link PM to other PM with a different management style
		Divide the tasks of PM: point out a contract manager, risk manager, and a “vice-project manager” (in Dutch: “manager projectbeheersing”)
		Discuss and share issues with “vice-project manager” (“manager projectbeheersing)
		Escalate to higher management
Step 4	Reactive	Change PM

2. Uncertainty Avoidance

The experts described the possible solutions to minimise the barrier Uncertainty avoidance. The experts discussed different possible solutions, described per interventions. Also, possible solutions described per actor are named. The overview of the possible solutions to minimise the uncertainty avoidance are shown in Table 15.

Table 15 - Possible solutions barrier Uncertainty avoidance

Minimising barrier Uncertainty Avoidance					
Type of interventions	**PM Style**	Create a safe atmosphere	Give trust to the team: don't punish honesty and openness	Appreciate transparency	Don't punish making mistakes
	Management (Dutch: 'beheersing')	Organise risk sessions	Execute an active risk management	Pay attention to EWS and stimulate responding	Propose solutions related to timeframe and financial influence
	Method	Introduce contract management			
	Reflection	Hold up a mirror, ask questions	Invest in one on one meetings	Show and explain different interests	Make uncertainties explicit, create new challenges, and adjust the frameworks
	Prioritise project importance	Realise the responsibility of the client in the project	Training project management (Dutch: 'beheersing') for PM	Escalation progress: -Discuss -Confront -Escalate	
Intervention per actor	**Project Manager**	Create a safe atmosphere for the team	Organise team evaluations	Organise risk sessions	
	Client	Execute an review or audit			
	Project Team	Create mutual agreements			

3. Effects of Politics

The possible solutions to minimise the barrier Effects of Politics presented by the experts are shown in Table 16. The possible solutions are divided into type of signal: hard or soft, and form of action, proactive of reactive.

Table 16 -Possible solutions barrier Effects of Politics

Minimising barrier Effects of Politics		
Type of signal	Hard	Setting frameworks
		Create a clear escalation protocol
	Soft	Stimulate informal meetings with the board
		Create clarity about why the pressure is increased by the board: reason can be different than expected
		Understand the interests of the board
Form of action	Reactive	Create transparency
		Clarify the consequences
		Put the EWS next to the project outlines: Money, Quality, Time
		Make the client aware of the consequences of their actions: remind them of their responsibility for the project
	Proactive	Stimulate interactions
		Present dilemmas instead of just saying no
		Accept the friction, confront the board, be independent, keep in mind what is best for the project
		Show alternatives of the changed requirements: now versus later, best versus good, and pressure versus more time

5.3 KEY FINDINGS EXPERT PANEL

This section presents the key findings of the expert panel.

Early Warning Signs

The expert panel evaluated the EWS categories based on the findings of the literature review and case study. All members of the expert panel recognised the EWS categories, and came up with some adjustments. Figure 19 shows the adjustments (highlighted) based on the input of the experts. The experts noted that 'Experience in the team' in fact consist of two different aspects: 'Cooperation' and 'Team Composition'. 'Cooperation' in hospital construction projects is about the ability to work together with different professionals in various roles and disciplines (including numerous stakeholders). 'Team Composition' in hospital construction projects relates to the need to have team members with different characters and experiences to complement each other. Therefore in this study 'Experience in the team' is substituted by 'Cooperation' and 'Team composition'.

> *"In my experience a team needs a mix of experienced people and people who have a fresh attitude and look at a project not hindered by previous experiences. What is also important in team composition is that attention is paid to appoint different characters in the team so that they complement each other."*
> *(Personal communication Expert Panel, 23/01/2024)*

Figure 19 also shows the EWS categories ranked on their impact. The experts all agree that EWS related to the 'Feasibility of the project goal', 'Decision making', and 'Cooperation' have most impact on the management of the hospital construction project.

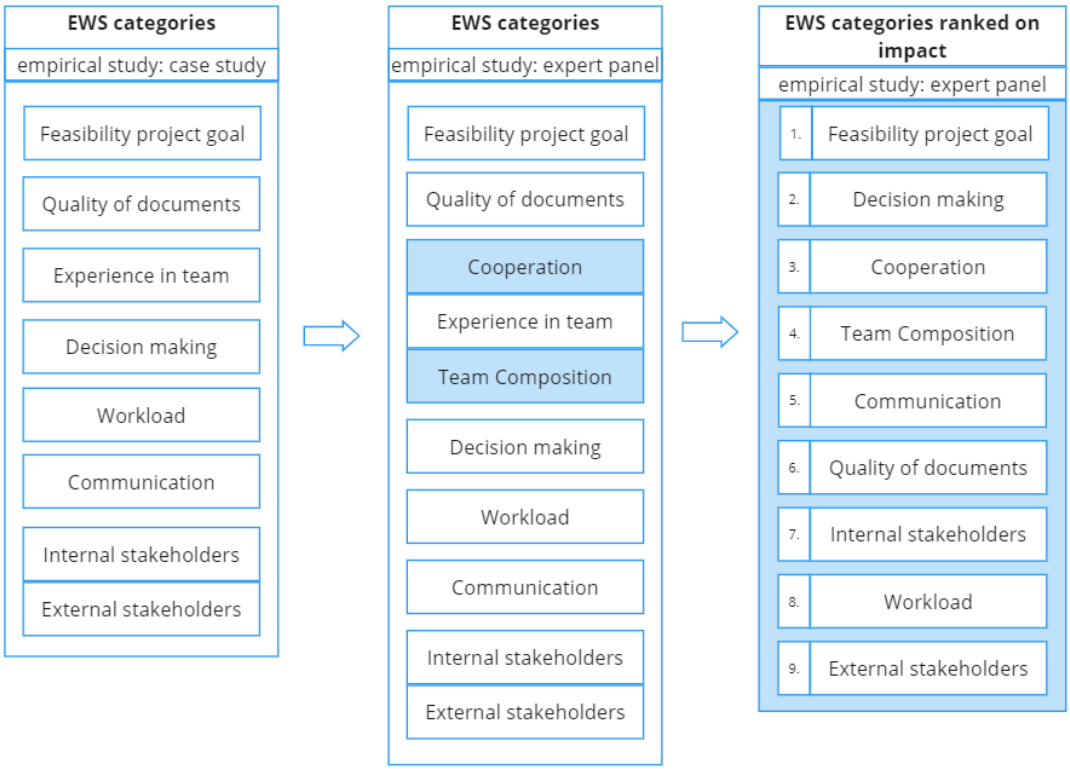

Figure 19 - EWS categories and impact derived from expert panel

Barriers

The expert panel evaluated the barriers that can occur while acting on EWS based on the findings of the literature review and the case study. All members of the expert panel recognised the barriers, and gave additional comments and suggestions. Figure 20 shows the additions based on the suggestions of the expert panel for the barriers. The experts noted that in a hospital construction project more contractors are involved and the barrier 'Client – Contractor Relation' manifests itself when the relationship is under pressure. Therefore, the barrier 'Client - Contractor Relation' is changed into 'Retaining good relationship with contractors'. Another remark made by the experts is that 'Time pressure' is not a negative issue in some cases, but that the actual barrier of time pressure is the 'Lack of time for reflection'.

> *"Time pressure is sometimes needed to achieve deadlines and helps to get focus in the team. However, when there is no time available for reflecting on important issues or paying attention to gut feelings of team members, you miss important signals."*
> *(Personal communication Expert Panel, 23/01/2024)*

Finally, the experts noted that in hospital construction projects the 'Effect of politics' is not only related to politics, but also to the board of the hospital. Hence the barrier 'Effects of politics' is changed into 'Effects of board/politics'.

