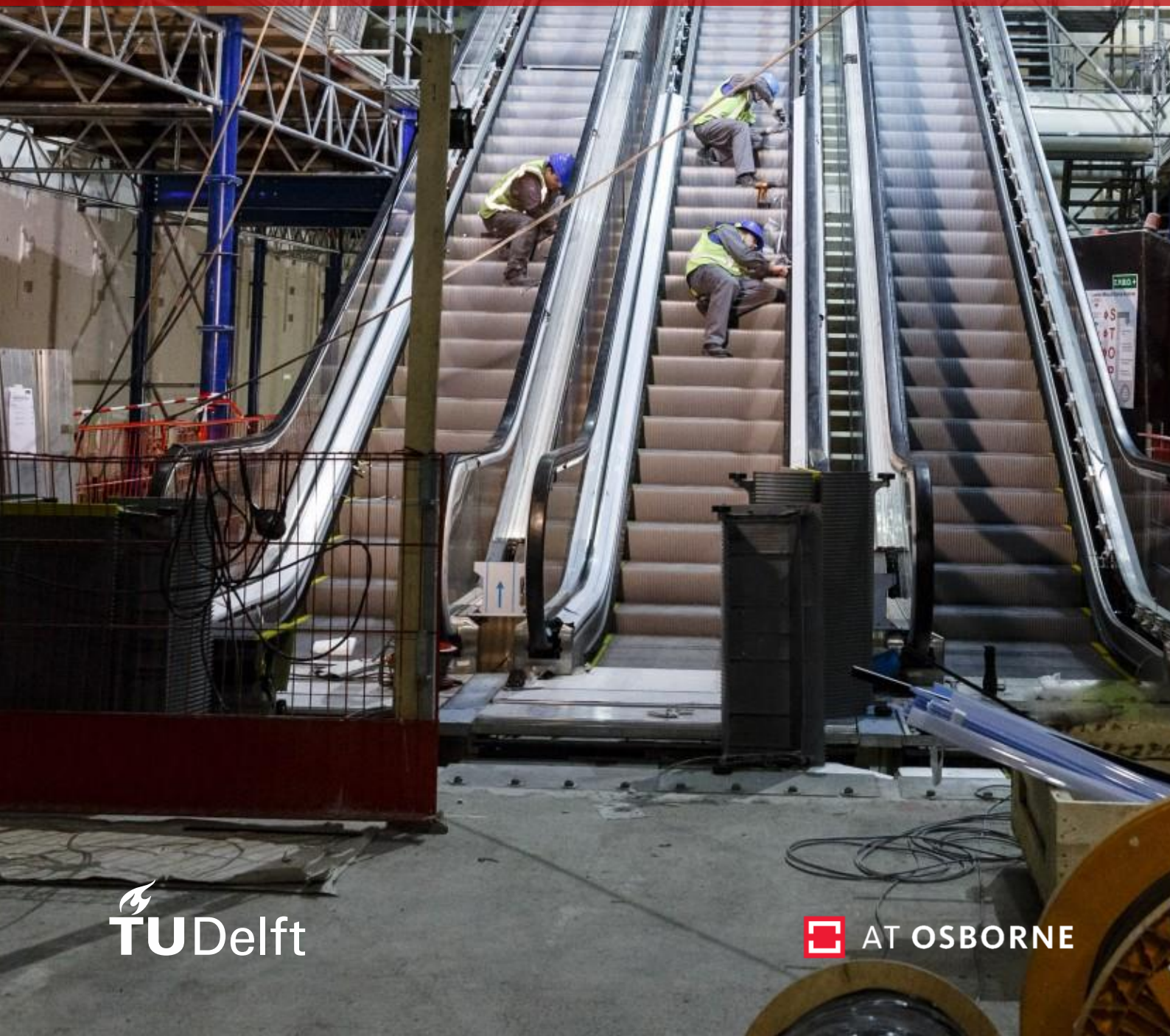
N.B. Wijtenburg

Stimulating Early Warning Responses

A Qualitative Study on Dutch Infrastructure Construction Projects

MSc. Thesis



TU Delft

AT OSBORNE

MSc. Thesis

Stimulating Early Warning Responses

A Qualitative Study on Dutch Infrastructure Construction Projects

By

Noud Bernard Wijtenburg

in partial fulfilment of the requirements for the degree of

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Author:

Name	Noud Wijtenburg
E-mail	n.b.wijtenburg@gmail.com
Student number	4112326

Graduation Committee:

Chair:	Prof. dr. ir. M.J.C.M Hertogh,	TU Delft
First supervisor:	Dr. ir. M. G. C. Bosch-Rekveldt,	TU Delft
Second supervisor:	Dr. M. Leijten,	TU Delft
External supervisor:	Ir. T. Kremers,	AT Osborne
External Supervisor:	Ing. A. Miggelenbrink	AT Osborne

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Preface

For me, the cover photo captures all the key aspects of this research. At first, because of the location. The photo is taken at the Vijzelsgracht station, part of the Noord-Zuidlijn, the newly built Amsterdam metro line. Discussing the many issues that occurred during the construction of this station with project manager Gerard Scheffrahn was my first introduction to the subject of project recovery and early warning signs.

Secondly, because of its symbolism with the subject. Early warning signs are best detected on the work floor, or 'at the coffee machine', as my supervisors Alex and Tom would say. To be responded to, early warning signs have to arise at the level of decision-making. However, many barriers occur in this process of early warning signs moving upwards. Minimising these barriers stimulates early warning signs to surface, just as the escalators stimulate the passenger flow out of the subway.

Over the past half year, I have dived into the subject of early warning signs and barriers in responding to them. A deep dive, which I have come to enjoy in the process. Besides the relevance of the subject, appearing in conversations with practitioners, a large part of this is due to my team of supervisors. This research would not have been possible without them. I want to thank Tom and Alex, who next to their busy jobs always took extensive time to discuss findings and brainstorm about next steps, and always pushed to improve the work. I enjoyed working with you both a lot. Many thanks to Marian, who guided me through this research, revised my work countless times, and stimulated me to take it to a higher level. And I want to thank Martijn and Marcel, who provided constructive feedback and inspired me in this research, making the team meetings productive and fun. I am very grateful for all your support.

Furthermore, I want to thank the people at AT Osborne, who were always open to discuss aspects of this research, and participated in different interviews and sessions. I felt very welcome and enjoyed my time as an intern a lot.

A special thanks to all other people involved in the project for interesting interviews and other conversations. I want to thank Sara Haji-Kazemi, on whose work this research is mainly based, for commenting on my work and discussing the results in a Skype meeting. And a thanks to photographer Gé Dubbelman and Gemeente Amsterdam for allowing me to use several beautiful photos of the Noord-Zuidlijn and Oostlijn (including the cover photo), and ProRail for sending me several photos of the DSSU project. Last but not least, many thanks to my friends and family who were frequently forced to take a look into the work that I sent them, but always responded with useful comments.

My goal for this thesis was to conduct a research that will contribute to scientific knowledge and at the same time provide actual usefulness to current practice. I hope succeeded in this goal, and hope you will enjoy reading the result!

Noud Wijtenburg

Summary

Introduction

Large cost overruns and delays are a global phenomenon in construction projects. Despite large scale application of performance- and risk management practices, some projects still fail. However, failure in projects does not happen overnight. Cost overruns and delays are not suddenly discovered, but instead follow an incremental accumulation of problems. Usually there are signs indicating problems, signs that a project is heading off track, so called early warning (EW) signs.

EW signs are indicators for a potential risk event to occur, whilst a time frame and magnitude cannot be determined yet. They trigger action in order to prevent future negative issues. Typically, organisations are aware of the presence of these signals, but struggle in their ability to respond to them. They experience certain barriers to their ability to respond. Research on the functioning of these barriers is limited, especially in their presence over the process of responding to EW signs. This research provides insight in why we fail to address and respond to EW signs, before a project enters a crisis situation. The main barriers to responding to EW signs are investigated. On basis of this information, recommendations are provided for dealing with these barriers, in order to stimulate our ability to respond to EW signs. The following research question is used in this research.

How can the responsiveness to early warning signs in Dutch infrastructure construction projects be stimulated?

Research approach

This research is approached by a combination of inductive and deductive research. Mixed qualitative research methods are used over four research phases. Phase I consists of a literature study to explore the concepts of EW signs, identification methods and barriers. In phase II, experts are consulted to identify the most important barriers. In phase III, a case study is conducted of three rail projects to investigate the functioning of barriers. In phase IV, an expert session is organised to discuss suggestions for improvement in responding to EW signs. The central organisational scope of this research is the project delivery organisation and client organisations of complex, publicly initiated construction projects. This research is conducted in accordance with AT Osborne, a consultancy firm specialised in managing of and advising on complex construction projects.

Results

The results of the literature study (phase I) show that EW signs are pre-eminently *leading* indicators, often have a *soft* character, and grow stronger over time. Literature shows that responding to EW signs has significant effect on project performance. EW signs can be detected by various identification methods, but are dependent on gut-feeling assessments as well. Whilst the importance of soft EW signs is acknowledged in project management literature, currently used project control methods in practice mainly focus on hard factors, such as time, cost, and scope. Furthermore, the process of identifying and responding to EW signs is described in literature by means of an *EW procedure* model, in which four filters limit the information flow. These are a *surveillance filter,* an *observer mentality filter,* a *decision-making mentality filter,* and a *political/power filter.* These filters are driven by various barriers, that can block a response to EW signs.

The results of the expert consultation (phase II) show that most of the barriers suggested in literature are recognised by experts. Following from seven interviews and an expert session, *optimism bias*, *time pressure*, *project complexity* and *uncertainty avoidance* are marked as most important barriers in responding to EW signs. *Fragmentation*, *client-contractor relation*, *political effects* and *management style* are considered to be important barriers as well. These eight barriers have been further analysed in the case study.

The results of the case study (phase III) show that both hard and soft EW signs are present in Dutch construction projects. Furthermore, the results demonstrate the occurrence and functioning of barriers in three rail projects in the Netherlands. All of the included barriers have occurred in one or more of the analysed

projects. This highlights the relevance of this research for the construction industry. Furthermore, the barriers are linked to all of the four filters of the *EW procedure*. This indicates that barriers occur throughout the process of responding to EW signs. Of the four filters, the *observer mentality filter* and the *decision maker mentality filter* are most linked to. This highlights the importance of the perception of individuals for the interpretation and follow-up of EW signs. This means that in order to improve the responsiveness to EW signs, behavioural change is necessary towards using EW signs.

The results of the expert session (phase IV) show that the effect of barriers can be minimised by implementing suggestions for improvement with regards to the surveillance, communication, and decision-making on EW signs. Furthermore, general conclusions are drawn per barrier on how to minimise negative effects.

- The effect of *optimism bias* can be minimised by applying an outside view on the project on a regular basis both on hard and soft factors.
- Negative effect of the *client-contractor* relation can be minimised by ensuring a healthy client-contractor relation based on transparent communication.
- The effect of *uncertainty avoidance* can be minimised by explicitly track and discuss hard and soft EW signs on a regular basis, and creating a culture of open communication.
- The effect of *time pressure* can be minimised by ensuring sufficient and effective time for reflection, and transparency in decision-making.
- *Fragmentation* is minimised by stimulating communication with colleagues of other projects, as well as within the project.
- Negative effects of *management style* are minimised by applying a bottom-up management style, while being decisive in decision making.
- The effects of *project complexity* can be minimised by stimulating interaction throughout the project.
- Negative *effects of politics* can be minimised by ensuring communication to higher management and politics.

Conclusion

Based on the findings of this research, several conclusions are drawn in order to answer the main research question: *How can the responsiveness to early warning signs in Dutch infrastructure construction projects be stimulated?*

In order to improve the ability to respond to EW signs, more attention should be paid to soft, managerial aspects. In addition, the occurrence of barriers limits the responsiveness to EW signs. These barriers are recognised by expert practitioners, and all occur in construction projects. The presence of these barriers should be recognised and actively taken into account. The responsiveness to EW signs is stimulated by improving the (1) surveillance, (2) communication, and (3) decision-making on EW signs, and thereby minimising the effect of barriers. This can only be achieved by cultural change throughout projects and project organisations.

At first, concerning the surveillance, a change in reflection is necessary. More and effective time for reflection needs to be incorporated in projects, both internally and externally. Besides known risk management practices, reflection with regards to soft EW signs needs to become an integral part of project management. Reflection also needs to be a continuous process, and in co-operation with stakeholders, contractors and other projects.

Second, communication on EW signs needs to be stimulated and ensured, facilitated by a culture of open communication. The interpretation and follow-up of soft aspects relies on the way they are communicated. Besides internal communication, open communication throughout project environment is just as important. Transparency is key in the follow-up of EW signs. Perceived opportunistic behaviour of stakeholders needs to be challenged, since this limits open communication.

Third, regarding decision-making, behavioural change is necessary. Decision-making needs to be transparent, whereby EW signs are taken explicitly into account at the right level of decision-making. The right response to EW signs is the right decision on follow-up in the dynamic and political arena of the project. Furthermore, front-end politics need to be followed by realistic expectations at the start of the project, to reduce pressure and eliminate hindsight identifying of culprits.

The role of the project manager is crucial in acting upon EW signs, due to its many responsibilities in this process. This role needs to be supported by tools for reflection on soft EW signs, challenged communication to higher management, and training of project managers with regards to EW signs and barriers to responding.

Recommendations

A set of recommendations is provided to stimulate the responsiveness to EW signs, by means of improving the surveillance, communication, and decision-making on EW signs. They serve as starting points for the required change in the sector.

Recommendations to improve the surveillance for EW signs:

1. Review the project externally on a periodical basis by assessing both hard and soft factors
2. Organise critical reflection on EW signs in the project team
3. Assign a central role to stakeholder management
4. Share information and knowledge actively in- and outside the project

Recommendations to improve the communication of EW signs:

5. Challenge communication from the project manager to higher management
6. Stimulate and reward communication of EW signs
7. Discuss difference in interests explicitly with stakeholders
8. Separate communication on EW signs from contractual conflicts with contractors on a human level

Recommendations to improve the decision-making and acting upon EW signs:

9. Consider EW signs explicitly in decision making
10. Take more time for reflection when pressure on planning is high
11. Create a political window when necessary
12. Lead by example in challenging mistrust in relation with other stakeholders

Implications of research

This research contributes to scientific knowledge of EW signs in project management by several means. At first, the concept of EW signs has been enriched by discussing its different dimensions. Second, the applicability of the EW procedure model in the construction industry has been demonstrated. Third, the discussed presence, functioning and importance of barriers contributes to existing literature. Fourth, links have been demonstrated between barriers and the filters of the EW procedure, as suggested in literature. And fifth, recommendations to minimise barriers complement insights in the literature.

Furthermore, this research contributes to practical knowledge in the construction industry. It shows that EW signs are present in construction projects, but not always responded to. It demonstrates that various barriers limit the response, occurring in all projects. The construction industry will benefit by assessing soft factors in project performance, and by creating awareness of barriers in responding to EW signs. However, cultural change throughout organisations is necessary to facilitate this, rather than implementation of several recommendations by project managers.

Limitations and suggestions for future research

This research faced several limitations, which provide opportunities for future research. At first, this research focused on the occurrence of EW signs and barriers, but not on their effect on the final project outcome. The effect of responding to EW signs should be subject to further research, soft EW signs specifically. Second, the qualitative character of this research limits the validity. Therefore, quantitative research on EW signs and barriers to responding is of interest in the future. Third, only infrastructure projects are considered in this study. Similar research in other type of projects and other project management industries is of high interest. Fourth, considering only Dutch projects limits the ability to generalise results internationally, due to cultural differences. Similar research in projects in other countries is of interest in the future.

Samenvatting

Introductie

Hoge kostenoverschrijdingen en vertragingen zijn een wereldwijd fenomeen in bouwprojecten. Ondanks grootschalige toepassing van prestatie- en risicomanagement, kampen projecten nog steeds regelmatig met problemen. Maar, 'project falen' komt niet uit de lucht vallen. Kostenoverschrijdingen en vertraging worden niet plots ontdekt, maar zijn het resultaat van opeenstapeling van problemen. Meestal zijn er signalen die problemen voorspellen, die erop wijzen dat een project ontspoort, zogenaamde early warning (EW) signs.

EW signs zijn indicatoren voor mogelijke risico's, waarbij een tijdsframe of impact nog niet te bepalen zijn. Ze vragen om actie om toekomstige problemen te voorkomen. Typisch zijn organisaties zich bewust van deze signalen, maar hebben moeite om er iets mee te doen. Ze ondervinden zekere barrières in hun mogelijkheid om er actie op te nemen. Er is nog weinig onderzoek gedaan naar de precieze werking van deze barrières. Zeker in hun rol in het proces van acteren op EW signs. Dit onderzoek geeft inzicht in de vraag waarom het ons niet lukt om EW signs aan de kaak te stellen en erop te acteren, voordat een project in een crisis terechtkomt. De belangrijkste barrières in het acteren op EW signs zijn onderzocht. Op basis van deze informatie worden aanbevelingen gegeven voor het omgaan met barrières, om het acteren op EW signs te stimuleren. Hierbij is de volgende onderzoeksvraag gebruikt.

Hoe kan de responsiviteit op early warning signs in Nederlandse infrastructuurprojecten worden gestimuleerd?

Onderzoeksaanpak

Dit onderzoek is een combinatie van inductief en deductief onderzoek. Verschillende kwalitatieve onderzoeksmethoden zijn gebruikt verdeeld over vier fases. Fase I bestaat uit een literatuurstudie gericht op het concept van EW signs, identificatie methoden, en barrières. In fase II zijn experts geraadpleegd om de belangrijkste barrières te selecteren. Fase III is een case studie van drie rail projecten om de werking van barrières in Nederlandse projecten te onderzoeken. In fase IV is een expert sessie georganiseerd om suggesties te vinden om beter om te gaan met EW signs. De centrale organisatorische scope van dit onderzoek is de projectorganisaties en client organisaties van grote, publiek geïnitieerde infrastructuurprojecten. Het onderzoek is uitgevoerd in samenwerking met AT Osborne, een consultant gespecialiseerd in het managen en adviseren van complexe bouwprojecten.

Resultaten

Uit de literatuurstudie (fase I) blijkt dat EW signs voornamelijk *leading* indicatoren zijn, meestal een *zacht* karakter hebben, en sterker worden over tijd. Het is aangetoond dat acteren op EW signs effect heeft op de prestatie van het project. EW signs kunnen worden gevonden door verschillende methodieken, maar zijn ook afhankelijk van onderbuikgevoelens. Ondanks dat het belang van zachte EW signs is erkent in literatuur, focussen de meest gebruikte projectbeheersingsmethodieken zich vooral op harde factoren, zoals tijd, kosten, en scope. Het proces van herkennen en acteren op EW signs is beschreven in de literatuur met een *EW procedure* model. Hierin wordt de informatiestroom beperkt door vier filters: De *surveillance filter, observer mentality filter, decision-making mentality filter,* en de *political/power filter.* Deze filters worden gestuurd door verschillende barrières, die het acteren op EW signs kunnen blokkeren.

Uit de raadpleging van experts (fase II) blijkt dat de meeste barrières herkent worden. Uit zeven interviews en een expert sessie blijkt dat *over optimisme, tijdsdruk, project complexiteit,* en *vermijding van onzekerheden* het meest als belangrijke barrières worden beschouwd. Daarnaast, andere belangrijke barrières zijn *fragmentatie, client-contractor relatie, politieke effecten* en *management stijl.* Deze acht barrières zijn verder onderzocht in de case studie.

Uit de case studie (fase III) blijkt dat zowel harde als zachte EW signs zich voordoen in Nederlandse bouwprojecten. Daarnaast is de werking van barrières in drie railprojecten aangetoond. Alle meegenomen barrières zijn in een of meer van de projecten voorgekomen. Dit benadrukt de relevantie van het onderzoek.

Door de barrières tegenover de vier filters van de *EW procedure* te zetten, blijkt hoe barrières zich voordoen in het proces van acteren op EW signs. De barrières zijn gelinkt aan alle vier de filters. Dit laat zien dat barrières over het gehele proces van acteren op EW signs werken. De meeste links zijn waargenomen bij de *observer mentality filter* en de *decision maker mentality filter*. Dit benadrukt het belang van de perceptie van individuen voor de interpretatie en opvolging van EW signs. Om de responsiviteit op EW signs te verbeteren is er dus gedragsverandering nodig in projecten.

De resultaten van de expert sessie (fase IV) laten zien dat het effect van barrières geminimaliseerd kan worden door verschillende verbeteringen met betrekking tot het herkennen, communiceren, en acteren op EW signs. Daarnaast worden per barrière conclusies getrokken over het minimaliseren van negatieve effecten.

- *Over optimisme* kan worden tegengegaan door een externe blik op het project toe te passen op reguliere basis, kijkend naar zowel harde als zachte factoren.
- Negatieve effecten van *client-contractor* relatie kunnen worden voorkomen door een goede relatie tussen client en contractor te houden, gebaseerd op transparante communicatie.
- *Vermijding van onzekerheden* kan worden geminimaliseerd door zachte en harde EW signs expliciet te bespreken op reguliere basis, en een cultuur van open communicatie te creëren.
- Negatieve effecten van *tijdsdruk* kunnen worden geminimaliseerd door voldoende en effectief de tijd te nemen voor reflectie, en door besluitvorming transparant te maken.
- *Fragmentatie* wordt tegengegaan door het stimuleren van communicatie met collega's van binnen en buiten het project.
- *Management stijl* kan als barrière worden voorkomen door een bottom-up stijl toe te passen, maar wel besluitvaardig te zijn als project manager.
- *Project complexiteit* als barrière kan worden tegengegaan door het stimuleren van interactie tussen werknemers door het gehele project, en met belanghebbende partijen.
- *Politieke effecten* als barrière kan worden tegengegaan door communicatie naar het hogere management en de politiek te garanderen.

Conclusie

Gebaseerd op de bevindingen van dit onderzoek, kunnen verschillende conclusies worden getrokken, en kan de onderzoeksvraag beantwoord worden: *Hoe kan de responsiviteit op early warning signs in Nederlandse infrastructuurprojecten worden gestimuleerd?*

Om beter om te kunnen gaan met EW signs moet er meer aandacht uitgaan naar zachte factoren. Daarnaast houdt de werking van barrières het reageren op EW signs tegen. Deze barrières zijn herkend door experts, en komen allemaal voor in infrastructuurprojecten in Nederland. Daarom moeten deze barrières worden erkend en actief in beschouwing worden genomen. De responsiviteit op EW signs kan worden gestimuleerd door het (1) herkennen, (2) communiceren, en (3) acteren op EW signs te verbeteren. Dat kan alleen verbeterd worden door een culturele verandering in projecten en projectorganisaties.

Ten eerste, ten aanzien van het (1) herkennen, is er een verandering in reflectie nodig. Hier moet meer en effectiever tijd voor worden genomen, met zowel interne als externe reflectie. Naast bekende risicomanagement werkwijzen, moet reflectie met betrekking op zachte EW signs een integraal onderdeel van project management worden. Reflectie moet ook een continu proces zijn, in samenwerking met stakeholders, aannemers en andere projecten.

Ten tweede, (2) communicatie over EW signs moet gestimuleerd en beloond worden, door een cultuur van open communicatie te creëren in het project. De interpretatie en opvolging van zachte factoren hangt namelijk af van de manier waarop deze gecommuniceerd worden. Naast interne communicatie, is open communicatie in de gehele projectomgeving net zo belangrijk. Transparantie is essentieel in de opvolging van EW signs. Verondersteld opportunisme tussen partijen moet daarom tegengegaan worden.

Ten derde, ten aanzien van het (3) acteren op EW signs, is een verandering in gedrag noodzakelijk. Besluitvorming moet transparant zijn, waarbij EW signs expliciet meegenomen worden tot het juiste niveau van besluitvorming. De juiste respons op EW signs is het juiste besluit tot opvolging in de dynamische en politieke omgeving van het project. Daarnaast, politiek aan de voorkant van het project moet gevolgd worden door realistische verwachtingen bij de start van het project. Hiermee wordt de druk op het project verminderd en wordt achteraf niet de zondebok gezocht.

De rol van de project manager is cruciaal in het reageren op EW signs, vanwege vele verantwoordelijkheden in het proces van reageren. Deze rol moet ondersteund worden met methodieken om te reflecteren op zachte EW signs, door verantwoording in communicatie met hoger management in te stellen, en training van project managers op EW signs en barrières in het acteren hierop.

Aanbevelingen

Een aantal aanbevelingen worden gegeven om de responsiviteit op EW signs te stimuleren, aan de hand van het herkennen, communiceren en acteren op EW signs. Deze aanbevelingen dienen als handvatten voor de benodigde verandering in de sector.

Aanbevelingen om het herkennen van EW signs te verbeteren:

1. Review het project extern op periodieke basis, kijkend naar zowel zachte als harde factoren
2. Organiseer kritische reflectie op EW signs in het projectteam
3. Zet omgevingsmanagement centraal
4. Deel actief informatie en kennis binnen het project en tussen projecten

Aanbevelingen om het communiceren van EW signs te verbeteren:

5. Challenge de communicatie van de projectmanager naar hogerop
6. Stimuleer en beloon het delen van EW signs
7. Bespreek verschil belangen expliciet met stakeholders
8. Koppel communicatie van EW signs los van contractuele besluitvorming met aannemers op persoonlijk niveau

Aanbevelingen om het acteren op EW signs te verbeteren:

9. Neem EW signs expliciet mee in besluitvorming
10. Neem meer tijd voor reflectie wanneer de tijdsdruk hoog is
11. Creëer een politiek window of opportunity wanneer nodig
12. Geef het juiste voorbeeld in tegengaan van wantrouwen in relatie met andere stakeholders.

Implicaties van het onderzoek

Dit onderzoek draagt op verschillende manieren bij aan theoretische kennis van EW signs in project management. Het fenomeen van EW signs is verrijkt door verschillende dimensies te belichten. De toepasbaarheid van het *EW procedure* model in de bouwsector is daarnaast aangetoond. De aangetoonde aanwezigheid, werking en belang van barrières draagt bij aan bestaande literatuur. En zoals voorgesteld in literatuur, zijn links aangetoond tussen barrières en de filters van de EW procedure. Ten slotte vullen aanbevelingen om barrières te minimaliseren bestaande literatuur aan.

Het onderzoek draagt ook bij aan praktische kennis in de bouwsector. Het laat zien dat EW signs aanwezig zijn in project, maar er niet altijd iets mee wordt gedaan. Het laat ook zien dat verschillende barrières een reactie belemmeren, voorkomend in alle projecten. De sector zal profijt hebben van het monitoren van zachte factoren in projecten, en door bewustzijn te creëren van barrières in het acteren op EW signs. Maar in plaats van het toepassen van een aantal aanbevelingen is hier een culturele verandering in de sector voor nodig.

Beperkingen en suggesties voor onderzoek

Dit onderzoek kent verschillende beperkingen, die vragen om verder toekomstig onderzoek. Het onderzoek focust op de werking van EW signs en barrières, maar niet op hun effect op de project uitkomst. Dit effect moet verder onderzocht worden, met name ten aanzien van zachte EW signs. Daarnaast zal vergelijkbaar kwantitatief onderzoek zorgen voor een vergroting van de validiteit.

Daarnaast kijkt dit onderzoek specifiek naar infrastructuurprojecten. Vergelijkbaar onderzoek in ander type projecten en andere project management industrieën is interessant om resultaten te kunnen vergelijken. Ook is vergelijkbaar onderzoek in andere landen is nodig om de resultaten internationaal te kunnen generaliseren.

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List of Abbreviations

CM	Contract Manager
EM	Environmental Manager
EW	Early Warning
KPI	Key Performance Indicator
MPC	Manager Project Control
PHS	Programma Hoogfrequent Spoorvervoer
PM	Project Manager, Project Management
PMI	Project Management Institute
TM	Technical Manager

1

Introduction

Construction worker walking into the Noord-Zuidlijn tunnel (photo: Gé Dubbelman)

1.1 Research context

On 19th of June 2008, a leakage in the drilling of Amsterdam's largest subway project caused several dwellings on the 'Vijzelsgracht' to sink centimetres into the clay soil of the capital of the Netherlands. This marks the start of a series of events leading to major cost overruns and delay of the project. The investigation report linked the fatal course of events to *'an existing culture of lack in co-operation'* between project organisations (Gemeentelijke Ombudsman, 2009). In addition, *'technical optimism'* and '*political pressure'* are indicated as important factors for the project to more than double the original estimated costs (Soetenhorst, 2011).

The question is if these problems could have been prevented. Although leakage occurred as an incident, hindsight reporting points to organisational and political factors as influencing causes for the escalation. Addressing signs of malfunctioning organisational culture and political pressure in an early stage could presumably have prevented massive cost escalation. However, in this case these signs apparently have not been picked up, or haven't been acted upon.

Large cost overruns and project delays are a global phenomenon in construction projects (Morris & Hough, 1987). This does not seem to have improved over time (Flyvbjerg, Holm, & Buhl, 2002;2003). Despite large scale application of widely used tools such as risk analysis, project costs are still underestimated, whether or not deliberately (Flyvbjerg, Garbuio, & Lovallo, 2009).

Entering a project crisis, or project 'failing', does not happen overnight (Kerzner, 2013 p.69). Series of events have taken place before a project can be diagnosed as failed. Large cost overruns and major delays are not suddenly discovered, but instead follow an incremental accumulation of problems. There are signs that indicate these problems, signs that a project is heading off track, so called Early Warning (EW) signs. Most of the time these EW signs are process-related, 'gut-feeling' type of signs. Examples are a lack of communication, poor moral in the project team, or low commitment to the project objective (Nikander, 2002, p. 150). Typically, organisations are aware of the presence of these signals, but struggle in their ability to respond to them (Haji-Kazemi, Andersen, & Klakegg, 2015). They experience certain barriers to their ability to respond (Williams, Jonny Klakegg, Walker, Andersen, & Morten Magnussen, 2012). However, responding to these signs has significant effect on project performance (Meng, 2014).

This research provides insight in why we fail to address these EW signs, and respond to them before a project enters a crisis situation. Therefore, the main barriers to responding to EW signs are investigated. On basis of this information, recommendations are provided how to deal with these barriers, in order to improve our ability to respond to EW signs.

1.2 Literature scan

To illustrate the process from identification up to acting upon EW signs, a model has been developed by Haji Kazemi (2015). It is based on a filter model introduced by Ansoff (1975). Haji-Kazemi's *EW procedure* model assumes four different filters in the process where a response to EW signs can be blocked, or 'filtered out': At the choice of surveillance, the person who observes, the decision maker receiving the EW sign, and the final decision to respond (Figure 1).

EW signs are filtered out by the influence of certain factors, which are called barriers in this research. In practice, these are factors such as *optimism bias* and *political effects,* as mentioned in the previous section (Flyvbjerg et al., 2009; Klakegg et al., 2010). Other factors and their influence on project success are discussed in various sources of literature, such as *uncertainty avoidance*, *normalisation of the deviance*, *time pressure*, and *project complexity* (Hertogh & Westerveld, 2010; Hofstede, 1991; Klakegg et al., 2010; Pinto, 2014). A set of these barriers has been clustered by Haji-Kazemi (2015), schematically represented in a circle in Figure 1.

1.3 Research gap

Research has not provided an answer yet on the question how the different barriers, such as optimism bias or political effects, are linked to the process of responding to EW signs. Specifically, at what filters in the *EW*

procedure they occur, and how. Suggestions of these links have been made by Haji-Kazemi (Haji-kazemi, 2015, p. 132) This research gap, as illustrated in Figure 1 is subject to this research.

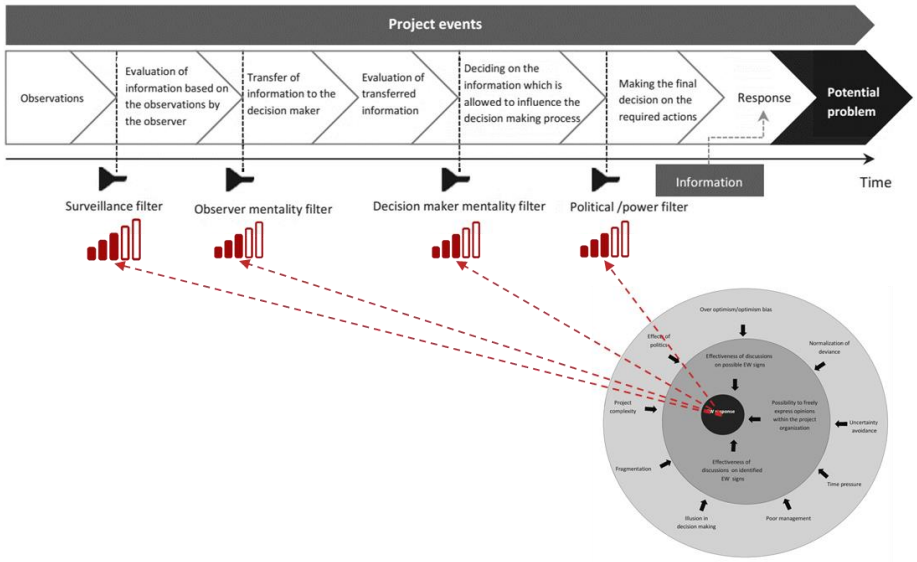

Figure 1: Research gap

In order to improve the responsiveness to EW signs in projects, it is essential to know what is withholding projects to respond properly to EW signs. By contributing to this gap of research, starting points for improvements are generated, on which recommendations are formulated.

1.4 Research question

In order to answer the current research gap, the following research question is formulated:

RQ

How can the responsiveness to early warning signs in Dutch infrastructure construction projects be stimulated?

This main research question is supported by the following sub questions:

SQ1 *What are early warning signs, how are they identified, and what prevents an adequate response?*

SQ2 *What are the most important barriers in responding to early warning signs in Dutch construction projects?*

SQ3 *How do barriers function in the process of responding to early warning signs in Dutch construction projects?*

SQ4 *How can barriers be minimised in the process of responding to early warning signs?*

1.5 Research goal

This research aims to fill the research gap as presented in section 1.3. By means of qualitative research, links are investigated between the above mentioned theoretical concepts of barriers and the filters in the process of responding to EW signs. Using this information, recommendations on how to tackle these barriers are formulated in correspondence with experts. Therefore, the goal of this research is:

to contribute to the knowledge of the early warning phenomenon by investigating the main barriers in responding to early warning signs and providing recommendations to minimise these barriers

1.6 Scientific relevance

The need for this research is highlighted by researchers. S. Haji-Kazemi stated the following suggestion for future research in barriers in the EW response: *'Further studies that investigate more thoroughly the conditions under which each of the filters are created and the approaches that can ease the information flow through those filters are likely to be of great interest in the near future'* (Haji-Kazemi, 2015). Furthermore, in a recent master thesis on barriers to EW signs it is suggested to investigate '*how responses to EW signs can be enhanced in order to prevent failure'* (Poshtekooh, 2014). These two suggestions form the basis of this research.

1.7 Practical relevance

Following from section 1.1, there is a need in the construction industry to make better use of EW signs, in order to prevent failure in projects. This research has been conducted in accordance with AT Osborne. AT Osborne is a consultancy firm specialised in managing of and advising on complex construction projects. As a result of their extensive experience in project management, they formed their own vision on 'project recovery' (AT Osborne, 2017b). Project recovery hereby refers to the recovery of construction projects in crisis (Ringoir, 2017). Managers experience parallels between these projects in crisis in the form of early warning signs, that indicate a project is moving off track. They believe EW signs can be used as seismograph for project performance. In their wish to expand knowledge of the concept project recovery, the company aims to make these EW signs visible in projects. It is believed that this will contribute to the prevention of project crises. By providing recommendations on how to tackle barriers, this research contributes to this knowledge.

1.8 Structure of research

This thesis is structured according to the diagram below (Figure 2). After this introduction, chapter two continues with the applied methodology of research. The sub questions of this research are answered in chapters three, four, five and six. Chapter three contains the results of a literature study. Chapter four elaborates on the results of a series of expert interviews and an expert session. Chapter five contains a case study on three different construction projects. Chapter six discusses suggestions to improve the responsiveness to EW signs. Chapter seven contains a discussion. Chapter eight contains conclusions, answers the research questions and provides recommendations for further research.

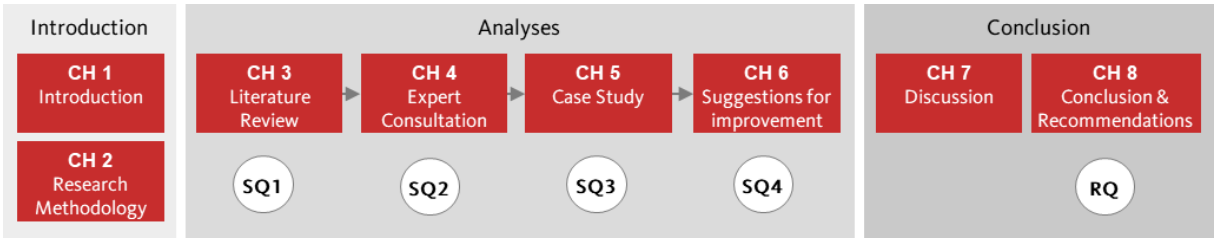

Figure 2: Thesis structure

2

Research Methodology

Project DSSU (photo: ProRail)

This chapter is devoted to how this research is conducted, the research methodology. In section 2.1, characteristics of this research are elaborated. Section 2.2 explains the scope of research. In section 2.3, the applied research framework is introduced. Section 2.4 is devoted to the validation of research.

2.1 Research characteristics

The main research question as formulated in the introduction has an *explorative* character. According to Yin (2003), this is typical for questions starting with 'how'. The research aims to further understand the occurrence of barriers that prevent early warning (EW) responses. Therefore, this research can also be characterised by a *constructivist* approach. This view is characterised by obtaining an understanding of the world around us, by questioning and interpretation (Creswell, 2014).

A mix of *qualitative* research methods is applied for this research, as opposed to quantitative research. Constructivism is typically considered as an approach for qualitative research (Creswell, 2014). Qualitative research aims to understand certain phenomena or processes. Since this research aims to understand the phenomenon of barriers to EW signs, it can be characterised as qualitative.

Furthermore, this research uses both an *inductive* and *deductive* approach. Research on barriers to EW signs is limited. Therefore, the research relies mainly on observations to create understanding. However, the conceptual framework as presented in section 1.3 and suggestions from literature are used as basis for research. Throughout this research, several different research instruments are used. These are explained in detail in section 2.3.

2.2 Scope of research

Construction project management

This research is written in light of construction project management. The theoretical concepts introduced in chapter three are mainly developed for project management in general, and based on project management research in different industries. The focus on construction projects is applied to investigate sector specific issues. Furthermore, it enables a valid comparison of projects and interviews, especially regarding the qualitative format of the research.

Early warning signs perspective

The perspective of this research is that of EW signs, as indicators for possible project failure. Closely related perspectives are risk management, project failure, and project control. These perspectives have large overlap with the concept of EW signs, and are therefore addressed when necessary. The relation of EW signs with risk management is discussed in section Relation with risk management3.1.7. A recent master thesis of the TU Delft has been written on 'project recovery' (Ringoir, 2017), a term introduced in chapter 1.7. It adopts the perspective of 'recovery' after a project arrived in a crisis situation (thus EW signs have been missed). Although this research adopts the more 'front-end' perspective of EW signs, the results are taking into account in this research.

Dutch infrastructure construction projects

The selected constructed projects for the case studies (presented in the next section) are all rail infrastructure projects, executed in the Netherlands. This enables a valid comparison of the results. In the expert interviews, projects of other modalities are discussed as well. It is presumed that the phenomenon of responding to EW signs is comparable for infrastructure projects of different modalities. This is acknowledged by these experts. However, this should be verified by further research. Furthermore, the projects included are considerable in size, to represent the complex system in which EW signs are typically hard to identify. Lastly, it is important to note that similar research in other countries can lead to different results. Since the barriers in EW response are mostly of organisational character, cross cultural differences will likely contribute to differences in other countries.

Selection of considered barriers

All of the four filters as part of the EW procedure are considered in this research. It is important to address all four to obtain a complete image of the process of responding to EW signs. However, only a selection of barriers is considered in this research. A selection is made by submitting barriers from existing literature to experts (chapter four).

Project delivery organisation and client organisation perspective

The organisational dimension of relations between all stakeholders is not extensively addressed in literature on EW signs. However, it is argued that for construction projects it is essential to know where barriers apply in an organisational context. Practitioners expect for example that strategic behaviour between organisations in construction projects plays a significant role in the EW response. This dimension is highlighted in this research, and further discussed in chapter seven. An organisational display by the NETLIPSE organisation is used as reference model for this organisational context (NETLIPSE, 2018) (Figure 3). This consists of several elements that represent the project environment: client organisations, project delivery organisation, stakeholders, contractors, related projects, and political context. The project delivery organisation and client organisation are chosen as central perspective in this research. In contrast, a recent master thesis exploring the effect of EW signs from a contractors perspective is written by Aziz (2016). Results of this research are taken into account in this research. The project delivery organisation is schematically represented by means of the IPM role model, adopted in Dutch construction projects (Rijkswaterstaat, 2014). These main roles are project manager (PM), manager project control (MPC), technical manager (TM), environmental manager (EM) and contract manager (CM).