> *"A difference with for example infrastructure projects is the fact that in hospital projects the board and/or the steering committee have much more influence on the project and the scope than politics."*
> *(Personal communication Expert Panel, 23/01/2024)*

Figure 20 also shows the barriers that can occur while acting on EWS ranked on their impact. The experts agreed that the barriers 'Management style', 'Uncertainty avoidance', and 'Effects of board/politics' have the most negative impact on acting on EWS and therefore the project management of a hospital construction project.

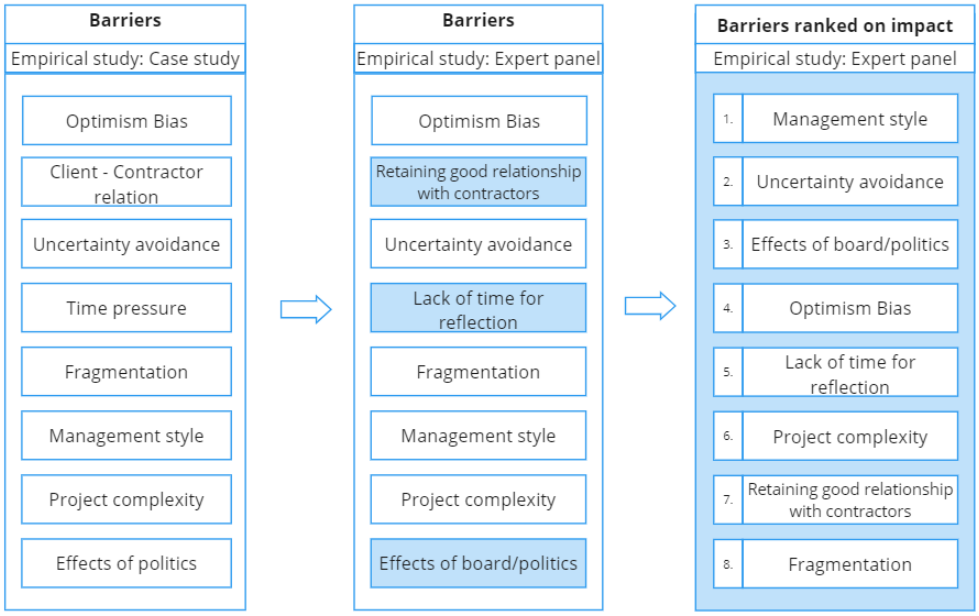

Figure 20 - Barriers and impact derived from expert panel

Minimising the barriers

Possible solutions to minimise the effect of the top three most impactful barriers are shown in Figure 21. Based on the broad experience of the experts they came up with several recommendations.

> *"It is interesting that a hard signal sometimes needs a soft approach. A review or audit is a hard [management] instrument, but needs a soft launch as trust and safety are important for the team members. And sometimes it is the other way around, where a soft signals needs hard action."*
> *(Personal communication Expert Panel, 23/01/2024)*

The solutions are divided into proactive (leading) and reactive (lagging) approaches, with a distinction made in a soft (human factors) or hard (project assessment) approach.

> *"Formulating a cooperation document including shared expectations of the team members is a proactive approach. It is important to regularly reflect on this document with the team so that the document and the cooperation can be adjusted."*
> *(Personal communication Expert Panel, 23/01/2024)*

The experts emphasised that combinations of these possible solutions are needed to minimise the barriers to stimulate acting on EWS in hospital construction projects as these projects are complex and have a high number of stakeholders with different interests.

		Management style	Uncertainty avoidance	Effects of board/politics
Proactive	Hard	Training/Coaching for PM	Propose solutions related to planning and budget	Setting frameworks
		Create cooperation document including shared expectations	Create mutual agreements	Show alternatives of changed requirements linked to now vs later and best vs good
			Create escalation protocol	Create escalation protocol
				Present dilemmas and consequenses instead of saying no
	Soft	Characters in the team	Focus on EWS	Stimulate informal meetings
		Create safe ambiance team	Create safe ambiance team	Accept friction, keep discussing, and keep in mind what is best for the project
		One on one meetings	One on one meetings	Stimulate interactions
		Stimulate informal meetings	Understand different interests	
Reactive	Hard	Organise risk management sessions	Organise risk management sessions	Show influence of EWS on project outlines: Money, Quality, Time
		Introduce a contract manager, risk manager, and a "vice-project manager"	Introduce contract management	Clarify consequences and who is responsible
		Escalate to higher management	Execute Review or Audit	
		Change PM		
	Soft	Reflect on regular basis	Reflect on regular basis	Create clarity why pressure is increased
		Discuss Management Style	Organise Team evaluations	Stimulate transparancy
			Stimulate transparancy	

Figure 21 - Possible Solutions to minimise top three barriers derived from expert panel

DISCUSSION & LIMITATIONS

6. DISCUSSION AND LIMITATIONS

In this section the discussion and limitations of this research are presented. First, the research findings are presented, after that the discussion is presented, and finally the limitations of this research are shown.

6.1 Research findings

By conducting a literature review, case study, and expert panel, this research shows nine categories of EWS, and eight barriers that can occur while acting on EWS in hospital construction projects. In Figure 22 the research findings of this study are shown.

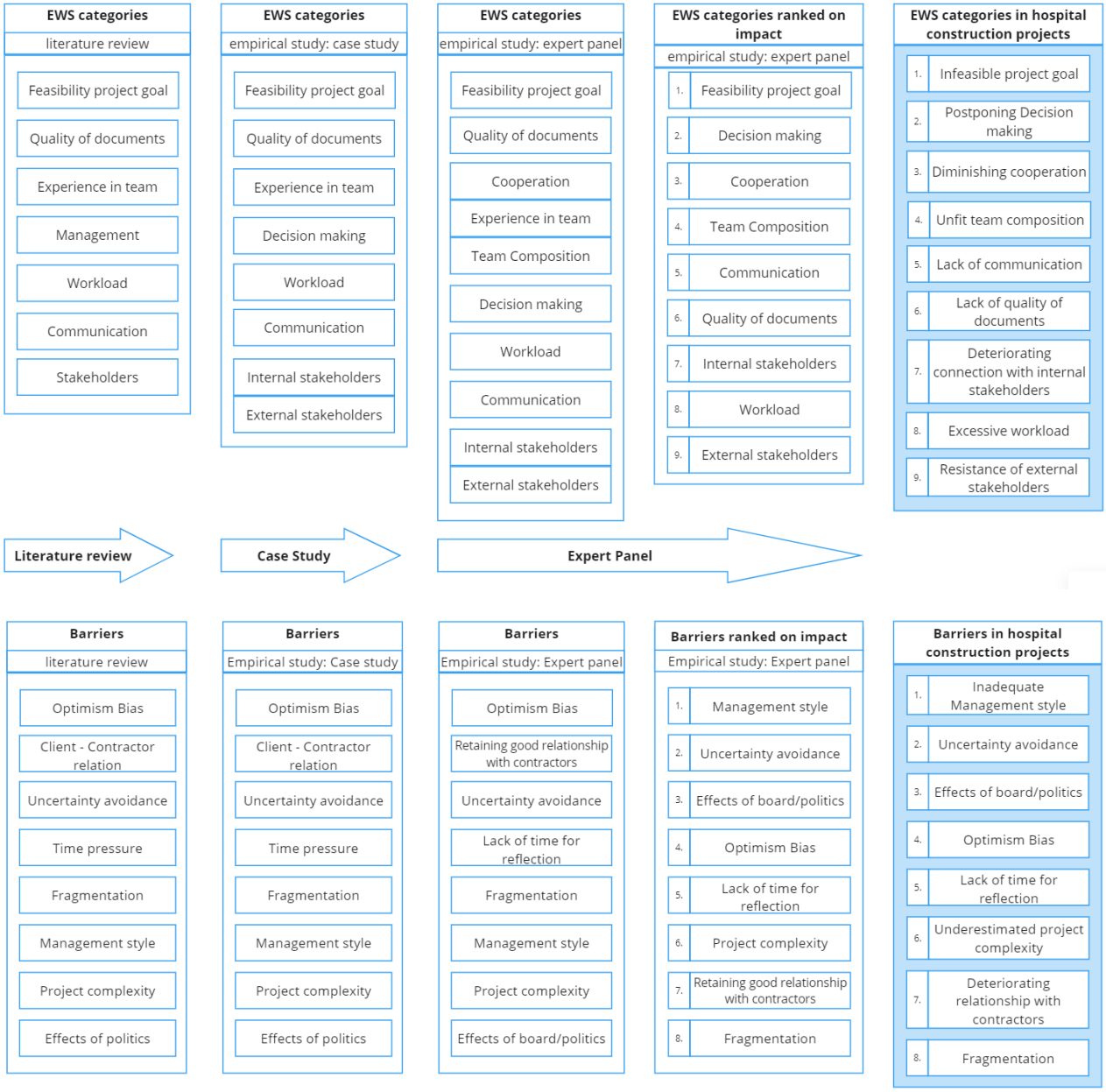

Figure 22 - Findings of EWS categories and Barriers in hospital construction projects

On the basis of the literature review existing EWS categories and barriers were explored in the empirical study (case study and expert panel) to establish EWS and barriers in hospital construction projects. By analysing the findings of this research the EWS categories and barriers ranked on their impact need to be refined because this research focuses on *negative* issues in EWS in hospital construction projects, as negative issues have the largest impact on the project management and the desired project results.

Regarding the identification of the EWS in hospital construction projects, only two of the filters of Haji-Kazemi (2015) appeared in the case study. The *surveillance filter* was found since some EWS were not identified and therefore no action on the EWS could be formed. The other filter that played a role in the case study was the *decision maker mentality filter*. The interviewees stressed the fact that because of different roles not everyone in the team had the same understanding and evaluated the information in different ways. This also led to not acting on EWS.

To minimise the possible negative effect of the barriers in hospital construction projects, the expert panel provided possible solutions for the top three most impactful barriers. The findings in this study not only confirm the findings of the literature study (paragraph 3.2.3) which provide several suggestions to minimise the effect of the barriers uncertainty avoidance, management style, and effects of politics, but also add new suggestions to minimise barriers in hospital construction projects. They are combined in Figure 23.

Possible solutions minimising barriers		
Proactive	Hard	In early phase of the project: create documents (escalation protocol, cooperation document, mutual agreements, and set frameworks)
		Invest in training/coaching for PM
		Discuss solutions or alternatives in changing environment related to time and cost
	Soft	Know the characters in the team and be clear about the division in roles
		Create safe ambiance in team with open communication
		Stimulate communication in informal meetings and one on one meetings
		Focus on EWS and stimulate responding
		Understand different interests of all stakeholders
Reactive	Hard	Organise risk management sessions focussing on EWS
		Introduce a contract manager, risk manager, and a "vice-project manager"
		Escalate to higher management
		Show influence of EWS on project outlines: Cost, Scope, Time
		Execute Review or Audit on a regular base
	Soft	Reflect on regular base
		Stimulate transparancy
		Organise Team evaluations

Figure 23 - Possible solutions to minimise barriers in hospital construction projects

6.2 Discussion

Limited literature available

The literature review conducted in this research shows that there is limited research available about EWS and barriers occurring while acting on these EWS in hospital construction projects. This provides an implication regarding the applicability of the EWS categories and barriers from literature used in this research. To validate the generalisation of the EWS categories and barriers it would be useful to research EWS and barriers in more hospital (re)construction projects. This research can function as a basis for that. However, the findings of this research are likely to be generalised since they are based on literature study about EWS and barriers in complex construction projects. The findings show that all EWS and barriers from literature are recognised in the hospital reconstruction sector. It suggests that focussing on the soft human aspects, with time for reflection positively influences the identification of EWS and acting on them in (hospital) construction projects.

EWS in practice

It was found that the concept of EWS was not known among some members of the project team working on such complex hospital reconstruction project. Every category of EWS is recognised, but the phenomenon of EWS itself was unfamiliar. More attention should be given to the concept of EWS so that project teams can be made aware. The participants of the interviews first tended to see EWS as related to the hard aspects of managing projects, such as risk management. However, focussing on soft aspects and time for reflection increase the change to find associated EWS. EWS are important to recognise and act upon, and therefore, it is worthwhile that attention to EWS is imbedded in team meetings and daily practice of managing a hospital construction project.

Another remark found in the empirical study is that in hospital construction projects a division is made in the category ‘stakeholders’ from literature, namely ‘internal and external stakeholders’. The participants of the interviews and expert panel stressed the importance of the role users (as internal stakeholders) have in the realisation of a hospital project. In the case studied it was shown that without the support of the users a project plan is likely to be rejected.

On the EWS categories ‘Postponing decision making’ and ‘Deteriorating connection with internal stakeholders’, the experts observed that an interesting factor in hospital construction projects is that not all clients have experience and knowledge about their real estate and the construction of hospitals. Only in academic hospitals there is a special real estate department, but region hospitals do not have such department. In these hospitals it is always a one-time team that is appointed to the project. Because of the similarities between the projects, it is likely that most EWS categories and barriers that prevent acting on these EWS found in this study are also adequate for academic hospital (re)construction projects. Regarding the applicability and validation of this, further research is needed.

Barriers in practice

This research focuses on getting possible solutions for the three most impactful barriers in hospital construction projects. This choice was made to assure the feasibility of the research in the limited time available and to provide a more in dept advise to minimise possible negative effect of the barriers. However, the findings are most likely also applicable on the barriers that were not discussed in the expert panel. The experts highlighted how close the barriers are interconnected with each other, and sometimes influence each other as well. By ensuring transparency, time for reflection, maintaining good communication, and creating a safe environment to share information, it is most likely that all barriers will be minimised.

Regarding the applicability and validation of the possible solutions on other barriers as well, further research is needed.

The participants in the expert panel stressed the fact that money, and especially the tension on the budget, can be an aspect of all barriers. Further research can shed light on the influence of budget issues on the barriers that occur while acting on EWS.

Reflecting on the barriers identified through literature it was remarkable that the influence of personal aspects was found lacking. Participants in the interviews noted that this was an aspect that was evaluated as being of great importance regarding other barriers. An example is the relation between uncertainty avoidance and the personal belief to not let the project fail. It was stressed by some members of the expert panel that personal characteristics and how they influence the team (and culture), are important to take into consideration.

Filters

The literature review suggested that the filters of Haji-Kazemi (2015) presented in paragraph 3.2.1 could play an important role in the identification of EWS to act on them. However, in the empirical part of this study this could not be confirmed. Only the surveillance and decision mentality filter seemed to play a role in the case study, but recognising possible barriers was far more important in stimulating acting on EWS then the filters.

Anonymisation of the findings

Because of confidentiality issues, the specific case studied is anonymised in this research. Talking about very sensitive and specific aspects to such projects, anonymising these findings could have let to missing certain subtleties as compared to non-anonymised results. However, by taking the non-anonymised results as base for the expert panel, the missing of nuance is negligible in the categorisation of EWS of hospital construction projects.