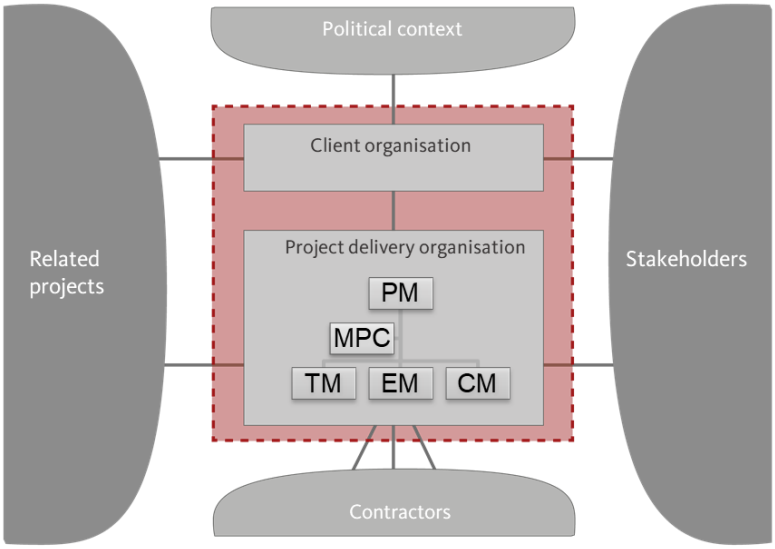

Figure 3: Organisational focus of this research (figure based on NETLIPSE, 2018)

Publicly initiated projects

This research is conducted from a public perspective. Only publicly initiated projects are considered, as are all large infrastructure construction projects in the Netherlands. As mentioned above, the main focus is on the project delivery organisation and client organisation. Therefore, the main focus is on public or semi-public organisations, such as Rijkswaterstaat, ProRail, and Nederlandse Spoorwegen, supplemented by external consultancy firms involved in projects, such as AT Osborne.

2.3 Research framework

In this part, the framework to answer the main research question is introduced. In the process of answering the main research question, the research is divided in four main phases. Each of these phases addresses a different sub-question. This research approach is schematically presented in Figure 4. The content of the four phases and the accompanying research methods are explained in the following section.

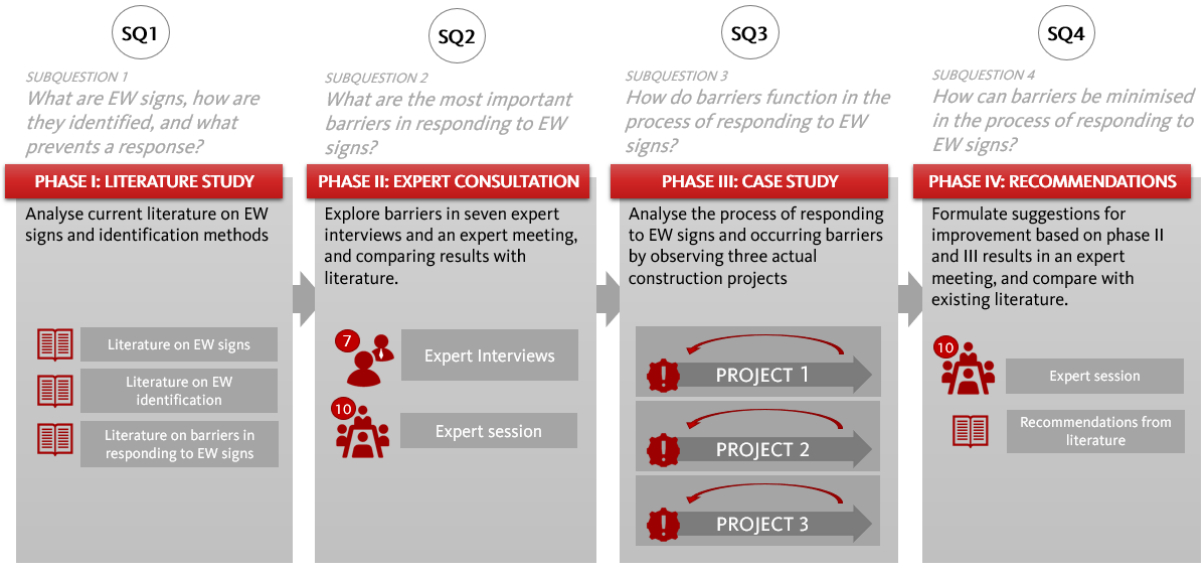

Figure 4: Research framework

2.3.1 Phase I: Literature study

The first phase of research is focused on obtaining an overview of important EW signs, identification methods and barriers. This enables to scope the research. For this phase, a desk research is executed by means of a *literature study*.

Literature on early warning signs is addressed to give an overview of the most important EW signs according to the literature. Literature of EW identification is used to identify the most common methods in identification of EW signs. Literature on responding to EW signs is addressed to identify the most important barriers in the literature. From this literature a theoretical framework is retrieved. The existing literature of I.O. Nikander and S. Haji-Kazemi is leading in this literature study, since these are the most comprehensive studies on EW signs yet. Relevant articles have been retrieved via Google Scholar, TU Delft Library, TU Delft repository, and Scopus. Search terms that have been used are: 'EW signs', 'weak signals', 'early warning', 'warning signs', 'project failure', 'project crisis', 'barriers in responding to EW signs', 'early warning barriers', 'project control', 'risk factors', 'risk symptoms', 'early warning identification', and 'risk identification'.

2.3.2 Phase II: Expert consultation

The second phase of research is focused on exploring the barriers in responding to EW signs. The goal is to compare existing theory on barriers in responding to EW signs with current practice of Dutch construction projects, and to obtain the most important barriers. Research on barriers to EW signs is limited. Consequently, no consensus exists yet on terminology and interpretation of the concepts. In order to capture the interpretation and effect of barriers to EW signs, expert interviews and an expert session are conducted.

At first, seven explorative interviews are conducted with experts in the field of construction project management. In these interviews, different barriers proposed in the literature are discussed. The experts are asked to point out the most important barriers. This serves as a basis for further scoping. Since the interviews have an explorative character, a *semi-structured interview* method is adopted. The exact approach of the expert interviews is discussed in section 4.1.3.

Furthermore, an expert session is organised with other experts than for the interviews. The reason for this meeting is twofold. Firstly, as a validation of the results on most important barriers. Secondly, it enables exploration of links between the barriers and filters in the EW process, as preparation for phase III. The exact approach of the expert session is discussed in section 4.1.4.

With the information of the interviews and session, a further scoping is made. A selection is made of the most important barriers in responding to EW signs. The selected barriers are investigated in detail in projects the third phase.

2.3.3 Phase III: In-depth case study

The third phase focuses on how the selected barriers function in projects. The answered research question has a qualitative and explorative character. Therefore, and in-depth case study is conducted. This is in line with Yin (1981), who reasons that a case study investigates a contemporary phenomenon in practice. The phenomenon of barriers to responding to EW signs is investigated in this research. Furthermore, it is in line with Schramm (1971), who states that the essence of case study is to highlight a decision or set of decisions. In this case it is attempted to show decisions regarding early warning signs. The barriers that are subject of research theoretically prevent objective and balanced decision making in construction projects.

For this case study, an holistic multiple-case design is used (R. Yin, 2003). It can also be characterised by a comparative case study, specifically the hierarchical method (Verschuren & Doorewaard, 2010). Three different construction projects in the Netherlands are analysed. For every case, the occurrence of barriers in the project is analysed, and linked to the filters of the EW procedure. Subsequently, the identified links are compared for the different cases in order to draw conclusions.

To obtain data, semi-structured interviews are conducted with different employees from in and around the project organisation, adopting an idiographic approach. Supplementary to interviews, project documents are addressed to analyse the course of events. This approach is used to address multiple viewpoints on the course of events, strengthening the construct validity. The exact approach of the case study is described in chapter 5.1.

2.3.4 Phase IV: Recommendations

The fourth and final phase of research is focused on providing suggestions to improve the responsiveness to EW signs. Phase I has provided insight in the concepts of EW signs, identifications methods and barriers in responding. Phase II has resulted in a selection of the most important barriers from practical experience. Phase III has provided a detailed overview of the presence of these barriers in the EW procedure in actual construction projects. From there it is possible to suggest recommendations to increase the responsiveness to EW signs.

On basis of observations from phase II and III, problem statements are drawn up. These statements are submitted to experts in an expert session. This expert session serves as verification and validation for the observations in this research, as well as basis for providing suggestions for improvement. The exact approach of this expert session is discussed in section 6.1. On basis of this expert consultation and expert opinions throughout the research, a set of recommendations for improvement is provided in chapter 8.

2.3.5 Input-output model

Supplementary to the research framework introduced in Figure 4, Figure 5 contains an overview of input and output of every phase, in the form of an input-output model. For each of the four phases, the required input, included processes, and expected output are described.

PHASE	INPUT	PROCESS	OUTPUT
PHASE I	▪ Relevant papers on: EW signs, identification methods, barriers, project failure	Literature study	▪ Overview EW phenomenon ▪ Overview identification methods ▪ Overview barriers ▪ Theoretical framework
PHASE II	▪ Experts in field PM infrastructure construction ▪ Barriers from literature ▪ Theoretical model EW response	Expert interviews (7) Expert session	▪ **Verification** of occurence and interpretation of barriers by experts ▪ **Selection** of most important barriers ▪ **Verification** of EW procedure model ▪ **Selection** of most important barriers ▪ Links between barriers and filters in EW process
PHASE III	▪ Three cases relevant Dutch infrastructure projects ▪ Most important barriers	Case studies (3) Dutch infrastructure projects	▪ **Observations** of occurence of barriers ▪ **Observations** of links between filters and barriers ▪ Combined observations of three proejcts
PHASE IV	▪ Results of expert interviews ▪ Results of expert session ▪ Results of case studies ▪ Provided recommendations	Expert session Comparison with literature	▪ **Verified** observations and suggestions for improvement by experts ▪ Set of **recommendations** for improving the responsiveness to EW signs

Figure 5: Input-output model

2.4 Validity of research

External validity

The external validity is generally under pressure in a case study (Verschuren & Doorewaard, 2010). To minimise this effect, *strategic sampling of results* is used. The interviewed project employees are strategically chosen, as explained in section 5.1. In addition, three different cases are investigated, by means of a *comparative case study*. Although limited conclusions can be drawn for the entire sector, combining the three cases provides insight applicable in the infrastructure construction sector.

Internal validity

Triangulation of sources, as described by Yin (2009) is used in the case studies to substantiate the results. For every case, multiple employees of the project are interviewed, supplemented by project documents. In addition, *literature validation* is used. Findings from both the expert interviews and case study are confronted with existing literature. Furthermore, multiple *member checks* are used as a verification for the retrieved results. Transcriptions of the expert interviews are sent for approval to the experts. The expert session in the fourth phase of this research is used as an extra verification and validation check for the recommendations following out of this research.

3

Literature Review

Early Warning signs, identification methods and barriers

'Noord-Zuidlijn cathedral' (photo: Gé Dubbelman)

This chapter contains a literature review on the phenomenon of early warning (EW) signs. This corresponds with the first of four phases of research. The aim of this chapter is to review the literature written on EW signs, identification methods, and barriers to responding to EW signs.

The sub question that is answered in this chapter is:

SQ1 *What are early warning signs, how are they identified, and what prevents an adequate response?*

In order to answer this question, three things are necessary to find out: (1) What are early warning signs, (2) how are EW signs identified, and (3) what barriers stop us from using them.

This is structured in three sections. At first, the concept of EW signs is introduced and defined for this research (3.1). Second, literature on identification methods for detecting EW signs is reviewed (3.2). Third, barriers for identifying and responding to EW signs are identified from literature (3.3).

Furthermore, section 3.4 explores the influence of the barriers on the EW response. Section 3.5 concludes on this literature study.

3.1 Early warning signs

In this section, the concept of early warning (EW) signs is introduced. Section 3.1.1 discusses definitions of EW signs, and a definition for this research is determined. Section 3.1.2 elaborates further on the concept, by discussing theoretical models on the occurrence of EW signs. To show variation in interpretation of the concept, section 3.1.3, 3.1.4 and 3.1.5 distinguish different types of EW signs. Section 3.1.6 contains examples of EW signs. In section 3.1.7 the relation with risk management is discussed. Section 3.1.8. discusses the effectiveness of using EW signs, and section 3.1.9 concludes this section.

3.1.1 Definition

Although the concept of EW signs is not widely used as such in construction project management, it is not new. It has been introduced by Ansoff (1975) in the discipline of organisational strategy. Ansoff used the term 'weak signals', with the following description: *'...imprecise early indicators about impending impactful events...all that is known is that some threats and opportunities will undoubtedly arise, but their shape and nature and source are not yet known'* (Ansoff & Mcdonell, 1990).

Following Ansoff's theory, the concept of weak signals has been adopted in a wide variety of disciplines. The terminology differs significantly in publications of these disciplines. Although interpretation differs slightly, in essence there is referred to the same basic phenomenon (Haji-kazemi, 2015; Nikander, 2002). Table 1 is composed to show an overview of different definitions of EW signs used in different disciplines.

Term	Author	Discipline
'Weak Signals'	Ansoff (1975)	Organisational strategy
'Germs'	Godet (1994)	Future-oriented studies
'Seeds of change'	COST (2009)	Foresight methodologies
'Early warning indicators'	Sharma & Mahajan (1980)	Business marketing
'Soft form of information'	Mintzberg, (1994)	Strategic planning
'Symptoms'	Mian, Sherman, Humphreys, & Sidwell (2004)	Project Management
'Future Signs'	Hiltunen (2008)	Futures studies, general
'Early warnings'	Nikander & Eloranta (2001)	Project Management
'Early Warning signs'	Haji-Kazemi (2015)	Project Management

Table 1: Terminology for warning signs in different disciplines (own composition)

As shown in table 1, Nikander adopted the concept in the discipline of Project Management (2001). In his doctoral dissertation, he defined 'Early Warnings' as follows:

> '*An early warning is an observation, a sign, a message, or some other item that is or can be seen as an expression, an indication, a proof, or a sign of the existence of some future or incipient positive or negative issue. It is a sign, omen, or indication of future developments'* (Nikander, 2002).

This definition is adopted in this research, since it is the most accepted definition in project management. However, in Nikander's definition EW signs predict both positive and negative issues. In this research, it is focused on EW signs predicting negative issues in projects. This is chosen since the starting perspective of research is project recovery. Furthermore, the term 'Early Warning sign' (EW sign) is used in this study. The term 'weak signal' is used when referred the earlier and more general studies of Ansoff.

3.1.2 Occurrence of EW signs

Following from the definition, EW signs are observations that can be interpreted as future issues. This implicates that interpretation of these signs in projects can tell something about future developments. On the basis of these signs, decisions can be made to potentially prevent future negative issues. Nikander (2002) visualised the occurrence of EW signs in the project environment as follows:

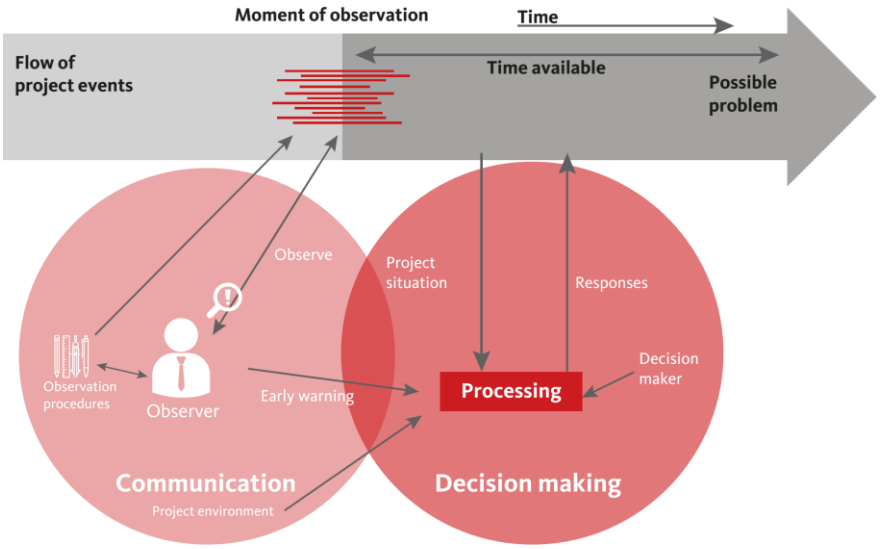

Figure 6: The character of the EW phenomenon (Modified from (Nikander, 2002, p.115)*)*

In the model a project is presented as a stream of events over time. When observing these events, signals can be detected by the observer and perceived as early warning signs. Subsequently, two phases are distinguished: the communication phase and the decision-making phase (represented by the two circles in Figure 6). The communication phase represents the detection, interpretation and acceptance of the EW signs, while the decision-making phase addresses the significance of the EW and its appropriate response. For this research, both of these phases are investigated, since both are part of the process to respond to EW signs.

In the literature there is discontinuity in terminology and interpretation around the concept of early warning signs. Section 3.1.1. showed that there is a difference in terminology. Furthermore, there is a difference in interpretation, in what type of signs are discussed. To illustrate this variation in interpretation, three different dimensions of EW signs are distinguished (Table 2). To further analyse the concept of EW signs, these three dimensions are discussed in the following sections. Meanwhile, this serves as scoping of the research.

Dimension			Distinction	Section
Weak signals	vs.	Strong signals	Strength	3.1.3
Leading indicators	vs.	Lagging indicators	Degree of prediction	3.1.4
Soft signs	vs.	Hard signs	Character	3.1.5

Table 2: Dimensions of EW signs

3.1.3 Weak and strong signals

The first dimension addresses the difference between so called ‘weak’ and ‘strong’ signals. According to Ansoff’s theory, signals grow stronger over time, from weak to strong. This makes timing crucial in responding to signals. The stronger the signal, the more accurately a response can be chosen. This is represented in Figure 7.

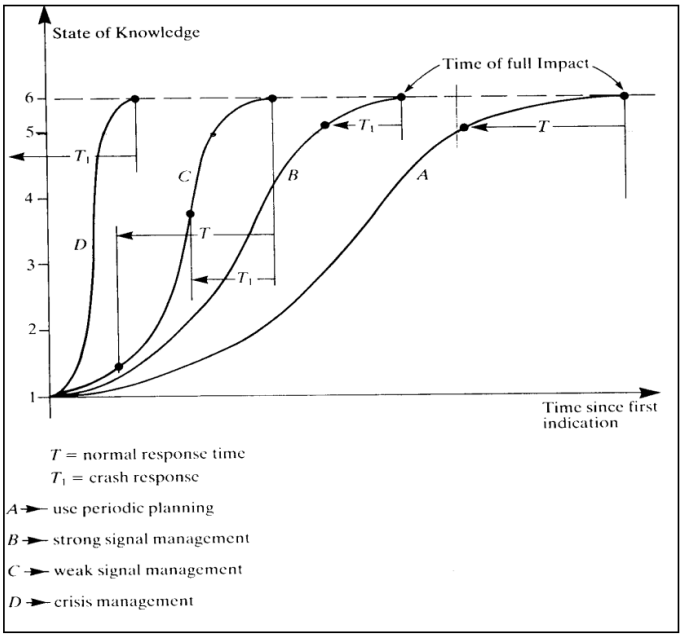

Figure 7: Choosing the system (Ansoff 84a (adopted from Nikander 2002)

Some signals have a long timeframe to reach the full impact of the issue (A and B). Therefore, in theory, a proper response can be chosen in a later stage. Other issues (C and D) have a very short time frame in which they grow strong and reach the full impact of the issue. For these issues a response is necessary to very weak signals. However, this model suggests that the timing and impact of the issue can be known in an early stage.

From a project management point of view this could be viewed in a slightly different way. The focus is here more on EW signs as indicators for future project problems. In this sense, the earlier potential problems are indicated, the sooner there can be acted upon, saving extra time and costs for the project (Kappelman, McKeeman, & Zhang, 2006). When a project is still in front-end stage, change costs are still low and there is relatively more time available to take preventive or corrective actions. EW signs that are detected in this stage of the project are of great value to the decision making process in the project (Haji-Kazemi, Andersen, & Krane, 2013b). Therefore, it is most of the time valuable to respond to weak signals.

To determine the strength of signals in project management, Nikander devised a four-point scale on the state of knowledge (Table 3). However, according to Nikander it is difficult to make an unambiguous scale. Moreover, this scale is likely to vary per type of project.

State of Knowledge	Description
1. An Inkling	A gut feeling; the early warning hardest to detect, recognise and interpret; very inexact information. Very minor plan deviations. The conviction that some kinds of problems are impending.
2. An inexact warning	Can be recognised and the source is detectable, but the information is very inexact. Plan deviations seen as minor. The characteristics of problems, the nature of impact, and the timing of impact are quite clear.
3. A clear warning	More manifest than the warnings in the previous category, but cannot be measured (assigned a number value). Clear plan deviations. Response identified: timing, action, budgets.
4. An exact warning	The signs can be measured; they can be assigned a number value. Major plan deviations. The profit impact and the consequences of responses are computable.
No warning procured	In addition to the above, situations were noted where no warning could be procured.

Table 3: Four stages of states of knowledge (Nikander, 2002)

3.1.4 Leading and lagging indicators

The traditional performance indicators in construction projects are cost, quality and scope, often referred to as the *iron triangle* (Atkinson, 1999). Through measurements such as earned value analysis, these performance indicators can be monitored. These are strong signs, since they provide a clear opportunity to choose an accurate response. These performance indicators are also lagging indicators. For example, information about financial problems in a project is lagging, since it is the result of events that occurred in the past. Traditional project performance measurement focuses on lagging indicators, being consequences of certain events or activities, not on leading indicators that could provide more relevant information (Williams et al., 2012).

The basic concept of EW signs is to focus more on leading indicators (Williams et al., 2012). According to Haji-Kazemi, there is a need to manage project performance in a proactive way rather than reactive. Hereby the focus needs to be on leading indicators, opposed to lagging indicators. Lagging indicators *'provide information about issues after the fact and can represent a basis for learning, not as a tool for EW'* (Haji-kazemi, 2015, p.143). Examples of leading indicators are employee satisfaction, amount of change orders, project team expertise, confidence level, or stakeholder relations (Choi, 2007; Haji-kazemi, 2015). Although leading indicators are more and more used in construction project management (Chan, Chan, & Chan, 2004), current project methods mostly do not include the above mentioned indicators.

3.1.5 Soft and hard signals

Close related to leading and lagging indicators, a distinction can be made in soft and hard EW signs. In this sense, 'soft' corresponds with managerial, organisational or human aspects (Haji-kazemi, 2015). 'Hard' corresponds with data related to project finance or planning. Project performance measurement focuses mostly on these hard factors. Project control KPI's are mostly related to costs and planning. However, it can be argued that the real reasons behind problems in project execution are often not just technical, but have a more soft character (Gavett, 2013).

Project management literature contains many examples of the importance of soft factors for project control. In a survey among project managers, the most frequently mentioned reasons for poor project performance were: problems with organising project team, weak project leadership, communication problems, conflict and confusion, and insufficient upper management involvement (Meredith & Mantel, 2011). These reasons are all related to managerial, organisational and human aspects. Furthermore, the Project Management Institute (PMI) concluded that ineffective communication is one third of the time the primary contributor to project failure (Project Management Institute, 2013). Mintzberg (1994) described soft indicators as an 'underbelly' of hard data, that needs to 'harden' to become measurable. This makes the hard date later in time. The most effective managers therefore rely on *'some of the softest forms of information, including gossip, hearsay, and various other intangible scraps of information'* (Mintzberg, 1994). Williams et al. (2012) contribute to this by indicating that the most early project problems and EW signs have a 'soft' character. If soft factors can be responded to, problems can be prevented in an earlier stage.

Combining with the previous section, it is hypothesized that 'hard' signs are most of the time lagging indicators. Therefore, focus should on the 'soft' factors, since signals of this character will appear first. This research focuses on soft EW signs, as they are leading indicators for future issues.

3.1.6 Early Warning signs from literature and practice

The previous sections showed the difference in interpretation of EW signs. In this section, examples are illustrated of EW signs in projects, and different categorisations. This illustrates what EW signs can be expected. Furthermore, it helps to illustrate the difference between EW signs and barriers to responding (section 3.3).

Nikander and Eleoranta (2001) composed the most comprehensive list of early warning signs in literature so far. It is a result of a combination of literature study, surveys to project managers in different industries, and

case material. They made a division of main type groups of EW signs, and examined the number of EW signs that were found from the different sources per group (Table 4).

Early Warning signs	Literature (%)	Basic material (%)	Case material (%)
Gut Feeling		5.2	2.7
Warnings expressed by personnel, project group	40.6	28.6	22.7
The project manager (as a person), management, managerial style	10.9	1.7	8.6
Project planning	8.8	6.2	13.6
Project control	18.7	9.3	5.2
Work on the project	5.5	10.5	10.9
Communication	4.4	10.7	5.4
Expressed by the parties (Owner, supplier, contractor)	6.6	10.7	9.6
Documents, reporting (typical for projects)	4.4	14.3	10.4
Differences or deficiencies in the project culture		5.2	9.9
External source		2.4	1.2
Total elements	91	420	405

Table 4: The distribution of the elements into main type groups of early warnings (Nikander, 2002)

AT Osborne derived their own list of EW signs, following from sessions with experienced project managers (AT Osborne, 2017a). Subsequently, these signs were divided over different categories, shown in Table 5.

	EW sign category
1	Trust within the team
2	Workload
3	Opportunity and attention for reflection
4	Clearness of strategy
5	Relation with environment
6	Collaboration between colleagues
7	Feasibility of project goal
8	Support by environment
9	Safety to express opinion
10	Team ambiance

Table 5: EW sign categories by AT Osborne (freely translated)

These categories contain many similar EW signs. The categories of Nikander and Eleoranta are mainly based on their source, whilst the categories by AT Osborne are mainly based on their character. Furthermore, AT Osborne focuses solely on soft EW signs, whilst Nikander and Eleoranta take hard signs into account as well.

Rijkswaterstaat, the Dutch institute responsible for the main infrastructure facilities in the Netherlands, conducted their own research in EW signs. By analysing several large infrastructure construction projects, a set of 38 EW sigs has been derived (Jansen, 2016). These EW signs are also mainly of soft character.

3.1.7 Relation with risk management

In this section, the relation between EW signs and risk management is discussed. The perspective of this research is that of EW signs, as indicators for potential project failure. Close related is the concept of risk management. However, the EW signs shown in the previous section are different than risks from a risk register.

The Project Management Body of Knowledge (PMBOK) describes the EW phenomenon as part of the project risk management process (Project Management Institute, 2008). It is linked to by means of *risk symptoms*. EW signs indicate the potential presence of a risk, and is therefore a symptom of a potential risk.

What distinguishes EW signs from risk management is that risk management is focused on identifying both positive and negative risk factors and their probability, while EW signs are solely indicators for negative events (Haji-kazemi, 2015).

Furthermore, EW signs do not provide a probability and time frame, unlike risks. The information that an EW sign provides is not the same as probability and time frame of a risk (Haji-kazemi, 2015, p. 37). From weak EW signs, the exact risk cannot yet be exactly determined. Therefore, a probability and time frame cannot be derived. Note that Ansoff's original weak signal model (Figure 7) does assume the impact could be estimated on basis of the signals. In project management literature this is not adopted.

The following definition for EW signs in relation with risk management is used by Haji-Kazemi:

> *'An EW sign is a specific **element**, **happening** or **event** which shows that the risk event will actually realize. The EW sign does not provide information on the exact time of the materialization of risk; neither does it reveal its expected magnitude. Rather it **acts as an alarm** which triggers action in order to either prevent the realization of the potential problem or possibly lessen the undesired consequences.'*(Haji-kazemi, 2015)

This interpretation is adopted in this research.

3.1.8 Effectiveness of utilising EW signs

Before continuing with identification methods and barriers to EW signs (section 3.2 and 3.3), this section explains why it is relevant to make use of EW signs. Improving the responsiveness to EW signs is only useful when responding to EW signs itself is effective.

Until now, Meng (2014) conducted the only empirical research examining the effectiveness of EW for preventing or solving problems and performance of projects. This research has been conducted in the construction industry in the United Kingdom, by means of a combination of literature review, expert interviews, and an extensive survey. It was concluded that EW has significant effect on problem solving and performance of projects in terms of time, cost and quality. This proves the effectiveness of acting on EW signs. The research is not distinct on the type of EW signs, in terms of hard or soft signals, which could be subject to further research as well. Rather, it deals with the effectiveness of EW signs in general.

3.1.9 Conclusion of section 3.1

This section explained the concept of EW signs. A definition is adopted for this research. Furthermore, the concept is explained by distinguishing three different dimensions of EW signs. This research is focused on soft and leading indicators. Examples of EW signs have been illustrated, and the relation with risk management is discussed.

3.2 Identification methods

This section is devoted to possible methods to identify early warning (EW) signs. To answer the main question how we can improve the responsiveness, it is essential to know how EW signs can be identified.

Literature provides significant content on the identification of project uncertainties, unhealthy project conditions possibly leading to future problems, and reasons for malperformance on projects (Klakegg et al., 2010). In addition, literature on project risk and detection of project risks is extensive. However, in de the context of EW signs, literature on identification methods is limited.

3.2.1 What EW signs to look for

In section 3.1.3 it is concluded that it is essential to detect EW signs in an early stage of the project. Furthermore, the hypothesis was set that most 'early' warning signs are mainly soft factors (3.1.5). Soft and leading EW signs are the main focus of this research. In order to detect these EW signs, methods must be used to detect soft and early signs.

Ansoff describes the detection of weak signals as by listening to the environment 'with an ear to the ground' (Nikander, 2002). Not only the higher management should be occupied with the detection of EW, but everyone in the organisation. The people detecting EW signs are employees who are widely connected within the organisation. Hiltunen, while studying the discipline of future studies, found that discussions around the coffee table or other unofficial interorganisational sources are important for the discovering of EW signs (Holopainen & Toivonen, 2012). In order to detect soft signals, methods must be used that are able to detect these kind of 'soft', 'underbelly' or 'gut-feelings'. Examples that are given in literature are stakeholder engagement tools, employee feedback surveys. The culture of a workplace can suppress the expression of soft signals (Williams et al., 2012). An important note is that every institutionalised identification method could contribute to this suppression, thus not revealing what it's trying to find out. Therefore, informal elements are just as important in detecting EW signs. Although ideally people of all organisations are questioned on EW signs, this research is limited to questioning employees of the higher management.

3.2.2 Literature sources discussing EW identification methods

One of the more recent articles on identification methods of EW signs is written by Williams, Jonny Klakegg, Walker, Andersen, & Morten Magnussen (2012). In their article, they divided the found EW signs in two groups: EW signs that are identified through assessments, and EW signs that are unlikely to be found by assessments, but are rather based on gut-feeling. The identification methods in their research are mainly focused on hard factors. The EW signs that, according to the article, can be expected to be found via project assessments, are mainly of hard character, such as documentation, contractual obligations, and milestones. Although the article addresses the fact that the gut-feeling EW signs are of significant importance, it does not discuss methods to identify these EW signs.

The most comprehensive recent research in EW identification methods is from Haji-Kazemi, Andersen and Krane (2013a). They summarised potential methods to identify EW signs based on literature and experiences from industrial case studies (Figure 8). It was found that methods explicitly written in literature, such as risk management, earned value management and project assessments, mostly focus on hard factors. At the same time, dialogue and culture of the organisation are very important to identify EW signs, which pleads for the need for 'gut-feeling approaches' that can detect the soft EW signs. However, these gut-feeling approaches are currently limited due to a lack of awareness and current practical experience. Haji-Kazemi concludes that almost all of the methods of Figure 8 are suitable to detect both soft and hard factors. This is up for discussion. For example, risk management normally does not take soft factors into account. This also applies for project assessments and performance measurement.

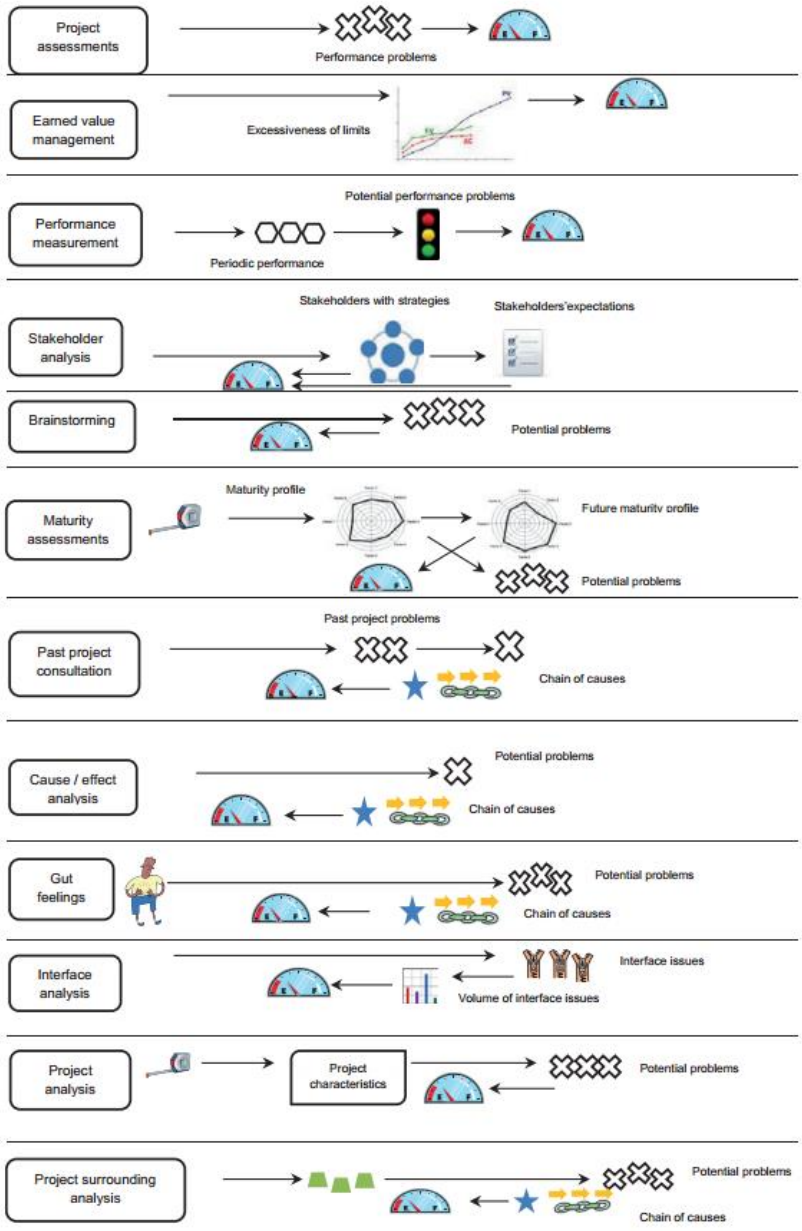

Figure 8: EW identification approaches by Haji-Kazemi (2015)

3.2.3 Overview of EW sign identification methods

Based on various sources in the literature, an overview is composed of EW sign identification methods. These are summarised in Table 6. Each identification method is briefly described, followed by a statement on its applicability to detect EW signs. Identification method one to thirteen are discussed by Haji-Kazemi (2015). Fourteen and fifteen are discussed in other literature sources. An extensive overview and discussion per identification method is presented in appendix A.

	Identification method	Description
1	Risk analysis	Identified risks can be monitored by the current risk management practice. However, it can be questioned if the ambiguous character of soft EW signs can be detected by risk management practices (Thamhain, 2013).
2	Earned Value management	EV method is set to measure the health of a project by a set of metrics. Since the main KPI's of the method are focused on costs and time, this is not the most suitable method to detect 'soft' type of EW signs. Nevertheless, it is a well-used method to track planning and cost deviations in an early stage.
3	Project assessments	Project assessments account for all sorts of reviews, audits and status check that are applied to the project. A problem Is that assessments can give a too optimistic view on the project. Project assessments can be used to acquire both hard and soft project data. However, most of the current used assessments focus mainly on hard KPI's.
4	Performance measurement	Performance measurement is a general term for approaches to periodically track progress of the project by means of KPI's or a balanced scorecard. most project performance measurement focuses on lagging KPI's, being mainly hard factors (Williams et al., 2012). To capture soft EW signs, it is necessary to monitor the KPI's that indicate the softer managerial issues of the project.
5	Stakeholder analysis	Stakeholder analysis is a tool designed to evaluate the stakeholders involved in the project, which is widely used in construction projects (Olander, 2007). According to Haji-Kazemi, stakeholder analysis can be used to identify EW signs by analysing the stakeholders involved in the project.
6	Brainstorming	Brainstorming can be periodically, evaluating, or non-systematic used as out-of-the-box reflecting on project issues. According to Haji-Kazemi, this is arguably the most used source for finding EW signs. Another strong advantage of this method is that it allows employees to ventilate their opinions more freely, creating a very realistic image of the project. This is important for soft EW signs.
7	Maturity assessments	Maturity assessments are used to evaluate the quality of the project organisation that is running the project. These assessments could function as a very EW, by assessing the quality of the project team that is assigned to the project.
8	Past project consultation	Evaluation of past projects in order to detect EW signs. While organisational learning is perceived as a problem in the construction industry, it is important in detecting EW signs.
9	Cause and effect analysis	Root cause analyses can be used to identify EW signs and their risk in projects, both systematic and non-systematic. The essence of these methods is to explain certain anomalies in the project, which makes it a good tool to detect 'soft' EW signs.
10	Gut feeling	Gut-feeling as described by Klakegg et. al (2010) is an important source of EW signs. Experts stress the fact that EW signs are mostly less measurable, making the detection of them depending more on gut-feeling than systematic approaches (Haji-Kazemi et al., 2013a).
11	Interface analysis	Interface analysis is used to detect problems with interfaces between technical systems, different actors, and people in the project that may arise in the project. It can be used to identify potential EW signs, both hard and soft signals.
12	Project analysis	Assessments used to examine the characteristics of the project, conducted in frond-end stage of the project. These kinds of frond-end analyses are tools that can present EW signs.
13	Project surrounding analysis	Analysis of project environment, made in frond-end stage of the project. Examines the external factors that could influence the course of the project. Issues related to political climate, market, financial climate, organisations can present EW signs for the course of the project.
14	Text mining	Scanning of management documents including meeting minutes in order to identify EW signs (Alsubaey, Asadi, & Makatsoris, 2015). Gives objective data, but can evoke strategic behaviour.
15	Project health checks	Type of project assessment. However, PHC's can be used explicitly to monitor soft EW signs. It is argued that PHC's should mainly focus on the managerial side. At the same time a PHC should be applicable at any time of the project.

Table 6: Overview of EW identification methods from literature

3.2.4 Methods applied in practice

In her dissertation, Haji-Kazemi conducted a survey among project managers to the different approaches to identify EW signs. At first, it has been asked which methods applied systematically in project organisations (Table 7).

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

Table 7: Methods applied systematically within the project organisations (adopted from (Haji-kazemi, 2015, p. 105)*)*

Project management methods and risk management methods stand out as most applied in the industry, as expected. All of the other methods are much less systematically applied in the project organisations. Of all of the other methods, only brainstorming was named by 20% of the respondents.

Second, the respondents were asked to rank the most important sources for EW signs (Table 8). After project management methods, gut-feelings and project assessment methods are indicated as most important sources.

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

Table 8: Essential sources for identifying EW signs and their average rankings by respondents (adopted from: (Haji-kazemi, 2015, p. 105)*)*

From these observations it can be concluded that besides project assessment and management methods, gut-feeling is considered as an important source for EW signs (Table 8). The main applied identification methods are project management methods and risk management (Table 7). Whether the latter method also entails managing soft EW signs is not clear. Nevertheless, identification methods to detect soft EW signs are underrepresented.

3.2.5 Conclusion of section 3.2

From this section it can be concluded that literature on EW sign identification methods is limited. Furthermore, there is a variation of different methods and tools that can be used to identify EW signs. The identification methods to detect soft EW signs are underrepresented, as is their application in practice.

3.3 Barriers to identifying and responding

This section focuses on these barriers, that prevent responding to EW signs. EW signs need a follow-up in order to result in a proper response. The process from occurrence of EW signs towards follow-up is viewed as a process, visualised by the *EW response* model (section 1.2). Whether or not EW signs are responded to, depends on the occurrence of barriers during this process.

3.3.1 Early Warning response as filter model

In his theory on EW signs, (Ansoff, 1984) identified three different filters that an EW sign need to pass through before reaching the organisation. These are the *surveillance filter*, the *mentality filter*, and the *political power* filter (Figure 9). These filters have been cited by Nikander (2002) in terms of project management. The surveillance filter is represented by the choice of the project about what information is needed and what identification methods should be used to retrieve it. The mentality filter is more sociological and psychological. It is characterised by the evaluation of the receiver of what information is necessary and what is not needed. A difference in mentality has large influence on the decision outcome. The political power filter refers to the decision-making process, in deciding what information is allowed to influence the decision making of the project. The political/power filter is hereby represented by the power structure of the organisation, that is challenged by an EW sign (Ilmola & Kuusi, 2006).

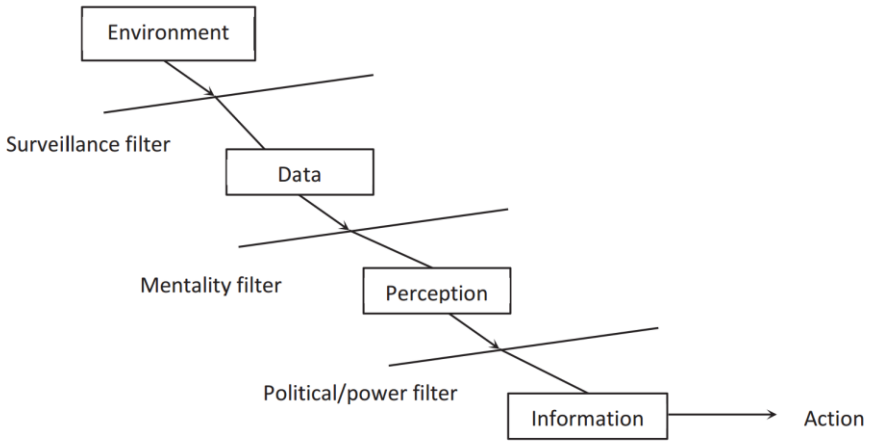

Figure 9: Management information (Ansoff & Mcdonell, 1990)

Apart from naming and describing the filters, Ansoff does not explain how these filters work, or what drives the existence of these filters.