Scientific relevance

In paragraph 1.5 the scientific relevance of this study is shown. This research contributes to the need for better knowledge on EWS and acting on EWS in daily practice of managing hospital construction projects. Identifying and acting on EWS can have a positive effect on project management and project control. This study shows that EWS and barriers that occur while acting on those EWS in hospital construction projects largely correspond with existing literature, but there are interesting differences. This study confirms that further research on EWS, barriers that occur while acting on EWS, and possible solutions to minimise these barriers is worthwhile.

6.3 Limitations

The following limitations should be taken into account in the interpretation of the results of this research.

The viability and transferability of the literature review

As mentioned above in paragraph 6.2, the basis of this research is a set of EWS categories which are derived from a limited set of literature. Also this literature was not necessarily specific of Dutch hospital construction projects. For the barriers the literature for identifying them and barriers for acting on EWS was also limited. The literature on EWS is not very extensive, but the studies that were available provide interesting material. They all indicate that human behaviour is important and deserves more attention.

The viability and transferability of the case study

A single case has been studied in this research. This means that the findings cannot directly be generalised to the Dutch hospital (re)construction sector. However, Gustafsson (2017) states that in a large and complex case, such as the case in this research, it gives a more in-depth inside in the project. There for it is interesting to use this research as a basis for further research which include multiple case studies.

Another limitation of the case was that this project is in execution, in the building phase of the project. Because of the sensitivity of the project, a certain caution could be present in the interviews with sharing information. However, by collecting and sharing the data in an anonymous way it may be assumed that all information is shared.

The viability and transferability of the expert panel

The expert panel is associated with one specific company and can therefor the findings can possibly be biased. However, these experts are experienced in a various amount of complex projects and other hospital construction projects in the Netherlands which are expected to be similar to the case studied. Therefore it may be assumed that these findings are not biased and could potentially be generalised to the hospital construction sector.

The generalisation of results

This research focusses on hospital construction projects, so results of this study cannot directly be generalised to other project management sectors. Also, a difference in the organisation of academic hospitals can have as result that the findings may differ. However, it is believed that general ideas can be interchanged between the academic hospital organisation and different industries. But similar research will have to be conducted in academic hospital construction projects, and other sectors to match the results of this research.

CONCLUSION

7. CONCLUSION

In this section conclusions are drawn by answering the main research question: “Which Early Warning Signs can be identified in Dutch hospital construction projects, and how can acting on these EWS be stimulated to mitigate possible problems?”

In hospital construction projects, Early Warning Signs (EWS) are indicators for potential negative future developments. Taking EWS into account, and responding to them can have a positive effect on project management and project results.

Table 17 shows the nine categories of EWS that are identified, and the eight barriers that occur while acting on EWS ranked based on their impact in hospital construction projects.

Table 17 - EWS categories and barriers in hospital construction projects

	EWS categories in hospital construction projects
1.	Infeasible project goal
2.	Postponing Decision making
3.	Diminishing cooperation
4.	Unfit team composition
5.	Lack of communication
6.	Lack of quality of documents
7.	Deteriorating connection with internal stakeholders
8.	Excessive workload
9.	Resistance of external stakeholders

	Barriers in hospital construction projects
1.	Inadequate Management style
2.	Uncertainty avoidance
3.	Effects of board/politics
4.	Optimism Bias
5.	Lack of time for reflection
6.	Underestimated project complexity
7.	Deteriorating relationship with contractors
8.	Fragmentation

Before responding to EWS, they must first be identified and barriers must be minimised. To stimulate acting on EWS, there must be *awareness* of which barriers can occur in hospital construction projects.

To minimise possible problems in the project, the three most impactful barriers can be managed by incorporating possible solutions regarding proactive and reactive approaches applying both soft and hard aspects of project management. Possible solutions to minimise the negative effect of the barriers are shown in Figure 24.

Possible solutions minimising barriers		
Proactive	Hard	In early phase of the project: create documents (escalation protocol, cooperation document, mutual agreements, and set frameworks)
		Invest in training/coaching for PM
		Discuss solutions or alternatives in changing environment related to time and cost
	Soft	Know the characters in the team and be clear about the division in roles
		Create safe ambiance in team with open communication
		Stimulate communication in informal meetings and one on one meetings
		Focus on EWS and stimulate responding
		Understand different interests of all stakeholders
Reactive	Hard	Organise risk management sessions focussing on EWS
		Introduce a contract manager, risk manager, and a "vice-project manager"
		Escalate to higher management
		Show influence of EWS on project outlines: Cost, Scope, Time
		Execute Review or Audit on a regular base
	Soft	Reflect on regular base
		Stimulate transparancy
		Organise Team evaluations

Figure 24 - Possible solution to minimise negative effects of barriers while acting on EWS in hospital construction projects

In project teams EWS are often neglected as the primary focus is on the hard project management aspects. However, when special attention is paid to EWS the *people-aspects* of projects are better illuminated and the communication and cooperation between team members can improve. This study shows that by focusing on soft people centered aspects, recognising and acting upon EWS can have a positive effect on managing hospital construction projects. This can be done by combining the proactive, reactive, soft, and hard approaches to stimulate acting on EWS and minimise the negative effect of barriers that can occur while acting on EWS.

RECOMMENDATIONS

8. RECOMMENDATIONS

In this section the recommendations based on the research findings, case study, interviews, the expert panel, and the conclusion to the research question are presented. Chapter 8.1 shows the recommendations for future research. In section 8.2 the recommendations for practice are presented. Finally, section 8.3 shows the recommendations for the case study.

8.1 Recommendations for future research

Several suggestions for future research are discussed in this section. Part of these recommendations are based on the limitations and discussion of this research (see chapter 6).

More in-depth research about EWS and barriers in hospital construction projects

As described in the discussion (section 6.2), the literature review conducted in this research shows that there is limited research available on EWS and barriers occurring while acting on these EWS in hospital construction projects. It is of high interest that more research in this sector is conducted to validate the generalisation of the EWS categories and barriers. This research can function as a basis for that.

Also, regarding the applicability and validation of the possible solutions on other barriers, further research is needed.

Research on EWS and barriers in academic hospital construction projects.

It is of value to research if and how the outcomes of this research on EWS, barriers and possible solutions to minimise the effects of these barriers function in academic hospital construction projects. In contrast to regular hospitals, academic hospitals have a separate real estate department, and therefore it is interesting to see if other findings can be found.

Research on EWS and barriers in other sectors/industries

This research showed the importance of identifying and acting on EWS in the management of projects in the hospital construction sector, but it is interesting to research if the findings of this research also apply in other sectors. Especially further research regarding the soft side of EWS is of high interest.

Effect of EWS and barriers on final project outcome

This research focused on the EWS and barriers that occurred in the process of hospital construction projects, but did not include the effects of the findings on the final project outcome. The effect of the found EWS and barriers in hospital (re)construction projects should be further research regarding the project outcome.

Influence of budget on EWS and barriers

In paragraph 6.2 money, and especially the tension on the budget, was mentioned as an aspect of all barriers. Further research can shed light on the influence of budget issues on the barriers that occur while acting on EWS.

8.2 Recommendations for practice

Influence of internal stakeholders

As mentioned in the interviews, the client is not always the one who makes the decisions. The influence of the users in hospital construction projects is big, and therefore it is needed to keep them on board with the project goal. The interest of the users should be investigated and incorporated at an early stage in the project.