Haji-Kazemi, who studied EW signs in her PhD dissertation, developed a model for the 'EW procedure' (Figure 10), as an extension of Ansoff's and Nikander's earlier work. In this model the mentality filter is split in two separate filters, to emphasise the difference between the observer and the decision maker (Haji-Kazemi et al., 2015). This was found necessary, since the observer is most of the time not the same person as the employee taking the decision. Furthermore, lack of communication between employees of the project can disturb the effective response as well.

The model integrates the filters with actual steps that have to be taken in the process of identifying and acting upon EW signs. Information that flows through, reaches the base for taking a response. The *strength* of these filters in the process determines the effectiveness of the response (Haji-kazemi, 2015).

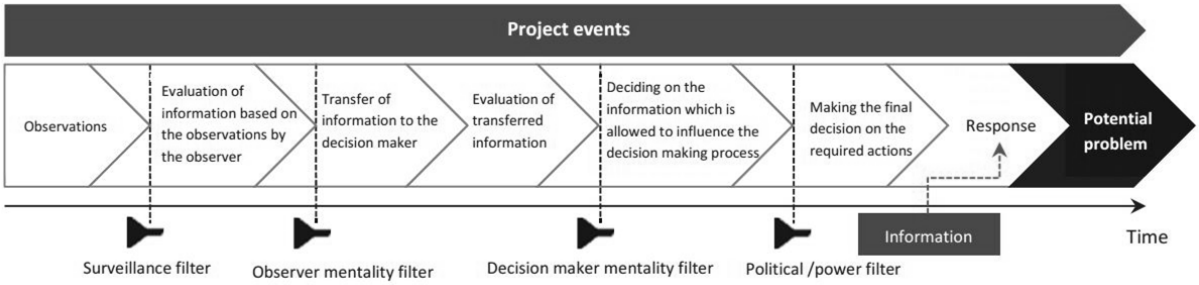

Figure 10: The EW procedure and the possible filters against flow of information (Haji-kazemi, 2015)

This model is used throughout this research as basic reference model for the procedure of acting on EW signs. The model helps to explain the functioning of barriers to proper action upon EW signs, since they can be coupled to moments in the process, represented by the filters.

The filters in the model represent the theoretical framework of filtering out EW sign. As mentioned, this does not explain the drivers of these filters. The reason for an EW sign to be filtered out of the process is the occurrence of barriers in the process, represented in the filters. These 'barriers' can be influencing factors of many different kinds. In section 3.3.4, different barriers from literature are identified.

3.3.2 Early Warning response and communication theory

In his dissertation, Nikander (2002) also relates the filter model to concepts of the communication theory, which is familiar with similar concepts. In communication theory the concept of 'communication noise' is closely related to the filters as presented by Ansoff.

In the communication theory, the communication process can be disturbed in four different ways: barriers, loss, distortion and noise (Wiio, 1989). Communication barriers is presented as a message that gets lost, is not delivered, or delayed. Communication loss includes disappearance or rejection of the message. Distortion of communication is misunderstanding or misinterpretation of the massage. Communication noise is caused by interference of the message by other less relevant information.

The filter theory and communication theory as presented do not match entirely, as was indicated by Nikander. The communication theory is mainly focused on the communication itself, while the filter model also includes the decision-making process that is driven by human factors. These human factors are of large importance in the EW response. Therefore, the filter model is chosen as preferred theoretical model in this research.

3.3.3 Literature on barriers to responding to EW signs

Despite different methods to identify EW signs, authors agree that we still struggle in our ability to pick up EW signs (Haji-Kazemi, 2015; Williams et al., 2012). Williams et al. (2012) identified different barriers to acting on EW signs. According them, people struggle to understand project risk and uncertainty, complexity, and interpersonal effects (tacit knowledge and interaction). Therefore, EW signs are easily missed.

Building on the work of Williams et al. (2012), Haji-Kazemi continued a literature review on possible barriers to EW signs. This research was conducted in different fields related to project management. This literature review is used for this research. Subsequently, Haji-Kazemi conducted a survey to explore the relation between these barriers and the EW response. The conclusions of this research for each barrier are discussed in section 3.4.

Furthermore, a recent master thesis has been conducted in barriers to EW signs by Poshtekooh (2014). She applied a special focus on environmental scanning, project governance and complexity. She concluded on implications for each of these concepts by means of a literature study and case study of two cases. Outcomes of this thesis have been used for this research.

3.3.4 Barriers to responding to EW signs

In this section, potential barriers to responding to EW signs are discussed. These are retrieved from a variation of literature sources and disciplines (Table 9). The table mainly builds on the literature studies discussed in the previous section, supplemented with several other concepts. In the following section, each barrier is elaborated and, subsequently, discussed as a barrier to EW response.

Barrier	Reference	Description
Over-optimism / optimism bias	Lovallo and Kahneman (2003); Flyvbjerg et al. (2007;2009)	Benefits are overestimated, costs underestimated, and the potential for problems and miscalculations are overlooked
Normalisation of Deviance	Pinto (2014)	The unexpected becomes expected, which becomes accepted. Three types: *strategic misrepresentation, client-contractor relation, planning issues.*
Fragmentation	Bartsch et al. (2013)	Fragmentation of projects hinders organisational learning
Uncertainty avoidance	Hofstede (1991)	The extent to which the members of a culture feel threatened by ambiguous or unknown situations
Systematic fallacy (illusion) in decision making	Flyvbjerg (2013)	Causes people to underestimate the costs, planning and risks, while they overestimate benefits of the same action. Stems from actors taking an 'inside view', focusing on the constituents of the specific planned action rather than on the outcomes of similar actions.
Time pressure	Williams et al. (2012); Klakegg et al. (2010)	Difficulties for acting due to lack of time to think ahead and question assumption
Effects of politics	Williams et al. (2012); Cantarelli et. al (2010)	Political pressure (exerted by the project owners) to implement a given solution
Poor Management	Haji-Kazemi (2015)	Poor management of the project
Project complexity	Bosch-Rekveldt (2011); Hertogh & Westerveld (2010)	A situation involved with flux and unpredictability and large number of unknown unknowns
Management style	Larsson et al. (2015)	Leadership style by project manager influences project performance
Deliberate ignorance (Irrelevance)	Kutsch and Hall (2010)	Deliberate ignorance by project manager by means of untopicality, taboo or undecidability
Lack of communication	Faridi & El-Sayegh (2006)	Lack of communication and coordination between parties in the project as cause for project issues

Table 9: Possible barriers against EW response (partially adopted from Haji-Kazemi (2015))

Over optimism / optimism bias

Optimism is a known factor in construction management (Kutsch, Maylor, Weyer, & Lupson, 2011; Son & Rojas, 2011; Winch, 2010, p. 271). Lovallo and Kahneman (2003) discussed optimism as it undermines decision making on executive level. Potential benefits of projects are overestimated, while costs are likely to be underestimated. Success scenarios are emphasised while failure possibilities are ignored. This is called *delusional optimism*. In order to bypass this optimism, it is suggested to include an 'outside view' in projects. Flyvbjerg (2007; 2009) agreed on this. Executives generally adopt an 'inside view', causing an optimistic view on the project outcome.

According to (Williams et al., 2012), optimism bias can function as a barrier to the identification of EW signs. According to the results of Haji-Kazemi (2015), higher optimism levels in the project organisation are correlated with identification of EW signs in a later project stage.

Normalisation of the deviance

Normalisation of the deviance as described by Pinto (2014) is related to Flyvbjerg's description of an inside view (Flyvbjerg, 2007; 2009; 2013). Pinto describes the phenomenon of counterproductive behaviour that is implicitly intertwined in projects, causing a disruption of processes. While it is counterproductive, there is a certain tolerance of this behaviour. Pinto describes three types of normalisation of deviance. Due to the wide explanation of the concept, it is decided to split these types and take them into account as separately in this research.

The first area is *'project proposals and strategic misrepresentation'*. This describes *'wilful flaws'* in the procurement stage of projects. On the contracting side, strategic misrepresentation occurs in a competitive bidding process to win a project. False information is deliberately used to influence the project. This can happen with support of public organisations to get a project *'on the books'*. Incentives exist to present the project as favourable as possible (Flyvbjerg et al., 2009). This kind of embedded behaviour can obstruct the EW response, for example by means of neglected EW signs at the front-end of the project.

The second area is *'client-contractor relationships'*. This relationship is subject to multiple dynamics, that have been studied extensively in literature. Trust plays an important role (Kadefors, 2004; Smyth, 2008), and actors having a different perception of project status (Bryde & Robinson, 2005). Furthermore, difference in satisfaction of the relationship and experienced project outcomes (Pinto, Slevin, & English, 2009). These issues often create a so called *'rival camp'* dynamic between the client and contractor parties, causing opportunistic behaviour (Pinto, 2014). This kind of principal-agent dynamic can imply withholding information and information asymmetry (Xiang, Zhou, Zhou, & Ye, 2012). In addition, the more difference in actor interest, the stronger the incentive to make information contested (De Bruijn & Leijten, 2007). Therefore, it is likely that EW signs can be either missed or wrong interpreted due to these dynamics.

The third area is that of *'planning and scheduling dynamics*'. This refers to occurring patterns in project planning, by means of manipulation of the planning process and top-down planning adjustments.

Fragmentation

Organisational learning is challenging in the unique project-based environment, but important (Bartsch, Ebers, & Maurer, 2013). If knowledge is not transferred between projects and the organisation, we speak of project fragmentation, limiting organisational learning. Consequently, limiting knowledge of EW signs as well. If knowledge from EW signs in previous projects is not transferred to current projects, they are likely to be missed again. There are numerous reasons for this fragmentation of projects. Williams (2012) described a lack of time to prepare lessons learned and a certain reluctance to 'air dirty laundry'.

Uncertainty avoidance

The concept of uncertainty avoidance has been introduced by Hofstede (1991) in the discipline of cross-cultural differences. It explains the extent to which people feel threatened by uncertain situations. A high level of uncertainty avoidance implies less tolerance for uncertainty and ambiguity. As for construction management, in projects with a culture of higher uncertainty avoidance people could potentially focus too much on rules and procedures, for example on measurable risk management. This causes them to miss the 'gut-feeling' EW signs. Another explanation could be: When people feel threatened by uncertainty coming from warning signs, they could be more likely to reject or neglect certain signs.

Systematic fallacy (illusion) in decision making

As part of methods to improve decision making in project management Flyvbjerg (2013) discussed taking an outside view (as introduced by the *optimism bias* barrier). This is based on the idea by Kahneman and Tversky (1979), that decision making under uncertainty leads to systematic fallacy, or illusion. Costs, planning and risks are underestimated, while benefits are overestimated. Kahneman (1994) argued that actors in the project tend to have an 'inside view' on the project, leading to this non-rational decision making. The focus is more on specifics of planned actions that on the results of completed actions. This fallacy in decision making could lead to missing and neglecting EW signs.

Time pressure

Time pressure, as it was suggested by Williams (2012) limits time for reflection. This means reflecting on decisions and progress, and looking ahead. Although a moderate pressure on the schedule can stimulate performance, too much time pressure has negative effects, such as cutting of corners, more number of defects, more out-off-sequence work and loss of motivation (Nepal, Park, & Son, 2006). With less time to reflect on things, less attention is paid to EW signs, leading to a higher chance of missing or neglecting them.

Effects of politics

Williams (2012) discusses political effects as a pressure to implement a certain solution and a political agenda determined by powerful interests. Cantarelli et. al (2010) explain political effects as the main cause for

infrastructure project cost overruns by means of three concepts, of which the principal-agent theory is considered the most dominant. This theory assumes that people mostly act out of self-interest, leading to strategic behaviour upfront and similar behaviour between parties during the project. Typical political effects in projects are top-down political pressure influencing decision making. Besides effects on front-end decision making, political effects can have influence on the decision to whether or not to act on EW signs. Haji-Kazemi (2015) found a correlation between political issues and not responding to EW signs.

Poor management

Another potential barrier is poor management. Haji-Kazemi found a positive relation between the level of optimism and the importance of poor management as an explanation for not responding to EW signs (Haji-kazemi, 2015). In addition, poor management was indicated as a main contributor to lack of effective responses to EW signs. Poor management could be explained as a barrier by lack of concrete approach to identify EW signs, resistance towards bringing up EW signs, ineffective communication or resistance towards actions.

Project complexity

Many authors have described complexity in the project context (Bosch-Rekveldt, 2011; Hertogh & Westerveld, 2010). Hertogh and Westerveld derived six types of complexities: technical, social, legal, financial, organisational, and time complexity. According to Hertogh and Westerveld, social complexity is the dominant form of complexity. Williams et al (2012) discuss complexity as an important factor in preventing the identification and response to EW signs. They refer to both structural complexity, as formulated by (Baccarini, 1996), as complexity by uncertainty formulated by (Turner & Cochrane, 1993). Furthermore, besides 'internal' project complexity, such as technology and interfaces with other systems, 'external' complexity in the form of stakeholder relationships is an important factor. In general, complexity of projects makes it difficult to link early indications to later incidents and results.

In Haji-Kazemi's study it was confirmed that project complexity complicates the discussion on EW signs and weakens responses. Her findings endorse those from Klakegg et al. (2010), who conclude that increasing complexity complicates identification and interpretation EW signs, since issues in complex projects are less familiar and more interconnected. However, this relation was not very strong, leading Haji-Kazemi to believe that organisational factors are in general more important to the EW response than project characteristics (Haji-kazemi, 2015, p. 107)

Management style

Another influencing factor could be related to the 'way' in which the project is managed. It is confirmed that the project manager's leadership style affects project performance (Larsson et al., 2015; Nauman, Mansur Khan, & Ehsan, 2010). Difference in personalities of project managers comes with a different leadership style. A certain leadership style is not necessarily 'poorer management' than another. However, difference in leadership style has influence on the way EW signs are handled in the project. It is not investigated which leadership style suits best for EW signs to be best acted upon. However, a culture of open communication seems vital for EW signs to surface. Open communication is considered a key factor in organisational success (Sunindijo, Hadikusumo, & Ogunlana, 2007). According to Gilbert (1983), good project management is participative, while stimulating creativity and imagination.

Deliberate ignorance (irrelevance)

Kutsch and Hall (2010) explored deliberate ignorance in project management, from the perspective of risk management. Since EW signs are indicators for potential risks (section 3.1), this applies to EW signs as well. The issue of deliberate ignorance is explained by three issues: *untopicality*, *taboo* and *undecidability*. Untopicality refers to a focus on what is critical in the project manager's experience, resulting in declaring other information off-topic. Taboo in this matter would refer to the fact that exposure of EW signs can create anxiety among stakeholders, creating negative thoughts on the project. As a result, project managers limit identification of new EW signs. Undecidability concerns credibility of risk estimates that is questioned by stakeholders in front-end of the project, which in result are not further taken into account. In the case of EW signs this should be signs that are discussed in an early stage, but not taken into account further in the project, due to disagreement about their reliability. According to Kutsch and Hall's article though, the *taboo* issue has

overlap with 'fear of the unknown' (uncertainty avoidance). Therefore, it can be argued that both factors explain similar phenomena. It is chosen not to take deliberate ignorance into account separately, but include the concept in the explanation of the barrier *uncertainty avoidance*.

Lack of communication

'Lack of communication and coordination between parties involved' is named as an important cause for delay in construction projects (Faridi & El-Sayegh, 2006). This functions as a barrier in acting on EW signs, since communication is essential to raise awareness on detected EW signs. However, this factor is related to several other factors. Fragmentation is discussed as organisational learning between projects, but could also be interpreted as fragmentation within the project. If parties within the project operate as separate silo's, EW signs can easily be missed. In addition, as far as the client and contractor parties, this factor is yet explained by the *client-contractor relation* barrier. Furthermore, this factor could also be explained as part of *poor management* or *management style*, with a lack of communication as a result of poor management or a certain management style.

3.3.5 Included barriers

The previous section introduced potential barriers in responding to EW signs. Most of these barriers are further investigated in this research. As explained in section 3.3.4, the barrier *normalisation of the deviance* is split into three factors, which are taken into account separately. *Deliberate ignorance* is not taken into account due to its overlap with uncertainty avoidance. Similarly, *lack of communication* is not taken into account as a separate barrier. Table 10 shows the factors that have been subject to expert interviews and expert session (chapter four).

	Barriers
1	Over optimism/ optimism bias
2	Strategic misrepresentation
3	Client-Contractor relation
4	Planning and scheduling dynamics
5	Uncertainty avoidance
6	Time pressure
7	Poor management
8	Illusion in decision making
9	Fragmentation
10	Management style
11	Project complexity
12	Effects of politics

Table 10: List of barriers included in interviews and session

3.3.6 Conclusion of section 3.3

This section discussed different barrier that can prevent acting upon EW signs. The *EW procedure* model introduced by Haji-Kazemi (2015) is used as main framework to illustrate this process. This model assumes four filters, as moments in the EW procedure where a response is blocked. Furthermore, limited literature exists on barriers to acting on EW signs. Therefore, potential barriers from literature have been identified. A selection of twelve barriers is made, and is subject to the expert consultation (chapter four).

3.4 Barriers and their influence on the EW response

Section 3.3 showed that many barriers can occur in the process of acting on early warning (EW) signs. To find out how to improve the EW response with regards to these barriers, it is necessary to know two things.

1. What are the most important barriers? In other words: on which barriers should be focused to improve the EW process? This is subject to chapter four.
2. How do these barriers apply to the EW response process? In other words: where in the process of EW response are barriers present and how? This is subject to chapter five.

3.4.1 What are the most important barriers?

The first question is a matter of scoping. To improve the EW response process in the construction sector, it is necessary to find the most important barriers. In her research, Haji-Kazemi conducted a survey, in which the main reasons for not identifying of and acting upon EW signs were asked to project managers. The most frequent named reasons for not identifying EW signs were 'lack of communication among project members', 'organisation's complexity', and 'over-optimism' (Table 11).

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

Table 11: Possible reasons for failure to identify EW signs in projects (adopted from (Haji-kazemi, 2015, p. 106)*)*

Subsequently, respondents were asked to rank the main reasons for not responding to EW signs on a five-point scale. The highest ranked factors were 'poor management', 'lack of effective communication among project members', and 'over-optimism' together with 'political issues' (Table 12).

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

Table 12: Reasons for not responding to EW signs and average rankings by respondents (adopted from: (Haji-kazemi, 2015, p. 106)*)*

This research was conducted combining different industries of project management. Since these industries differ, it has to be investigated if these results are the same the construction sector. This is the aim of Phase II of this research (chapter four), in which project managers in the infrastructure construction sector are questioned.

3.4.2 How do barriers occur in the EW response process?

This second question examines how these barriers apply in the EW process, which covers the main research gap, as described in the introduction.

Haji-Kazemi viewed this as shown in Figure 11. According to the model, the elements in the outer circle influence the three main elements in the inner circle: 'Effectiveness of discussions on possible EW signs', 'Possibility to freely express opinions within the project organisation', and Effectiveness of discussions on identified EW signs'. Together they influence the final EW response.

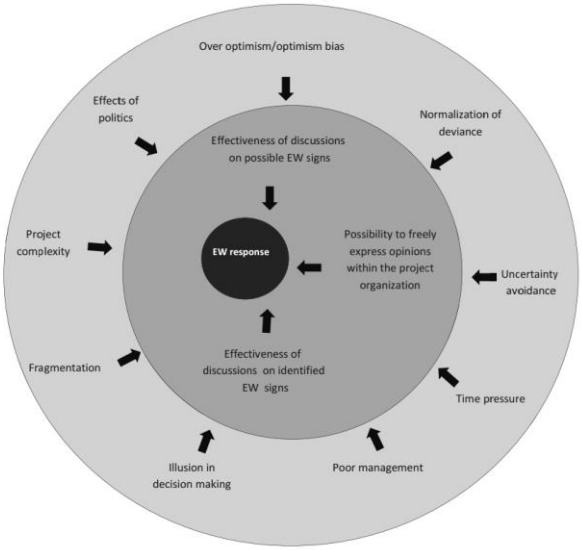

Figure 11:Influencing factors (barriers) on the EW response (Haji-kazemi, 2015)

Since this EW response can be viewed as a process with four filters, the inner circle resembles this procedure. To find out how barriers function in the EW process, it must be investigated how they are linked to the four filters. This is shown in Figure 12.

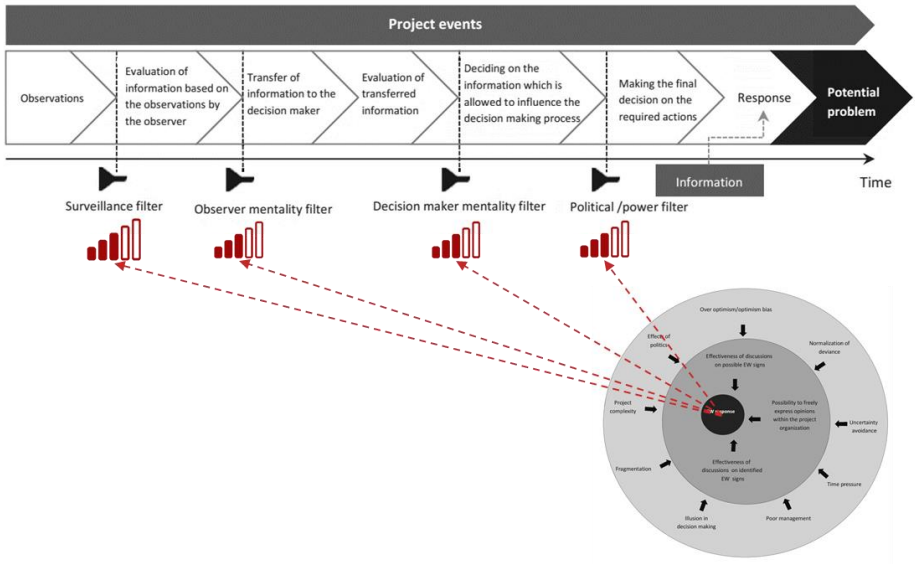

Figure 12: Link between barriers and the four filters of the EW procedure

In the case study, these links are investigated by analysing three rail infrastructure construction projects. Suggestions for these links have been provided by Haji-Kazemi (2015). In section 6.1, the result is compared with the suggested links in literature.

3.5 Conclusion

This literature study has been conducted to provide insight in the concept of early warning (EW) signs as discussed in the literature. The sub question that is used is:

SQ1 *What are early warning signs, how are they identified, and what prevents an adequate response?*

Early Warning (EW) signs are indicators for potential future developments. They serve as indications for potential risk events to occur, whilst a time frame and magnitude cannot be determined yet. This distinguishes EW signs from risks. EW signs are pre-eminently leading indicators, often have a soft character, and grow stronger over time. Literature shows that responding to EW signs has significant effect on project performance.

EW signs are identified by listening 'with an ear to the ground'. They can be identified by various identification methods, but are dependent on gut-feeling assessments as well. It is noted that most project control methods mainly focus on hard factors (such as time, cost and quality), whilst EW signs are mostly characterised by soft factors (such as trust and collaboration). Since the importance of soft factors is acknowledged in literature, there is a need for more focus on these factors.

The process of identifying and responding to EW signs is described in literature by means of an *EW procedure* model, in which four filters limit the information flow. These filters are driven by different barriers.

Two questions rise form the existing literature, as discussed in section 3.4. The first is what the most important barriers are. This is subject of research in chapter four. The second is how these barriers occur in the EW response process. This is subject of research in chapter five.

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4

Expert Consultation

Barriers in responding to Early Warning signs

Construction worker at project Oostlijn (photo: Gé Dubbelman)

This chapter contains the results of an expert consultation. The aim of this chapter is to verify the existence and importance of barriers in the construction industry. A verified selection of barriers is analysed in the case study of chapter five.

The sub question that is answered in this chapter is:

> *What are the most important barriers in responding to early warning signs in Dutch construction projects?*

This research question is answered by conducting seven expert interviews, and one expert session with ten participants. This corresponds with phase II of this research.

This chapter is constructed as follows. Section 4.1 elaborates on the interview approach. Chapter 4.2 contains general results of the expert consultation. Section 4.3 is devoted to the interpretation of the barriers. In section 4.4 discusses the applicability of the EW procedure model in the construction sector. Section 4.5 concludes the chapter.

4.1 Expert consultation approach

In this section, the expert consultation approach is explained. The goal is explained (4.1.1) and the expert selection criteria are discussed (4.1.2). Furthermore, the design of the interviews (4.1.5) and expert session (4.1.6) is explained.

4.1.1 Goal

The goal of the expert interviews is explorative and testing: to explore the interpretation of the selected barriers in construction practice and test their occurrence and importance. Furthermore, the applicability of the EW procedure model is tested.

The goal of the expert session is twofold. At first, as well as the interviews, to test the occurrence and importance of barriers. Second, to explore the links between barriers and filters of the EW procedure model. Since there hasn't been conducted research to these specific links, the expert session enables to explore these links prior to the case study.

4.1.2 Expert selection criteria

The selection of experts for the interviews is made on basis of the following three criteria.

1. High level of experience in Dutch infrastructure construction projects
2. Variation in both organisations and projects
3. Variation in roles within and around project organisations.

1. High level of experience in Dutch infrastructure construction projects

The interviews are aimed to collect experience in the form of EW signs and barriers in responding. Experts are asked to substantiate their opinions with project examples. A high level of experience is considered necessary for the interviewees to be able to provide substantiated responses and sufficient practical examples. A high level of experience is considered a minimum of 10 years relevant experience in construction projects.

2. Variation in organisations and projects

With regards to validation of the interview results, the group of interviewed experts should contain difference in backgrounds in both different projects and organisations. Different interviewees with a public background should be from different public parties. Although this research applies a public perspective, the view of other parties such as contractors or external consultancy firms is valuable as well. Interviewees are required to have background in various infrastructure projects, for various modalities.

3. Variation in functions within and around project organisations

To take multiple perspectives into account, it is necessary to interview people (with experience) in different functions in and around the project organisation. In the Netherlands, project organisations of Rijkswaterstaat (the Dutch public organisation responsible of infrastructure in the Netherlands) and the Provinces are formed according a so-called 'Integral Project Management' (IPM) model (Rijkswaterstaat, 2014), as introduced in section 2.2. It is necessary to interview people with experience in different roles. In addition to the project manager, the manager project control is expected to be of utmost interest, since this person is occupied with project risks. The same goes for the contract manager and environmental manager, since they manage relations with related parties and contractors. Furthermore, it is valuable to interview people from the client organisation and external consultants.

4.1.3 Interview design

As discussed in chapter two, the expert interviews are constructed in a semi-structured way. The applied interview guideline is included in appendix B. The structure of the interviews is as follows.

The first part of the interview serves as an introduction to the experts' background and the concept of EW signs. Here it is verified to what extent the experts are familiar with the concept and terminology.

The second part of the interview is about EW signs in projects. The experts are asked about experience in their projects with EW signs, their follow-up, and how these signs indicated future problems. The goal of this part is to verify the applicability of the EW procedure model by Haji-Kazemi.

The third part of the interview is focused on the barriers in the EW response. The respondents are first asked to point out barriers in responding to EW signs from their own experience. Subsequently, they are asked to prioritise this list of barriers. Then the experts are confronted with the barriers from literature, presented on cards. Per barrier, it is asked to what extent they recognise it as a barrier to EW response. Probe questions are used to question their perspective on the barriers. Subsequently, it is asked to prioritise the barriers in a top five. Part of the top five are the barriers which they find to be the most impactful on the EW response.

4.1.4 Expert session design

The expert session is prepared in correspondence with several AT Osborne employees, with extensive experience in organising similar sessions. A detailed program of the session is provided in appendix D.

The expert session is divided into two parts. The first part contains the recognition and categorisation of the barriers. This is conducted in the same manner as in the expert interviews. The second part has been devoted to exploring the link between the barriers and the four filters of the EW procedure. The experts have been asked to describe concrete project examples of their top five barriers. Subsequently it was asked to place these examples to one or more of the filters.

4.2 General results of expert consultation

Seven experts have been interviewed (Table 13). The selected experts meet the criteria as set. The interviews took one to one-and-a-half hour. The interviews have been recorded and transcribed. These transcriptions have been submitted for approval with the interviewees. A list of interviewed people is provided in APPENDIX C: List of interviewed people. In this chapter, the interviews are referred to by using codes 'i1' up to 'i7'.

Ref.	Current function	Organisation	Years exp.
i1	Project Manager	Rijkswaterstaat	10
i2	Manager Project Control	ProRail	>10
i3	Project Director	Rijkswaterstaat	>10
i4	Project Director	Rijkswaterstaat	>10
i5	Project Manager	Gemeente Rotterdam	>10
i6	Implementation Manager	GVB Amsterdam	>10
i7	Manager Project Control	Rijkswaterstaat	>10

Table 13: Interviewed experts

The session is held with employees from consultancy firm AT Osborne. Several employees with less than 10 years of experience are invited as well. Thus, criteria one is milder applied here, in order to assemble as much knowledge as possible. The employees of the company both conduct consulting works and are detached to work within public organisations of projects. Therefore, the employees have acquired experienced in a wide variety of organisations and projects (criteria 2). Furthermore, the employees have experience in different positions in and around project organisations (criteria 3). A list of participants, detailed program, and results of the session are provided in appendix APPENDIX D: Expert session 1.

4.2.1 Barriers recognised in interviews

In the interviews, the experts were asked to indicate per barrier to what extent they recognised it as a barrier in responding to EW signs. An impression of the results is presented in Figure 13. The figure shows how much of the experts recognised the barrier. Recognition here means that the expert recognised from his experience that this factor can function as a barrier to acting on EW signs. The exact interpretation of the separate barriers is discussed in section 4.3.

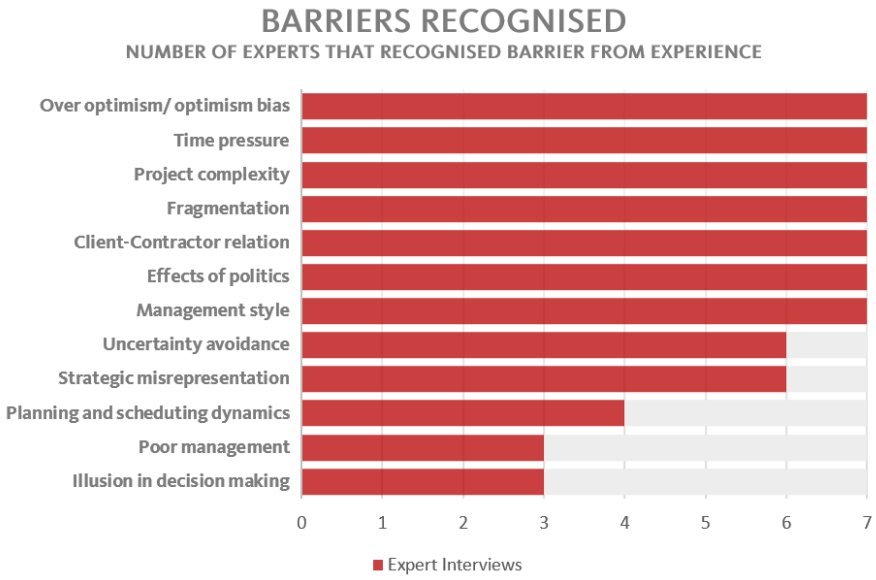


Figure 13: Barriers recognised; number of interviewees that recognised barrier from experience

The figure shows that most barriers included from literature are indeed recognised by experts as barriers in responding to EW signs. However, some more than others. Three barriers are moderately recognised: *Planning*

and scheduling dynamics, *poor management* and *illusion in decision making*. Only three or four out of seven experts recognised these barriers as such.

4.2.2 Most important barriers from interviews and session

Both in the expert interviews and the expert session, experts were asked to make a top five of most important barriers. In this top five, barriers were included, that according to them, had the most impact on the EW response in construction projects. Besides the presented barriers, additional devised barriers were allowed to be included as well. The results are shown in Figure 14.

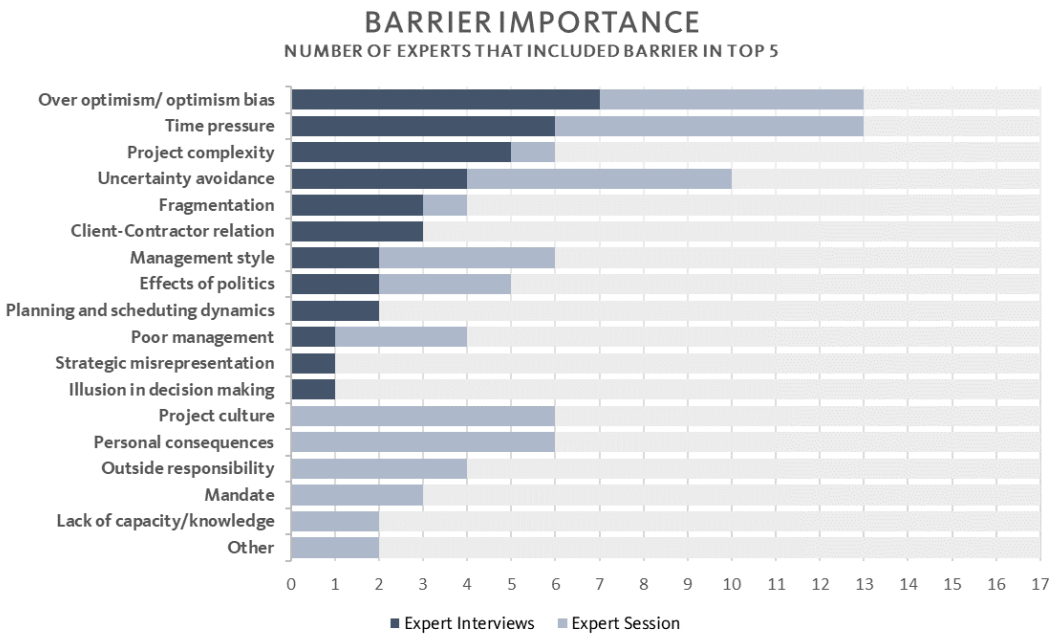


Figure 14: Barrier importance; number of experts that included barrier in top 5

The results of the interviews are marked in dark blue. Four barriers stand out in their perceived importance to the EW response: *optimism bias*, *time pressure*, *project complexity,* and *uncertainty avoidance.* Four or more out of seven experts included these barriers in their top five.

The results of the expert session are marked in light blue. Again, *optimism bias, time pressure,* and *uncertainty avoidance* are most frequent marked as important. *Complexity* is mentioned less frequently. Furthermore, several extra barriers were devised in the expert session. After grouping, important barriers are related to *project culture* and *personal consequences*. Although these barriers can be related to other barriers such as *management style* and *uncertainty avoidance,* their frequent naming demands special interest.

When combining the both results, it can be concluded that *optimism bias, time pressure,* and *uncertainty avoidance* are considered most important by both sources. Furthermore, *project complexity, fragmentation, client-contractor relation*, *management style,* and *effect of politics* are considered as important by several experts.

When comparing the both graphs with Table 11and Table 12 from chapter 3, several things arise. *Optimism bias* is considered in both analyses as important. *Political effects* is relatively higher ranked in the analysis of Haji-Kazemi. Time related aspects are retrieved in both tables as important. Communicative aspects are ranked high in the analyses of Haji-Kazemi, but are not retrieved in this figure, since these aspects were not included as a barrier in this research. *Poor management* was considered the most important barrier in the analysis of Haji-Kazemi, but is here only recognised and perceived important by several experts. As is discussed in section 4.3, this is due to the presence of the *management style* barrier.

4.3 Interpretation of barriers

This section covers the results of the barriers that have been discussed with experts. The barriers are discussed one by one. Per barrier, three aspects are discussed:

1. To what extent barriers were recognised and considered important as a barrier to EW response
2. Interpretation and highlighted aspects
3. Relation and overlap with other barriers

1. Over optimism / optimism bias

Over optimism, or optimism bias, is recognised by all of the experts as a barrier to acting upon EW signs. In its interpretation as such, several findings were discussed. Some experts regarded optimism as *typical for the construction sector*. Typically, optimisation possibilities later in the project are overestimated (i4). Furthermore, interviewees noted that optimism has influence the perception on EW signs (i5, i6), since the bias determines what is observed. Optimism bias can create blindness to signals. (i6). However, some experts stressed that optimism itself is *not necessarily bad*. It can be a powerful force in the project, for example by ensuring clarity and commitment for project managers (i6).

Most of the interviewees linked this barrier with *systematic fallacy (illusion) in decision making*. This is understandable, since both barriers are based on literature by Flyvbjerg and Kahneman. Kahneman indicates optimism (delusion) as main cause for fallacy in decision making (Lovallo & Kahneman, 2003). Flyvbjerg adopts this relation but handles another explanation for the planning fallacy: *strategic misrepresentation* (deception) (Flyvbjerg, 2007b; Flyvbjerg et al., 2009). This relation is shown in Figure 15.

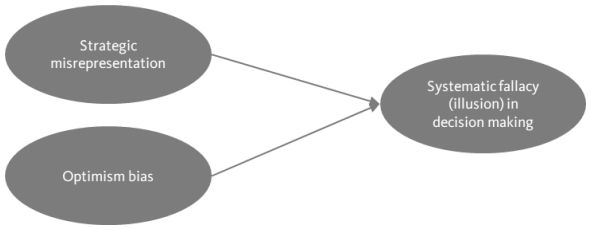


Figure 15: Strategic misrepresentation (deception) and optimism bias (delusion) as causes for planning fallacy (own illustration)

Furthermore, optimism bias was related to political pressure. Political pressure can have influence on the optimism of a team, and thus the way in which EW signs are handled.

2. Strategic misrepresentation

Strategic misrepresentation is recognised by most of the respondents, although opinions vary on its importance. Some believe it's typical for the culture in the (ground, road and water) construction sector (i1). This is illustrated by a familiar word in the industry: 'price diving'. It addresses contractors offering excessive low project offerings in the tender phase in order to win the project. Typically, by means of these strategic offerings, EW signs are neglected. To generate a low tender price, sometimes risks are simply crossed out of the pricing by the board of directors (i3).

Besides price diving at private parties, some interviewees recognised strategic misrepresentation on the public side as well. Initiating projects with an unrealistic planning in essence provokes strategic behaviour (i3, i5). Other experts did not expect this public strategic misrepresentation in general to happen on purpose. Instead they devote incorrect cost estimations to naivety (i2, i6). Opposed to deliberate actions, a subtle process in which political effects and optimism play an important role was described (i6).

3. Client-Contractor relation

Client-contractor relation dynamics was recognised by all the experts as a potential barrier to acting upon EW signs. Important aspects of this barrier that surfaced in the interviews were related to *difference in interests* and lack of *trust*.

Difference in interests between the client and contractor was considered typical for this barrier (i2, i3, i4). It was noted that an unhealthy client-contractor relation hinders sharing of EW signs (i7). Expecting opportunistic behaviour from a contractor influences the perception towards shared EW signs (i6), since objectivity and rationality is lost (i6). Furthermore, it hampers the effectiveness of some responses. For a response that affects other parties as well, a healthy relation is essential (i7). For example, when requesting for a replacement at the contractor's side (i7).

Trust was by several experts noted as a key factor to minimise this barrier, since it creates an open atmosphere in which EW signs are shared (i4, i5). To create trust, it was noted that parties need to allow themselves to show their vulnerability (i4). A contractor generally will only do as a result of client behaviour (i4).

4. Planning and scheduling dynamics

This barrier was recognised by most of the respondents. However, several experts coupled this barrier with the barrier time pressure (i1, i3, i4, i5). Some experts considered the barrier forthcoming out of other barriers such as political effects and optimism (i1, i5, i6).

The element *manipulation of the planning* was recognised by several experts (i1, i5, i6). For example, by means of an unrealistic initial planning due to frond-end politics and optimism (i5, i6). This planning is being held on to and tweaked for as long as possible, until a political window of opportunity arises to report project delays. This process is a barrier for EW signs, since the EW signs become unwanted messages.

At the same time, experts doubted the presence of a context of deliberate manipulation of the planning (i2, i4, i6). It was considered to be a subtler process (i6). Furthermore, it was stressed that to a certain extent remaining critical on the planning is necessary, and not allowing too much buffers in it (i2).

5. Uncertainty avoidance

This barrier is recognised by most of the experts. Interpretations of this barrier were both in *communication to superiors*, as well as in *decision-making by managers*.

In *communication to superiors,* uncertainty avoidance influences the communication of EW signs to higher management (i2, i6, i7). Personal consequences are taken into account. Typically, reporting a normal progress report is much easier than reporting an unexpected twist (i6).

In *decision-making by managers,* two issues were highlighted. Firstly, EW signs sometimes come with poor timing (creating uncertainty) for the project (i1, i2). This causes them to be neglected by managers. This was illustrated by the phrase: *'Sometimes it is easy to create a reality in which there is no uncertainty. Neglecting of signals will hereby create a false feeling of certainty'* (i1). Secondly, responding to EW signs was perceived as at odds with the western leadership style of a *'strong leader who keeps course'* (i6). In this perception, EW signs come with uncertainty for the project, putting the decision maker for a choice: profiling as a firm leader who keeps course, or daring to address the uncertainty presented by EW signs. This trade-off, as viewed in Figure 16, has to be made constantly. Neither were considered per definition good or bad (i6). Sticking to the project plan was considered an essential strategy to ensure progress. Furthermore, it is not possible to steer the project on the basis of every signal.

Figure 16: Sticking to the project plan vs. responding to EW signs

Another interviewee referred to this dilemma as a paradigm: *'speaking of uncertainties will evoke feelings that uncertainty has increased; While in practice uncertainty has decreased, since knowledge of the puzzle is increased' (i7).* When EW signs are reported to a decisionmaker, it seems to bring uncertainty. But actually, the knowledge is increased. This functions as a barrier for reporting EW signs. Therefore, acknowledging a certain EW sign as a project team is not the same as reporting it to the client organisation. Reporting will have consequences that will bring new uncertainties to the project.

Respondents linked uncertainty avoidance to effects of politics. Within the project organisation, political effects influence the perceived psychological security to express opinions (i6).

6. Time pressure

Time pressure was recognised by all the experts as a barrier in responding to EW signs. Aspects of the effect of time pressure that were discussed are related to the *time for reflection* that is taken, and *receptiveness* for EW signs.

First of all, time pressure can cause a project team to take *less time for reflection* (i1, i5, i6, i7). An illustrating example is a choice to not do a second opinion on an advice because of time pressure, whilst there are doubts about this advice (i1). EW signs are hereby neglected. Furthermore, time pressure makes make people *less receptive for signals* (i1, i4, i6). This was described as a tunnel vision of the project (i1). EW signs can be perceived as disruptions of a planning that is already under pressure (i1). This can cause people to neglect signals, both while aware and unaware. One of the experts described this process by means a vicious circle (i6) (Figure 17): time pressure can be caused by missing earlier signals in the project. This causes a project team to take less time for reflection, leading to potential missing or neglecting of new signals.

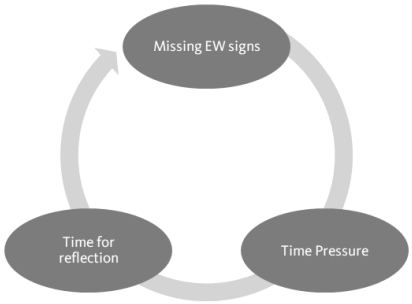


Figure 17: Vicious circle of time for reflection

To break this vicious circle, it was suggested to work contra-intuitive now and then (i6). '*When time pressure is high, sometimes it can be very effective to give employees time off*' (i6).

In contrast, positive effects of time pressure were discussed as well. People are pushed by time pressure to deliver, which is considered as valuable, even though this makes them potentially less reflective for EW signs (i4). Furthermore, time pressure was related to other factors. First of all, political power can put a planning under pressure (i1, i2). Second, it was related to project complexity. Time pressure is described as a multiplier for matters that are already complex (i4).

7. Poor management

On *poor management* as a barrier for EW signs, opinions differed. Some experts recognised the factor as a barrier (i1, i2, i3). It was recognised as a barrier in communicating EW signs in the project (i1). In addition, by the extent to which it is dared to report signals to the top management (i3). Furthermore, it was considered to be poor management when no time is reserved for reflection (i6).

Others recognised the factor to a lesser extent as a barrier (i6, i7). An argument is that the way in which EW signs are dealt with is a deliberate trade-off, rather than good or bad management. In hindsight it can be judged if something was good or bad management (i6).

Most of the experts coupled the factor to *management style*, whilst the latter was considered as more appealing (i5, i6, i7).

8. Illusion in decision making

This barrier was recognised by several experts. However, most experts referred specifically to *optimism bias* when discussing this barrier (i2, i3, i4, i5). In the results of the barrier *optimism bias,* the relation of *illusion in decision making* with *effects of politics* and *optimism bias* has yet been discussed. It can be concluded that optimism bias is regarded as main explanation for *illusion in decision making*.

Regarding interpretation of the barrier, experts named several effects. The effect of *optimism bias* limits an objective response to EW signs. The consequence is failure in decision-making by taking wrong decisions or neglecting EW signs (i5). In projects that are heading off-course, this effect of *illusion in decision* making is often present. Next to optimism, illusion in decision making was further explained by *influence of past decisions* (i1). When regarding a project as a stream of decisions, decisions made in the past steer the course of the project (i1).

Furthermore, the barrier was explained by the *character of EW signs* that are taking into account in decision making (i7), phrased by: '*Decision making is focused on giving hard signals a place, while the soft and 'earliest' warning signs are at least as important'. The further in the project, the less steering is possible' (i7).*

9. Fragmentation

Fragmentation of projects was recognised by all interviewed as a barrier to EW response in projects. Similar to the conclusion in the literature study (section 3.3), it was indicated that organisational learning is considered a problem in construction projects (i1, i4, i5, i6).

Besides fragmentation between projects, fragmentation *within* projects was remarked as well (i2, i6). This occurs when a project is separated in silo's (i6). It was remarked that if performance targets for divisions of the project do not include the collective interest, the divisions will optimise targets to themselves (i6). Due to such fragmentation of the project, EW signs are not optimal brought together. And this is important, since decisions are made on patterns of multiple EW signs, rarely on individual signals (i2).

10. Management style

The style of management of the project manager was recognised by all interviewed as a potential barrier in EW response.

In comparing top-down and bottom-up styles of management, both were indicated as potentially blocking a response to EW signs. A top-down management style can cause employees to not feel heard(i4), or limit the extent to which employees are prepared to open up (i2, i7). One interviewee phrased strikingly: *'When managing too much top-down, nothing is heard bottom-up'* (i4). If a project manager has no feeling with the employees, signals are not always shared. Furthermore, the response by managers to reported signals is important for this factor. These reactions determine if employees will share future signals as well. On the contrary, an explicit bottom-up leadership style can potentially create a culture of too much harmony and consensus (i2). In order to keep this harmony, team members might become reluctant to speak their minds explicitly.

11. Project complexity

Project complexity was recognised by all of the experts as a barrier to responding to EW signs. Interviewees agreed that the more complex the project, the more difficult it is to detect EW signs and provide them with the right response (i3, i5, i6).

Regarding the interpretation of the barrier, several aspects submerged. These aspects are related to the *observation*, *sharing*, and *decision* making on EW signs. Complexity complicates the *observation EW signs*, and thus can function as a surveillance filter for EW signs (i2, i4, i7). In addition, increased complexity by conflicting interests of different stakeholders makes the *sharing of EW signs* difficult (i5). It was noted that increased organisational complexity complicates communication of signals. The more complex a project, the more important the influence and mandate is for communicating signals (i5). Furthermore, increased complexity due to time pressure and political pressure, impacts the *decision making on EW signs (i5, i7)*. It was mentioned that complexity *'complicates the 'valuation' of signals' (i7).* The importance and potential impact of EW signs is more difficult to estimate in a complex project.

12. Effects of politics

Political effects were recognised by all experts as a barrier to EW response. In interpretation, several aspects are highlighted: *Political pressure in front-end*, Its effect on *follow-up of EW signs,* and *interorganisational political effects.*

It was noted that in *front-end stage of the project*, political pressure can have large consequences for the time pressure later in the project (i4, i5). EW signs can be supressed due to this pressure (i5). This was phrased by*: 'While everyone knows the project delivery date is not feasible, indicating this is 'not done' in this phase of the project'* (i5). Often a certain adaption phase follows, in which it takes a while to 'prove' the project delays (i5).

In addition, it was noted that political effects influence the *follow-up of EW signs* (i5, i7). It determines if an EW sign finds 'political breeding ground' (politically accepted) (i5). Due to these effects, deliberate trade-offs are made whether or not to mention EW signs. This was illustrated by: *'I know the planning is not feasible, but it is better if it is noted somewhere else'* (i5). In this sense, project parties try to cover up their own delays by reporting them at the right time. As project manager, this political pressure can lead to integrity issues. Whilst having a different view on the planning feasibility, political pressure can determine the planning (i1).

Furthermore, besides political effects on national or regional level, political effects play an important role *within in the organisation* as well (i6, i7). The reputation and mandate that someone has in an organisation determines the extent to which shared EW signs are accepted (i6). This makes it difficult to bring a bad message. The project and even project organisation itself are a political arena (i6). Project parties having all different interests creates biased views on EW signs.

4.4 Applicability of the EW procedure model in the construction sector

The EW procedure model (Figure 18) has been introduced in section 3.3. This model is developed for project management in general. Prior to conducting the case study, it is essential to verify the applicability of the EW procedure model in the construction sector. In this section, the EW procedure is run through, based on the information retrieved in the interviews. Hereby the application of the filter model is tested. Furthermore, this serves as starting point for links with the barriers, as explained in section 3.3.

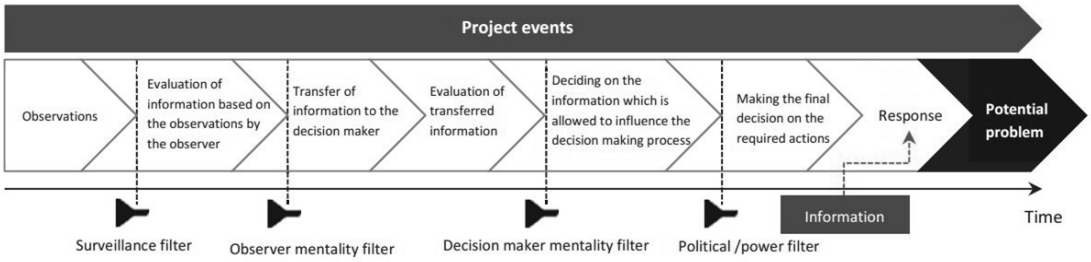


Figure 18: The EW procedure model (adopted from Haji-Kazemi (2015))

4.4.1 Applicability per filter

Filter 1: Surveillance filter

The surveillance filter is represented by the choice of the project about what information is needed and what identification methods should be used to retrieve it. In short, how the identification of EW signs is organised in a project. To verify the occurrence of this filter in the construction industry, respondents should recognise the functioning of this filter as such. If EW signs are missed due to insufficient or incomplete surveillance, this indicates the presence of this filter.

Respondents indicated several issues regarding the identification of EW signs. At first, it was noted that EW signs most of the time are not recognised as such. In hindsight things make much more sense than at the moment of observation with the available information (i2). Furthermore, it was highlighted that separate EW signs are sometimes too weak, and the issue is only seen in a pattern of EW signs (i2). This pattern is spread over both time and over different parts of the organisation, and therefore difficult to spot (i2, i6). Second, most of the experts indicated that construction projects sometimes lack critical reflection, while the organisation of reflection in a project was considered crucial in retrieving EW signs (i6, i7). These issues indicate the presence of the surveillance filter. If insufficient time for reflection is organised and the appropriate methods are not being used, EW signs can be 'filtered out'.

Filter 2: Observer mentality filter

The observer mentality filter is characterised by the evaluation of the receiver of what information is necessary and what is not needed. To verify the presence of this filter, its functioning in the construction industry should be derived from the interviews. Regarding the *observer* as a person, project examples showed that just as EW signs originate from different sources, they are identified by different people. An EW sign can be spotted by a project manager or someone else in the organisation, but also from outside the organisation. For example, an inhabitant of the project environment, or a sub-contractor (i2).

Several issues regarding the observer mentality filter were identified from the interviews. A first, it was considered difficult to assess one's own project objectively (i3). All kinds of factors such as optimism and time pressure influence this. As one interviewee phrased: '*Commitment to the project plan, a valuable goal for a PM, makes employees in a way more blind for EW signs* '(i6). A second issue is the 'valuation' of the EW sign. Employees are uncertain about the value of the sign, since it is difficult to estimate the potential impact. Since no project works perfectly according to plan, warning signs can often be explained as small deviation (i6). This uncertainty complicates the evaluation of information for the observer. A third issue is the consideration of communication of EW signs. Whilst the impact of a EW sign is mostly unknown, the impact of reporting a sign

often is. This has consequences for if and how the sign is communicated. All kinds of factors influence this consideration. For example, employees doubt if it is their responsibility to report an EW sign. Or a reluctance to deliver the 'bad message' (i5). A project manager questioning his own assignment potentially has personal consequences for his job (i1). Due to this uncertainty, EW signs are sometimes communicated in a weak way (i2), whilst this way of reporting is essential for the decision-making process. The time perspective is important as well. Often it is chosen to wait until more certainty about the impact of the EW sign (i3). Furthermore, EW signs related to internal team performance such as trust, co-operation and individual performance, are more difficult to share, since they can be perceived as an insult (i7). All three of these issues reflect the presence of an observer mentality filter. The evaluation of information is influenced by different factors before it is decided to communicate the EW sign.

Supplementary to the EW procedure as shown in Figure 18, the interviews made clear that multiple layers of communication can exist between the *observer* and the *decision-maker*. Larger organisations come with more organisational layers, making the communication of EW signs vulnerable to errors. Furthermore, in some cases the observer is the same person as the decision maker. Both alternatives are not explicitly represented in the model. When sticking to the current model, multiple layers of communication could be resembled by multiple sequential observers of an EW sign, and thus multiple functioning of the observer mentality filter. The decision maker as observer could be resembled as merging the two mentality filters in the model.

Filter 3: Decision Maker Mentality Filter

The decision maker mentality is characterised by the evaluation of the decision maker of what information is necessary and what is not needed. It is the choice of taking signals into consideration. To verify the presence of this filter, its functioning in the construction industry should be derived from the interviews. Regarding the *decision-maker* as a person, interviews showed that this differs per situation and per project. It depends on the type of EW signs, the potential risks, and contractual agreements. In some cases, the project manager of the project organisation is the decision-maker. For decisions with more magnitude the decision-maker is the project director from the client organisation, or a government official.

Several issues regarding the *decision maker mentality filter* were identified in the interviews. At first, a decision-maker must make a decision based on information that is known, while dealing with uncertainties. The information can be incomplete, biased, contested or an overload (i1). Second, it is not possible and desirable to respond to every sign (i6). Furthermore, as well as the observer can choose to keep information to him- or herself, decision makers will sometimes want to wait with taking a response for more information on the EW sign. These examples reflect the presence of a decision maker mentality filter. The evaluation that the decision maker makes when receiving information from *observer* is influenced by various factors.

Supplementary to the EW procedure model, it was highlighted that the *receptiveness* of the decision maker has consequences further on in the project (i7). Whether or not signals are taken into account, influences the extent to which project employees 'feel heard'. This influences the perception of the observer as well.

Filter 4: Political Power Filter

The political power filter refers to the decision-making process, in deciding what information is allowed to influence the decision making of the project. The filter is hereby represented by the power structure of the organisation, that is challenged by an EW sign. To verify the presence of this filter, its functioning in the construction industry should be derived from the interviews.

From the interviews it has been derived that besides the perspective of the decision maker (filter 3), all kinds of factors influence the decision-making process. For example, the presence of a political window of opportunity, the political will to do something with the EW sign (i1, i3, i4, i5, i6, i7). Or optimism bias resulting from wishful thinking on top-level (i3, i5, i6, i7). Relations are important as well, in the extent to which the response can be implemented. In project execution, a client organisation is limited in its power to implement a response at the contractor's side (i3). The strength of the relation determines the possibility and success of the response. These examples reflect the effect of the political power filter. Regardless of the perception of the decision maker, political and power effects influence the decision-making process.

Applicability of the EW procedure

The process of acting upon EW signs from its observation to its response has been described as perceived in the construction sector. All of the four filters in the model are reflected in the issues that were derived from the expert interviews. It can be concluded that, in general, the process of acting upon EW signs can be described with the EW procedure model by Haji-Kazemi.

However, several remarks are noted supplementary to the model, as discussed in the previous sections. At first, crucial aspects of communication of signals between the observer and final decision maker are somewhat underrepresented in the model. The 'way' in which EW signs are communicated and the time perspective are considered important. These are not explicitly found in the description of the filters by Haji-Kazemi. Second, the difference in organisational layers in communication upwards are not reflected in the model. The observer can be the decision maker at the same time, as well as multiple layers of communication can exist between them. These remarks can be accommodated in the existing model. Therefore, it is not required to change the model. However, it is worthwhile to reflect the organisational perspective to the filter model. This is discussed in chapter 7.

4.4.2 Exploring the link between the barriers and the four filters of the EW procedure

As section 4.1.5 explains, the second part of the expert session has been devoted to exploring the link between the barriers and the four filters of the EW procedure. The experts were asked to describe concrete project examples of their top five barriers. Subsequently, it was asked to link these examples to one or more of the filters. The following figure shows an impression of these links. The links are worked out in Appendix D.

		Filters			
	Barriers	1: Surveillance	2: Observer mentality	3: Decision maker mentality	4: Political / power
1	Over optimism/ optimism bias				
2	Strategic misrepresentation				
3	Client-Contractor relation				
4	Planning and scheduling dynamics				
5	Uncertainty avoidance				
6	Time pressure				
7	Poor management				
8	Illusion in decision making				
9	Fragmentation				
10	Management style				
11	Project complexity				
12	Effects of politics				
	Project culture				
	Personal consequences				
	Mandate				
	Outside responsibility				
	Lack of capacity/knowledge				
	Other				

Figure 19: Impression of links between barriers and the four filters of the EW procedure. Dark red colour indicates an observed effect, while light red colour indicates an expected effect.

These examples demonstrate the application of plotting barriers and filters. The different barriers can be linked to different filters in the EW procedure. These results were retrieved by means of examples from experience. In the case study (chapter five), similar links are identified by observing the follow-up of certain EW signs in project documents, and interviews with project employees.

4.5 Conclusion

This chapter was aimed to verify the existence and importance of barriers in the construction industry. The sub-question formulated at the beginning of this chapter is:

SQ2

> *What are the most important barriers in responding to early warning signs in Dutch construction projects?*

Optimism bias, *time pressure*, *project complexity* and *uncertainty avoidance* are marked by most experts as important barriers. *Fragmentation*, *client-contractor relation, management style* and *political effects* are considered to be important as well. These eight most important barriers are further investigated in the case study. The remaining four barriers *planning and scheduling dynamics, poor management, strategic misrepresentation, illusion in decision* were moderately recognised and considered less important. *Project culture* and *personal consequences* are considered as additional important barriers. However, it can be argued that these barriers are a result of an applied *management style* by the project manager.

When compared with literature, *optimism bias*, *political effects* and *time pressure* correspond in importance. Communicative aspects are ranked high in the analyses of Haji-Kazemi, but are not retrieved in this research, since these aspects were not included as a barrier in this research. *Poor management* was considered the most important barrier in the analysis of Haji-Kazemi, but in this research moderately recognised. The introduced barrier *management style* is considered to be more appealing instead.

Furthermore, it can be concluded that the EW procedure model is applicable in the construction sector. However, communicational and organisational effects are considered underrepresented in the current model. In advance of chapter five, links from project experience demonstrated the application of plotting barriers and filters, which serves as methodology in the case study.

5

In-depth Case Study

Functioning of barriers in Dutch infrastructure construction projects

Project DSSU (photo: ProRail)

This chapter contains the results of a case study conducted on three rail infrastructure projects in the Netherlands. The goal is to investigate the occurrence of barriers in these projects and explore links with the four filters from the EW procedure. This corresponds with phase III of this research. The sub-question that is answered in this chapter is:

SQ3

How do barriers function in the process of responding to early warning signs in Dutch construction projects?

This chapter is constructed as follows. Section 5.1 elaborates on the case study approach. Section 5.2 discusses general findings from the case study. Subsequently, the results per case are presented in sections 5.3, 5.4 and 5.5. Section 5.6 discusses cross-project findings. In section 5.7 conclusions are drawn.

Several things are noted regarding the results of this case study. The results are an interpretation of interviews and documents on the selected framework. It is shown how EW signs and the discussed barriers have occurred in the project. However, the case study results are by no means an evaluation of project events. These interpretations should therefore not be confused with statements about failures in the projects. Judgements on the impact of barriers on project outcome, or actions taken by the project team are beyond the scope of this research.

5.1 Case study approach

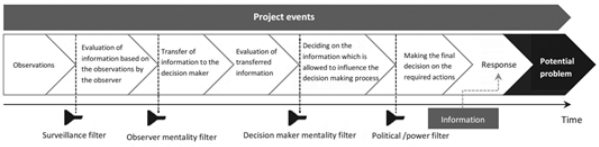
In this section, the applied case study approach is discussed. The goal is motivated (5.1.1), applied criteria are introduced (5.1.2), and the interview design is explained (5.1.3). Section 5.1.4 concludes with motivating the approach to retrieve data.

5.1.1 Case study goal

The goal of this case study is to investigate how barriers function in the EW response process in practice. Therefore, three cases are investigated. As discussed in the research methodology, this goal is in line with Yin (1981) and Schramm (1971).

5.1.2 Data retrieving approach

To investigate how barriers function in the EW response process, the following approach is used. The barriers discussed in the previous chapter are plotted against the filters of the EW procedure (as presented in section 3.1). This is schematically presented in Figure 20. The links in the plot explain how each of the barriers occur in every stage of the EW procedure. These links are retrieved by conducting interviews and analysing project documents.



Barriers	Filter 1	Filter 2	Filter 3	Filter 4
Over optimism/ optimism bias				
Client-contractor relation				
Uncertainty avoidance				
Time pressure				
Fragmentation				
Management style				
Project complexity				
Effects of politics				

Figure 20: Links between barriers and the filters of the EW procedure

In order to focus, not all barriers are considered. In chapter four it has been concluded that the barriers *systematic fallacy (illusion) in decision making*, *poor management, planning issues*, and *strategic misrepresentation* were moderately recognised by experts or explained by other barriers. For the case study it is focused on the remaining barriers, shown in Figure 20.

Two approaches are used to investigate the links between barriers and the filters of the EW procedure. The first method is schematically represented in Figure 21. In the interviews and project documents is searched for concrete EW signs (1). These signs should, in some way, function as an indication for problems later in the project. Per signal, the follow-up is analysed (2). This follow-up is projected on the EW procedure model. It is determined what occurred at every filter. When the follow-up of an EW sign has been (partly) filtered-out, an explanation is sought in a specific barrier (3).

The second method is the same as used in the expert interviews (chapter 4). In evaluating project documents, general reasons for project problems are viewed in light of the different barriers. Interviewees are asked to point out the most influential barriers to EW signs in the project. By asking probing questions on their effect on EW response, barriers are linked to one or more of the filters. In project documents, similar links are sought.

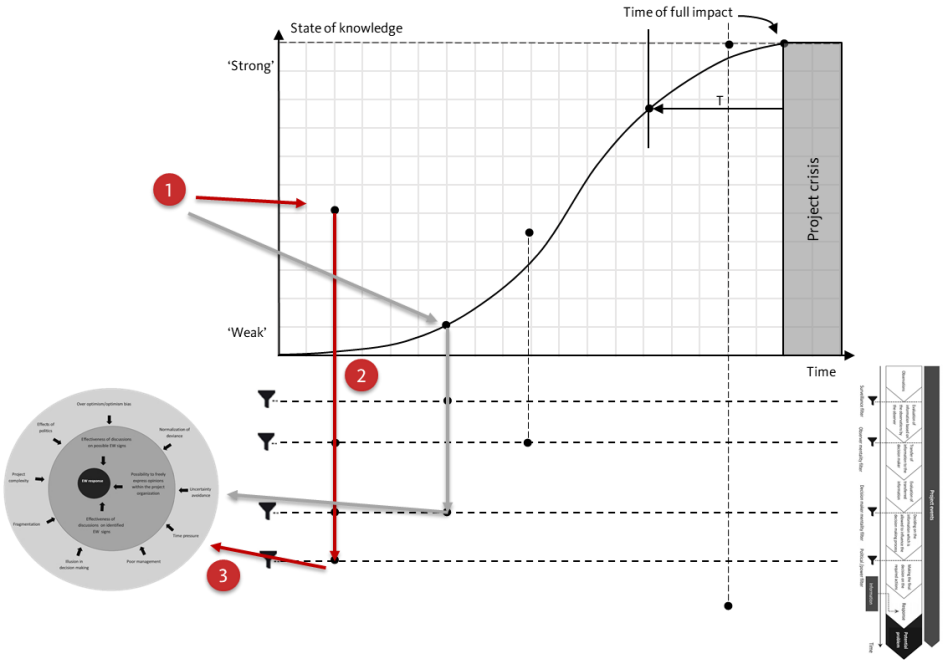


Figure 21: illustration of retrieving the follow-up of EW signs in the case study

From this analysis, the links between barriers and the filters of the EW process are established. An issue is linked to the *surveillance filter* if it concerns the identification of EW signs in the project. It is linked to the *observer mentality filter* if it concerns the perception of the observer and the consideration in communication towards decision making. It is linked to the *decision maker mentality filter* if it concerns the consideration of the decision maker, being mostly the project manager or client organisation (depending on the issue). It is linked to the *political/power filter* if it concerns the pressure on decision making and considerations in actual action undertaken.

5.1.3 Case selection criteria

The selection of case studies is made on basis of the following criteria. Case studies should be:

1. Rail infrastructure construction projects
2. In different project stages
3. Characterised as complex
4. Publicly initiated

1. Rail infrastructure construction projects

Since the scope of research (section 2.2) is focused on infrastructure construction projects, all case studies are required to be of this type. A further selection is made regarding modality; only rail infrastructure projects are investigated. This enables a valid comparison. For this research, it is assumed that the EW response will be comparable for different modalities. This assumption should be subject to future research.

2. In different project stages

EW signs occur during the entire course of a project. Projects that are near completion provide the advantage to reflect on the whole project duration. Moreover, it is expected that project employees can reflect more objectively when they are no longer closely involved in a project. However, retrieving gut-feeling type of EW signs from years before can be problematic as well. Therefore, projects in an early stage are considered as well. These projects provide the advantage that EW signs should be currently present. Furthermore, it is argued that EW signs in early project stages are most valuable (chapter 3). Therefore, projects both in the planning phase and projects that are (almost) finished are considered.

3. Characterised as complex

Project complexity complicates the EW response, as shown in the previous chapter. Therefore, projects with a complex character are interesting to study for barriers to EW response. This complex character can for example entail an extensive scope, technical complexity, or a wide variety of actors involved.

4. Publicly initiated projects

In the scope definition it is chosen to take a public perspective. This limits the scope to projects with significant presence of public organisations. Therefore, only publicly initiated projects are subject to research.

5.1.4 Case interviews setup

As mentioned in section 2.3, interviews are used to collect data from the case projects. These interviews take one up to one-and-a-half hour. The conversations are recorded and transcribed, and submitted for approval with the interviewees. A semi-structured character is used, structured as follows (appendix E contains the interview guideline).

The first part of the interview serves as an introduction to the interviewee and the concept of EW signs. Here it is verified to what extent interviewees are familiar with the concept and terminology. The second part of the interview is about the project. Questioned are the main challenges upfront, and impactful events that have determined the course of events. Subsequently, it is asked which EW signs preceded these events. In addition to the answers by the respondents, identified EW signs from other interviews and project documents are discussed. The follow up these signs is questioned, as well as the barriers influencing this process. The barriers are presented on cards to the interviewees. In the third part of the interview, the interviewees are asked to indicate the most important barriers to EW response in their project. They can choose from the cards, or additional barriers. The influence per barrier on the project is discussed. Concluding the interview, it is asked what in hindsight could have improved the response to EW signs.

5.2 General case study results

5.2.1 Selected cases

The following projects have been selected as subject to the case study:

	Project name	Description	Initiated	Budget	Delivery
1	Doorstroom Station Utrecht (DSSU)	Drastic adjustments to the rail infrastructure around Utrecht Central station to improve the capacity, quality, and robustness	Ministerie van I&M, ProRail, NS	€300M	2016
2	Renovation Oostlijn	Renovation of the 25-year-old Eastern metro line of Amsterdam; sub-project *tunnel safety improvements*.	Gemeente Amsterdam, GVB	€150 M	2015
3	PHS Amsterdam Centraal	Drastic adjustments to the rail infrastructure around Amsterdam Central station to improve the capacity, quality, and robustness	Ministerie van I&M, ProRail, NS	No budget set	2026 (planned)

Table 14: Projects included in case study

5.2.2 Retrieved data

In analysing the different projects, twelve interviews have been conducted (Table 15). The information from these interviews is supplemented by different project documents, such as project evaluation reports (Table 16). An evaluation of the retrieved data is discussed in section 7.3.2. The interviews and documents are referred to following the codes in the tables below.

Case	Code	Function	Organisation
1	i1.1	Project Director	ProRail
	i1.2	Manager Project Control	ProRail
	i1.3	Project Manager	Gemeente Utrecht
	i1.4	Construction Manager	ProRail
	i1.5	*Anonymous* 1, *anonymous* 2	ProRail
2	i2.1	Project Manager	AT Osborne
	i2.2	Project Manager	Gemeente Amsterdam
	I2.3	Project Manager	AT Osborne
3	i3.1	Project Manager	ProRail
	i3.2	Manager Project Control	ProRail
	i3.3	Plan Developer	ProRail
	I3.4	Project Supervisor	Ministerie van Infrastructuur en Milieu

Table 15: Interviewed employees per case

Case	Code	Type	Document name	Source
1	d1.1	Evaluation report	Evaluatie besluitvorming, informatie-uitwisseling en projectbeheersing OV SAAL KT cluster c en Doorstroomstation Utrecht	(Twynstra Gudde, 2015)
	d1.2	Project initiation plan	Doorstroomstation Utrecht; Versie 1.0	(Ministerie van Infrastructuur en Milieu, 2013)
2	d2.1	Report	Renovatie Oostlijn; lessen uit een complex en problematisch project	(Rekenkamer Amsterdam, 2016)
3	d3.1	Notation	Programma Hoogfrequent Spoorvervoer Amsterdam Centraal; Notitie Reikwijdte en Detailniveau Milieueffectrapportage	(Ministerie van Infrastructuur en Milieu, 2016)
	d3.2	Information Document	Informatie Document PHS Amsterdam Centraal; ten behoeve van besluitvorming alternatiefkeuze	(ProRail, 2014)
	d3.3	Progress Report	Voortgangsrapportage nr. 13; PHS	(Ministerie van Infrastructuur en Milieu, 2017)

Table 16: Document sources per case

5.3 Results case I: Doorstroom Station Utrecht (DSSU)

5.3.1 Case introduction

Project DSSU entails a selection of drastic adjustments to the rail emplacement at and around Utrecht Central train station. The project goal is to '*increase the capacity, quality and robustness of the rail infrastructure around Utrecht Central station in the coming years*' (Ministerie van Infrastructuur en Milieu, 2013). Motivation for the project is the 'Pogramma Hoogfrequent Spoorvervoer' (PHS). This program is initiated to be able to manage the expected growth in number of train passengers for 2020. By upgrading several stations and corridors, the number of trains per hour on the major trajectories of the railway net is increased.

The main works of the project are rerouting and replacing of train tracks, and removal and replacement of track switches (Ministerie van Infrastructuur en Milieu, 2013). Furthermore, an extra platform is realised and additional changes to the station are made, including passenger tunnels, platform roofs, technical buildings and emergency transitions.

The initial cost estimate was 271 million euro. The original planning was to finish the project at the end of 2015 (Ministerie van Infrastructuur en Milieu, 2013). During the execution phase, the project has frequently been under attention in news articles. In 2014 the project reported a project delay of one year, and a potential cost overrun of 100 million (FD.nl, 2015). This was reason for the ministry to put the project under extra attention. In the following period, the potential cost overruns were returned to 29,5 million euro. According to the last estimations the project will end with a positive balance of 50 million euro (NU.nl, 2016). The projects main phase is finished at the end of 2016.

5.3.2 Stream of events

In the following section, the course of the project is reproduced by mapping a stream of events. Of these events, a timeline is created (Figure 22). This is based on both used project documents Table 16.

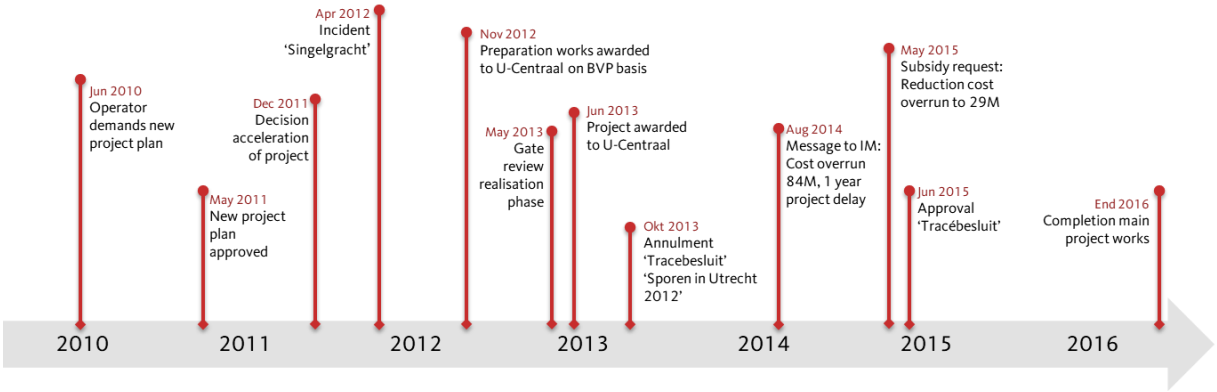


Figure 22: Timeline of project DSSU (own illustration)

In 2010 the train operating company Nederlandse Spoorwegen (NS) rejected the original project execution plan. A new plan was finished in May 2011 and approved by the program directors board. In December 2011 it was decided to accelerate the project and to finish the works before 2016. The necessary 'Tracéwet' procedure would be conducted in parallel with realisation of the project. A drastic train accident in 2012 at the Singelgracht in Amsterdam had consequences for the project. Safety regulations of NS and ProRail were up for discussion. In November 2012, a selection of preparational works have been awarded to a combination of contractors 'U-centRaal'. This is done on basis of the so called Best Value Procedure (BVP).

In May 2013, a project gate review reported a predominantly low risk profile, except for two aspects: project management/scope and project control (both high risk profile). It is decided to continue the tendering process. The project is awarded in June 2013 to 'U-centRaal'. In October 2013, the 'Tracébesluit' is annulled. Following this annulment, a new project planning phasing has to be drawn up by the project team.

In August 2014 ProRail informs the ministry in detail about an expected cost increase of 107M (an expected budget overrun of 84M), and a delay of one year. This is reason for the ministry to initiate an evaluation. In November 2014 the project manager is replaced. After usage of cost saving opportunities and an in-depth analysis in the financial situation, the expected cost overrun is brought back to 29M in May 2015. In June 2015, the renewed 'Tracébesluit' has officially ben approved. End of 2016, the main project components have been finished, and the project is considered as delivered.

5.3.3 Early warning signs

On the basis of the interviews and project documents, several EW signs have been identified in the project. These are presented in Table 17.

Early Warning sign		Description	Period	Source	Follow-up
1	Decision to merge two projects	Decision to merge project with DSSU with 'Sporen in Utrecht'. This decision can be questioned; no Tracébesluit yet. (i1.5)	2009	(i1.5)	*No data found*
2	Vibrations a problem	Annulment of Tracébesluit in Arnhem, indication for issues at DSSU.	2011	(i1.5)	*No data found*
3	Discussion on project plan	Discussions on the project plan caused uncertainty by NS and ProRail. New variant worked out in a late phase (i1.4). Difficult process, in which parties opposed each other (i1.4). This delayed the planning phase. Once agreed, there was an urge to stick to the target completion in 2016 (i1.1).	2008-2012	(i1.1) (i1.4)	*No data found*
4	'Ambitious planning'	Optimisation is sought after delays in the initiation phase. In advance of final plan, contact was sought with the contractor (i1.1). The planning upfront was too ambitious, both the planning and the engineering (i1.4)	2008-2012	(i1.1) (i1.4)	None. Both transport and rail company wouldn't admit 2015 was not feasible (i1.4)
5	First time usage of BVP contracting	First time usage of Best Value contracting. The 'optimism of BVP idea potentially has influence' (i1.1). It can be questioned why this form was chosen in such a complex project (i1.2).	2012	(i1.1) (i1.2)	*No data found*
6	Incident Singelgracht	Incident at the Singelgracht changed safety perceptions on rail works. Caused changes rail technical design (d1.1)	2012	(d1.1)	*No data found*
7	Project phasing revised short before start	Disagreement on the project phasing plan by the operators and ProRail led to a new phasing plan. This disrupted the process. 'Signal that date of 2015 will not be met' (i1.2). 'Disruption of the process'(i1.1)	2012-2013	(i1.1) (i1.2) (d1.1) (i1.4)	'PM has probably mentioned these EW signs (i1.2). It was decided to continue.'
8	To market with unfinished contract	The contract that was brought to the market was not worked out in detail (i1.4). The urgency to finish the project before 2016 played a part in this (i1.2).	2012-2013	(i1.2) (i1.4)	*No data found*
9	Problems at beginning of contract	Problems at start: engineering planning was not met, problems with forming project team contractor, follow-up of contractual agreements, and delays in first execution weekend (i1.4).	2013	(i1.4)	*No data found*
10	1 contractor, but loose parties	The contractor party consists of different companies that worked very differently (i1.4)	2013	(i1.4)	Addressed with contractor, and more control on contracting parties (i1.4)
11	Gate review: high risk on scope and project control	During a gate review of 2013 it was decided to continue with the contracting phase. However, a high risk profile was drawn for scope and project control.	2013, May	(d.1.1)	Appointment of a new Manager Project Control
12	Contractor: planning not feasible	Contractor was too short in time to prepare execution phases of 2014 and 2015. (i1.4)	2013	(i1.4)	End of 2013 decided to delay one year
13	Annulment of Tracébesluit	Tracébesluit 'Sporen in Utrecht' was annulled in October 2013.	2013, Oct	(d1.1)	Warning given in email by PM (i1.2)

Table 17: Early warning signs in case project 1

Following from the table, both hard and soft EW signs preceded issues in the project. Signs 4 and 10 are considered as soft. It is noted that the evaluation report mainly covers hard EW signs. Moreover, most of the interviewees joined the project in a later stage, replacing employees. Therefore, interviewees found it difficult to retrieve soft type of EW signs. The EW signs are input for the identified barriers. Some are provided with follow-up, as stated in the table. Others have not been followed up, or no data has been retrieved.

5.3.4 Identified barriers

The follow-up of EW signs is investigated by analysing the interviews and project documents, according to the approach presented in section 5.1.2. From this analysis, the links between barriers and different filters of the EW process are established. The result of these links is presented in Table 18Table 18. In this table, an overview is presented of the influence of barriers in the EW response in the project. The full analysis of the different links can be found in appendix F1.

	Filters			
Barriers	1: Surveillance	2: Observer mentality	3: Decision maker mentality	4: Political / power
Over optimism/ optimism bias	Will to use BVP procedure in contracting (i1.1, i1.2), potentially hampered critical monitoring.	'Potentially issues missed due to optimistic thinking in contracting phase' (i1.2); unfinished contract to market. Optimism in project team (i1.4)	'PM optimistic on scope changes, not discussed with project supervisor' (d1.1)	'Desire for consensus in rail sector' (d1.1). pressures decision making on scope changes.
Client-contractor relation		Possibly naivety in emphasis on mutual trust, lack of critical reflection (i1.1,i1.4)	Neglecting of EW signs to preserve good relation with contractor (i1.4)	
Uncertainty avoidance		Hesitance to share signals due to personal consequences (i1.1). Waiting with signal sharing for more certainty (d1.1). Difficulties to substantiate, potentially neglecting (i1.2).	Declining trust between line and project organisation (i1.1).	
Time pressure	Not 'open' for signals due to pushing on schedule (i1.2). Progress not discussed in detail due to full agenda (d1.1)	Signals weakened in project team (i1.2)	'signals that didn't fit were neglected' (i1.2)	
Fragmentation	Previous learnings not sufficiently taken into account (d1.1)			
Management style			Bottom-up steering, potentially missing top-down steering (i1.1). 'Lack of hard project management', lack of critical view on change implementation (d1.1).	'lack of hard project management by Min. of I&M as well' (d1.1)
Project complexity		Complexity of organisation complicates interpretation and communication (i1.4,i1.5)		
Effects of politics		Hesitance to report planning unfeasibility to ministry (i1.4)	Warnings by PM not heard (i1.1,i1.2). Political targets influenced follow-up of signals (i1.4)	Acceleration of project, as part of PHS (d1.2), political pressure on planning in planning phase (i1.1,1.2,1.4).

Table 18: Influence of barriers in case project 1 per filter of the EW procedure

The table shows that all eight barriers have been recognised somewhere in the project, based on different sources. Most frequent links are found at *optimism bias, uncertainty avoidance, time pressure and effects of politics.*

In addition to the introduced barriers, elements of communication are several times considered as barriers in EW response as well. One of the main conclusions of the evaluation report states that the decision making in the project did not always proceed via the agreed line (the directors meeting) (d1.1). In addition, progress reports from ProRail to the ministry do not always reflect the desired information for decision making (d1.1). Furthermore, the report states that frequent informal consultation helped to make progress but created a 'messy' process of decision making as well (d1.1).

5.3.5 Findings from case 1

Following from this case analysis, several findings are noted. Following the interpretation of the interviews and case documents:

- Both hard and soft EW signs have been present in the project. Interviewees experienced difficulties retrieving soft EW signs.
- All eight considered barriers are recognised as barriers to EW response somewhere in the project. Some are mentioned more than others. *Optimism bias*, *uncertainty avoidance*, *time pressure*, *management style* and *effects of politics* are retrieved from both interviews and documents.
- Barriers have had effect at all of the four filters of the EW procedure. *Optimism bias, time pressure, and effects of politics* are linked to three or four filters of the EW procedure. *Fragmentation* and *project complexity* are linked to only one filter.
- The most links are presented by the observer mentality filter and the decision maker mentality filter. Almost all barriers are linked to these filters.