EWS in daily practice

This research showed the importance of identifying and acting on EWS in hospital construction projects. It is important that project managers implement EWS in daily practice by being a leading example and making the team aware of EWS. EWS should be specifically tracked, for example by an issue list for soft signals, or discussed in risk sessions for EWS. Also, an outside view should be incorporated by a periodic review which includes both soft and hard factors.

Make time for reflection

In the project there should be enough time for reflecting. The project manager must make time for reflecting on a regular basis by organising informal meetings, such as lunches or coffee breaks with the team and organisation, and formal meetings, such as risk sessions and project start and follow ups.

Character and experience in project team

A project manager should understand the team composition and character traits of the project team, stimulate cooperation and open communication, so knowledge and information is shared. This benefits critical thinking.

Assign a contract manager, risk manager, and 'vice-project manager'

To support the project manager in terms of time and knowledge, a contract manager, risk manager and 'vice'-project manager (Dutch: manager projectbeheersing) can be appointed in the team. This also contributes to being clear about the responsibilities and role descriptions.

Invest in training/coaching the Project Manager

The project manager should have enough knowledge and tools to manage big complex projects such as hospital construction projects. Therefore time and effort should be put into training and coaching the project manager. Especially training about EWS and management styles are highly recommended.

Create documentation in an early phase of the project

In an early phase of the project, it is advised to create a cooperation document including the expectations of the team members. Also, an escalation protocol should be discussed and documented. The project manager should focus on setting a framework and mutual agreements, which are discussed and reviewed throughout the project. This stimulates openness and transparency.

8.3 Recommendations for the hospital case

Incorporate time for reflection in project team meetings

To improve awareness of EWS and possible barriers that prevent acting on EWS it is recommended to incorporate enough time for reflection in the meetings so that team members feel free to express their gut feelings in an early stage. This may help early identification of possible problems.

Special attention for soft signals in risk sessions

As the project team already has risk sessions on a regular basis, the recommendation is to pay special attention to soft people-related issues. Especially the low chance, high impact issues that may occur in the project can benefit from discussing them in the team in an early stage. It may help to keep a track record of these issues to enhance awareness, responsibility and ownership.

Celebrate intermediate milestones in the project team

Since the hospital project has a long development and construction time, including different phases, in a complex and changing environment, it is important that a positive atmosphere in the project team is ensured. By celebrating milestones people are not only reward for their contribution to the project, but are also stimulated to stay involved and keep up the good work.

Renew cooperation in project start-ups and project follow-ups

The hospital project has different phases which have different goals and focus points. New team members, new contractors, and new stakeholders can get involved in the different phases. To create a solid base for a new phase in the project, it is recommended to reflect on the previous phase (including the project documentation) and to anticipate on the phase ahead by assessing the needs of team members, stakeholders, the scope of the project, and the planning. A project start-up is an official moment in time where special attention can be given to the importance of good cooperation. In the project follow-ups the cooperation can be evaluated and adjusted on a regular basis.

Quality of documentation and decision making

Make sure that enough time is reserved to investigate and prepare all the necessary documentation before an important decision in the project is made. To be able to make decisions on time both the project team and the decision makers must have enough time to get familiar with the topics, prepare the required documentation and are in control of the decision making process.

Pay attention to team composition

Special attention should be given to the team composition. It is important to maintain the balance between regular staff and external employees. Especially in a hospital setting the connection with the hospital organisation and the users need special attention as these stakeholders have great influence on the project. Each new phase may require specific expertise and knowledge in the project team. Therefore it is recommended to assess the project on a regular basis and establish whether extra skills (new staff or training) are needed.

9. Reflection on Research EWS in hospital (re)construction projects

Master Science (MSc) track

This research is the final assignment of the Master Management in the Built Environment (MBE), Faculty of Architecture, Urbanism and Building Sciences at TU Delft. In the MBE domain Design and Construction Management (DCM) the scientific quest for finding answers to the questions why complex (construction) projects tend to turn out to be more expensive and take much longer to build than predicted have puzzled many researchers before and still continue to do so. With my research on Early Warning Signs (EWS) I hope to provide more insight in how recognising and acting on EWS can help improve project management in complex construction projects so that the results that are hoped for can be achieved more easily.

Why research on EWS?
EWS and how they can be employed in (complex) construction projects have fascinated me ever since my Minor at ProRail as part of my Bachelor studies. At ProRail I participated in the project team of the large infrastructure project PHS Rotterdam-Rijswijk. Although many tools, methods, procedures and project management-approaches were used to manage the project, the development of the project was an obstacle run and the expected outcome of the project could not be reached due to the complexity of the task, conflicting interests, the great number of stakeholders involved and the constant pressure on all the people involved in the project. A consultant from AT Osborne who was also involved in the project introduced me to the concept of Early Warning Signs. In the ProRail project I noticed firsthand how working with EWS had a positive effect on the communication and cooperation in the team.

As a daughter of a project manager at ProRail and a doctor, both infrastructure- and healthcare projects are 'family topics'. For my MBE graduation I wanted to focus on project management in the hospital sector. Once again I came into contact with AT Osborne as they also do consulting work in this field.

With my research on EWS in the construction of hospital projects I wanted to get more insight in EWS and how they can help improve the project management of these projects. Afterall, these kind of projects are important for society at large.

Dutch hospital construction projects also tend to turn into a struggle as project goals are not always met, budgets are overrun, delays in planning occur, and the progress of the projects does not proceed the way it should. The (re)construction of hospitals is a challenging undertaking. The complexity makes it hard to keep the project in control. Project failure is often linked to the hard sides of project management, but both literature and the experience of professionals indicate that soft factors and skills, such as negotiation, team capabilities and communication also influence the outcome of a project.

Process and planning

In this research a qualitative research method is used. An explorative study and an empirical study were conducted. The theoretical study consists of a literature review, and functions as the theoretical framework on the basis of which the empirical study is conducted. The empirical study consists of a case study, including semi-structured interviews, and an expert panel.
This approach turned out well: the theoretical starting point from the literature and especially the interviews and the expert panel produced useful information for answering the research questions.

The literature review showed that earlier research on EWS was mainly done in the infrastructure sector. Only one study dealt with EWS in hospital construction. The literature study and the empirical study both confirmed the presumption that more knowledge on EWS can have a possible positive effect on project management. Also in complex hospital construction projects. It also made clear that EWS are mostly process-related and linked to human behaviour and 'gut-feeling'.

The expert panel not only confirmed the findings from literature and case study, but they emphasized the fact that project management is first of all *people* management. They came up with additional suggestions for improving EWS-awareness and identifying and acting on them. Recommendations for further investigation on EWS and possible tools that might be used are included in the thesis.

Finding a suitable case study was tricky. Hospital projects, especially in the construction phase, are limited. The projects are sensitive because of the (political) context and financial constraints. With the help of AT Osborne supervisors a very interesting case was found. The hospital project in this research has a long history, and is still under construction. Being a sensitive project, some of the findings in this study are confidential. This caused extra difficulties in analysing and processing the data. As privacy and confidentiality are important issues, the case included in this research is described in an anonymous way, as are the interviewees that participated. All interviews are transcribed and the summaries are approved by the interviewees. Confidential material is anonymised in the report, but is listed in an appendix that will not be published. Transcribing and analysing the interviews turned out to be quite a task. But the interviews themselves were inspiring and productive. The semi-structured approach worked out well; the preparation of the questions beforehand, a good planning, together with the personal setting at the actual site of the project where the interviews were held, contributed to the safe atmosphere in which each interviewee felt enough at ease to freely share information. Linking the knowledge acquired from the literature study with the findings from the interviews provided me with very interesting information that was analysed and processed. It was also used as input for the expert panel, that helped evaluate and sharpen the results.
The literature study was done in P2, the interviews took place before P3. The evaluation of the results by the expert panel has taken place between P3 and P4. The time between P4 and P5 is used to sharpen the findings and conclusions, review the final report, and prepare the final presentation.