5.4 Results case II: Renovation Oostlijn

5.4.1 Case introduction

The project was initiated in 2004, and entailed a renovation of the 25-year old Eastern metro line of Amsterdam. The project was divided in two main works. (1) Renovating both underground and upper ground metro stations, and (2) Improving tunnel safety. The second work has been organised in a separate sub-project called 'Vluchtwegmaatregelen' (escape route measures). This subproject is the focus of this case study.

The original planning was to finish this subproject in 2010. However, the project has coped with large cost overruns and a severe project delay. The original cost estimation of the subproject was estimated at 68,5M euro. Several setbacks in the project raised this up to 150M euro (Rekenkamer Amsterdam, 2016). In two consecutive years, works during planned train-free periods in summer months haven't been finished, causing frustrating for involved stakeholders (AT5, 2011, 2012).

According to a report by the 'Rekenkamer Amsterdam', several issues caused problems in the project (Rekenkamer Amsterdam, 2016). The project was characterised by complexity due to required integrated operating systems, a poorly documented tunnel, and limited interruptions of the metro operating schedules. In addition, the project was characterised by tight budgeting and planning. Furthermore, problems with the contractor and a 'reserved project culture' contributed to a troublesome course of the project.

5.4.2 Stream of events

In the following section, the course of the project is reproduced by mapping a stream of events. A timeline is created of these events (Figure 23), based on the project evaluation report (Rekenkamer Amsterdam, 2016).

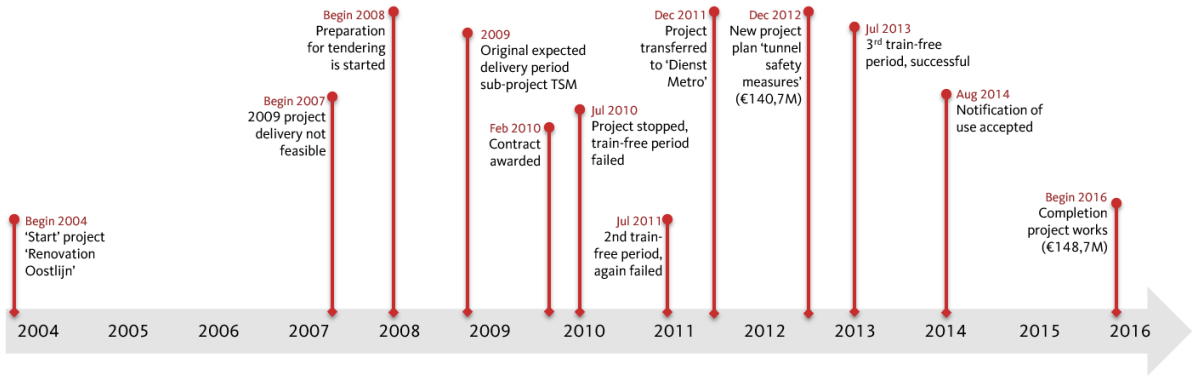


Figure 23: Timeline of project 'Renovation Oostlijn', sub-project 'tunnel safety measures' (TSM)

In 2007 it was clear that the original project deadline of 2009 would not be met. In February 2010, the contract has been awarded to a combination of contractors called 'CSWE'. This is later than planned, and the start of the project is described as miserable. The main works should have been executed during a train free period in the summer of 2010. In May 2010 it becomes clear that this will not be completed, and the project enters a crisis. Only small parts of the works are executed. After the summer this is evaluated, and preparations are made to execute the works in the summer of 2011. But that year disaster strikes again, and the second train free period is failed as well. In December 2011, the project is stopped, and transferred by the client organisation from 'DIVV' to the 'Dienst Metro' project organisation. A new project plan is presented in December 2012. A third train free period in 2013 is successful, and the main works of the project are finished in 2016.

5.4.3 Early warning signs

On the basis of the interviews and project documents, several EW signs have been identified for the project. These are presented in Table 19. When the follow-up of these EW sign is known it is shown as well.

Early Warning sign		Description	Period	Source	Follow-up
1	Too vague image of exact execution is illustrated	Project description illustrates a vague image of execution. 'Exploitation will continue' and minimum amount of 'out of services' are promised (d2.1). However, this project was never possible without large 'out of service' periods (i2.2)	2004-2005	(d2.1) (i2.2)	*No data found*
2	Original planning not feasible	The original planning (from 2004) of project delivery in 2009 will not be met	2007, Feb	(d2.1)	New planning is made, set on January 2010
3	Unclear existing situation	Starting point of the project insufficiently described (i2.2). Existing situation unclear due to undocumented works over the years. Asbestos was known to be present as well	Project start	(i2.2)	No funding available for full documentation and cable sanitation.
4	Negative advice committee 'tunnel safety'	A negative advice is issued from the 'tunnel safety commission', stating that the planning is insufficient. Subsequently, in October, a second negative advice is estimated at 45%, risk of 25M not budgeted.	2008, Jun	(d2.1)	focused on new request due to expected 'political hassle', (d2.1)
5	New estimation: 16M overrun	New cost estimation: cost overrun of 16M	2009	(d2.1)	No extra budget requested (d2.1)
6	Again, negative advice 'tunnel safety' commission	Again, negative advice tunnel safety committee is issued. According to the DMB (environmental service), no building permit can be issued.	2009, Jan	(d2.1)	*No data found*
7	Bad relation between DIVV and Arcadis	The evaluation report describes a difficult relation between DIVV (client organisation) and the engineering company.	2009	(d2.1)	'no time to replace team members' (d2.1, p.33)
8	Unrealistic planning	Internally, the planning is described as 'very tight' (d2.1). The period between contracting and the first out of service period was too short (i2.2). There were signals internally that it was not possible (i2.3)	2009	(d2.1) (i2.2) (i2.3)	*No data found*
9	Only 1 contester in tender	Only 1 contester takes part in the tender: CSWE. 'Signal of failed tendering' (i2.1). Potentially they are aware that they are the only.	2009, June	(d2.1) (i2.1)	Continued; no extra parties expected (i2.1)
10	Tender price exceeds budget	Offered tender price is much higher than budget: 51M. Internally discussed to stop tender procedure. But when CSWE lowers price 10M, project organisation advises to continue	2009, Oct	(d2.1)	*No data found*
11	Type of contract	Contract was an E&C type. 'The applicability of this type can be questioned. E&C suits projects where contractor can optimise during the project. However, with such a renovation project this space is not present' (i2.2)	2009	(d2.2)	*No data found*
12	Contractor organisation	The separate organisations took part in the project at own risk, which is a risk for the project (i2.2) Both profit and risks were distributed between the parties, disastrous for the project (i2.3)	2010	(i2.2) (i2.3)	Is not recognised at that time (i2.2)
13	Budget overrun discussed	Internally, a 'budget overrun is discussed. Externally not	2010, Jan	(d2.1)	*No data found*
14	Worries about CSWE	At the start of the project, there are worries at DIVV about the contractor CSWE. The project organisation 'gets the impression that the contractor is not aware of the tightness of the planning' (d2.1).	2010	(d2.1)	Contractor did not signal until 4 weeks before the out of service period.
15	Design specifications very late	It is not until February 2010 that the design specifications are worked out. Originally this should have started in November 2009. Execution is planned for 3 months later.	2010, Feb	(d2.1)	*No data found*

Table 19: Early warning signs in case project 2

These EW signs of both hard and soft character. EW signs 1,12,13,14 are considered as soft. The evaluation report mainly covers hard EW signs. Moreover, all interviewees joined the project in a later stage, replacing employees. Therefore, interviewees found it difficult to retrieve (soft type of) EW signs. The EW signs are input for the identified barriers. Some are provided with follow-up, as stated in the table. Others have not been followed up, or no data has been retrieved.

5.4.4 Identified barriers

The follow-up of these EW signs is investigated by analysing the interviews and project documents, according to the approach presented in section 5.1.2. From this analysis, the links between barriers and different filters of the EW process are established. The result of these links is presented in Table 20. In this table, an overview is presented of the influence of barriers in the EW response in the project. The full analysis of the different links can be found in appendix F2 Analysis case project 2.

	Filters			
Barriers	1: Surveillance	2: Observer mentality	3: Decision maker mentality	4: Political / power
Over optimism/ optimism bias	Signals missed due to wishful thinking at frond-end (i2.2); optimistic thinking at front-end.	Bad start of project will be all right (2010) (i2.1); Risk shifted to client not reported to alderman (d2.1)	Will to start with project, neglecting signals (i2.1); holding on to unrealistic planning (i2.2)	Optimistic in budget tightness, no extra funding requested (i2.1, d2.1)
Client-contractor relation		Difference in project status (d2.1)	Signals from contractor interpreted as opportunistic behaviour, (i2.2).	
Uncertainty avoidance		Not opening up in negotiations (i2.1); progress reports do not reflect situation (d2.1); issues too late reported (i2.1)	Issues 'pushed' to next phase in project (i2.1); Continuation in contracting (i2.1); Unwanted message by politics that planning was not feasible (i2.3); risk negative advice avoided (i2.3)	No extra budget requested (i2.1)
Time pressure	Lack of overview on situation (i2.1, d.2.1)			Continuation of contracting despite only 1 contester (i2.1); No time to replace team members (d2.1).
Fragmentation	Fragmentation of client projects (d2.1); fragmentation of the project (i2.3, d2.1)			
Management style	Organisation of reflection is lacking (i2.1)	No culture of transparency (d2.1); no room for bad news (d2.1)		
Project complexity	Underestimated complexity at frond-end (i2.2)	Complex for client organisation (i2.3)		
Effects of politics			No extra budget requested (d2.1); Unfeasibility planning unwanted message by politics (i2.3).	Not making public negative advice of 'tunnel safety' committee (i2.1); Project could not fail politically(i2.3)
Poor management			'No time to replace teammates' (i2.1)	

Table 20: Influence of barriers in case project 2 per filter of the EW procedure

All of the included barriers have been identified somewhere in the project. *Optimism bias* and *uncertainty avoidance* contain the most links. In addition, *poor management* was named as well. 'No time to replace teammates' was considered as *poor management* (i2.1).

5.4.5 Findings from case 2

From the results of the analysis, several findings are noted. Following the interpretation of the interviews and case documents of case 2:

- Both hard and soft EW signs are retrieved. Project documents contain mainly hard factors.
- All eight considered barriers are recognised somewhere in the project, supplemented with *poor management*. Some are mentioned more than others. All barriers, except for *project complexity,* are recognised in both interviews and documents.
- Barriers have had effect in all of the four filters of the EW procedure. *Optimism bias* and *uncertainty avoidance* are linked to three or four filters.
- *Optimism bias* and *uncertainty avoidance* contain the most frequent links in total
- The most links are found by the decision maker mentality filter. Furthermore, each of the other filters represents a significant quantity of links as well.

5.5 Results case III: PHS Amsterdam Centraal

5.5.1 Case introduction

In contrast to the first two case study projects, this project was situated in the planning phase. The project is comparable with the first case study project (DSSU, section 5.3). Both are aimed to improve the rail emplacement to facilitate high frequent train movements, demanded by the 'PHS' programme.

Project PHS Amsterdam Centraal is being initiated to facilitate more passengers and more trains. The project goal is *'to increase the capacity, quality, and robustness of the rail infrastructure'* (Ministerie van Infrastructuur en Milieu, 2016). The works will include widening and lengthening of the platforms, removal of middle tracks, and adjustments of stairs, escalators and elevators. In addition, the eastern tunnel is widened and the western tunnel is modified. Furthermore, a fly-over crossing will be realised at the 'Dijkgracht'.

5.5.2 Stream of events

In the following section, the course of the project is reproduced by mapping a stream of events. A timeline is created of these events Figure 24, based on the interviews and project documents (Table 16). The data past January 2018 are deterministic.

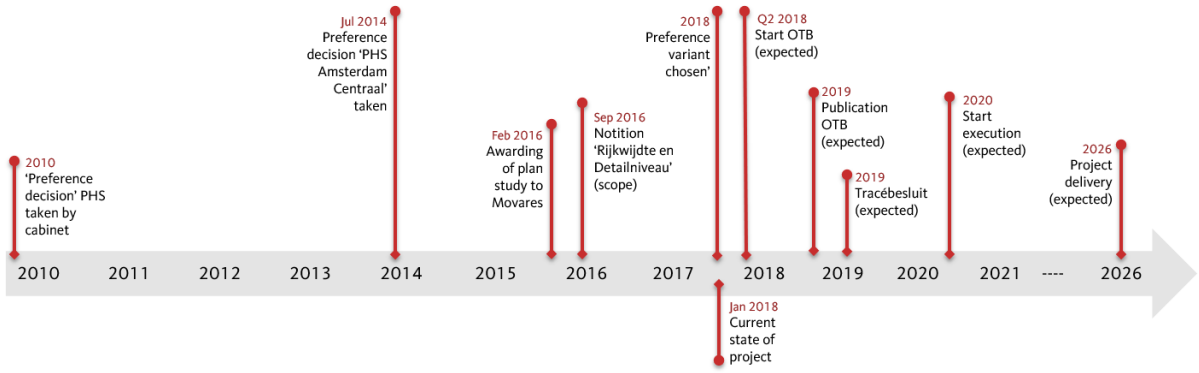


Figure 24: Stream of events of project 'PHS Amsterdam Centraal'

In 2013, the Dutch rail infrastructure company (ProRail) started the design of project variants. Subsequently, in June 2014, a preferred variant is chosen. In September 2016, the scope notation has been delivered. For this project, the 'Tracéwet' procedure and 'MER' procedure are required. In the second quarter of 2018, the environmental report (MER) and initial 'Tracébesluit' (OTB) will be started. The 'Tracébesluit' itself is planned for 2019. The project delivery is planned for 2026.

5.5.3 Early warning signs

On basis of the interviews and project documents, several EW signs have been identified for the project. These are presented in Table 21. When the follow-up of these EW sign is known it is shown as well.

Early Warning sign		Description	Period	Source	Follow-up
1	Low initial estimation	Original (rough) estimation of costs 60M, but everybody knew that that was not possible.	2010	(i3.3)	Noted as uncertainty.
2	Lack of trust in project goal	Trust in achieving the final project goal. Started in 2011/2012 (i3.1)	2011, currently	(i3.2) (i3.1)	*No data found*
3	Many unknowns in existing situation	Amsterdam Centraal has a 'rich history of modifications' (d3.3). This means a lot of unknowns of the existing situation.	From start	(d3.3) (i3.1) (i3.2) (i3.4)	Noted as risks in risk register, consequences on budget estimated
4	IJ-viaduct unknown	Extra costs due to unexpected extra necessary foundations at IJ-viaduct. In 2014 the effect insufficient estimated (i3.3).	2014	(d3.3) (i3.3)	Noted as risk. New detailed cost estimation made

5	Feasibility of the project plan	The feasibility of the current project plans is questioned by people are well aware of the current situation. Regarding the amount of extra trains and necessary works.	Present	(d3.1)	*No data found*
6	Financial feasibility	If project is possible with current reserved budget. Current issue, new estimations exceed initial budget.	Present	(i3.1)	*No data found*
7	Feasibility of execution (phasing)	Station is crowded, Limited physical building space (d3.3), surrounding environment crowded and small. Limits execution feasibility. Classified as 'unforeseen risks that are currently difficult to estimate'(d3.3).	Present	(i3.1) (d3.3) (i3.4)	Preparations by client organisations, meetings with stakeholders.
8	High work load	High workload perceived by employees in transition phase of the project	Present	(i3.2)	*No data found*
9	Support of the program and project	The usefulness and necessity of the project and program is questioned by some ('is all this necessary'). These sounds are heard in the hallways, outside meetings.	Present	(i3.1)	*No data found*

Table 21: Early warning signs in case project 3

Both hard and soft EW signs are retrieved for this project. Signs 2,3,5,8 and 9 are considered as soft. These are relatively more soft EW signs compared to the other case projects. Soft EW signs were easier described by the interviewees than the other projects.

5.5.4 Identified barriers

The follow-up of EW signs is investigated by analysing the interviews and project documents, according to the approach presented in section 5.1.2. From this analysis, the links between barriers and different filters of the EW process are established. The result of these links is presented in Table 22. In this table, an overview is presented of the influence of barriers in the EW response in the project. The full analysis of the different links can be found in appendix F3.

	Filters			
Barriers	1: Surveillance	2: Observer mentality	3: Decision maker mentality	4: Political / power
Over optimism/ optimism bias		Strong responsibility to solve issues, therefore not always discussed (i3.1). Tunnel vision of people longer in the team (i3.1)	Potentially optimistic towards feasibility of planning (i3.2)	Optimism as part of the planning phase, focus on decision making (i3.1)
Client-contractor relation				
Uncertainty avoidance			Not wanting to 'keep on calculating' (i3.1)	
Time pressure				Momentum for decision making (i3.1, i3.3)
Fragmentation		Different perception due to different people for different project phases (i3.1). Organisational fragmentation hampering communication (i3.2)		
Management style				
Project complexity			Stakeholder and technical complexity influences decision making (i3.1, i3.3)	
Effects of politics		Momentum of sharing EW signs (i3.2)	Pressure on budget at front-end (i3.1).	Political window of opportunity influencing decision making (i3.1)

Table 22: Influence of barriers in case project 3 per filter of the EW procedure

Several observations are made from the table. Compared to case 1 and 2, the amount of retrieved links is lower. A first explanation is that the project is still in the planning phase. Issues are currently observed. Since there is still time to solve these issues, the exact functioning of barriers in responding to the signals is not yet

clear. No evaluation reports have been drawn up, as are used in case 1 and 2. Another potential explanation is a bias by the project employees towards the project, since the project is still in execution.

No link to the surveillance filter has been found. This is explainable as well, since you don't see what you don't know. Later in the project or afterwards, it will become clear if EW signs have been missed due to the choices of surveillance.

Furthermore, no effects of the client-contractor relation and management style have been found. With regards to client-contractor relation this is logical. Since project is in the planning phase, not many contractors are involved in this stage.

5.5.5 Findings from case 3

Following from the analysis, several findings are noted. Following the interpretation of the interviews and case documents of case 3:

- Both hard and soft EW signs are retrieved. Soft EW signs were easier retrieved than in other projects.
- All eight considered barriers, except for *client-contractor relation* and *management style* are recognised as barriers to EW response somewhere in the project.
- Some are mentioned more than others. *Optimism bias, time pressure, fragmentation, project complexity,* and *effects of politics are* retrieved from multiple sources.
- Barriers have had effect in three of the four filters of the EW procedure. *Optimism bias* and *time pressure* are linked to three filters, and are most referred to in total
- The most links are found by the observer mentality filter and decision maker mentality filter.
- No links for the surveillance filter have been found.

5.6 Cross-case observations

In this section, the observations from the three cases are combined, in order to obtain a general overview of the occurrence of barriers in rail infrastructure construction projects (Table 23). The case findings are supplemented with information from the expert interviews. Together, Table 23 provides an overview of all the demonstrated occurrences of barriers to EW responses in infrastructure projects. The full cross-case analysis is shown in appendix F4 Cross-case analysis.

5.6.1 Findings from cases combined

	Filters			
Barriers	1: Surveillance	2: Observer mentality	3: Decision maker mentality	4: Political / power
Over optimism/ optimism bias	Signals missed due to wishful thinking and tunnel vision on the project (case 1,2) (i1)	EW signs overlooked, underestimated, not communicated or neglected due to optimistic perspective (case 1,2,3) (i3,i5,i7);	EW signs neglected or underestimated in decision-making while optimisation possibilities are overestimated. (case 1,2,3) (i5,i6)	Pressure on decision making by wishful thinking, desire for consensus, or planning feasibility (case 1,2,3)
Client-contractor relation	Naivety in too much emphasis on mutual trust, missing EW signs (i2)	Difference in project status (case 2); perception on EW signs guided by too much mutual trust (case 1) or mistrust (i2,i6)	EW signs from contractor interpreted as opportunistic behaviour (case 2) (i6); or neglecting of EW signs to maintain good relation with contractor (case 1).	Bad relation with contractor limits response possibilities. (i7)
Uncertainty avoidance	-	Hesitance or reluctance to share EW signs due to personal consequences, uncertainties about consequences of sharing, or deliberately waited. (case 1,2) (i2,i6,i7)	EW signs bringing new uncertainties neglected or avoided, unknown consequences (case 2) (i1,i2,i6); issues pushed to a later project stage (case 2);	Pressure on decision making EW signs as unwanted messages by higher management or politics. (case 2)
Time pressure	Lack of time taken for reflection, leading to missing EW signs. (case 1,2) (i6,i7)	Less receptive for EW signs, signals avoided or weakened in communication (case 1) (i4)	EW signs as unwanted message 'don't fit' in pressured planning, therefore neglected. (case 1) (i1)	EW sign neglected or deliberately not acted upon due to time pressure (case 2,3) (i2)
Fragmentation	Fragmentation of projects (case 1,2) (i4,i5,i6), or fragmentation of the project limiting EW surveillance (case 2) (i6)	Fragmentation hampering communication of EW signs (case 3)	-	-
Management style	Style of management lacks organised bottom-up reflection, EW signs missed. (case 2)	Too much focus on consensus (bottom-up) (i2), or too much top-down steering limiting EW communication. (case 2) (i6,i7)	Too much top-down steering, 'nothing is heard bottom-up'. (i6,i7) Or non-decisiveness, lack of critical project management. (case 1)	-
Project complexity	EW signs missed due to underestimated complexity, unknowns, or lack of overview, limiting surveillance of EW signs. (case 2) (i2,i4,i6,i7)	Interpretation and communication of EW signs complicated by organisational complexity (case 1,2) (i5,i7)	Decision making on EW signs complicated due to stakeholder complexity in the project (case 3)	-
Effects of politics	-	Hesitance in reporting or consideration in moment of reporting of EW signs due to political effects. (case 1,3) (i5)	EW signs unwanted message by politics (case 2), no political window (i5), or not heard by management due to organisational politics. (case 1) (i6)	Political pressure limit ability to take action. (case 1, 3) (i7)

Table 23: Cross-case observations of barriers supplemented with expert interviews

This table is by no means exhaustive, and neither prescriptive. Rather it demonstrates how barriers can occur in acting upon EW signs in infrastructure construction projects.

The table shows that the most links are observed at the observer mentality filter and the decision maker mentality filter. Almost all barriers are linked to these filters, and the filters have the most frequent links from the cases and interviews. The observer mentality filter is about the perception of the observer towards EW signs and communication towards decision maker. The decision maker mentality filter is about the perception of the decision maker towards the EW signs in decision-making. Since both filters are about perception and communication, it can be concluded that both the perception of individuals and communication is crucial in the process of responding to EW signs

5.6.2 Comparison with suggested links from literature

Table 23 is compared with the suggested links by Haji-Kazemi (2015, p. 132). In general, several findings are noted. Most of the links that are demonstrated in this research correspond with the suggested links. The links in the literature are more generic, whereas the demonstrated links from the case study are more detailed and concrete. Some extra links are found in this research, whereas some suggested links haven't been retrieved in this research. A comparison is made per barrier in the following section.

- The links of *optimism bias* correspond mostly with the suggestions from literature. In both it is linked to all of the filters.
- The links of *client-contractor relation* are supplementary to the literature. In the literature, the factor normalisation of deviance is discussed, of which *client-contractor relation* is a part. While the concept of normalisation of deviance is quite generic, the links at *client-contractor relation* are specific for the construction sector.
- *Uncertainty avoidance* has a slight different interpretation in this research, since the concept of deliberate ignorance has been incorporated (as explained in section 3.3). The links in literature more focus on uncertainty avoidance as preferring the familiar over uncertainties. In this research, uncertainty avoidance includes also personal considerations on sharing of EW signs. Furthermore, no link with the surveillance filter has been found in this research. However, that does not exclude its occurrence.
- The observed links of *time pressure* correspond well with the suggested links in literature. In both sources, links with all four filters have been noted.
- *Fragmentation* has in literature only been linked to the surveillance filter, and only address fragmentation of projects. The findings of this research complement the literature.
- *Management style* is added for this research. The results are different from the suggested links for *poor management,* which was included in literature.
- The findings of *project complexity* correspond quite well with the links from literature. A link with the fourth filter was suggested in literature. This link has not been found in this research, but is believed to be occurring in projects.

5.7 Conclusion

This chapter contains the results of the case study conducted for this research. It was aimed to investigate the occurrence of barriers in actual construction projects. The sub-question that is answered in this chapter is:

SQ3

> *How do barriers function in the process of responding to early warning signs in Dutch construction projects?*

The results of the case study show that both soft and hard EW signs occur in three different Dutch rail construction projects. Furthermore, the occurrence and functioning of barriers is demonstrated. All of the eight included barriers in the case study are recognised in one or more of the analysed projects. This highlights the relevance of this research. The identified links with the EW procedure model show that barriers occurred at all of the four filters. General conclusions on the effect of barriers are:

- *Optimism bias* can create wishful thinking and a tunnel vision in the project. EW signs can be overlooked, not communicated or neglected in decision-making due to a too optimistic perception.
- The *client-contractor relation* can influence the search and interpretation of EW signs when the relation is dominated by mistrust, or too much emphasis on mutual trust. An unhealthy relation or preservation of good relation limits decision-making on EW signs, as well as response possibilities.
- The effect of *uncertainty avoidance* can limit communication of EW signs due to personal considerations and uncertainties. In decision-making under pressure and uncertainties, EW signs can be perceived as unwanted messages, causing them to be neglected, or pushed to later in the project.
- *Time pressure* limits the ability to reflect effectively on the project, causing EW signs to be missed. Furthermore, people are less receptive for EW signs. EW signs are weakened in communication, neglected or not acted upon, since they do not fit in a planning under pressure.
- *Fragmentation* of projects limits learning from EW signs in other projects. Fragmentation within the project limits the surveillance for EW signs, as well as communication.
- The applied *management style* influences the EW response. Too much top-down steering causes EW signs to be missed or not communicated. On the contrary, too much focus on consensus can limit critical reflection and cause decisiveness in responding to EW signs.
- *Project complexity* limits the ability to overview the project in terms of organisational and technical complexity. This complicates the surveillance, communication and decision-making on EW signs.
- *Effects of politics* influence communication of EW signs, and can cause EW signs to be perceived as unwanted messages by higher management and national politics. Political pressure and lack of a political window limit action upon EW signs.

Most of the effects of barriers correspond with the functioning as expected in literature. Thereby, these effects are confirmed. Furthermore, the findings at *client-contractor relation*, *uncertainty avoidance*, *fragmentation* and *management style* complement existing literature.

Of the four filters, the two filters with regards to the observer and decision-maker on EW signs are most linked to. This highlights the importance of the perception of individuals for the interpretation and follow-up of EW signs. This means that in order to improve the responsiveness to EW signs, behavioural change is necessary throughout projects.

6

Minimising the Effect of Barriers

Amsterdam Central station (stockphoto)

In this chapter, suggestions for improvements are sought based on the results of the case study and expert consultation. These suggestions are formulated in consultation with experts, and compared with existing literature. This corresponds with phase IV of this research.

The sub-question that is answered in this chapter is:

SQ4 *How can barriers be minimised in the process of responding to early warning signs?*

This question is answered by conducting the following steps. On basis of the observations of chapter five, a set of problem statements is drawn up. Following from these problem statements, desired situations are formulated. In an expert meeting, concrete remedies are formulated to achieve these desired situations. These suggestions are compared with existing literature.

This chapter is constructed as follows. Section 6.1 explains the approach of the expert session. Section 6.2 discusses the formulated set of problem statements. 6.3 discusses the desired situation. In section 6.4, remedies for improvements are discussed, as a result of an expert meeting. Section 6.5 compares suggestions with existing literature. In section 6.6 conclusions are drawn.

6.1 Approach to finding improvements

The case study and expert consultation have resulted in observations of the functioning of barriers in projects, as shown in section 5.6. The sub-question in this chapter is devoted to minimising the effect of barriers.

6.1.2 Guiding framework

The observations from the case study and expert consultation can be considered as reflecting the current situation in Dutch infrastructure construction projects. In a desired situation, the effect of barriers is known and the negative effect can be minimised when responding to EW signs. Currently, a gap exists in between the current situation and the desired situation. This gap can be filled by means of improvements in the process of responding to EW signs, that will minimise the effect of barriers. This is represented in Figure 25.

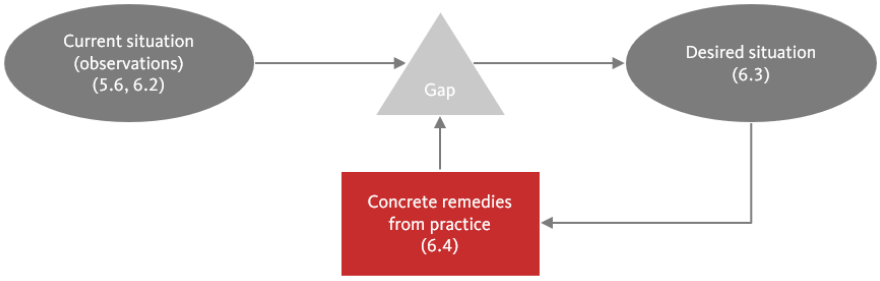


Figure 25: Approach to minimise the effect of barriers

These improvements are sought by consultation of experts in an expert session. This is done in order to ensure concrete applicable and industry supported improvements. In order to facilitate this session, the observations of the current situation are summarised into a set of problem statements (section 6.2). Subsequently, desired situations are derived in order to create a reference point for improvements (section 6.3).

6.1.3 Expert session setup

The goal of this session is twofold. Firstly, to verify the observations and desired situation. Secondly, to provide concrete remedies in order to achieve the desired situation.

During this session, fourteen problem statements have been submitted to experts in three different rounds, corresponding with three phases focused on (surveillance, communication, decision-making). In small groups people were confronted with one issue every time. After a personal brainstorm, possible solutions were discussed in this group, resulting in one main recommendation per issue. Requirements for this recommendation were: concrete and practically applicable. Subsequently, groups were rotated. An overview of the program and attendees can be found in appendix G. In total, twelve experts participated in this session. The results of this session are presented in section 6.4.

6.2 Problem statements on basis of observations

The observations from the case studies and expert interviews are summarised into a set of problem statements. In this way, they are tangible and structured, in order to submit to experts. It is chosen to structure these statements by three phases of the EW procedure, since this provides the most tangible lead for managerial implications in practice. These phases correspond almost with the filters from the EW procedure. However, for this purpose the third and fourth filter of the procedure are merged. The difference between the third and fourth filter is mainly between the decision-maker as executive manager, and the higher powers of the client organisation or national politics represented by the fourth filter. As for barriers in EW signs, this difference is clear. However, in providing recommendations some overlap is perceived. Therefore, for the practical usefulness of recommendations these filters are combined as one phase of the EW procedure: ‘decision making’. This is shown in Figure 26.

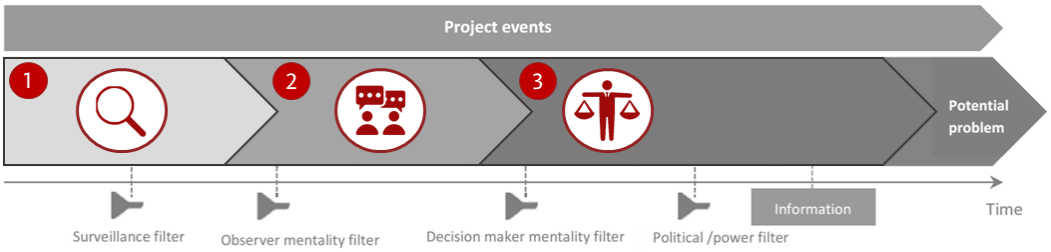


Figure 26: The EW procedure divided in three phases

The statements resemble most of the links between the barriers and filters as shown in section 5.6. It is focussed on the barriers with the most observed links, as well as the most important barriers (discussed in chapter 4). A short motivation is provided for every phase.

Regarding the **surveillance** of EW signs (1), early warning signs can be missed, due to:

1. Wishful thinking and tunnel vision in projects *(optimism bias)*
2. Lack of time taken for reflection *(time pressure)*
3. Lack of overview of the project and underestimation of complexity *(complexity, client-contractor relation)*
4. Lack of learnings taken into account, and projects operating in separate silo's *(fragmentation).*

The effects of *optimism bias*, *time pressure*, *fragmentation* and *complexity* were most observed at the surveillance filter. The effects of *client-contractor relation* are combined with *complexity.* The effects of *management style* are hereby not taken into account. These were only observed in case 2, and are captured at the next phase.

Regarding the **communication** of EW signs (2):

5. EW signs are underestimated, not communicated, or neglected due to over optimistic perception *(optimism bias)*
6. People are less receptive to EW signs due to time pressure, causing EW signs to be weakened, not communicated, or neglected *(time pressure).*
7. Difference in interests among different parties hinders communication of EW signs *(complexity, client-contractor relation).*
8. EW signs are not heard, neglected, non-communicated, or stalled due to uncertainties about their consequences, or expected personal consequences *(uncertainty avoidance, management style).*

All links are taken into account, except for *fragmentation* and *effects of politics*. *Fragmentation* was only observed at case 3. *Effects of politics* are mainly observed in the decision making and action phase. Some effects are combined.

Regarding the **decision making** on EW signs (3):

9. EW signs are underestimated or neglected in decision-making, while optimisation possibilities are overestimated *(optimism).*
10. EW signs are not taken into account in decision making or are not acted upon due to time pressure *(time pressure).*
11. EW signs are not acted upon when perceived as unwanted message by politics and lack of a political window *(political effects).*
12. EW signs are not heard or pushed towards later project phases due to their accompanied uncertainty *(uncertainty avoidance).*
13. Too much top-down management limits EW signs to come up, while too less top-down can result in a lack of decision-making on EW signs *(management style).*
14. EW signs by contractors are interpreted as opportunistic behaviour, and EW signs are not acted upon to preserve a good relation with contractors *(client-contractor relation).*

All barriers are taken into account, except for *complexity*. This was only observed in case 3. The effects of some barriers for filter 3 and 4 are in several cases combined.

6.3 From problem to desired situation

In order to provide recommendations, a desired situation must be formulated. For every problem statement presented in section 6.2, a desired situation is formulated. This is shown in Table 24.

		Problem statement	Desired situation
	1	EW signs are missed due to wishful thinking and tunnel vision in projects *(optimism bias)*	Awareness of wishful thinking and tunnel vision
	2	EW signs are missed due to lack of time taken for reflection *(time pressure)*	Sufficient time for reflection taken at all times, and well-used
	3	EW signs are missed due to lack of overview of the project and underestimation of complexity *(complexity)*	Overview on actors, technical complexity and unknowns during all times
	4	EW signs are missed due to lack of learnings taken into account, and projects operating in separate silo's *(fragmentation)*.	EW signs from previous projects taken into account; Prevention of emergence of silo's in the project
	5	EW signs are underestimated or neglected due to over optimistic perception *(optimism bias)*	Awareness of optimism bias; EW signs are taken into account and discussed.
	6	People are less receptive to EW signs due to time pressure, causing EW signs to be weakened, not communicated, or neglected *(time pressure)*	EW signs communicated at all times, especially under time pressure
	7	Difference in interests among different parties hinders communication of EW signs *(complexity, client-contractor relation)*	EW signs communicated at all times, despite awareness of actors' difference in interests,
	8	EW signs are not heard, neglected, non-communicated, or stalled due to uncertainties about their consequences, or expected personal consequences *(uncertainty avoidance, management style)*	Team members feel free to share EW signs and feel heard. EW signs are shared despite uncertainties about consequences.
	9	EW signs are underestimated or neglected in decision-making, while optimisation possibilities are overestimated *(optimism bias)*	Conscious assessment of optimism bias in decision making on EW signs, resulting in a substantive decision
	10	EW signs are not taken into account in decision making or are not acted upon due to time pressure *(time pressure)*	EW signs taken into account in decision making, especially under time pressure.
	11	EW signs are not acted upon when perceived as unwanted message by politics and lack of a political window *(political effects)*	EW signs acted upon; not being pushed in time or neglected.
	12	EW signs are not heard or pushed towards later project phases due to their accompanied uncertainty *(uncertainty avoidance)*	EW signs acted upon; not pushed or neglected by management
	13	Too much top-down management limits EW signs to come up, while too less top-down can result in a lack of decision-making on EW signs *(management style)*	Bottom-up management style in listening for EW signs, while decisive when necessary
	14	EW signs by contractors are interpreted as opportunistic behaviour, and EW signs are not acted upon to preserve a good relation with contractors *(client-contractor relation)*	Trust in relation with contractor whereby EW signs are taken into account and action can be initiated together with contractor

Table 24: Problem statements and desired situations

In the expert session, both the problem statements and the desired situations have been verified by experts. The experts were asked to verify their existence, and to comment on the statements.

6.4 Results of expert session

The following suggested improvements are the result of an expert meeting with twelve experts, supplemented with suggestions from the expert interviews. It is questioned how the formulated desired situations can be achieved. Again, structured around the surveillance, communication and decision-making on EW signs.

6.4.1 Improving surveillance of early warning signs

1. *How to create awareness of wishful thinking and tunnel vision*

According to experts, it is essential to organise both external and internal challenge in the project. External challenge firstly means holding external reviews periodically. The frequency is dependent on the project, but a guideline is every quarter year. Secondly, gate reviews are necessary at transition phases in the project. Internally, a project manager can assign a dissenter role to one or more team members. In general, experts highlight the necessity of a so called 'plan B'. Project teams should actively question what would happen if the plan (plan A) will not work. This ensures team members to remain critical on the project.

2. *How to ensure sufficient and effective time for reflection*

To ensure sufficient useful time taken for reflection, experts recommend to assign specific moments, and organise informal meetings. A project manager has an exemplary role in organisation of reflection. The project manager should assign priority to reflection by assign specific moments for it, that should be well facilitated. EW signs originating from these moments should have a follow-up. Furthermore, organisation of periodical informal meetings, such as a weekly lunch or coffee moment with the entire team. This facilitates an environment in which EW signs are shared.

3. *How to get an overview of stakeholders, technical complexity and unknowns*

In order to get an overview on complexity, experts recommend several things. Firstly, stakeholder management should be given a central role, regarding EW signs. This could be done by assigning stakeholders to team members, and keep track of an issue list. Secondly, there should be awareness on each other's activities. Visualising progress and issues on daily or weekly standings can stimulate this. Thirdly, attention should be given to the soft aspects of EW signs. soft EW signs should be managed just like risks.

4. *How to take EW signs from previous projects into account, and prevent silo's*

In order to take learnings into account, it was found essential to mirror the project continuously by control mechanisms. These are mechanisms such as gate reviews, peer reviews, project assessments in transition phases. In addition, to establish learning KPI's in projects. In order to prevent fragmentation of the project, it is suggested to actively share information, both inside and outside the project. Examples are periodically sharing of knowledge in sessions or lunch meetings, maintaining a knowledge database, and actively discussing interface management.

Reflection as key component to improve the surveillance

From these suggestions it appears that reflection is considered key in improving the surveillance. More time for reflection and more effective reflection is necessary, both internal and external. Besides monitoring risks, reflection focused on soft EW signs should be incorporated. Furthermore, reflection needs to be applied together with stakeholders, and applied throughout the project and cross-projects.

6.4.2 Improving communication of early warning signs

5. *How to prevent over optimism in communication of EW signs*

In order to prevent over optimism in communication of EW signs, several remedies were given. It is recommended to challenge the communication upwards to ensure accountability. This can be done by organising 'challenge conversations' around critical moments, and the instalment of an escalation line when necessary. Agreements with the client organisation can help in this. Furthermore, an internally balanced organisation counteracts groupthink. This can be achieved by ensuring a complementary project team, and to give cross thinkers a voice. Furthermore, thinking critically should be rewarded.

6. *How to ensure communication of EW signs under time pressure*

In order to assure communication of EW signs under time pressure, several recommendations were given. It is highlighted that the more time pressure, the more time for reflection should be taken, which is counterintuitively. Furthermore, it is suggested that multiple communication lines should exist between the project manager and client organisation, to ensure and challenge communication.

7. *How to ensure communicate of EW signs despite difference in interests*

In order to ensure communication on EW signs despite conflicting interests, experts advise to explicitly discuss these and separate on a human level. At first, interests should be discussed with all stakeholders, for example by organising sessions. This helps mutual understanding. Second, it is advised to separate contractual decision-making and issue solving on a human level. The people who discuss contractual conflicts should not be responsible for sharing EW signs simultaneously. This ensures the communication of EW signs at all times.

8. *How to ensure team members to feel free to share EW signs, despite uncertainties about consequences*

In order to ensure team members feel free to share EW signs, this communication should be stimulated and rewarded. It can be stimulated by assessing soft team performance factors, informal meetings or simply managing by walking around. It should also be rewarded. A project manager should lead by example.

Communication key to improve the transfer of EW signs

From these suggestions it appears that improving the communication is key to transfer EW signs. It is suggested that communication is challenged, is redundant, and needs to happen at all times. Communication itself on EW signs should be actively stimulated and rewarded. Both in the project team as with stakeholders.

6.4.3 Improving decision-making on early warning signs

9. *How to avoid over optimism steering decision-making on EW signs*

In order to avoid over optimism steering decision-making, EW signs should explicitly be taken into account in decision-making. It is necessary to examine the underlying problem of the signs, and explicitly balance possible responses.

10. *How to take EW signs into account in decision-making, especially under time pressure*

To ensure EW signs are acted upon under time pressure, it is advised to use the urgency of time to create extra room for decision-making. Furthermore, it is essential to highlight the influence and importance of responding to EW signs on results in the project.

11. *How to avoid EW signs are pushed in time or neglected due to political effects*

In order to avoid that EW signs aren't acted upon due to political effects, it was highlighted that escalating upwards is important. Creating a political window when necessary. In some cases, this means creating a crisis by calling out a crisis in the project. Furthermore, again it is highlighted that an extra line between the project manager and politics should be created.