Personal note

During the first part of my graduation project I was struck by an illness that turned my life upside down. For over a year I was unable to continue my research.
The journey of my graduation had started so well: the topic of my research inspired me, project management is a line of work I want to explore, the health care business is important for society and I had found excellent supervisors, both at TU Delft and at AT Osborne. The usual graduation stress with its time pressure and struggles to get the research questions right and the whole process on track I also experienced. But the real challenge was my health. For a long time I was unable to continue my research and had to find ways to survive this very dark period.
Fortunately, I eventually got better and could start working on my thesis again.
With the help and feedback of my supervisors Louis Lousberg, Marian Bosch-Rekveldt, Jeroen Brinkman and Laurens Lancee, and the study advisor Sylvia van Opdorp-Stijlen I gradually got back on track. They all kept faith in me and my research and that really made the difference.

Last year was a year full of uncertainty. Looking back at that period, I realise that I learned a lot in 'the school of life' that I take with me for the rest of my life. I am very grateful that I am given the chance to get my life back and that I am able to finish my research. I am still excited about my subject: EWS are really worthwhile to investigate and MBE was definitely the right track for me to graduate in. I am also grateful that Louis Lousberg remained my supervisor, even after his retirement and that he and Marian Bosch-Rekveldt from the faculty of Civil Engineering provided me with such valuable feedback and support. The days that I can work in the office of AT Osborne in Baarn are the highlights of my study. The contact and communication with the supervisors and the co-workers at AT Osborne are stimulating and really make my day.

The last few months, especially the period from P3, P4 to P5 was very intensive and a lot of progress is made in a short time frame. I enjoyed conducting the interviews and working with the expert panel was a great experience. Bringing all the findings together in the final report was hard work, but gives me great satisfaction. It all comes together now. I am proud that the interviewees and experts shared their information with me freely and that the awareness for EWS increased. The literature review and the empirical analysis form a stepping stone to the actual findings of this study, the interesting results that shed more light on how EWS can be used in improving the project management of complex (hospital) construction projects. I hope that this study contributes to the increasing awareness of EWS in the hospital project, and that the participants of the case can use the findings of this study in the next stages of their project.

Yara Bergers,

April 2024

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Appendix A – Research Scopus

Search term Scopus	Document results
"early warning sign" OR "weak signal" OR "early warning system"	27099
(“early warning sign" OR "weak signal" OR "early warning system") AND "Civil engineering"	52
(“early warning sign" OR "weak signal" OR "early warning system") AND "Construction projects"	38
(“early warning sign" OR "weak signal" OR "early warning system") AND “Civil engineering” AND "Construction projects"	12
("early warning sign" OR "weak signal" OR "early warning system") AND ("hospital real estate" OR "hospital construction project" OR "Health care real estate" OR "health care construction project")	1

Retrieved from Scopus.com at 14/08/2023.

Appendix B – Interview Guide

Begin interview:

Datum:
Locatie:

- Persoonlijke introductie
- Doel interview introduceren
- Behandeling van informatie (anonimiteit)
- Toestemming vragen om interview op te nemen

Naam:
Leeftijd:
Positie:
E-mail:
Tel. Nummer:

Vragen ALGEMEEN (7 minuten)

1. Wat is uw functie binnen het project?
2. Wat heeft u hiervoor gedaan?
    a. Wat voor type projecten (ziekenhuis, of ander soort)
3. Bent u bekend met het fenomeen Early Warning Signs?
    a. Deel definitie: Signalen die in een vroeg stadium potentiële problemen in projecten voorspellen
4. Herkent u deze betekenis in uw werk?
    a. Voorbeelden?

Vragen PROJECT (20 min)

5. Wanneer bent u bij dit project betrokken?
6. Wat viel er op toen u startte bij het project?
    a. Wat waren de belangrijkste uitdagingen vooraf? En wat waren potentiële problemen vooraf?
    b. Is dit verandert in de loop van het project?
    c. Wat ziet u nu als grootste uitdaging en als potentieel probleem?
        i. *Kijk naar de fases (zie tijdlijn project)*
7. Welke gebeurtenissen of momenten hebben in het licht van EWS impact gehad op het verloop van het project tot dusver?
    a. Wat ging er mis volgens u?
    b. Wat was het gevolg hiervan op het project?
    c. Terugkijkend: wat waren de eerste signalen die dit probleem voorspelde?
8. Zijn er richtlijnen beschreven voor dit project hoe om te gaan met vroege signalen voor problemen?
9. Hoe stond de omgeving tegenover dit project? (*bespreek wat gezien wordt als omgeving).*
    a. Zijn er signalen geweest vanuit de omgeving op het proces?
10. Gekozen contractvorm UAVGC, wat voor invloed heeft dit op het project?

Vragen EWS & Barrières (vanuit filters) (**15 min)**

11. Wat is een vroeg signaal dat problemen voorspelde?
    a. Wat voor signaal?
    b. Hard of zacht?
12. Hoe kwam dit signaal aan het licht? (surveillance filter)
    a. Wie pikte het op?
    b. Wanneer werd het signaal ontdekt?
    c. Hoe werd het ontdekt?
13. Wat gebeurde er vervolgens met dit signaal? (Observer mentality filter)
    a. Werd het gerapporteerd?
    b. Waarom wel of waarom niet?
    c. Hoe komt dit?
14. Werd er een besluit genomen over dit signaal? (Decision maker mentality filter)
    a. Waarom wel/niet?
    b. Wie nam dit besluit?
15. Wat werd er besloten over dit signaal? (Political/power filter)
    a. Wanneer werd er actie ondernomen?
        i. Waarom wel/niet?
    b. Wat was het resultaat van deze actie?
16. Terugkijkend: waren er ook zachte signalen die een probleem aan gaven? *Denk aan sfeer in het team, vertrouwen, werkdruk.*
17. Had het omgaan met het vroege signaal anders gekund?
    a. Had het eerder herkend kunnen worden?
    b. Had er een ander besluit over genomen kunnen worden?
18. Wat is volgens u een barrière om een vroeg signaal te herkennen?
    a. En om op een vroeg signaal te reageren?

Afsluiting (5 min)

19. Wat ben ik vergeten te vragen?
20. Wat neemt u mee uit dit interview?
21. Is er nog iets dat u zelf zou willen delen?

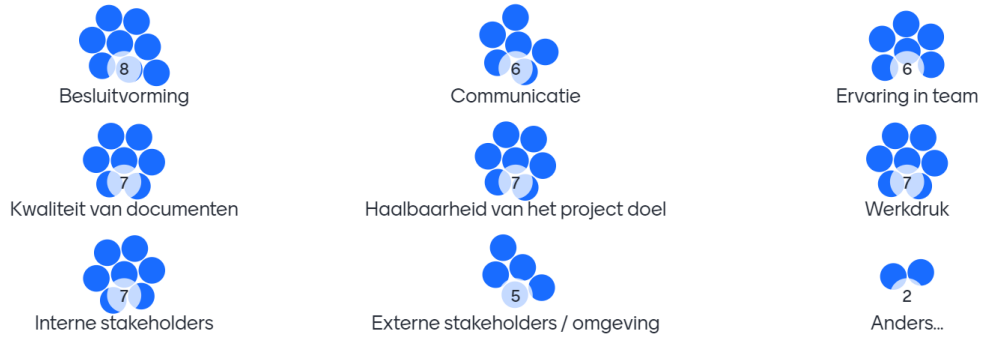
Verslaglegging:

Interview is opgenomen, wordt uitgewerkt in een samenvatting welke wordt gedeeld met geïnterviewde ter goedkeuring.