12. *How to ensure acting upon EW signs despite uncertainties*

In order to avoid ignoring EW signs due to uncertainties, EW signs should be tracked explicitly. Advised is either a risk register (but focused on soft aspects), a separate issue register, and/or interface management register.

13. *How to ensure bottom-up management of EW signs while being decisive*

In order to ensure EW signs to come up and avoid decisiveness, it was advised to organise critical thinking and capacity. Internal challenge is essential for EW signs to be shared. While organising this in the project team, capacity for follow-up of EW signs should be ensured as well.

14. *How to create trust in relation with contractor to ensure decision-making and action upon EW signs*

In order to avoid misinterpretation in client-contractor relation in decision-making, the project organisation should lead by example. Presumed opportunism should be challenged by questioning, before judgement. In addition, ensure knowledge and experience to investigate this. And lead by example in open communication, then the same can be expected from other parties.

Behaviour as key component to improve the decision-making on EW signs

Most of the suggested remedies to minimise barriers are related to behaviour of individuals. EW signs should be taken into account more explicitly in decision-making. This decision-making also needs to be more transparent. Presumed opportunism between parties needs to be challenged, and escalation towards politics needs to be ensured.

6.5 Suggestions compared with existing literature

In this section, the provided suggestions are compared with recommendations from literature to minimise barriers.

Outside view to counter optimism bias

One of the recommendations made by Flyvbjerg to mitigate *optimism bias* is the use of an outside view throughout the project (Flyvbjerg, 2013). This confirms the suggestions of the previous chapter to challenge the project by internal and external reviews (suggestions for issue 1).

Organisational learning to counter fragmentation

In order to avoid fragmentation of projects, Bartsch showed that organisational social ties of project employees with colleagues outside the project contributes to organisational learning as a whole (Bartsch et al., 2013). This corresponds with the suggestion to facilitate sharing of information both inside and outside the project (suggestions for issue 4).

Transparency to counter rival client-contractor relation

Pinto recommends ensuring transparency throughout the organisation to counter normalisation of the deviance (Pinto, 2014). Client-contractor relation dynamics are part of this phenomenon. Transparency can assure that all actors understand the standards and perceive that this contributes to project success. This is similar to suggestions for issue 7, which state that difference in interests should be discussed explicitly. This transparency creates mutual understanding.

Transparency of decision making to counter time pressure

In order to avoid the negative effects of time pressure on decision making on EW signs, Klakegg advises to secure transparency in decision making (Klakegg et al., 2010). Recommendations to counter time pressure in chapter 6 focus mainly on the organisation of and time taken for reflection. However, suggestions for issue 6 plead for multiple communication lines to the decision maker. This ensures transparency in decision making as well.

Encourage interactions to counter complexity

In order to avoid negative effects of project complexity, Klakegg advices to use approaches that stimulate interactions (Klakegg et al., 2010). In this way patterns of unknowns can be revealed. This corresponds with suggestions for issue 3 and 4, advising to actively share progress and information by means of interaction.

6.6 Conclusion

This chapter is focused on providing recommendations to mitigate the effects of barriers in the EW response. The sub-question that is answered is:

SQ4 *How can barriers be minimised in the process of responding to early warning signs?*

The expert session has resulted in suggestions to minimise barriers structured by the (1) surveillance, (2) communication, and (3) decision-making on EW signs.

Regarding the (1) surveillance of EW signs, reflection appears to be key in minimising barriers. By organising external and internal reflection, sufficient time for reflection, and reflection on soft EW signs specifically. Furthermore, reflection is important to utilise in co-operation with stakeholders, and cross-projects.

Regarding the (2) communication of EW signs, improving communication itself is considered key in minimising barriers. Communication on EW signs needs to be redundant, transparent, and continued at all times. Both communication on EW signs within the project team and with stakeholders needs to be stimulated.

Regarding the (3) decision-making on EW signs, behaviour appears to be key in minimising barriers. EW signs need to be tracked and taken into account explicitly, in transparent decision-making. Presumed opportunism between parties needs to be challenged, and escalation towards politics needs to be ensured.

Furthermore, conclusions can be drawn per barrier on how to minimise negative effects. These conclusions are based on the suggestions by experts and recommendations from literature.

- Negative effect of *optimism bias* can be minimised by applying an outside view on the project on a regular basis, both on hard and soft factors.
- Negative effect of the *client-contractor* relation can be minimised by ensuring a healthy client-contractor relation based on transparent communication.
- The effect of *uncertainty avoidance* can be minimised by explicitly track and discuss soft and hard EW signs on a regular basis, and creating a culture of open communication.
- The effect of *time pressure* can be minimised by ensuring sufficient and effective time for reflection, and transparency in decision-making.
- *Fragmentation* is minimised by stimulating communication with colleagues of other projects, as well as within the project.
- Negative effects of *management style* are minimised by applying a bottom-up management style, while being decisive in decision making.
- The effects of *project complexity* can be minimised by stimulating interaction throughout the project.
- Negative *effects of politics* can be minimised by ensuring accountability and communication to higher management and politics.

7

Discussion

Pouring concrete at project Noord-Zuidlijn (photo: Gé Dubbelman)

This chapter contains a discussion based on the findings in this research. In chapter 7.1, implications and contributions with regards to scientific knowledge are discussed. In section 7.2, practical and managerial implications for the construction sector are discussed. Section 7.3 discusses limitations of this research.

7.1 Scientific implications

This research contributes to existing literature by several means. This is captured in three parts: the character of early warning (EW) signs (7.1.1), barriers in responding to EW signs (7.1.2), and stimulating the EW response (7.1.3). Furthermore, 7.1.4. mentions the discussion of the findings with leading researcher in the field of EW signs Sara Haji-Kazemi.

7.1.1 Character of EW signs

In the literature study, a difference in interpretation of EW signs has been addressed by distinguishing three different dimensions: weak vs. strong signs, soft vs. hard signs, and leading vs. lagging signs. This distinction contributes to existing literature. To further illustrate the combination of these dimensions, a hypothetical model of the characteristics of EW signs over time is composed (Figure 27). This is an extension of the model by Ansoff (section 3.1.3). Next to the state of knowledge of signals (weak vs. strong), the dimensions of soft vs. hard signs and leading vs. lagging indicators are incorporated. The model is explained below.

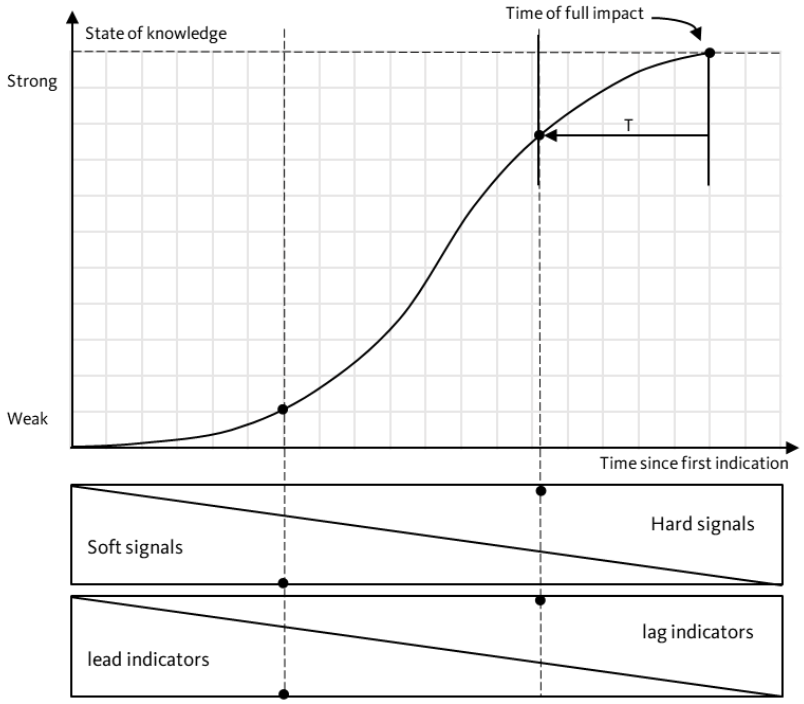


Figure 27: Hypothetical model of EW sign characteristics (own illustration)

EW signs grow stronger over time, meaning that the value of the sign in predicting the problem increases. This is called the state of knowledge. This is the basis of the model. Simultaneously, over the course of this research it is perceived that the most 'early' warning signs are mainly soft signals. This is not certainly not always the case. Sometimes in front-end stage of projects, strong and hard signals present themselves as well. However, following the expert opinions and literature by Williams et al. (2012), the EW signs earliest in time are mainly soft signals. Since these are the first indications, these are leading signs as well. Over time, harder and lagging EW sign present themselves, as the occurring problem and its consequences becomes clearer.

These statements are not based on solid empirical evidence, but rather on conceptual reasoning. Weaker signals are not exclusively leading indicators, and 'stronger' signals are not exclusively lagging indicators. The characteristic traits of EW signs should be subject to further research. However, the model contributes to research by combining the different dimensions of EW signs.

7.1.2 Barriers in responding to EW signs

With regards to barriers in responding to EW signs, this research contributes to existing literature by several means.

Applicability of the EW procedure model

The EW procedure model with its four filters has been developed for project management purposes. It has been demonstrated in this research (section 4.4) that this model is applicable in the construction industry. It can be used to explain the process of responding to EW signs, with four elements where information is filtered out due to occurring barriers. Furthermore, limitations of the model in the industry are discussed as well. This contributes to the existing application of this model.

Functioning and importance of barriers

Findings in this research demonstrate the presence, functioning and importance of barriers to EW response in construction. The presence and functioning has been demonstrated by means of an expert consultation and three case studies (chapter four and five). The results contribute to existing literature on barriers to EW signs, since this is the first study to explicitly investigate barriers to EW signs in construction projects in this matter. The importance of barriers is ranked on basis of an expert consultation (section 4.2.2). These results and the comparison with existing literature contribute to theoretical knowledge.

Links between barriers and filters

In this research, links have been demonstrated between barriers and the filters of the EW procedure, as suggested in literature. The table in section 5.6 plots barriers to the four filters of the EW process. This contributes to existing research, since this is the first research to demonstrate these links by conducting case studies. It follows from one of the recommendations for further research by Haji-Kazemi (section 1.5). The results complement the suggested links from literature, as discussed in section 5.6.2.

7.1.3 Stimulating the EW response

This research contributes to existing literature by providing recommendations to stimulate the responsiveness to EW signs. With these recommendations it expands existing knowledge on responding to early warning signs. Furthermore, these recommendations are based on the barriers occurring specifically. Therefore, they provide insight in minimising the effect of these barriers. This complement insights in current literature on the effects of barriers, or sometimes called influencing factors. Further implications of these recommendations for project management practice are discussed in section 7.2.

7.1.4 Findings of research discussed with Haji-Kazemi

This research is mainly funded on the PhD dissertation *'The Early Warning Procedure in Projects; Foundations, Approaches and Challenges'* (Haji-kazemi, 2015). A large part of the literature study in this research is based on the extensive research by Haji-Kazemi, including definition of EW signs, identification methods, and potential barriers. Furthermore, the *EW procedure* model with the four filters is forthcoming out of this study, as well as suggested links between barriers and filters. As an extra validation step, the main findings of this research have been discussed with Sara Haji-Kazemi over a skype conversation. These main findings were recognised, and supplemented with several comments, which have been taken into account in this thesis.

7.2 Practical and managerial implications

This research contributes to practical knowledge in the construction industry. The practical and managerial implications for the industry are elaborated in this section. At first, the importance of using soft EW signs is discussed (7.2.1), followed by the occurrence of barriers in the organisational context (7.2.2). Furthermore, three key aspects are discussed that follow from the suggestions for improvement in the previous chapter (7.2.4, 7.2.5, 7.2.6). Concluded is with attention for the crucial role of the project manager (7.2.7).

7.2.1 Broadening the focus towards soft EW signs

The findings in this research demonstrate that EW signs are present in construction projects, but not always responded to. In the literature review it has been concluded that soft EW signs are important as indications for future project problems. It is argued that soft EW signs are the first indications, and thus more leading indicators. This is illustrated in the hypothetical model introduced in section 7.1.1. Furthermore, it was concluded that currently used identification methods mainly focus on hard factors.

At the same time, in the case study more hard than soft EW signs are retrieved. This is due to a number of reasons. The project documents contain more hard EW signs than soft EW signs. Soft EW signs are difficult to couple to moments in time, while hard EW signs are coupled to for example planning or cost updates. Furthermore, employees experienced difficulties in retrieving soft EW signs. It is difficult to retrieve a gut-feeling from several years back in time. At the same time, this shows that difficulties are experienced in hardening gut-feelings into concrete EW signs on which action can be taken. Apparently gut-feelings are currently not always hardened, therefore it is not possible to act on it. Also, this confirms that the current focus is on hard factors rather than soft. Furthermore, the occurring barriers are of soft character as well. This strengthens the conclusion that soft, managerial aspects are crucial in the prevention of project problems.

Thus, there is a need to broaden the focus towards soft EW signs. In order to do this, it is important to find a way to harden the data of soft EW signs, in order to use gut-feelings better as indicators for project problems. As suggested in the previous chapter, both hard and soft factors should be assessed in project assessments. Furthermore, soft team performance aspects should be monitored frequently to facilitate discussion on soft EW signs. But in general, this requires a cultural change throughout the sector, since soft EW signs are detected by all involved in the project, and at all times. At the same time, more research should be conducted to the effect of responding to soft EW signs specifically, which is discussed in section 7.3.

7.2.2 Addressing the occurrence of barriers throughout the project environment

Following from the previous sector, a shift towards soft EW signs by means of cultural change in the sector is necessary. This is illustrated in this section by viewing the occurrence of barriers in an organisational context.

Barriers to EW response occur throughout the organisational context

For this research, the *EW procedure* model has been used to reflect the occurrence of barriers to EW response. It has been noted in chapter 4 (section 4.2) that this model is limited in reflecting organisational layers and dynamics. Over the course of the project it is noted that for infrastructure construction projects, these dynamics are important to take into account. Most publicly initiated infrastructure projects are organised by the same organisational structure, according to project management methods (such as PRINCE 2).

The following figure is composed to reflect the organisational dynamics in infrastructure projects. The organisational structure is adopted by NETLIPSE (2018), as introduced in the scope of research (section 2.2). On basis of expert interviews and case study, barriers have been indicated at positions in the organisational model where they occur. Some barriers occur at specific lines or positions in this organisational model, such as client-contractor relation (2) or management style (6). Other barriers have influence in multiple organisational layers, such as optimism bias and time pressure. Note that the occurrence of barriers can be different for other (type of) projects, and the circles can 'move around' in the figure.

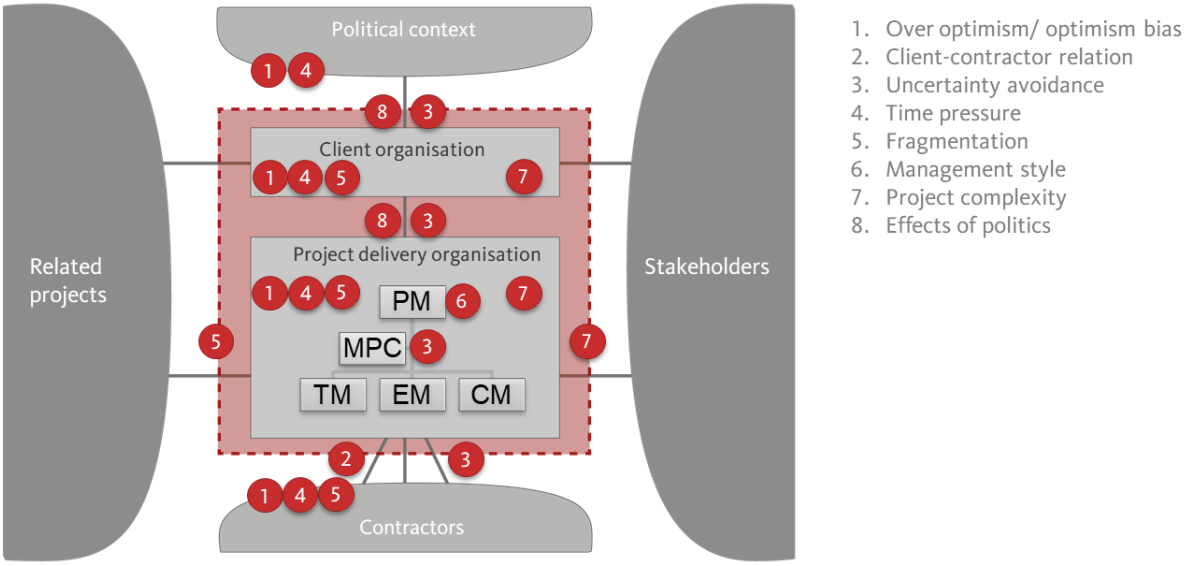


Figure 28: Organisational perspective of barriers to EW response (own illustration)

Change is necessary throughout the project environment

This figure shows that barriers occur in and between all different organisational elements. This implicates that in order to improve the responsiveness, change throughout the project context is necessary, not just within the project organisation. In chapter five it was concluded that the perception of individuals is crucial for the interpretation and follow-up of EW signs. This figure shows that these individuals are from all organisational elements of the project.

In the following section, three key aspects of responding to EW signs are discussed: (1) reflection, (2) communication and (3) behaviour. Following from chapter 6, these aspects appear to be essential in improving the responsiveness to EW signs. They correspond with the surveillance, communication, and decision-making on EW signs, as three phases of responding to EW signs.

7.2.3 Change in reflection (surveillance)

Throughout this research it appears that critical reflection is crucial for the surveillance of EW signs. Although reflection in form of risk management practices is an integral part in project management, it appears that too less time is taken for reflection. In addition, not the right reflection is taken.

Therefore, change is necessary in the way it is reflected. At first, reflection needs to include soft aspects of team performance (section 7.2.1). Project control methods mainly focus on hard factors, while it is demonstrated that soft aspects are just as important. Suggestions from chapter 6 include informal meetings and assessing soft team performance aspects.

Furthermore, reflection needs to be a continuous process. AT Osborne underlines this in their own view on project control. They developed a model in which four stages of project control are distinguished (Figure 29) (Kremers, 2018).

1. Management: The project is fully under control and is progressing according to plan.
2. Systematic doubt: There are uncertainties in the project organisation, nobody can oversee everything, but there is good hope for project success.
3. Repair: The current way of working is failing and need to be repaired
4. Recovery: Crisis is called out; the project needs to be fully recovered.

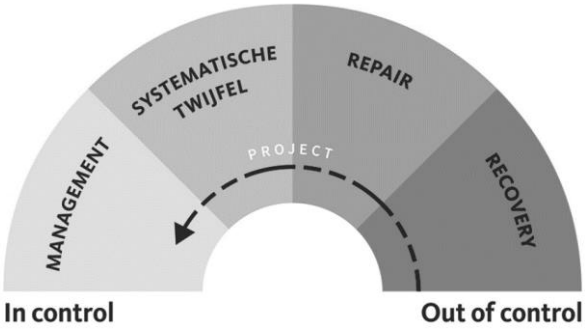


Figure 29: Four stages of project control by AT Osborne (adopted by (Kremers, 2018))

Kremers notes that large and complex projects never appear to be fully in control (stage 1). However, this is not believed to be necessary, and from an efficiency point of view neither desirable. Complex projects are characterised by 'systematic doubt', due to the impossibility to fully understand the complex project. The only way to cope with this well is to organise systematic reflection, in the form of checks and balances for the project. Therefore, reflection needs to be a continuous process. External reviews and gate reviews are essential elements of reflection.

Furthermore, reflection also needs to be an integral part of the project environment. EW signs are detected in all elements of the project environment. Barriers occur throughout the project environment as well. Therefore, for reflection to succeed, it needs to be intra-organisational, in co-operation with all stakeholders.

7.2.4 Change in communication (communication)

Communication appears to be another key aspect of improving the responsiveness to EW signs. The communication between the observer(s) and decision-maker(s) is essential in the process of responding to EW signs, and vulnerable for errors. This research shows that many barriers can influence the communication between the observer of an EW sign and the decision-maker. These are often personal considerations, resulting in whether a sign is shared, in what way it is communicated, and in what time frame.

The importance of communication for project performance is known in construction (Dainty, A, Moore D, 2002). Communication is especially important, since this research highlights the importance of soft EW signs, and occurring barriers of soft aspects. Since soft aspects are less objectively measurable, the interpretation and follow-up rely on the way they are communicated. Therefore, it is essential to create a culture in the project team in which EW signs are shared, as is discussed in section 7.2.6.

Besides internal communication, communication throughout project environment with all stakeholders is just as important. The organisational context of a construction project is a network of interdependent governance structures (Pryke, 2012). If this network is characterised by clear and open communication, the communication on EW signs is improved. Transparency is key in the follow-up of EW signs. Perceived opportunistic behaviour needs to be challenged in construction projects, since it limits open communication and thus is a barrier to responding to EW signs.

7.2.5 Change in behaviour (decision-making)

The third key aspect of improving the responsiveness to EW signs is behaviour. This research showed that behaviour of individuals is crucial for responding to EW signs. Starting from the decision-making point of view, but this accounts to all involved in the process of responding to EW signs. Behaviour determines if EW signs are taken into account. It determines the follow-up of EW signs. And thereby, it also determines future sharing of EW signs.

A change in behaviour is necessary in the way EW signs are approached and used. This research shows that different barriers prevent action upon EW signs. Since these barriers relate to individuals, behavioural change is necessary to change this. EW signs need to be taken into account explicitly. By hardening soft team performance aspects, EW signs can easier be used by managers. As with communication, transparency is an

important aspect in changing behaviour. Transparency in decision-making counters the effect of barriers such as optimism bias and uncertainty avoidance.

Furthermore, a change of behaviour in decision-making at front-end of projects. Projects are steered by decisions made at project initiation. Front-end politics used to initiate projects are often characterised by optimistic expectations, as highlighted in this research. This steers a project in a certain direction, and pressures managers from the start of the project. Thereby, choices that are made fire back in later stages of the project, when the expectations cannot be met. To counter this, it is important that front-end politics need to be followed by realistic expectations at the start of the project, to eliminate pressure and hindsight identifying of culprits. It is essential to ensure realistic expectations at the start of the project. This is a change of behaviour, since it involves project managers to assess the feasibility of the project critically from the start.

7.2.6 Supporting the crucial role of the project manager

Over the course of the project, it appears that the role of the project manager is crucial in responding to EW signs. The project manager has a central role from the surveillance of EW signs up to acting upon them. Therefore, the project manager has a key role in the beforementioned changes, and improving the responsiveness to EW signs. This is illustrated by five responsibilities of the project manager.

1. Organisation of reflection in the project team (surveillance)
2. Creating a culture in the project team in which EW signs are shared (communication)
3. Ensuring communication of EW signs to the right level of decision-making (communication)
4. Decisive in what signs are taken into account in the abundance of signs (decision-making)
5. Depending on the signal, acting properly to EW signs (decision-making).

1. Organisation of reflection in the project team (surveillance)

For the surveillance of EW signs to be successful, sufficient and effective reflection must be organised. This is highlighted by the suggestions given in chapter 6. Within the project organisation, this is mainly the responsibility of the project manager. At the same time, more time for reflection means also looking more closely to the uncertainties of the project. Not every project manager will find this intuitively pleasant. However, the more uncertainties are known, the more knowledge in the project is generated. One interviewed expert phrased this as a paradigm: *'speaking of uncertainties will evoke feelings that uncertainty has increased; While in practice uncertainty has decreased, since knowledge of the puzzle is increased' (i7).* To successfully organise surveillance for EW signs, a project manager must dare to address the uncertainties in the project.

2. Creating a culture in the project team in which EW signs are shared (communication)

Throughout the research, the importance of the organisational culture in projects is highlighted. A project manager is responsible for the culture in the project organisation. In order to improve communication regarding EW signs, a culture needs to be created in which people feel free to share signs. It should be a culture in which sharing of EW signs is stimulated and rewarded (suggestions for issue 8). Such a culture is characterised by experts as an open culture with place for critical opinions (i1, i2, i5, i6, i7). Throughout this research, several factors have been indicated as determining for this project culture, illustrated in Figure 30. These are by no means exhaustive, but are considered as key factors in obtaining a culture in which EW signs are shared.

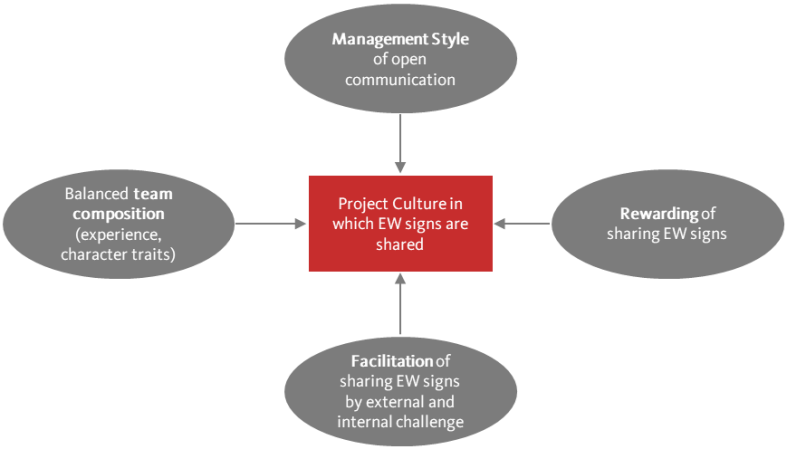


Figure 30: Factors influencing project culture (own illustration)

At first, the project culture is mainly determined by the applied management style of the project manager (i5, i7). A bottom-up management style facilitates open communication on EW signs. Second, it can be determined by the composition of the team (i7, suggestions for issue 5). A balanced team in terms of experience and character traits counteracts groupthink. Third, rewarding of sharing EW signs is important (suggestions for issue 8). A project manager needs to be open for signals. EW signs are only shared if employees feel heard, if EW signs are taken into account. Fourth, sharing EW signs needs to be facilitated. Organising external and internal reviews, formal or informal dedicated meetings provides a platform to share EW signs. If communication on EW signs is not facilitated, EW signs remain in low levels of the organisation, or in organisational silo's. A project manager should be aware of these factors, and facilitate a culture in which EW signs are shared.

3. Ensuring communication of EW signs to the right level of decision-making (communication)

It appears that one of the most important lines in communication regarding EW signs is between the project manager and the client organisation. It is suggested to challenge this communication by organising challenge conversations, and creating an extra line of communication between these parties (suggestions for issue 5,6) (Figure 31). Other suggestions included an escalation line for the project team to higher up.

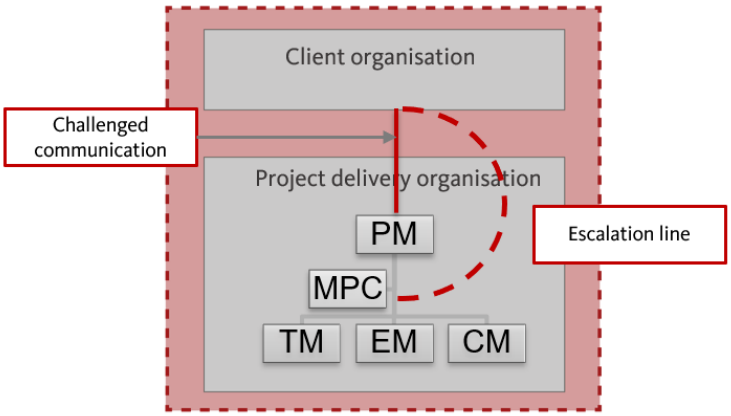


Figure 31: Redundancy in communication between project manager and client organisation (own illustration)

The reason is that this crucial line of communication is vulnerable for errors. This research has shown that different barriers influence the communication of EW signs between the project manager and client organisation. To avoid errors in communication of the EW signs, experts advise that a redundancy should be incorporated in this line of communication. This is not to undermine the authority of the project manager. Rather it is a step to improve the redundancy of the communication on EW signs, by ensuring the communication is challenged. This should strengthen the position of the project manager.

4. Decisive in moving in the abundance of signs (decision-making)

Multiple experts stressed that project managers are confronted with an abundance of signals (i1, i6). It is for a project manager not possible to respond to every signal. Moreover, this is not desirable. Changing course at every signal limits the project progress and credibility of the project manager. At the same time, whether EW signs are responded to determines not only the outcome of responses, but also future sharing of EW signs. It has been highlighted by experts that employees only feel free to share EW signs if they know that these are taken into consideration.

Following from the analyses and suggestions, it is all about the right consideration. Not every separate sign can be responded to, but a project manager needs to ensure EW signs are shared at all times. The course does not always have to be changed, as long as the right people are informed and EW signs are taken into account. Whether or not provided with an action, EW signs need to be taken into account. This is important, since project managers will be held accountable for not responding to EW signs. It is crucial not to be influenced by the effects of barriers such as time pressure (suggestions for issue 10), optimism bias (suggestions for issue 9), and uncertainty avoidance (suggestions for issue 12). The project manager has a leading role in steering this.

5. Responsibility in decision-making: choosing the right response

Another theme that has frequently been addressed by interviewed experts is choosing the right response upon EW signs. EW signs do not always need a response in the form of a concrete action. In some cases, it is sufficient to note the EW sign, and monitor its future progress. Parking an EW sign can be a sufficient follow up (suggestions for issue 12). However, EW signs should be taken explicitly into account in decision-making (suggestions for issue 9). This means that communication needs to be facilitated, time needs to be taken (suggestions for issue 10), and capacity needs to be ensured (suggestions for issue 13).

The main question of this thesis is how to stimulate the responsiveness to EW signs, with responsiveness meaning the quality of reacting quickly and positively. This reaction can be stimulated by minimising blocking barriers. The right response to EW signs is the right decision taken by the decision-maker. According to Nikander (2002, p. 115), the decision-maker should at all times consider the both the impact of EW signs and potential responses to it on the project, and reactions by other parties of the project. This final decision can then be undertaking an action, or parking and monitoring the EW sign.

Supporting the role of the project manager

It is clear that the role of the project manager is crucial in responding to EW signs. In order to stimulate the responsiveness to EW signs, this role should be supported. Following from the above, there are two concrete means. At first, to support reflection. By providing the project manager with appropriate tools to assess and discuss soft team performance indicators. Second, to challenge the communication between the project manager and client organisation. Furthermore, this requires training of project managers. To change the approach to EW signs project managers should be trained. This training is different from current training since the focus is on soft EW signs, and awareness of barriers to responding.

7.3 Limitations of research

Several limitations should be taken into account in interpretation of the results of this research. These are discussed in the following sections.

7.3.2 Limitations of research methodology

A first limitation is related to the external validity of the interviews and case study. Due to the limited number of both interviews and case studies, the *external validity* of the results is under pressure (Verschuren & Doorewaard, 2010). At the same time, since the interviews and sessions are conducted with experts, the results are expected to be accepted in the field.

In addition, another challenge is the *verification and validation* of observations and results of the case study. The case study discusses the occurrence of barriers in projects linked to the EW procedure. However, these links are based on interpretation of events by interviewees, project documentation and the author on the course of events. The results of occurrence of barriers are therefore up for discussion. However, this research is by no means an evaluation of project events. The results do not explain what the exact consequences of both occurred EW signs and barriers have been. Furthermore, it does not evaluate decision making in terms of good or bad either. Rather the results indicate how barriers can occur in construction projects.

7.3.2 Limitations of obtained data

A first limitation is regarding the obtained data is related to the *availability of projects* for case studies. Finding case study projects for this research has proven to be difficult. When requested to collaborate in this research, several project managers responded that the project was situated in a difficult situation, and were therefore not keen on a research to EW signs. Arguably, these projects that experience problems are interesting to observe. Potentially, this indicates the occurrence of barriers by itself.

A second limitation is related to the *collection of data*. Two of the projects considered were projects that have been delivered. During the interviews, it has been reflected on events several years in time. This has consequences of the verification and validation of results.

A third limitation is related to the *attendees* of the expert session. In both expert sessions, all attendees were employees of AT Osborne. Therefore, the results are potentially biased. However, since all attendees have been detached at various organisations and projects over the years, they obtained a broad perspective.

Reflection on validity of case study data

Several issues have challenged the validation of the retrieved case study data. It is aimed to counter these issues by addressing multiple and varied sources, and by using two methods of retrieving data (section 5.1). Nevertheless, these issues are relevant to take into account for further research.

- *Inside view bias:* Most of the people interviewed have participated in the project. It can be argued that these people are in some way biased in their evaluation of the project. Although different sources are used, potentially some effects are missed.
- *Missing knowledge*: With the currently available knowledge, EW signs that occurred in the past are possibly better explained. This complicates implications that are made about the effect of responses to EW signs. However, the research is focused on demonstrating the occurrence of barriers, and no evaluation of decisions made.
- *Job switches:* In both the first and second project, several changes have occurred in employees over the course of the project. In both cases, this was caused by the course of events. Most employees that have been interviewed currently work on the project. These job switches come with a loss of knowledge. This is a disadvantage of investigating delivered projects.
- *Projects in execution:* One of the cases was still in completion phase. Due to several issues in the project, a certain caution was present in the interviews with project employees. This potentially limits the amount of useful data that can be retrieved from such projects.

- *Type EW signs:* The retrieved EW signs are for a considerably larger share of hard type signals. It has been found challenging to collect the softer type of EW signs, characterised by gut-feelings. This shows that people struggle with 'hardening' these soft signals in projects. The fact that people found it difficult to link these feelings to moments in time, shows that limited opportunity is reserved to the expression of these type of signals in projects.
- *Identified EW signs*. Most of the EW signs that are retrieved from the available information, have been considered in the project itself. In the process, these signals have all passed filter one and two. It can be argued that these are collected, *because* they have been identified in the project (or afterwards). EW signs that haven't been identified in projects aren't necessarily visible afterwards.

7.3.2 Limitations of generalisation of results

As explained in section 2.2, the investigated case study projects are all rail projects. It is assumed that the phenomenon of responding to EW signs is comparable for infrastructure projects of different modalities. This is acknowledged by the interviewed experts, but should be subject to further research. In expert interviews and sessions, other modalities are discussed as well. Therefore, conclusions are drawn for infrastructure construction projects in general.

Due to the focus on infrastructure construction projects, the results cannot directly be generalised to other project management industries. However, it is believed that general ideas can be interchanged between industries. Nonetheless, similar research will have to be conducted in other industries to match results.

Furthermore, the usage of solely Dutch construction projects limits the ability to generalise results internationally. Since the addressed barriers to EW response are mostly organisational related, cross-cultural difference will have influence on the results in other countries. For example, it can be argued that projects in countries with a larger power distance (Hofstede, 1991) will experience more difficulties in freely expressing opinions within the project organisation. Similar research in an international context will have to verify this.

8

Conclusion & Recommendations

Amsterdam Central station stop of Noord-Zuidlijn (photo: Gé Dubbelman)

8.1 Answering the research questions

In this section, the research question and corresponding sub-questions are answered. In order to fill the current research gap, the following research question has been formulated.

RQ *How can the responsiveness to early warning signs in Dutch infrastructure construction projects be stimulated?*

This main research question is supported by the following sub questions:

SQ1 *What are early warning signs, how are they identified, and what prevents an adequate response?*

SQ2 *What are the most important barriers in responding to early warning signs in Dutch construction projects?*

SQ3 *How do barriers function in the process of responding to early warning signs in Dutch construction projects?*

SQ4 *How can barriers be minimised in the process of responding to early warning signs?*

In the following section, each of the separate sub-questions is answered, followed by the answer to the research question.

1. What are early warning signs, how are they identified, and what prevents an adequate response?

Early Warning (EW) signs are indicators for potential future developments. They serve as indications for potential risk events to occur, whilst a time frame and magnitude cannot be determined yet. This distinguishes EW signs from risks. EW signs are pre-eminently leading indicators, often have a soft character, and grow stronger over time. Literature shows that responding to EW signs has significant effect on project performance.

EW signs are identified by listening 'with an ear to the ground'. They can be identified by various identification methods (Table 25), but are dependent on gut-feeling assessments as well. It is noted that most project control methods mainly focus on hard factors (such as time, cost and quality), whilst EW signs are mostly characterised by soft factors (such as trust and collaboration). Since the importance of soft factors is acknowledged in literature, there is a need to broaden the focus to these factors.

The process of identifying and responding to EW signs is described in literature by means of an *EW procedure* model, in which four filters limit the information flow. These are the *surveillance filter*, *observer mentality filter*, *decision-maker mentality filter*, and *political/power filter*. These filters are driven by different barriers, which are influencing factors in projects. An overview of these barriers is provided in Table 25.

	Identification Methods
1	Risk analysis
2	Earned Value management
3	Project assessments
4	Performance measurement
5	Stakeholder analysis
6	Brainstorming
7	Maturity assessments
8	Past project consultation
9	Cause and effect analysis
10	Gut feeling
11	Interface analysis
12	Project analysis
13	Project surrounding analysis
14	Text mining
15	Project health checks

Barriers
Over optimism/ optimism bias
Strategic misrepresentation
Client-Contractor relation
Planning and scheduling dynamics
Uncertainty avoidance
Time pressure
Poor management
Illusion in decision making
Fragmentation
Management style
Project complexity
Effects of politics

Table 25: EW sign identification methods and barriers from literature

2. What are the most important barriers in responding to early warning signs in Dutch construction projects?

Most of the barriers suggested in literature are recognised by experts. *Optimism bias*, *time pressure*, *project complexity,* and *uncertainty avoidance* are marked by most experts as important (Figure 32). *Fragmentation*, *client-contractor relation*, *management style,* and *political effects* are considered to be important barriers as well. These eight most important barriers are taken further into account. The remaining four barriers were moderately recognised or considered less important. Additional considered barriers are *project culture* and *personal consequences*. However, it is argued that these factors are a result of an applied *management style* by the project manager.

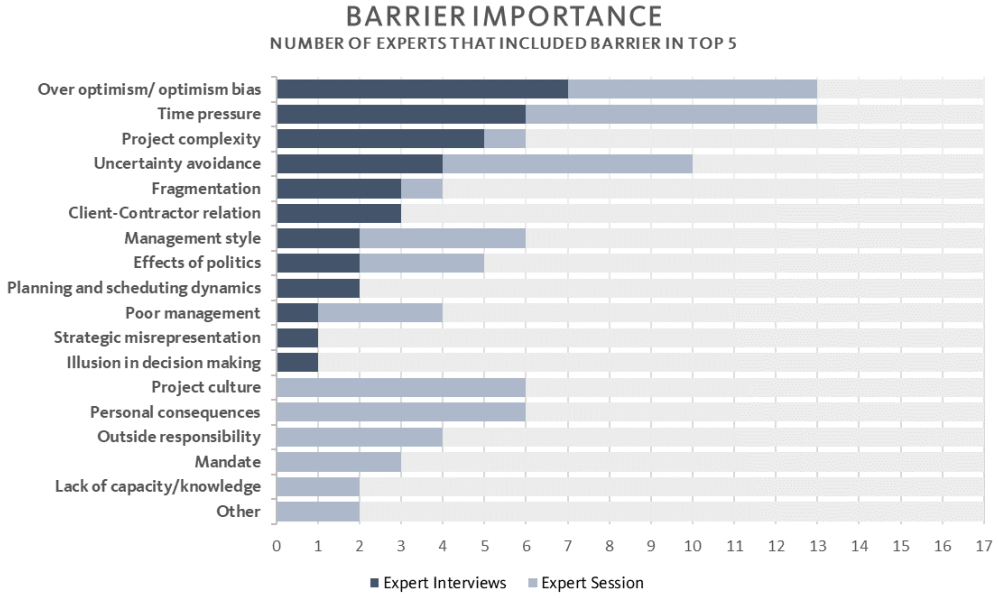


Figure 32: number of experts that included barrier in top 5 of most important barriers

Compared to literature, *optimism bias, project complexity, time pressure* and *political effects* had been expected as important barriers. *Poor management* is disputed by several experts in this research, whereas it was ranked high in literature. *Uncertainty avoidance* was not high ranked in literature, but could have overlap with other included communicational aspects and poor management.

3. How do barriers function in the process of responding to early warning signs in Dutch construction projects?

The results of the case study show how barriers occurred in three different rail infrastructure projects in the Netherlands. All of the eight included barriers are recognised in one or more of the analysed projects. This highlights the relevance of this research. The identified links with the EW procedure model show that barriers occurred at all of the four filters. General conclusions on the effect of barriers are:

- *Optimism bias* can create wishful thinking and a tunnel vision in the project. EW signs can be overlooked, not communicated or neglected in decision-making due to a too optimistic perception.
- The *client-contractor relation* can influence the search and interpretation of EW signs when the relation is dominated by mistrust, or too much emphasis on mutual trust. An unhealthy relation or preservation of good relation limits decision-making on EW signs, as well as response possibilities.
- The effect of *uncertainty avoidance* can limit communication of EW signs due to personal considerations and uncertainties. In decision-making under pressure and uncertainties, EW signs can be perceived as unwanted messages, causing them to be neglected, or pushed to later in the project.
- *Time pressure* limits the ability to reflect effectively on the project, causing EW signs to be missed. Furthermore, people are less receptive for EW signs. EW signs are weakened in communication, neglected or not acted upon, since they don't fit in a planning under pressure.

- *Fragmentation* of projects limits learning from EW signs in other projects. Fragmentation within the project limits the surveillance for EW signs, as well as communication.
- The applied *management style* influences the EW response. Too much top-down steering causes EW signs to be missed or not communicated. On the contrary, too much focus on consensus can limit critical reflection and cause decisiveness in responding to EW signs.
- *Project complexity* limits the ability to overview the project in terms of organisational and technical complexity. This complicates the surveillance, communication and decision-making on EW signs.
- *Effects of politics* influence communication of EW signs, and can cause EW signs to be perceived as unwanted messages by higher management and politics. Political pressure and lack of a political window limit action upon EW signs.