Appendix C – EWS overview case study

Confidential – Excluded from Final Master Thesis

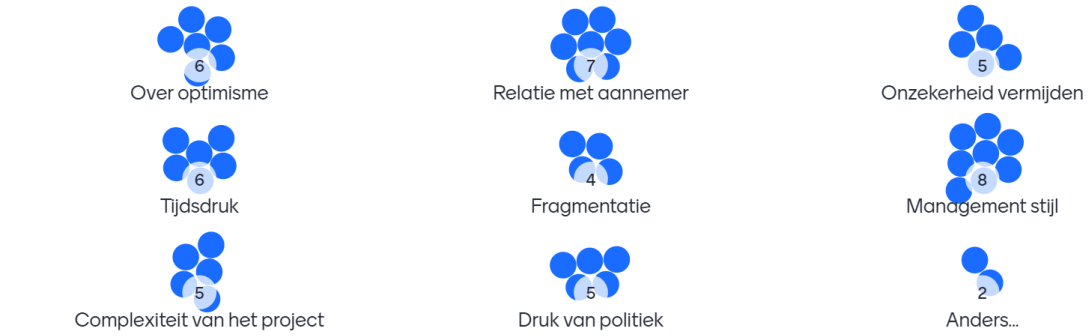
Welke categorieën Early Warning Signs herken je in de praktijk?



Hoe schat je de impact van de categorieën Early Warning Signs in?

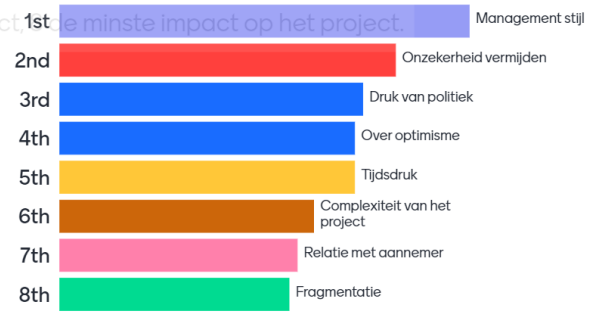
Rank de categorieën:
1 heeft de grootste impact de minste impact op het project.

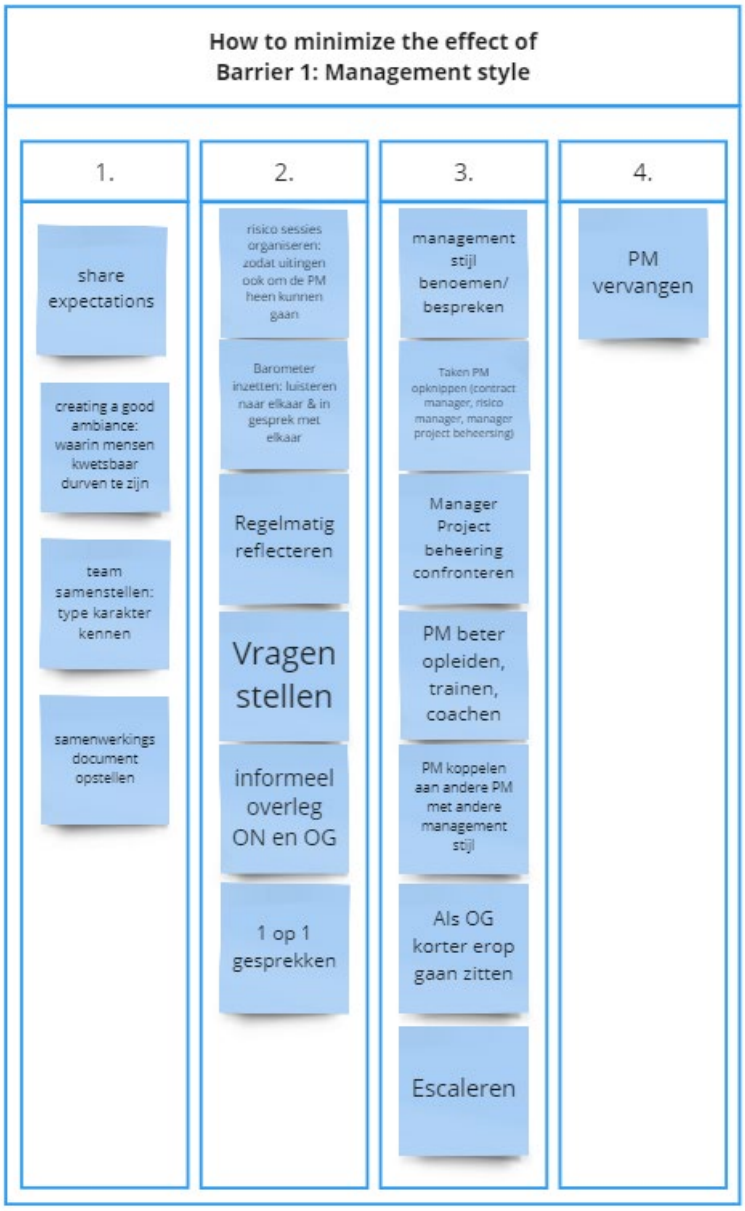
Welke barrières om op een Early Warning Sign te reageren herken je in de praktijk?