Most of the effects of barriers correspond with the expected effect in literature. Thereby, these effects are confirmed. Furthermore, the findings at *client-contractor relation*, *uncertainty avoidance*, *fragmentation* and *management style* complement existing literature.

Of the four filters, the two filters with regards to the observer and decision-maker on EW signs are most linked to. This highlights the importance of the perception of individuals for the interpretation and follow-up of EW signs. This means that in order to improve the responsiveness to EW signs, behavioural change is necessary throughout projects.

4. How can barriers be minimised in the process of responding to early warning signs?

An expert meeting resulted in suggestions to minimise the observed negative effect of barriers, structured by the surveillance, communication and decision-making on EW signs. These suggestions are compared and supplemented with remedies provided in literature. For all considered barriers, general conclusions are drawn on how to minimise negative effects.

- Negative effect of *optimism bias* can be minimised by applying an outside view on the project on a regular basis, both on hard and soft factors.
- Negative effect of the *client-contractor* relation can be minimised by ensuring a healthy client-contractor relation based on transparent communication.
- The effect of *uncertainty avoidance* can be minimised by explicitly track and discuss soft and hard EW signs on a regular basis, and creating a culture of open communication.
- The effect of *time pressure* can be minimised by ensuring sufficient and effective time for reflection, and transparency in decision-making.
- *Fragmentation* is minimised by stimulating communication with colleagues of other projects, as well as within the project.
- Negative effects of *management style* are minimised by applying a bottom-up management style, while being decisive in decision making.
- The effects of *project complexity* can be minimised by stimulating interaction throughout the project.
- Negative *effects of politics* can be minimised by ensuring accountability and communication to higher management and politics.

Answer to the research question: How can the responsiveness to early warning signs in Dutch infrastructure construction projects be stimulated?

Based on the findings of this research, several conclusions can be drawn on what is necessary to improve the ability to respond to EW signs (i.e. the responsiveness). More attention should be paid to soft, managerial aspects. Identification methods should include assessments of soft factors. Furthermore, the presence of barriers to responding to EW signs should be recognised and actively taken into account. The fact that all barriers are shown to be present in projects indicates that change is required throughout projects. The demonstrated importance of perception and considerations of individuals in responding to EW signs indicates that it requires behavioural change, thus a change of culture.

The responsiveness to EW signs is stimulated by improving the (1) surveillance, (2) communication, and (3) decision-making on EW signs throughout projects, and thus minimising the effect of barriers. Changing these three aspects can effectuate a cultural change. At first, concerning the surveillance, a change in reflection is necessary. More and effective time for reflection needs to be incorporated in projects. Besides known risk

management practices, reflection with regards to soft EW signs needs to become an integral part of project management. Reflection, both internal and external, also needs to be a continuous process. Furthermore, reflection needs to happen in co-operation with stakeholders, contractors and other projects.

Second, communication on EW signs needs to be stimulated and ensured, facilitated by a culture of open communication throughout the project. The interpretation and follow-up of soft aspects relies on the way they are communicated. It is essential to create a culture in the project team in which EW signs are shared. Besides internal communication, open communication throughout project environment is just as important. Transparency is key in the follow-up of EW signs. Perceived opportunistic behaviour of stakeholders needs to be challenged, since it limits open communication.

Third, regarding decision-making, behavioural change is necessary. Decision-making needs to be transparent, whereby EW signs are taken explicitly into account at the right level of decision-making. The right response to EW signs is the right decision on follow-up in the dynamic and political arena of the project. Furthermore, front-end politics need to be followed by realistic expectations at the start of the project, to reduce pressure and eliminate hindsight identifying of culprits.

In general, the role of the project manager is crucial in the responsiveness to EW signs, due to its many responsibilities in this process. This role needs to be supported by tools for reflection on soft EW signs, challenged communication to higher management, and training of project managers with regards to EW signs and barriers to responding.

The recommendations provided in the next section are starting points to facilitate the required change, starting points to stimulate the responsiveness to EW signs.

8.2 Recommendations to stimulate the responsiveness to early warning signs

In the process of responding to EW signs, three crucial sequential elements are distinguished: surveillance, communication, and decision-making. The recommendations are structured by these elements.

Surveillance of EW signs

1. *Review the project externally periodically by assessing both hard and soft factors*

In order to prevent an inside view on the project, it is recommended to review the project periodically. The frequency is dependent on the project, but a guideline is every quarter year. For transition phases in the project, gate reviews are necessary. Other review methods are project assessments, project health checks, and peer reviews. Assess both hard and soft indicators in reviews.

2. *Organise critical reflection on EW signs in the project team*

Keep track of EW signs. Either in risk management practices, separate EW lists, and/or interface management practices. However, essential is to discuss EW signs broader than just a manager project control. Organise discussion on EW signs by both formal and informal moments. Formal moments such as project meetings, where EW signs are consequently discussed. Informal moments such as lunches and coffee meetings with the whole organisation. Furthermore, organise a balanced team composition by means of experience and character traits. This benefits critical thinking in the team.

3. *Assign a central role to stakeholder management*

Conduct stakeholder analysis and develop stakeholder approaches. Furthermore, assign a central role to stakeholder management in the project team, by dividing stakeholders over employees. And actively think along with contractors in execution, instead of acting on contract basis only.

4. *Share information and knowledge actively in and outside the project*

Exchange of both information and people between projects. This contributes to organisational learning on EW signs. It can be organised by periodical sessions or lunch meetings, or keeping track of a cross-project knowledge data base.

Communication of EW signs

5. *Challenge communication from the project manager to higher management*

The communication line between the project manager and higher management is vulnerable for the influence of factors such as *optimism bias* or *uncertainty avoidance*. Challenge this communication to ensure accountability. Organise 'challenge conversations' at critical moments of the project, and install an escalation line when necessary.

6. *Stimulate and reward communication of EW signs*

A project manager should stimulate and reward communication of EW signs actively. Therefore, discuss the importance of responding to EW signs in the project team, and take a leading role in sharing of EW signs. Stimulate communication by assessing and discussing soft team performance factors and informal meetings. Furthermore, reward sharing of EW signs to ensure they continue to be shared by employees.

7. *Discuss difference in interests explicitly with stakeholders*

Mutual understanding can be created by explicitly discussing interests with stakeholders. To facilitate this, organise sessions with all stakeholders periodically. Hereby, barriers blocking the relation are prevented, and EW signs are shared.

8. *Separate communication of EW signs with contractors from contractual decision making*

In order to ensure communication of EW signs at all times, different people should be assigned to these two forms of communication. The people who solve contractual issues should not be the same as who share EW signs.

Decision-making on EW signs

9. *Consider EW signs explicitly in decision-making*

The right response to EW signs is the right decision on follow-up. Therefore, grasp the underlying problem of EW signs that are shared. Track hard and soft EW signs explicitly in either risk management practices, an EW sign register, and/or an interface management register. Show that EW signs are taken into account by parking EW signs instead of neglecting them.

10. *Take more time for reflection when pressure on planning is high*

Counterintuitively, more time should be taken for reflection when the pressure on the project is high. Use the sense of urgency to create extra room for decision-making. When a team is mainly fire-fighting, a project is running out of control. Take the time to discuss a new, realistic planning to get in control of the project.

11. *Create a political window when necessary*

Escalation upwards is important, in order to timely respond to EW signs. Sometimes it is necessary to create a political window, by calling out a crisis in the project.

12. *Lead by example in challenging mistrust in relation with other stakeholders*

Challenge presumed opportunism in relation with contractors. Lead by open communication, in order to expect the same from other parties. Hereby, misinterpretation due to mistrust in decision-making can be avoided.

8.3 Suggestions for future research

Several suggestions for further research are discussed in the following section. These are partly forthcoming out of the limitations of this research (section 7.3).

1. Effect of EW signs and barriers on final project outcome
2. Quantitative research in barriers to EW response
3. Similar research in different infrastructure modalities, other type of construction projects, and in other project management industries
4. Similar research in other countries
5. Effect of provided recommendations on responsiveness to EW signs
6. Occurrence and character of EW signs

At first, this research is focused on the occurrence of EW signs and barriers, but not on their effect on the final project outcome. The effect of responding to EW signs in construction projects should be subject to further research, specifically responding to soft EW signs. Research in the effect of responding to soft EW signs is of high interest.

Second, this research has examined the functioning of barriers to EW responses in a qualitative manner. Quantitative research can strengthen results on the presence and influence of barriers in the EW response.

Third, similar research in projects for different modalities, and other types of construction projects is of interesting to be able to compare results for the construction industry. Furthermore, research in other types of project management industries is of interest to be able to compare different industries.

Fourth, similar research in construction projects in other countries is of interest in the future, to be able to compare results internationally.

Fifth, the effect of applying the recommendations from this study on the responsiveness to EW signs in practice should be subject to further research, to verify their effect.

Sixth, the importance of soft EW signs is highlighted in this research. Is hypothesised that soft EW signs occur the most early in projects, when compared to hard signs. This hypothesis, and the corresponding theoretical model should be subject to further research.

References

Almahmoud, E. S., Doloi, H. K., & Panuwatwanich, K. (2012). Linking project health to project performance indicators: Multiple case studies of construction projects in Saudi Arabia. *International Journal of Project Management*, *30*(3), 296–307. https://doi.org/10.1016/j.ijproman.2011.07.001

Alsubaey, M., Asadi, A., & Makatsoris, H. (2015). A Naïve Bayes approach for EWS detection by text mining of unstructured data: A construction project case. *IntelliSys 2015 - Proceedings of 2015 SAI Intelligent Systems Conference*, 164–168. https://doi.org/10.1109/IntelliSys.2015.7361140

Ansoff, H. I. (1975). Managing Strategic Surprise by Response to Weak Signals. *California Management Review*. https://doi.org/10.2307/41164635

Ansoff, H. I. (1984). *Implanting Strategic Management*. Prentice/Hall International.

Ansoff, H. I., & Mcdonell, E. J. (1990). *Implanting strategic management*. Prentice hall.

AT5. (2011). "Renovatie Oostlijn nu alweer een chaos." Retrieved from http://www.at5.nl/artikelen/62921/renovatie-oostlijn-nu-alweer-een-chaos

AT5. (2012, April 25). "Kosten Oostlijn Exploderen." *Webarticle*. Retrieved from http://www.at5.nl/artikelen/80040/kosten-oostlijn-exploderen

AT Osborne. (2017a). Early Warning signals - Project Recovery. Baarn: Unpublished.

AT Osborne. (2017b). *Onze visie op Project Recovery*. Retrieved from www.atosborne.nl

Atkinson, R. (1999). Project management: cost, time and quality, two best guesses and a phenomenon, its time to accept other success criteria. *International Journal of Project Management*, *17*(6), 337–342. https://doi.org/10.1016/S0263-7863(98)00069-6

Baccarini, D. (1996). The concept of project complexity - A review. *International Journal of Project Management*, *14*(4), 201–204. https://doi.org/10.1016/0263-7863(95)00093-3

Bartsch, V., Ebers, M., & Maurer, I. (2013). Learning in project-based organizations: The role of project teams' social capital for overcoming barriers to learning. *International Journal of Project Management*, *31*(2), 239–251. https://doi.org/10.1016/j.ijproman.2012.06.009

Bassioni, H. A., Price, A. D. F., & Hassan, T. M. (2004). Performance Measurement in Construction. *Journal of Management in Engineering*, *20*(2), 42–50. https://doi.org/10.1061/(ASCE)0742-597X(2004)20:2(42)

Bjar Aziz. (2016). *How can Early Warning Signs contribute to the predictability of potential cost overruns in public infrastructure road works under integrated contracts, so that costs can be reduced for the contractor?* Delft University of Technology.

Bosch-Rekveldt, M. G. C. (2011). *Managing project complexity. A study into adapting early project phases to improve project performance in large engineering projects. Faculty of Technology, Policy and Management*. https://doi.org/798-94-91005-00-8

Bryde, D. J., & Robinson, L. (2005). Client versus contractor perspectives on project success criteria. *International Journal of Project Management*, *23*(8), 622–629. https://doi.org/10.1016/j.ijproman.2005.05.003

Cantarelli, C. C., Flyvbjerg, B., Molin, E. J. E., & van Wee, B. (2010). Cost overruns in large-scale transportation infrastructure projects: Explanations and their theoretical embeddedness. *European Journal of Transport and Infrastructure Research*, *10*(1), 5–18.

Chan, A. P. C., Chan, A. P. L., & Chan, A. P. C. (2004). *Key performance indicators for measuring construction success*. https://doi.org/10.1108/14635770410532624

Choi, J. W. (2007). *Forecasting Potential Project Risks Through Leading Indicators to Project Outcome*. Texas A&M University.

COST. (2009). *COST Action A22 Foresight Methodologies - Exploring new ways to explore the future parts :* Retrieved from http://www.costa22.org

Creswell, J. W. (2014). *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*. *SAGE Publications* (Fourth Edi). SAGE Publications. https://doi.org/10.1007/s13398-014-0173-7.2

Dainty, A, Moore D, M. M. (2002). *Communication in Construction Design*.

De Bruijn, H., & Leijten, M. (2007). Megaprojects and contested information. *Transportation Planning and Technology*, *30*(1), 49–69. https://doi.org/10.1080/03081060701208050

Faridi, A. S., & El-Sayegh, S. M. (2006). Significant factors causing delay in the UAE construction industry. *Construction Management and Economics*, *24*(11), 1167–1176. https://doi.org/10.1080/01446190600827033

FD.nl. (2015). Verbouwing station Utrecht dreigt miljoenen extra te kosten. Retrieved from https://fd.nl/economie-politiek/1112921/verbouwing-station-utrecht-dreigt-miljoenen-extra-te-kosten

Fleming, B. Y. Q. W., Koppelman, J. M., & Fleming, W. (2016). Earned Value Project Management, 4th Edition. *Project Management Journal*, 231.

Flyvbjerg, B. (2007a). Policy and planning for large-infrastructure projects: Problems, causes, cures. *Environment and Planning B: Urban Analytics and City Science*, *34*(4), 578–597. https://doi.org/10.1068/b32111

Flyvbjerg, B. (2007b). Policy and planning for large-infrastructure projects: Problems, causes, cures. *Environment and Planning B: Planning and Design*, *34*(4), 578–597. https://doi.org/10.1068/b32111

Flyvbjerg, B. (2013). Quality control and due diligence in project management: Getting decisions right by taking the outside view. *International Journal of Project Management*, *31*(5), 760–774. https://doi.org/10.1016/j.ijproman.2012.10.007

Flyvbjerg, B., Garbuio, M., & Lovallo, D. (2009). Delusion and deception in Large Infrastructure Projects: Two Models for Explaining and Preventing Executive Disaster. *California Management Review*, *51*(2), 170–194. https://doi.org/10.1225/CMR423

Flyvbjerg, B., Holm, M. S., & Buhl, S. (2002). Underestimating costs in public works, error or lie? *American Planning Association Journal*, *68*(3), 279–295. https://doi.org/10.1080/01944360208976273

Flyvbjerg, B., Skamris, M. K., & Buhl, S. L. (2003). How common and how large are cost overruns in transport infrastructure projects? *Transport Reviews*, *23*(1), 71–88. https://doi.org/10.1080/0144164022000016667

Flyvbjerg, B., Skamris holm, M. K., & Buhl, S. L. (2003). How common and how large are cost overruns in transport infrastructure projects? *Transport Reviews*, *23*(1), 71–88. https://doi.org/10.1080/01441640309904

Gavett, G. (2013). The Hidden Indicators of a Failing Project. *Harvard Business Review*. Retrieved from https://hbr.org/2013/10/the-hidden-indicators-of-a-failing-project

Gemeentelijke Ombudsman. (2009). *Noord / Zuidlijn Vijzelgracht Deel 2 Verzakking van wevershuizen op 10 september 2008*. Amsterdam.

Gilbert, G. P. (1983). Styles of project management, *1*(4), 189–193.

Godet, M. (1994). From anticipation to action. *Futures*. Paris: UNESCO. Retrieved from

http://www.laprospective.fr/dyn/anglais/ouvrages/from-anticipation.pdf

Haji-kazemi, S. (2015). *The early warning procedure in projects; Foundations, Approaches and Challenges*. NTNU, Trondheim. Retrieved from https://brage.bibsys.no/xmlui/bitstream/handle/11250/283959/SaraHaji-kazemi.pdf?sequence=4&isAllowed=y

Haji-Kazemi, S., Andersen, B., & Klakegg, O. J. (2015). Barriers against effective responses to early warning signs in projects. *International Journal of Project Management*, *33*(5), 1068–1083. https://doi.org/10.1016/j.ijproman.2015.01.002

Haji-Kazemi, S., Andersen, B., & Krane, H. P. (2013a). A review on possible approaches for detecting early warning signs in projects. *Project Management Journal*. https://doi.org/10.1002/pmj.21360

Haji-Kazemi, S., Andersen, B., & Krane, H. P. (2013b). Identification of Early Warning Signs in Front-End Stage of Projects, an Aid to Effective Decision Making. *Procedia - Social and Behavioral Sciences*, *74*(1877), 212–222. https://doi.org/http://dx.doi.org/10.1016/j.sbspro.2013.03.011

Hertogh, M., & Westerveld, E. (2010). Playing With Complexity. Management and Organisation of Large Infrastructure Projects. *World*, 377.

Hiltunen, E. (2008). The future sign and its three dimensions. *Futures*, *40*(3), 247–260. https://doi.org/10.1016/j.futures.2007.08.021

Hofstede. (1991). *Cultures and Organizations. Cultures and Organizations*. https://doi.org/10.1007/s11569-007-0005-8

Holopainen, M., & Toivonen, M. (2012). Weak signals: Ansoff today. *Futures*, *44*(3), 198–205. https://doi.org/10.1016/j.futures.2011.10.002

Ilmola, L., & Kuusi, O. (2006). Filters of weak signals hinder foresight: Monitoring weak signals efficiently in corporate decision-making. *Futures*, *38*(8), 908–924. https://doi.org/10.1016/j.futures.2005.12.019

Jaafari, A. (2007). Project and program diagnostics: A systemic approach. *International Journal of Project Management*, *25*(8), 781–790. https://doi.org/10.1016/j.ijproman.2007.05.008

Jansen, G. (2016). *Uitgebreide uitwerking early warnings*.

Kadefors, A. (2004). Trust in project relationships-inside the black box. *International Journal of Project Management*, *22*(3), 175–182. https://doi.org/10.1016/S0263-7863(03)00031-0

Kagioglou, M., Cooper, R., & Aouad, G. (n.d.). Cross-Industry Learning : The development of a Generic Design and Construction Process Based on Stage / Gate New ..., (1998). Retrieved from https://www.researchgate.net/publication/239921854

Kahneman, D., & Tversky, A. (1979). Prospect Theory: An Analysis of Decision under Risk. *Econometrica*, *47*(2), 263–292. https://doi.org/10.2307/1914185

Kappelman, L. A., McKeeman, R., & Zhang, L. (2006). Early Warning Signs of it Project Failure: The Dominant Dozen. *Information Systems Management*, *23*(4), 31–36. https://doi.org/10.1201/1078.10580530/46352.23.4.20060901/95110.4

Kerzner, H. (2013a). *Project management: a systems approach to planning, scheduling, and controlling*. *New York*. https://doi.org/10.1016/0377-2217(82)90164-3

Kerzner, H. (2013b). *Project Management Metrics, KPIs, and Dashboards - A Guide to Measuring and Monitoring Project Performance (2nd Edition)*. John Wiley & Sons. Retrieved from https://app.knovel.com/web/toc.v/cid:kpPMMKPID8/viewerType:toc/root_slug:project-management-metrics/url_slug:kt011BDIAR

Klakegg, O., Williams, T., Walker, D., Andersen, B., & Morten Magnussen, O. (2010). *Early Warning Signs in Complex Projects*. Project Management Institute.

Kremers, T. (2018). AT Osborne - Project Recovery. Retrieved January 15, 2018, from https://www.atosborne.nl/service/projectrecovery/

Kutsch, E., & Hall, M. (2010). Deliberate ignorance in project risk management. *International Journal of Project Management*, *28*(3), 245–255. https://doi.org/10.1016/j.ijproman.2009.05.003

Kutsch, E., Maylor, H., Weyer, B., & Lupson, J. (2011). Performers, trackers, lemmings and the lost: Sustained false optimism in forecasting project outcomes - Evidence from a quasi-experiment. *International Journal of Project Management*, *29*(8), 1070–1081. https://doi.org/10.1016/j.ijproman.2011.01.010

Larsson, J., Eriksson, P. E., Olofsson, T., & Simonsson, P. (2015). Leadership in Civil Engineering : Effects of Project Managers ' Leadership Styles on Project Performance. *Journal of Management in Engineering*, *31*(6), 1–11. https://doi.org/10.1061/(ASCE)ME.1943-5479.0000367.

Lovallo, D., & Kahneman, D. (2003). Delusions of Success: How Optimism Undermines Executives' Decisions. *Harvard Business Review*. https://doi.org/10.1225/R0307D

Meng, X. (2014). Is Early Warning Effective for the Improvement of Problem Solving and Project Performance? *Journal of Management in Engineering*, *30*(2), 146–152. https://doi.org/10.1061/(ASCE)ME.1943-5479.0000205

Mian, D. M., Sherman, S. R., Humphreys, M. F., & Sidwell, A. C. (2004). Construction Projects Immediate Health Check: A CSF & KPI Approach. *Project Management Australia Conference (PMOZ)*. Retrieved from http://eprints.qut.edu.au/25606/

Mian, D., & Tsoukas, J. (2005). *Project Diagnostics - Assessing the Conditions of Projects and Identifying Poor Health*. Brisbane. Retrieved from http://www.construction-innovation.info/images/pdfs/Research_library/ResearchLibraryC/Refereed_Conference_Papers/2002-052-C_RCP_Helsinki_Jun_2005__Final_.pdf

Ministerie van Infrastructuur en Milieu. (2013). *Doorstroomstation Utrecht; versie 1.0*. Den Haag. Retrieved from https://www.rijksoverheid.nl/binaries/rijksoverheid/documenten/rapporten/2013/05/23/doorstroomstation-utrecht/doorstroomstation-utrecht.pdf

Ministerie van Infrastructuur en Milieu. (2016). *Programma Hoogfrequent Spoorvervoer Amsterdam Centraal; Notitie Reikwijdte en Detailniveau*.

Ministerie van Infrastructuur en Milieu. (2017). *Programma hoogfrequent spoorvervoer, voortgangsrapportage 13*. Den Haag. Retrieved from http://www.prorail.nl/projecten/goederenroute-oost-nederland/programma-hoogfrequent-spoorvervoer

Mintzberg, H. (1994). The Fall and Rise of Strategic Planning. *Harvard Business Review*, 107–114. https://doi.org/10.1016/0024-6301(94)90173-2

Morris, P. W. G., & Hough, G. H. (1987). The anatomy of major projects: a study of the reality of project management. *1987*, 326. Retrieved from http://books.google.dk/books?vid=ISBN0471915513&redir_esc=y

Nauman, S., Mansur Khan, A., & Ehsan, N. (2010). Patterns of empowerment and leadership style in project environment. *International Journal of Project Management*, *28*(7), 638–649. https://doi.org/10.1016/j.ijproman.2009.11.013

Nepal, M. P., Park, M., & Son, B. (2006). Effects of Schedule Pressure on Construction Performance. *Journal of Construction Engineering and Management*, *132*(February), 182–188. https://doi.org/10.1061/(ASCE)0733-9364(2006)132:2(182)

NETLIPSE. (2018). Infrastructure Project Assessment Tool (IPAT®). Retrieved from http://netlipse.eu/project-assessments/ipat#.Wl_CRKjT5PY

Nikander, I. O. (2002). *Early Warnings, a Phenomenom in Project Management*. Helsinki University of Technology. https://doi.org/10.1038/458679a

Nikander, I. O., & Eloranta, E. (2001). Project management by early warnings. *International Journal of Project Management*, *19*(7), 385–399. https://doi.org/10.1016/S0263-7863(00)00021-1

NU.nl. (2016, November 23). Spoorvernieuwing Utrecht Centraal valt miljoenen goedkoper uit. Retrieved from https://www.nu.nl/binnenland/4354947/spoorvernieuwing-utrecht-centraal-valt-miljoenen-goedkoper.html

Olander, S. (2007). Stakeholder impact analysis in construction project management. *Construction Management and Economics*, *25*(3), 277–287. https://doi.org/10.1080/01446190600879125

Pinto, J. K. (2014). Project management, governance, and the normalization of deviance. *International Journal of Project Management*, *32*(3), 376–387. https://doi.org/10.1016/j.ijproman.2013.06.004

Pinto, J. K., Slevin, D. P., & English, B. (2009). Trust in projects: An empirical assessment of owner/contractor relationships. *International Journal of Project Management*, *27*(6), 638–648. https://doi.org/10.1016/j.ijproman.2008.09.010

Poshtekooh, N. G. (2014). *Barriers of identification of early warninig signals*. Norwegian University of Science and Technology Trondheim. Retrieved from http://www.diva-portal.org/smash/record.jsf?pid=diva2:747983

Project Management Institute. (2008). *A Guide to the Project Management Body of Knowledge (PMBOK® Guide) - Fourth Edition. A Guide to the Project Management Body of Knowledge (PMBOK® Guide) - Fourth Edition*. https://doi.org/10.1007/s13398-014-0173-7.2

Project Management Institute. (2013). The High Cost of Low Performance: The Essential Role Of Communications. *PMI, Project Management Institute*, (May), 14. Retrieved from http://www.pmi.org/~/media/PDF/Business-Solutions/PMI-Pulse Report-2013Mar4.ashx

ProRail. (2014). *Informatiedocument Programma Hoogfrequent Spoorvervoer Amsterdam Centraal*. https://doi.org/P832182

Pryke, S. (2012). *Social Network Analysis in Construction*. *Social Network Analysis in Construction*. https://doi.org/10.1002/9781118443132

Rekenkamer Amsterdam. (2016). *Renovatie Oostlijn; Lessen uit een complex en problematisch project; Bestuurlijk Rapport*. Amsterdam.

Rijkswaterstaat. (2014). Integraal projectmanagement (IPM); Eén manier van werken voor elk project.

Ringoir, V. (2017). *Project Recovery; Assessing how recovery interventions by public project managers in the crisis of a Dutch large construction project contribute to a succesful recovery outcome*. Delft University of Technology.

Schramm, W. (1971). Notes on Case Studies of Instructional Media Projects. *Working Paper for the Academy for Educational Development*, 1–43. Retrieved from http://www.eric.ed.gov/ERICWebPortal/contentdelivery/servlet/ERICServlet?accno=ED092145

Sharma, S., & Mahajan, V. (1980). Early Warning Indicators of Business Failure. *Journal of Marketing*, *44*(4), 80–89. Retrieved from http://www.jstor.org/stable/1251234

Shokri, S., Ahn, S., Lee, S., Haas, C. T., & Haas, R. C. G. (2016). Current Status of Interface Management in Construction: Drivers and Effects of Systematic Interface Management. *Journal of Construction Engineering and Management*, *142*(2), 4015070. https://doi.org/10.1061/(ASCE)CO.1943-7862.0001035

Smyth, H. (2008). Developing Trust. In *Collaborative Relationships in Construction: Developing Frameworks and Networks* (pp. 129–160). Oxford, UK: Wiley-Blackwell. https://doi.org/10.1002/9781444301069.ch6

Soetenhorst, B. (2011). *Het wonder van de Noord/Zuidlijn; Het drama van de Amsterdamse metro*. Amsterdam: Bert Bakker.

Son, J., & Rojas, E. M. (2011). Impact of Optimism Bias Regarding Organizational Dynamics on Project

Planning and Control. *Journal of Construction Engineering and Management*, *137*(2), 147–157. https://doi.org/10.1061/(ASCE)CO.1943-7862.0000260

Sunindijo, R., Hadikusumo, B., & Ogunlana, S. (2007). Emotional Intelligence and Leadership Styles in Construction Project Management. *Journal of Management in Engineering*, *23*(4), 166–170. https://doi.org/10.1061/(ASCE)0742-597X(2007)23:4(166)

Thamhain, H. (2013). Managing risks in complex projects. *Project Management Journal*, *44*(2), 20–35. https://doi.org/10.1002/pmj.21325

Turner, J. R., & Cochrane, R. A. (1993). Goals-and-methods matrix: coping with projects with ill defined goals and/or methods of achieving them. *International Journal of Project Management*, *11*(2), 93–102. https://doi.org/10.1016/0263-7863(93)90017-H

Twynstra Gudde. (2015). *Evaluatie besluitvorming, informatie-uitwisseling en projectbeheersing OV SAAL KT cluster c en Doorstroomstation Utrecht*.

Vanhoucke, M. (2013). Project Management with Dynamic Scheduling. Heidelberg: Springer - Verlag Berlin. https://doi.org/10.1007/978-3-642-40438-2

Verschuren, P., & Doorewaard, H. (2010). *Designing a Research Project* (2nd editio). The Hague: Eleven international publishing.

Wiio, O. (1989). *Viestinnän perusteet [The Principals of Communication]* (fifth). Helsinki: Weilin+Göös.

Williams, T., Jonny Klakegg, O., Walker, D. H. T., Andersen, B., & Morten Magnussen, O. (2012). Identifying and acting on early warning signs in complex projects. *Project Management Journal*. https://doi.org/10.1002/pmj.21259

Winch, G. M. (2010). *Managing Construction Projects: An Information Processing Approach* (Second Edi). John Wiley & Sons. https://doi.org/10.1080/01446193.2010.513397

Xiang, P., Zhou, J., Zhou, X., & Ye, K. (2012). Construction project risk management based on the view of asymmetric information. *Journal of Construction Engineering and Management*, *138*(11), 1303–1311. https://doi.org/10.1061/(ASCE)CO.1943-7862.0000548

Yazici, H. J. (2009). The Role of Project Management Maturity and Organizational Culture in Perceived Performance. *Project Management Journal*, *40*(3), 14–33. https://doi.org/10.1002/pmj.20121

Yin, R. (2003). *Case Study Research; Design and Methods. Applied Social Research Methods Series Volume 5* (Third Edit). SAGE Publications. https://doi.org/10.1097/FCH.0b013e31822dda9e

Yin, R. K. (1981). The case study as a serious research strategy. *Science Communication*, *3*(1), 97–114. https://doi.org/10.1177/107554708100300106

Yin, R. K. (2009). *Case Study Research: Design and Methods. Essential guide to qualitative methods in organizational research* (Vol. 5). https://doi.org/10.1097/FCH.0b013e31822dda9e

APPENDICES

APPENDIX A: EW sign identification methods

This appendix is an elaboration of section 3.2.3. Based on various sources in the literature, an overview is composed of EW sign identification methods. In the following section, each identification method from Table 6 is discussed. A description is given, followed by their applicability for detecting EW signs, as discussed in literature. Identification method one to thirteen are discussed by Haji-Kazemi (2015). Fourteen and fifteen are discussed in other literature sources.

	Identification methods
1	Risk analysis
2	Earned Value management
3	Project assessments
4	Performance measurement
5	Stakeholder analysis
6	Brainstorming
7	Maturity assessments
8	Past project consultation
9	Cause and effect analysis
10	Gut feeling
11	Interface analysis
12	Project analysis
13	Project surrounding analysis
14	Text mining
15	Project health checks

Table 26: Overview of EW identification methods

1. Risk analysis

The overlap between the early warning phenomenon and risk management practice is discussed in section 3.1.7. Identified risks can be monitored by the current risk management practice. However, in section 3.1.5 it was explained that EW signs are indications of potential risks. A proper risk register is therefore not sufficient of all important EW signs in an early stage. At least as important are work processes, organisational environment and people (Thamhain, 2013), and these are underrepresented in risk management. EW signs can present themselves in an ambiguous way, which makes it difficult to link them to an impact and time frame. These EW signs might need monitoring in a different way. It is questioned if these ambiguous EW signs are detected by risk management practices.

2. Earned Value management

The Earned Value (EV) method is used to measure the health of a project by a set of metrics, such as Planned Value (PV), Actual Cost (AC) and Earned Value (EV). In this way the actual cost can be compared with budget, and schedule progress compared with planned. As described, these methods function as 'Early Warning signals' to detect project problems and opportunities in time (Vanhoucke, 2013). Furthermore, it is described to generate an 'Early Warning buzzer' in a project when the project costs are higher than what is accomplished at the moment (Fleming, Koppelman, & Fleming, 2016). According to Haji-Kazemi, this approach generates both hard and soft data (with 'hard' meaning technical managerial aspects, and 'soft' meaning dynamics of human side of the project). However, since the main KPI's of the method are focused on costs and time, this is not the most suitable method to detect 'soft' type of EW signs. Nevertheless, it is a well-used method to track planning and cost deviations in an early stage.

3. Project assessments

Project assessments account for all sorts of reviews, audits and status check that are applied to the project. Examples are stage gate reviews, internal or external reviews, health checks, benchmarking or pre-sanctioning assessments (Kagioglou, Cooper, & Aouad, n.d.; Kerzner, 2013a; Klakegg et al., 2010). Various types of these methods are described extensively in literature. A problem Is that assessments can give an too optimistic view on the project, since problems are often underestimated and benefits overestimated (Flyvbjerg, Skamris, & Buhl, 2003).

According to Haj-Kazemi, these assessments can also be used to acquire both hard and soft project data. However, most of the current used assessments focus mainly on hard project data. As was found by

Almahmoud, Doloi and Panuwatwanich (2012), 'governance and leadership' and 'information and communication management' were the most influential management functions affecting all performance indicators in their project health checks. This highlights the importance of those factors.

4. Performance measurement

Performance measurement is described as a general term for approaches to periodically track progress of the project, not with a specific goal to look for EW signs (Haji-Kazemi et al., 2013a). Mostly these types of assessments include measurements of key KPI's, such as costs, planning, health and safety. Another method is the use of a balanced scorecard (Bassioni, Price, & Hassan, 2004).

As was mentioned in the introduction, most project performance measurement focuses on lagging KPI's, being mainly hard factors (Williams et al., 2012). In a review on performance measurement in construction, Bassioni et. al (2004) describe the problem with this hard data based performance measurement as it is the outcome of managerial actions after they occurred in the past. The real needed information to take decisions is current, and mostly not financial data. According to Chan and Chan, more other types of performance indicators are used (Chan et al., 2004). To capture soft early warning signs, it is necessary to monitor the KPI's that indicate the softer managerial issues of the project.

5. Stakeholder analysis

Stakeholder analysis is a tool designed to evaluate the stakeholders involved in the project, which is widely used in construction projects (Olander, 2007). Since a lot of construction projects are complex and impact a lot of different stakeholders, it is essential to understand the desires of these parties. Furthermore, not understanding stakeholder is a clear EW sign on its own (Klakegg et al., 2010). According to Haji-Kazemi, stakeholder analysis can be used to identify EW signs by analysing the stakeholders involved in the project. When monitoring the desired outcome and motivation of these stakeholders it is possible to identify future issues if these goals will not be met. This approach generates both hard and soft data, and could be used to identify EW signs coming from the stakeholder domain of the project.

6. Brainstorming

Another proposed method to identify early warning signs is brainstorming. This is a very wide-ranging tool, that can be either institutionalized or not. Brainstorming can be periodically, evaluating, or non-systematic used as out-of-the-box reflecting on project issues. According to Haji-Kazemi, this is arguably the most used source for finding EW signs. Another strong advantage of this method is that it (mostly, and if well governed) allows employees to ventilate their opinions more freely, creating a very realistic image of the project. This is extremely important for early warning signs that are based on gut-feeling.

7. Maturity assessments

Maturity assessments are aimed at evaluating the quality of the project organisation that is running the project. These assessments could function as a very early warning, by assessing the quality of the project team that is assigned to the project. However, the strength of these warnings can be limited, since the influence of maturity on project success is discussed (Yazici, 2009). However, a project organisation with very low maturity is definitely a warning for the project.

8. Past project consultation

It is known that learning lessons from previous projects is important for detecting potential problems in project management. Therefore, evaluation of past projects is an important tool to detect EW signs. However, organisational learning is perceived as one of the main problems in the dynamic project environment, which is discussed in this research by the *fragmentation* barrier. A lack of lessons-learned can function as a barrier to detect early warning signs, since the signals are simply not received.

9. Cause and effect analysis

Since early warnings and project problems can be described by a causal relation, methods for cause and effect analysis are closely related. It is suggested that different types of root cause analyses can be used to identify EW and their risk in projects. These types of analyses can be either systematic or non-systematic implemented. The essence of these methods is to explain certain anomalies in the project, which makes it a good tool to detect 'soft' EW signs.

10. Gut feelings

Another type of 'approach' that is discussed is 'gut-feeling'. Gut-feeling as described by Klakegg et. al (2010) is an important source of EW signs. Experts stress the fact that EW signs are mostly less measurable, making the detection of them depending more on gut-feeling than systematic approaches (Haji-Kazemi et al., 2013a). How these gut-feelings should be approached and dealt with is not discussed, while this should be part of the discussion. Bringing gut-feelings to attention and create a proper follow up could be essential to the improvement of the EW procedure.

11. Interface analysis

Interface analysis is aimed to detect problems with interfaces between technical systems, different actors, and people in the project that may arise in the project. Management of these interfaces means setting agreements with all stakeholders involved regarding responsibilities, planning, and information sharing. As described in literature on interface management, identifying interface points in an early stage of the project and identifying their potential risks should result in less issues during the execution phase (Shokri, Ahn, Lee, Haas, & Haas, 2016). In this way, interface management could be used to identify potential EW signs, both hard and soft signals.

12. Project analysis

With project analysis, assessments aimed to examine he characteristics of the project are referred to. These are conducted in frond-end stage of the project, in order to determine a projects complexity, application of new techniques, degree of physical distribution or other characteristics that define the project. These kinds of frond-end analyses are tools that can present EW signs. However, since these signs are based on the project characteristics, these will be mostly hard signals. Only benchmarking with other projects based on project team composition (see maturity assessments), or characteristics of stakeholders on the project will arguably present soft aspects.

13. Project surrounding analysis

Another type of analysis made in frond-end stage of the project cover the surroundings of the project. This type of analysis examines the external factors that could influence the course of the project. Issues related to political climate, market, financial climate, organisations can present EW signs for the course of the project.

14. Text mining

Alsubaey, Asadi and Makatsoris (2015). They tested text mining as a source of EW identification. As part of the research, management documents including meeting minutes were scanned by a system in order to identify EW signs. The frequency that certain words were mentioned is important factor in this method. This type of analysis generates both hard and soft project data. An advantage of this method is that it gives very objective data, which can be used as an easy opening to make certain topics discussed. In addition, application of the method in various projects generates project learning. However, a prerequisite is that the real issues are discussed in official meetings, which is not always the case. Furthermore, this method can evoke strategic behaviour in meetings, by avoiding certain words that can indicate EW signs.

15. Project Health Checks focused on soft KPI's

Project Health checks (PHC's) were already discussed in the previous section as part of project assessments. Some of these PHC's do also include soft sorts of KPI's (D. Mian & Tsoukas, 2005). However, there is a need for more focus on these soft KPI's, as was indicated in the section on PHC's. Potentially, this should be PHC's that are only focused on softer factors. This ensures that these factors are not considered inferior to hard KPI's. Jaafari (2007) discusses PHC's as project diagnostics. He argues that PHC's should mainly focus on assessing the managerial performance and capabilities that are applied to a project. At the same time a PHC should be applicable at any time of the project, making it not a formal and staged assessment.

APPENDIX B: Guideline expert interviews

Expert interviews guideline

Stijl: Semigestructureerde interviews. Dit document functioneert als guideline tijdens de interviews

Doel: (1) Ophalen van de belangrijkste barrières (factoren) in de EW response uit de ervaring van managers in Nederlandse bouwprojecten

(2) Toetsen van het EW response model op werkelijkheid bij experts uit de praktijk.

Begin interview:

- Persoonlijke introductie
- Uitleggen doel interview
- Uitleggen hoe informatie behandeld wordt
- Toestemming vragen om interview op te nemen

Datum:
Locatie:

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

Controlevragen na interview:

1. **Zijn alle filters uit het model benoemd?**
2. **Zijn de factoren herkend en geprioriteerd?**
3. **Nuttige praktijkvoorbeelden?**

Vragen

A: Ervaring (10 min)

1. Hoe lang bent u Project Manager? / Betrokken bij bouwprojecten?
2. Bij wat voor soort projecten bent u betrokken geweest?
3. Bent u bekent met het fenomeen early warning signs?
    a. (Signalen die in een vroeg stadium potentiele problemen in projecten voorspellen)
4. [EXTRA] Kunt u uit ervaring een aantal voorbeelden van early warning signs noemen die problemen in projecten voorspellen?

B: EW signalen in projecten (20 min)

(Model doorlopen met praktische voorbeelden, d.m.v. vragen stellen. Zonder model te laten zien.)
(wanneer het stokt, terug naar andere EW signs – en anders vragen wanneer en waardoor er wel iets gedaan werd).