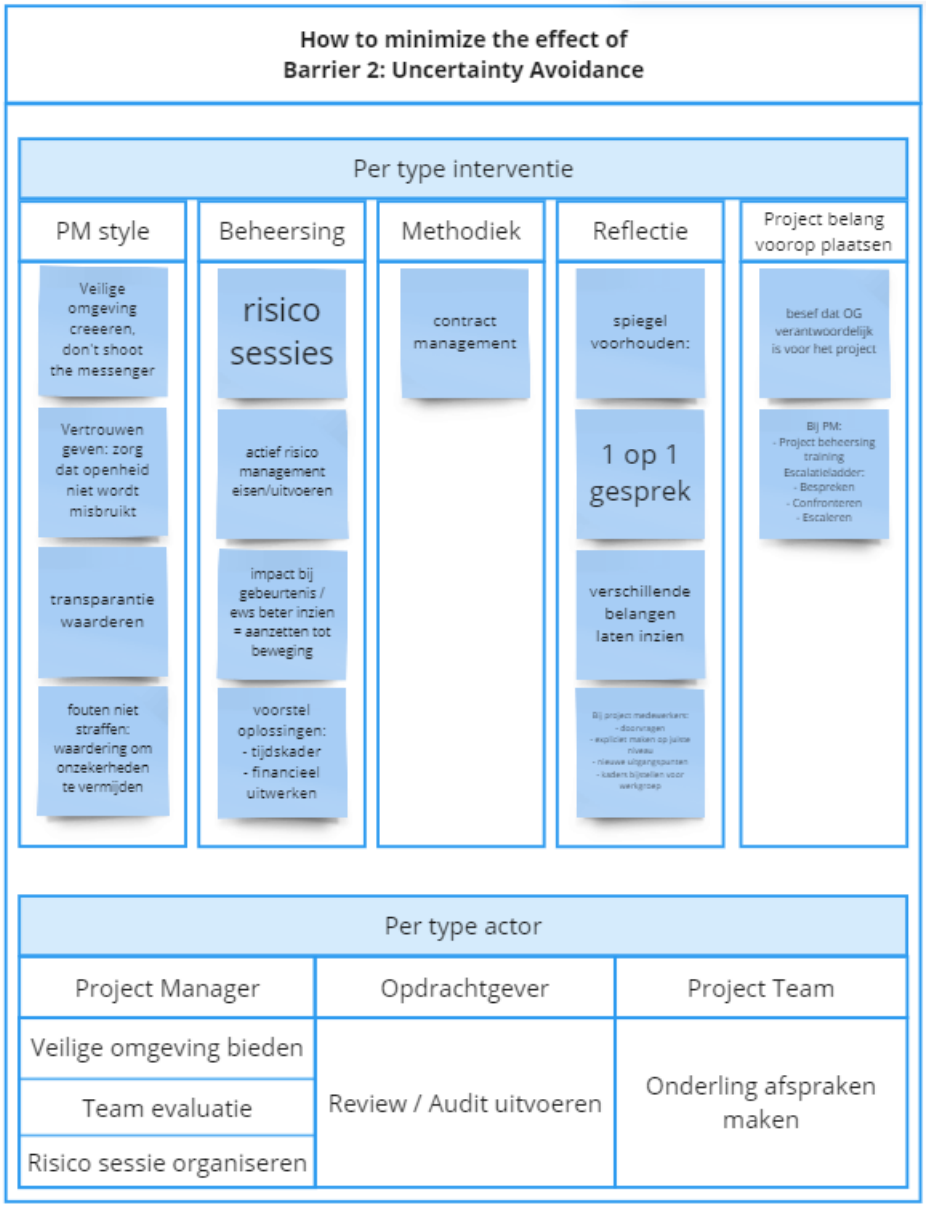


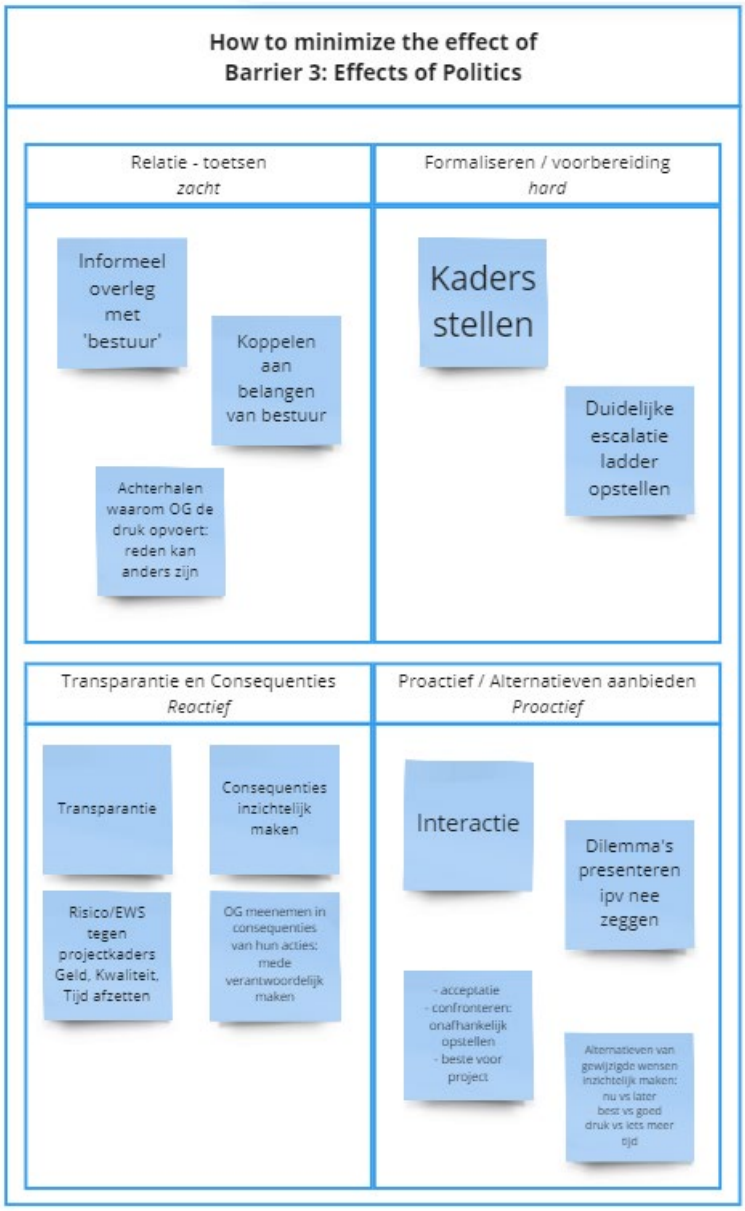
Hoe schat je de impact van deze barrières in?

Rank de barrières:
1 heeft de grootste impact, de minste impact op het project.




How to minimize the effect of
Barrier 1: Management style
1.
share expectations
creating a good ambiance: waarin mensen kwetsbaar durven te zijn
team samenstellen: type karakter kennen
samenwerkings document opstellen
2.
risico sessies organiseren: zodat uitingen ook om de PM heen kunnen gaan
Barometer inzetten: luisteren naar elkaar & in gesprek met elkaar
Regelmatig reflecteren
Vragen stellen
informeel overleg ON en OG
1 op 1 gesprekken
3.
management stijl benoemen/ bespreken
Taken PM opknippen (contract manager, risico manager, manager project beheersing)
Manager Project beheering confronteren
PM beter opleiden, trainen, coachen
PM koppelen aan andere PM met andere management stijl
Als OG korter erop gaan zitten
Escaleren
4.
PM vervangen


How to minimize the effect of
Barrier 2: Uncertainty Avoidance
Per type interventie
PM style
Beheersing
Methodiek
Reflectie
Project belang voorop plaatsen
Veilige omgeving creeeren, don't shoot the messenger
Vertrouwen geven: zorg dat openheid niet wordt misbruikt
transparantie waarderen
fouten niet straffen: waardering om onzekerheden te vermijden
risico sessies
actief risico management eisen/uitvoeren
impact bij gebeurtenis / ews beter inzien = aanzetten tot beweging
voorstel oplossingen:
- tijdskader
- financieel uitwerken
contract management
spiegel voorhouden:
1 op 1 gesprek
verschillende belangen laten inzien
besef dat OG verantwoordelijk is voor het project
Bij PM:
- Project beheersing training
Escalatieladder:
- Bespreken
- Confronteren
- Escaleren
Per type actor
Project Manager
Opdrachtgever
Project Team
Veilige omgeving bieden
Team evaluatie
Risico sessie organiseren
Review / Audit uitvoeren
Onderling afspraken maken


How to minimize the effect of
Barrier 3: Effects of Politics
Relatie - toetsen
zacht
Formaliseren / voorbereiding
hard
Informeel overleg met 'bestuur'
Koppelen aan belangen van bestuur
Achterhalen waarom OG de druk opvoert: reden kan anders zijn
Kaders stellen
Duidelijke escalatie ladder opstellen
Transparantie en Consequenties
Reactief
Proactief / Alternatieven aanbieden
Prooctief
Transparantie
Consequenties inzichtelijk maken
Risico/EWS tegen projectkaders Geld, Kwaliteit, Tijd afzetten
OG meenemen in consequenties van hun acties: mede verantwoordelijk maken
Interactie
Dilemma's presenteren ipv nee zeggen
- acceptatie
- confronteren: onafhankelijk opstellen
- beste voor project
Alternatieven van gewijzigde wensen inzichtelijk maken: nu vs later best vs goed druk vs iets meer tijd


TU Delft


AT OSBORNE