5. Kun je een voorbeeld geven van een project waar grote problemen speelden? PROBLEEM
    a. Wat ging er mis?
    b. Wat was het gevolg?
6. Terugkijkend: Welke EW-signalen gingen hieraan vooraf? EW SIGNS
    a. Wat waren de allereerste signalen?
7. Hoe kwamen deze signalen op? SURVEILLANCE
    a. Wie ontdekte deze signalen?
    b. Wanneer werden deze signalen ontdekt?
    c. Hoe werden ze ontdekt? (Methodiek, en waarom dus wel/niet)
8. Wat gebeurde er vervolgens mee? OBSERV. MENT.
    a. Werden deze signalen gerapporteerd?
    b. Waarom wel/niet?
9. Wie besloot vervolgens of er wel of niet iets mee gebeurde? DEC.MAK. MENT.
    a. Waar in de organisatie? Wie was besluitnemer?
    b. Waarom? Is dat de logische persoon?
10. Wat werd er vervolgens besloten? POL.POW. FILT.
    a. Wanneer werd er actie ondernomen?
    b. Wat voor invloed werkte er op deze beslissing? (Politieke druk?)
    c. Wat was het resultaat van de actie?
11. Kun je een (ander) voorbeeld noemen wanneer er niet werd gereageerd op EW signs?
    a. Waarom werd er niet gereageerd?
12. Kun je een (ander) voorbeeld noemen wanneer er juist wel adequaat werd gereageerd op EW signs?
    a. Waarom werd er op die manier gereageerd?
13. [EXTRA] (Wat is er nodig voor een EW-signaal om opgevangen te worden en van een respons voorzien?)

C: Barrières in EW response (20 min)

14. [PRIORITEIT] Welke factoren houden het tegen om te reageren op EW signs?
    a. Noem er vijf, schrijf ze op kaartjes
    b. Leg ze vervolgens in een volgorde van belangrijkheid
15. [PRIORITEIT] Herken je de volgende factoren (welke nog niet genoemd) ook in hun invloed op het reageren op EW signalen? (Op kaartjes)

    1. Over optimisme
    2. Afwijkingen die normaal zijn geworden (Costa concordia v.b.) (aparte kaartjes)
        a. Strategisch gedrag bij aanbesteding
        b. Client-contractor relatie
        c. Planning issues

3. Vermijding onzekerheden
4. Tijdsdruk
5. Slecht management (wat voor slecht management? Is dit ook PM-stijl?)
    a. (Of losse) Stijl Project Manager
6. Onderschatting kosten/planning/risico's + overschatting effect van besluiten
7. Verdeeldheid tussen projecten (niet leren van elkaar)
8. Complexiteit v.h. project (onvoorspelbaarheid, en onbekendheid)
9. Politieke effecten

16. [PRIORITEIT] Op basis van uw ervaring, welke van deze factoren zijn het meest belangrijk in het blokkeren van de EW-response? Leg de kaartjes in een volgorde van grote invloed naar kleine invloed.
    a. Waarom deze volgorde?

17. [PRIORITEIT] Welke andere factoren zouden nog aan deze lijst toegevoegd kunnen worden?
    b. Specifieke factoren voor bouwprojecten?

D: Afsluiting (5 min)

18. Wat ben ik vergeten te vragen?
19. Wat neemt u mee uit dit interview? (Heeft u er iets aan gehad?)
20. Is er nog iets dat u zelf zou willen delen?

- Verslaglegging:
    - Interview is opgenomen, wordt uitgewerkt
    - In onderzoek wil ik gebruik maken van: quotes, genoemde EW signs, barrières en volgorde. Vergelijking maken met andere antwoorden.
- Voordat ik dit gebruik zal ik uw uitspraken ter goedkeuring leggen bij u. Als dit langer dan 2 weken duurt ga ik ervanuit dat u ermee akkoord bent.

APPENDIX C: List of interviewed people

	Name	Organisation	Date
1	Joost van de Beek	Rijkswaterstaat	2/10/2017
2	Jeroen Versteegen	ProRail	4/10/2017, 13/11/2017
3	Hans Ruijter	Rijkswaterstaat	11/10/2017
4	Jaap Zeilmaker	Rijkswaterstaat	16/10/2017
5	Dolf Booij	Gemeente Rotterdam	25/10/2017
6	Gerard Scheffrahn	AT Osborne, GVB Amsterdam	27/10/2017
7	Gerrit Jansen	Rijkswaterstaat	6/11/2017
8	Jaap Balkenende	ProRail	13/11/2017
9	Ronald Hazeu	ProRail	23/11/2017
10	MV	ProRail	28/11/2017
11	MF	ProRail	28/11/2017
12	Peter van Sterkenburg	Gemeente Utrecht	13/11/2017
13	Alex Miggelenbrink	AT Osborne	22/11/2017
14	Felix Paleari	TASK	12/12/2017
15	Bastiaan Sommeling	AT Osborne	13/12/2017
15	Ankie Hectors	ProRail	21/12/2017
16	Thomas van Leengoed	AT Osborne, ProRail	21/12/2017
17	Robin de Reus	ProRail	10/01/2018
18	Dirk-Jan de Vries	Ministerie van Infrastructuur en Milieu	11/01/2018

Figure 33: List of interviewed people

APPENDIX D:
Expert session 1

D1 Participants

	Name	Experience (years)	Company	Other
1	Pau Lian Staal	18	AT Osborne	RWS, Gemeente Amsterdam, ProRail
2	Anne Beekers	5	AT Osborne	Gemeente Amsterdam
3	Bastiaan Sommeling	19	AT Osborne	ProRail
4	Pelle de Wit	7	AT Osborne	Gemeente Amsterdam
5	Rutger Bartels	6	AT Osborne	Rijkswaterstaat
6	Thomas Neijenhuis	3	AT Osborne	Various governmental
7	Reijer Baas	20	AT Osborne	Various governmental
8	Jeroen Brinkman	16	AT Osborne	Various governmental
9	Floris Bakemans	10	AT Osborne	Various governmental
10	Theofiel Jetten	10	AT Osborne	
11	Jan-Floor Troost	20	AT Osborne	Various governmental
12	Mark Marijnissen	1	AT Osborne	

Table 27: Participants of expert session 1

D2 Program

Programma – Sessie: Early Warning Response						
Tijd	***Leerdoel/Onderwerp***	***Wie***	***Werkvorm***	***Hulpmiddel***		
14:30	Voorbereiden					
15:00 [5 min]	Inloop					
15:05 [5 min]	Uitleg sessie + onderzoek achtergrond + Doel vandaag					
15:10 [10 min]	**EW signs** Doel: Onderwerp EW signs introduceren		Achtergrond EW signs vertellen, vraag om input over: - Concrete EW signs - Hoe te ontdekken Vragen en suggesties altijd	ppt		
15:20 [40 min]	**Barrières** *Doel: ophalen belangrijkste barrières* Introduceren barrières 1. Benoemen 2. Volgorde maken 3. Post-its Bespreken wat genoemd Introduceren cirkel-model 4. Ophangen aan cirkelmodel Bespreken wat er genoemd is 5. Prioritering alle factoren 6. Post-its Bespreken wat er genoemd is en wat niet		 Paar voorbeelden laten noemen Formulier individueel beschrijven (1,2). Post its zelf invullen en dan ophangen aan cirkelmodel. Paar voorbeelden 1 voor 1 een afgaan, afhankelijk van de tijd.			
16:00 [50 min]	**Response** Introductie filter model model [10 min] Koppeling opdracht: [20 min] 1. Top 5 op post its laten schrijven 2. Ophangen onder model 3. Schrijven op welke filters het nog meer van toepassing is Bespreken welke links zijn gemaakt. [20 min]		 Model herkenbaar? Wat wel, wat niet? Individueel 1 voor 1 afgaan, afhankelijk van de tijd			
16.00 [10 min]	Afsluiting/conclusies [10 min] Doelen gehaald?					

Table 28: Program session 1

D3 Results

	Filters			
Factors	1: Surveillance	2: Observer mentality	3: Decision maker mentality	4: Political / power
Over optimism/ optimism bias		Structural underestimation of problems, and over estimation of chance 'it will figure out'	Structural underestimation of problems, and over estimation of chance 'it will figure out'	Pressure to keep pushing planning to procurement, while no longer realistic
Strategic misrepresentation				
Client-Contractor relation			Mistrust in relation guides decision making process	
Planning and scheduling dynamics				
Uncertainty avoidance		Attitude of 'others will know it better for sure'		
Time pressure	Little time for reflection is initiated.	Overscheduled/ no sense for what is going on / busy 'firefighting'	No time to listen in the team in informal conversations	
Poor management			Not enough integral consideration in decision making	
Illusion in decision making				
Fragmentation	No experience in project, don't know where to look			
Management style			Too much top-down PM style; signals not listened to	
Project complexity				
Effects of politics				'Now is not the right time', no political window.
Project culture		Gossiping in the team.	Employees don't feel heard	
Personal consequences		No dare tob e critical on project after employee fired following 'negative attitude'		
Mandate			'nothing is done with signals'	
Outside responsibility				
Lack of capacity/knowledge				
Other				

Figure 34: Examples of links between barriers and the four filters

D4 Impression

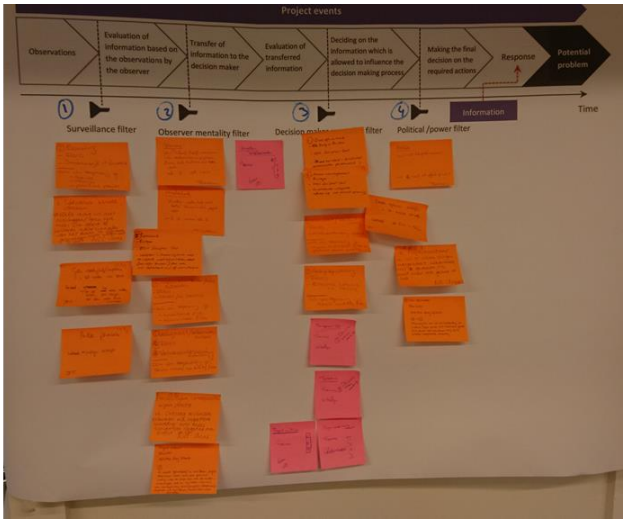


Figure 35: Impression of expert session 1

APPENDIX E: Guideline Case Study Interviews

Case study interview guideline

Stijl: Semi-gestructureerde interviews. Dit document functioneert als guideline tijdens de interviews

Doel:

1. Ophalen projectverloop: Belangrijkste challenges,
2. Early Warning signs die voorafgingen aan gebeurtenissen
3. Barrières die een rol gespeeld hebben in het herkennen van en acteren op deze early warning signs
4. Hoe deze barrières precies werkten
5. Hoe het proces van EW response verbeterd zou kunnen worden

Begin interview:

- Persoonlijke introductie
- Uitleggen doel interview
- Uitleggen hoe informatie behandeld wordt
- Toestemming vragen om interview op te nemen

Datum:
Locatie:

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

Project:

Vragen

A: Ervaring (5 min)

1. Kunt u wat meer vertellen over uw functie in het project?
    a. Wat was uw rol?
    b. Aan wie rapporteerde u? Wie rapporteerde er aan u?
2. In wat voor projecten heeft u hiervoor gewerkt?
3. Bent u bekend met het fenomeen early warning signs?
    a. (Signalen die in een vroeg stadium potentiele problemen in projecten voorspellen)

B: Project (20 min)

Uitvragen verloop van gebeurtenissen. In het uitvragen de factoren er al aan koppelen tijdens de doorvragen. Zo niet genoemd, er impliciet of expliciet naar vragen.

4. Wat waren de belangrijkste uitdagingen aan de voorkant van dit project?
5. Welke gebeurtenissen hebben het verloop van het project bepaald?
    a. Impactvolle gebeurtenissen, problemen die zich voordeden tijdens het project?
6. Wat was het probleem? PROBLEEM
    a. Wat ging er mis?
    b. Wat was het gevolg?
7. Terugkijkend: Wat waren de eerste signalen die problemen in het project mogelijk voorspelden?

8. Welke signalen zijn er vanuit de omgeving gekomen?
9. Hoe stond de omgeving tegenover het project?
10. Het contract is aanbesteed met een BVP-procedure. Wat heeft dat tot gevolg gehad? Was dit achteraf gezien een signaal?

C: EW signs (10 min)

11. Wat is in jouw ogen een vroeg signaal geweest dat problemen voorspelde? EW SIGNS
    a. **Wat** was dat?
    b. **Wat voor** signalen waren dit? (Hard/zacht)
12. Hoe kwam dit signaal op? SURVEILLANCE
    a. **Wie** ontdekte deze signalen?
    b. **Wanneer** werden deze signalen ontdekt?
    c. **Hoe** werden ze ontdekt? (Methodiek, en waarom dus wel/niet)
13. (Wat gebeurde er vervolgens mee?) OBSERV. MENT.
    a. Werden deze signalen gerapporteerd?
    b. **Waarom** wel/niet?
    c. **Hoe** komt dat denkt u?
14. Wat gebeurde er vervolgens mee? DEC.MAK. MENT.
    a. Werd er een **besluit** over genomen?
    b. **Waarom** wel/ niet?
    c. **Wie** was besluitnemer? Waar in de organisatie?
    d. **Waarom**? Is dat de logische persoon?
15. Wat werd er vervolgens besloten? POL.POW. FILT.
    a. **Wanneer** werd er actie ondernomen?
    b. Wat voor **invloed** werkte er op deze beslissing? (Politieke druk?)
    c. Wat was het **resultaat** van de actie?
16. **Welke factor** speelde er mee in het reageren op dit signaal?
    a. **(Zie kaartjes met factoren)**

Waren er ook 'zachte' signalen die problemen aangaven? Zoals signalen vanuit het team, met betrekking op bijvoorbeeld:

1. Sfeer
2. Vertrouwen
3. Werkdruk
4. Commitment
5. Veiligheid om mening te uiten

ALTERNATIEF:

17. Hoe had het **anders** gekund? Hoe hadden de signalen eerder afgevangen kunnen worden?
    a. Hoe eerder ontdekt?
    b. Hoe eerder doorgegeven?
    c. Hoe eerder een besluit over genomen?
    d. Hoe beter besluit over genomen?

D: Barrières in EW response (20 min)

18. Welk 3 van de volgende factoren speelden in de meeste mate een rol bij het omgaan met de signalen in het project?
    a. Tijdsdruk
    b. Over optimisme
    c. Vermijding van onzekerheden
    d. Project complexiteit
    e. Fragmentatie van projecten
    f. Relatie tussen cliënt en contractor
    g. Politieke effecten
    h. Management – project cultuur
    i. Anders...?

19. **Hoe speelden deze factoren een rol in:**
    a. Het ontdekken van signalen (werd men er blind van?)
    b. Het aan de kaart stellen van signalen (durfde of wilde men het op te roepen?)
    c. Het meewegen en besluitnemen over signalen?
    d. Het actie ondernemen op basis van de signalen?

D: Afsluiting (5 min)

20. Wat ben ik vergeten te vragen?
21. Wat neemt u mee uit dit interview? (Heeft u er iets aan gehad?)
22. Is er nog iets dat u zelf zou willen delen?

- Verslaglegging:
    - Interview is opgenomen, wordt uitgewerkt
    - In onderzoek wil ik gebruik maken van: quotes, genoemde EW signs, barrières en volgorde. Vergelijking maken met andere antwoorden.
- Voordat ik dit gebruik zal ik uw uitspraken ter goedkeuring leggen bij u. Als dit langer dan 2 weken duurt ga ik ervanuit dat u ermee akkoord bent.

APPENDIX F:
Case Study Analyses

F1 Analysis case project 1

Table 29 presents the result of the analysis of the first case. In the section afterwards, motivation is provided for every link in the table.

	Filters			
Barriers	1: Surveillance	2: Observer mentality	3: Decision maker mentality	4: Political / power
Over optimism/ optimism bias	Will to use BVP procedure in contracting (i1.1, i1.2), potentially hampered critical monitoring.	'Potentially issues missed due to optimistic thinking in contracting phase' (i1.2); unfinished contract to market. Optimism in project team (i1.4)	'PM optimistic on scope changes, not discussed with project supervisor' (d1.1)	'Desire for consensus in rail sector' (d1.1). pressures decision making on scope changes.
Client-contractor relation		Possibly naivety in emphasis on mutual trust, lack of critical reflection (i1.1, i1.4)	Neglecting of EW signs to preserve good relation with contractor (i1.4)	
Uncertainty avoidance		Hesitance to share signals due to personal consequences (i1.1). Waiting with signal sharing for more certainty (d1.1). Difficulties to substantiate, potentially neglecting (i1.2).	Declining trust between line and project organisation (i1.1).	
Time pressure	Not 'open' for signals due to pushing on schedule (i1.2). Progress not discussed in detail due to full agenda (d1.1)	Signals weakened in project team (i1.2)	'signals that didn't fit were neglected' (i1.2)	
Fragmentation	Previous learnings not sufficiently taken into account (d1.1)			
Management style			Bottom-up steering, potentially missing top-down steering (i1.1). 'Lack of hard project management', lack of critical view on change implementation (d1.1).	'lack of hard project management by Min. of I&M as well' (d1.1)
Project complexity		Complexity of organisation complicates interpretation and communication (i1.4,i1.5)		
Effects of politics		Hesitance to report planning unfeasibility to ministry (i1.4)	Warnings by PM not heard (i1.1,i1.2). Political targets influenced follow-up of signals (i1.4)	Acceleration of project, as part of PHS (d1.2), political pressure on planning in planning phase (i1.1,1.2,1.4).

Table 29: Influence of barriers in case project 1 per filter of the EW procedure

Optimism bias / Over optimism

- *Will to use BVP in contracting (EW sign 5).* According to one interviewee, this potentially hampered critically monitoring the process (i1.1), with an ambitious planning and revised phasing plan at start of project. It was considered to be potentially optimistic to use new contracting in such a complex project (i1.2). This issue is linked to the surveillance filter.
- *Unfinished contract to market*. When the tendering process started, the contract was not worked out in detail (EW sign 8). It was considered that potentially issues were missed by optimistic thinking (i1.2). Since this regards the perception, it is linked to the observer mentality filter.
- *Ambitious planning (EW sign 4).* According to an interviewee, the planning was unfeasible at the moment of contracting (i1.4). Optimistic thinking by the willingness to succeed ('How difficult can it be') had influence.

- *Optimistic on scope changes.* According to the evaluation report, the project team was optimistic on fitting in (scope) changes and their consequences in planning and budget (d1.1). The project manager *'is optimistic on fitting in scope changes'* is given as reason for not discussing scope changes between the PM and the project supervisor of the ministry. This issue is linked to the decision maker mentality filter.
- *Optimism in project team*. 'will be all right' (i1.4). Potentially EW signs have been underestimated and not communicated upwards, and some issues not sufficiently recognised (i1.4). There was a will to not give up on planning (i1.5).
- *Desire for consensus*. According to the evaluation report, there is a desire to consensus in rail sector (d1.1). Project teams and operators, as well as the ministry of I&M. This enabled scope changes initiated by operators 'to enter via a side door' (d1.1). This pressures the decision making, and is interpreted as a political/power filter.

Client-Contractor relation

- *Naivety in observing signals*. A downside of the positive 'BVP (best value procedure) thinking' is potential naivety. Interviewees argued that potentially too much emphasis has been based on mutual trust between the client and contractor in the beginning, whereby naivety played a role at the client side (i1.1, i1.4). Consequently, strategic behaviour from the other side decreases this trust. This issue is linked to the observer mentality filter.
- *Neglecting of signals to preserve relation*. It was indicated that EW signs were observed at the contractor side at the beginning of execution. According to the interviewees, it was tried to bring these issues up for discussion. However, these were neglected in order to maintain the good relation with the contractor (i1.4). This is interpreted as a decision maker mentality filter.

Uncertainty avoidance

- '*Closed culture'.* According to the project evaluation, a 'closed' culture was experienced in the project team (d1.1). In addition, interviewees mentioned that problems in the project possibly caused the team to turn more into itself, creating a 'we vs. them' culture (i1.1).
- *Declining trust between project and line organisation.* According to interviewees, trust between the project organisation and the line organisation was slipping at a certain point (i1.1). This complicates the sharing of signals (filter 3).
- *Pressure on project team.* The project team was under pressure at a certain point, caused by the potential large cost overrun (d1.1). This caused the team to be cautious in their communication. The team wants to be absolutely sure before cost overruns are communicated (d1.1). This is linked to the observer mentality filter.
- *Waiting to report signs, due to uncertainty about effect*. Potentially PM couldn't substantiate signals, causing neglecting or non-communication of signals (i1.1, i1.2). In the evaluation report, this is discussed as the dilemma between early reporting and waiting for more certainty (d1.1). '*Short lines within the ministry make ProRail reserved in reporting signals in an early stage*' (d1.1).

Time pressure

- *Pressure to go to market.* The interest to go to the market was high and put pressure on the project. As a result, the project is tendered with a contract of substandard quality (i1.2). According to interviewees, this had influence on the 'openness' to signals (i1.2). Time pressure partly determined choices in contracting (i1.1).
- *Time pressure influencing communication.* Time pressure had influence on the perception to EW signs, both inside the project team and in communication to higher management (i1.2). Signals that didn't fit were neglected. Internally signals have been weakened, and communication to higher management was reporting a delay not the desired message (i1.2). Multiple warnings have been issued from the PM to the higher management, that have been neglected or not acted upon. Either the signals weren't communicated clear enough, or haven't had the correct follow-up. This is linked to the observer mentality filter.

- *Lack of time to discuss progress*. The evaluation report states that the directors meeting had a full agenda and lack of time to discuss the project progress in detail (d1.1). Furthermore, actions are not always followed-up. This can be interpreted as a surveillance filter.

Fragmentation

- *Learnings from previous projects*. In the evaluation report it is mentioned that the project is unique in its complexity. However, in the past years the ministry is confronted with cost overruns and delays in several other rail infrastructure projects. 'Previous observations, conclusions, and advices are still relevant' (d1.1.). This can be interpreted as a surveillance filter for EW signs. Apparently, learnings from other projects are not sufficiently taken into account.

Management style PM

- *Bottom-up style*. According to interviewees, the management style of the project manager could be characterised as bottom-up. Harmony was considered an important factor in the team. Potentially this type of management has had its effect on the way signals were dealt with (i1.1, i1.2). In a situation with potentially large cost overruns, potentially too little top-down is managed (i1.1). Since this concerns the communication of EW signs, it is linked to the observer mentality filter.
- *Lack of hard project management*. In the evaluation report a 'lack of sufficient hard and pragmatic project management' is discussed (d1.1). This comes up in interviews as well (i1.4). There is lack of critical view on implementation of scope changes. Although the project manager warns the higher management for the influence of these scope changes, no hard deadlines are set. Furthermore, it is mentioned that the ministry is not pressing the brake as well. This is linked to the decision maker mentality filter and political/power filter.

Complexity

- *Internal complexity*. According to interviewees, complexity had effect on interpretation of signals (1.4, 1.5). The complexity of the organisational structure, combined with the quantity of actors complicated the interpretation of EW signs and communication upwards. This is interpreted as an observer mentality filter.

Political effects

- *Political pressure on planning*. The project was accelerated by the parliament (d1.2), and the target was set to deliver the project before 2016 (d1.1). As a consequence of extensive discussions in the initiation phase, it was pushed to meet this deadline by the boards of (i1.1). This planning was perceived by the project team as highly ambitious (i1.1). This political pressure on the project is interpreted as a political/power filter.
- *New plan required*. Simultaneously to the acceleration of the project, the transportation company had declined the initial project plan. In half a year a new plan had to be drawn up, under political pressure of the ministry (i1.2). This disrupted the process of the second phase of contracting (i1.1). This is linked to the political/power filter.
- *Pressure to contracting*. At the start of tendering, warnings have been issued by the project manager that the contract was not ready yet for tendering (i1.2). It was decided to proceed to contracting due to political pressure. This is linked to the political/power filter.
- *Pressure to meet political targets*. According to an interviewee, pressure to make progress in order to meet the political targets influenced follow up on EW signs (i1.4). This is linked to the decision-making mentality filter.
- *Organisational politics*. For both the rail infrastructure managing company and the operator, the planning of 2016 was unfeasible at a certain point. However, both parties were hesitant in reporting this to the ministry, resulting in a political struggle (i1.4). This can be interpreted as limiting the communication of signals to the decision maker, the ministry in this case. Therefore, it is linked to the observer mentality filter.

Communication errors

In addition to the introduced barriers, elements of communication are several times considered as barriers in EW response as well.

- One of the main conclusions of the evaluation report states that the decision making in the project did not always proceed via the agreed line (the directors meeting) (d1.1).
- Furthermore, progress reports from ProRail to the ministry do not always reflect the desired information for decision making (d1.1)
- There is frequent and informal contact between the project manager and ministerial project responsible. According to the report, this consultation helped to make progress but created a 'messy' process of decision making as well (d1.1)
- Before the decision of project initiation is made, it is chosen to redesign the rail-technical design. The consequences of this choice are barely shared with the ministry.

F2 Analysis case project 2

Table 30 presents the result of the analysis of the first case. In the section afterwards, motivation is provided for every link in the table.

	Filters			
Barriers	1: Surveillance	2: Observer mentality	3: Decision maker mentality	4: Political / power
Over optimism/ optimism bias	Signals missed due to wishful thinking at frond-end (i2.2); optimistic thinking at front-end.	Bad start of project will be all right (2010) (i2.1); Risk shifted to client not reported to alderman (d2.1)	Will to start with project, neglecting signals (i2.1); holding on to unrealistic planning (i2.2)	Optimistic in budget tightness, no extra funding requested (i2.1, d2.1)
Client-contractor relation		Difference in project status (d2.1)	Signals from contractor interpreted as opportunistic behaviour, (i2.2).	
Uncertainty avoidance		Not opening up in negotiations (i2.1); progress reports do not reflect situation (d2.1); issues too late reported (i2.1)	Issues 'pushed' to next phase in project (i2.1); Continuation in contracting (i2.1); Unwanted message by politics that planning was not feasible (i2.3); risk negative advice avoided (i2.3)	No extra budget requested (i2.1)
Time pressure	Lack of overview on situation (i2.1, d.2.1)			Continuation of contracting despite only 1 contester (i2.1); No time to replace team members (d2.1).
Fragmentation	Fragmentation of client projects (d2.1); fragmentation of the project (i2.3, d2.1)			
Management style	Organisation of reflection is lacking (i2.1)	No culture of transparency (d2.1); no room for bad news (d2.1)		
Project complexity	Underestimated complexity at frond-end (i2.2)	Complex for client organisation (i2.3)		
Effects of politics			No extra budget requested (d2.1); Unfeasibility planning unwanted message by politics (i2.3).	Not making public negative advice of 'tunnel safety' committee (i2.1); Project could not fail politically(i2.3)
Poor management			'No time to replace teammates' (i2.1)	

Table 30: Influence of barriers in case project 2 per filter of the EW procedure

Optimism bias / over optimism

- *Optimistic image of execution*. In the project planning phase, an optimistic image of the execution is presented in which no 'out of service periods' are required (EW sign 1) (i2.1) (i2.2). According to interviewees, this could have been known beforehand (i2.1). Therefore, it can be interpreted as a filter in surveillance.
- *Optimism in contracting*. Only one contender participated in the tendering, and its offer exceeded the budget (EW sign 9). Interviewees linked this to optimism bias on the feasibility of the project. Both sides have underestimated the risks, and overestimated the project feasibility (i2.3). Lowering the tender price from 55 to 45M is optimistic, since the scope has not been changed (i2.3). Risks shifted from contractor to client side, are not reported to the alderman (d2.1, p.36).
- *Optimistic in budget tightness*. Despite a budget shortage of 16M, no extra funding is requested. According to the evaluation report this was politically not possible (d2.1). Financial cuts are initiated, but the problem is simply pushed forward (i2.1). This can be interpreted as optimism bias at the political/power filter.

- *Holding on to unrealistic planning*. Even though there were signals that the planning to finish in 2010 was unrealistic (EW sign 8), this was still held as deadline. Only four weeks in advance of the out of service period in summer 2010, the contractor reported that it was not feasible. This is optimism bias at both the client and contractor side (i2.3) (i2.1). It is interpreted as a decision maker mentality filter. The evaluation report states in hindsight a high level of optimism in the project organisation, up to wishful thinking (d2.1, p.47).

Client-contractor relation

- *Mistrust in relation*. The evaluation report states that the relation between involved parties is under pressure from the start (d2.1, p.47). Furthermore, it states that the project organisation notes in April 2010 that the contractor is not aware of the planning pressure. This seems to be a difference in project status, and therefore a barrier at the observer mentality filter. According to another interviewee, the contractor did indicate in an early stage that the 2010 summer planning was unfeasible. However, these signals were interpreted by the project organisation as opportunistic behaviour of the contractor (i2.2). This would be a barrier in the decision maker mentality filter (filter 3).

Uncertainty avoidance

- *Problems not reflected in communication*. Both interviewees and the evaluation report indicate that the communication of problems in the run up to the failed out of service works in summer of 2010 is lacking a realistic image of situation (d2.1). This lacking of communication is linked to uncertainty avoidance (i2.1). It is linked to the observer mentality filter.
- *Risk negative advice avoided.* The consequences of another negative advice of the 'tunnel safety' commission are not budgeted (EW sign 4). According to interviewees, this is a choice of the project manager, and resembles uncertainty avoidance (i2.3).
- *Continuation of contracting*. Despite only 1 contender potentially aware of their solitude, and a very high offered budget, the contracting phase is continued. This can be interpreted as uncertainty avoidance, issues are simply pushed to a later phase (i2.1).
- *No extra budget requested.* Despite a shortage of 16M, no extra budget is requested. In addition to optimism bias, this is linked to uncertainty avoidance as well (i2.1), since the issue is simply pushed further in the project. This is interpreted as a political / power filter, since it is steered by political effects.
- *Unwanted message*. Several EW signs indicated the unfeasibility of the planning (EW sign 8, 14). According to the evaluation report, these problems are barely reflected in the communication of the project team towards the board (d2.1, p.42). This is interpreted as an observer mentality filter. On the other hand, according to others, that it was an unwanted message by the higher management. This is uncertainty avoidance steered by political effects. This is interpreted as a decision maker mentality filter.

Time pressure

- *Continuation of contracting*. The choice to continue with the tender is linked to time pressure as well (i2.2, d2.1). The pressure to start with the project was considered significant. Therefore, this is interpreted as a political/power filter. The evaluation report states that in the decision to continue with contracting time pressure on the project played a role: the consequences of stopping would delay the project half a year without guarantee on more interesting parties in a second tender (d2.1, p.35).
- *Lack of overview on situation*. An interviewee links time pressure to blindness in surveillance (i2.1). In the run up to the failed summer works milestones are constantly not met in time (d2.1, i2.1), such as the design specifications (EW sign 15) and the building permit. The reflection on this pattern is insufficiently critical. The evaluation report states that a financial overview is lacking due to insufficient project control. 'Due to work pressure, there is insufficient time for control and critical reflection' (d2.1, p.51).
- *No time to replace employees.* According to the evaluation report, the relation between the project organisation and the engineering company deteriorated at the end of 2009 as a result of mistakes

found by the project organisation in the specifications. However, there is 'no time to replace team members, and solve new mistakes' (d2.1, p.33). This is interpreted as a political/power filter.

Fragmentation

- *Fragmentation of client projects*. The evaluation report notes that DIVV lacks in professionalism as project organisation, resulting in fragmentation of projects. Projects are often developed separately, leaving project managers on their own (d2.1, p.54). This is interpreted as limiting surveillance possibilities for EW signs.
- *Fragmentation of the project*. Both at the client and contractor side, signs of fragmentation of the project within the organisation are visible (d2.1, p.73). The four contracting organisations divided both risks and profit amongst each other (EW sign 12) (i2.3). This influences the communication between the parties, it is therefore interpreted as a surveillance filter. According to the report, the project organisation works in separate groups without much cooperation, and no list of 'possible contract changes' is used (d2.1, p.41). This causes a lack of overview on changes and their consequences for the project.

Management style

- *Organisation of reflection is lacking*. In interviews, the organisation of reflection was linked to management style. The evaluation report mentions a closed culture in the project organisation. This organisation of reflection was considered not well organised (i2.1) This is linked to the surveillance filter.
- *No culture of transparency*. According to the evaluation report, there is little room in the project organisation for bringing bad news (d2.1, p. 47). It states that 'people feel left on their own, not appreciated and working hard without light at the end of the tunnel'. Furthermore, it states that there is no culture of transparency and a 'pleasing' attitude often is taken that blocks focus and pragmatism (d2.1, p.55). This is a consequence of the applied management style. It can be considered as 'poor management' as well. It is linked to the decision maker mentality filter.

Project complexity

- *Underestimated complexity*. In the interviews, the complexity of the project was considered to be underestimated at the start of the project (i2.2). Referred was to the technical complexity of the existing situation, of which a large part was unknown. Furthermore, the organisational complexity of dealing with a lot of actors. However, no stakeholder analysis has been made. Both forms of complexity have potentially limited the surveillance for EW signs.
- *Complex for client organisation*. Another interviewee considered the project too complex for the existing client organisation, influencing their perception on EW signs, (i2.3). It is therefore linked to the observer mentality filter.

Political effects

- *Political pressure to start project*. While existing situation contained a lot of unknowns and asbestos was present, no extra funding was made available to investigate this situation. The political pressure to start with the project was high, since the tunnel would no longer apply with safety regulations (i2.2).
- *Project cannot fail politically.* The image of the project organisation was negative, due to failures in the 'Noord-Zuidlijn' project, another metro project in Amsterdam. Therefore, the political pressure on the project organisation was very high, another project failure was considered not possible (i2.3).
- *Unfeasible planning is unwanted message.* As mentioned, the political pressure to succeed the project was high. According to the interviews, it can be questioned if warning signs regarding these problems have been properly heard (i2.2). These signals were 'unwanted messages' in the politics (i2.3). Therefore, it is linked to the decision maker mentality filter.
- *No extra budget requested.* A new cost estimation in 2009 reports a shortage of 16M (EW sign 5), and initially it is planned to request extra budget. This idea is abandoned for 'strategic reasons', since the ministry had indicated that it had no intentions to facilitate extra subsidy for the subproject (d2.1, p.27). This is interpreted as a decision-making mentality filter, since it is influencing decision-making on EW signs.

F3 Analysis case project 3

Table 31 presents the result of the analysis of the first case. In the section afterwards, motivation is provided for every link in the table.

	Filters			
Barriers	1: Surveillance	2: Observer mentality	3: Decision maker mentality	4: Political / power
Over optimism/ optimism bias		Strong responsibility to solve issues, therefore not always discussed (i3.1). Tunnel vision of people longer in the team (i3.1)	Potentially optimistic towards feasibility of planning (i3.2)	Optimism as part of the planning phase, focus on decision making (i3.1)
Client-contractor relation				
Uncertainty avoidance			Not wanting to 'keep on calculating' (i3.1)	
Time pressure				Momentum for decision making (i3.1, i3.3)
Fragmentation		Different perception due to different people for different project phases (i3.1). Organisational fragmentation hampering communication (i3.2)		
Management style				
Project complexity			Stakeholder and technical complexity influences decision making (i3.1, i3.3)	
Effects of politics		Momentum of sharing EW signs (i3.2)	Pressure on budget at front-end (i3.1).	Political window of opportunity influencing decision making (i3.1)

Table 31: Influence of barriers in case 3 per filter of the EW procedure

Optimism bias / over optimism

- *Strong feeling of responsibility to solve issues.* In the project team, a strong feeling of responsibility to solve issues is present. This is mainly positive thing. However, it sometimes limits sharing of signals (i3.1).
- *Optimism towards feasibility of planning.* New estimated planning shows setbacks. When compared with people their thoughts of planning feasibility, potentially too optimistic towards feasibility of the planning in decision making (i3.2).
- *Part of planning phase.* It was noted by an interviewee that optimism is naturally part of the planning phase. There is a strong focus on decision making. Perception about solvability EW signs is optimistic (i3.1).

Client-contractor relation

For the client-contractor relation factor, no effects have been found. This is logical, since the project is in the planning phase, thus the execution has not been awarded to contractors.

Uncertainty Avoidance

- *Not wanting to keep on calculating.* It was noted by an interviewee that sometimes there is a certain fear to keep on calculating, mainly by decision makers. When uncertainties and worries are piled up, nobody will want to start a work. This is related to optimism as well.

Time pressure

- *Momentum for decision making.* Time pressure was noted to have influence on the decision making (i3.1, i3.3). Partly as part of the current phase (planning phase), not all solutions are worked out in detail, leaving uncertainties. While time pressure for decision making is present. Also, in the initiation

phase at budget estimation of the project this played a role (i3.3). It would have cost a lot of time to calculate the project in detail at front-end.

Fragmentation

- *Of project: different people per phase.* It has been noted that fragmentation plays a role over the different phases of the project, as it happens in most large projects (i3.1). In the planning phase, the decision for execution is made, along with acceptance of uncertainties. However, the uncertainties are still present. Due to switches in the project, the collective memory fades. This is linked to the decision maker mentality filter.
- *Organisational fragmentation.* A certain fragmentation of the client organisation has been noted as well (i3.2). Different parts of the organisation have their own targets to meet. Therefore, integral balance of interests is sometimes lacking. This makes sometimes sharing of EW signs difficult, in the sense that signals are there, but people don't know where to bring them. This is linked to the observer mentality filter.

Management style

Management style has not been experienced as a barrier in dealing with EW signs. Interviewees noted a very open management style, in which it is actively stimulated to share signals.

Project complexity

- *Decision making influenced by stakeholder complexity.* It was noted that complexity influences decision making on EW signs (i3.1, i3.2). Due to a wide variety of stakeholders with different interests, it is sometimes impossible to compromise. This is linked to the decision maker mentality filter.
- *Budget estimation.* Due to the complexity of the project, it has been found difficult to estimate the project costs at front-end of the project (i3.3). Therefore, it has been only roughly estimated.

Political Effects

- *Pressure on budget in frond-end:* Original budget was 40-60M. But first estimate of project team in 2012 was 500M. this was an unwanted message politically. Stimulated to find a variant for around 100M.
- *Political window influencing decision making.* It was noted that political effects have influence on the momentum for EW signs (i3.1) (filter 4). There is a pressure on decision making when budget is available, as in many large projects. But, decisions have to be taken, even though uncertainties on EW signs remain. This influences the message to the politics as well (filter 3)
- *Momentum of sharing EW signs.* It was noted that sometimes it is a balance in finding the right momentum to share EW signs to politics (i3.2). Although the project aims to share all signals, overloading politics with signals was found to be destructive for the process. Therefore, a balance in sharing EW signs has to be made sometimes. This is interpreted as observer mentality filter, whereby decision maker is represented by client organisation and politics.

F4 Cross-case analysis

This appendix elaborates on the cross-case analysis, of which the result is presented in section 5.7. Per factor, the links with each filter will be discussed. The information from the three discussed cases is combined. Furthermore, information from the expert interviews is included as well. It is included when a link has been explicitly discussed by the expert in the interview.

In the table (Table 32), information from that cases is noted with '(case #)'. Information from the expert interviews is noted with '(i#)'.

	Filters			
Barriers	1: Surveillance	2: Observer mentality	3: Decision maker mentality	4: Political / power
Over optimism/ optimism bias	Signals missed due to wishful thinking and tunnel vision on the project (case 1,2) (i1)	EW signs overlooked, underestimated, not communicated or neglected due to optimistic perspective (case 1,2,3) (i3,i5,i7);	EW signs neglected or underestimated in decision-making while optimisation possibilities are overestimated. (case 1,2,3) (i5,i6)	Pressure on decision making by wishful thinking, desire for consensus, or planning feasibility (case 1,2,3)
Client-contractor relation	Naivety in too much emphasis on mutual trust, missing EW signs (i2)	Difference in project status (case 2); perception on EW signs guided by too much mutual trust (case 1) or mistrust (i2,i6)	EW signs from contractor interpreted as opportunistic behaviour (case 2) (i6); or neglecting of EW signs to maintain good relation with contractor (case 1).	Bad relation with contractor limits response possibilities. (i7)
Uncertainty avoidance	-	Hesitance or reluctance to share EW signs due to personal consequences, uncertainties about consequences of sharing, or deliberately waited. (case 1,2) (i2,i6,i7)	EW signs bringing new uncertainties neglected or avoided, unknown consequences (case 2) (i1,i2,i6); issues pushed to a later project stage (case 2);	Pressure on decision making EW signs as unwanted messages by higher management or politics. (case 2)
Time pressure	Lack of time taken for reflection, leading to missing EW signs. (case 1,2) (i6,i7)	Less receptive for EW signs, signals avoided or weakened in communication (case 1) (i4)	EW signs as unwanted message 'don't fit' in pressured planning, therefore neglected. (case 1) (i1)	EW sign neglected or deliberately not acted upon due to time pressure (case 2,3) (i2)
Fragmentation	Fragmentation of projects (case 1,2) (i4,i5,i6), or fragmentation of the project limiting EW surveillance (case 2) (i6)	Fragmentation hampering communication of EW signs (case 3)	-	-
Management style	Style of management lacks organised bottom-up reflection, EW signs missed. (case 2)	Too much focus on consensus (bottom-up) (i2), or too much top-down steering limiting EW communication. (case 2) (i6,i7)	Too much top-down steering, 'nothing is heard bottom-up'. (i6,i7) Or non-decisiveness, lack of critical project management. (case 1)	-
Project complexity	EW signs missed due to underestimated complexity or lack of overviews, unknowns, limiting surveillance of EW signs. (case 2) (i2,i4,i6,i7)	Interpretation and communication of EW signs complicated by organisational complexity (case 1,2) (i5,i7)	Decision making on EW signs complicated due to stakeholder complexity in the project (case 3)	-
Effects of politics	-	Hesitance in reporting or consideration in moment of reporting of EW signs due to political effects. (case 1,3) (i5)	EW signs unwanted message by politics (case 2), no political window (i5), or not heard by management due to organisational politics. (case 1) (i6)	Political pressure limit ability to take action. (case 1, 3) (i7)

Table 32: Cross-case analysis, supplemented with information from expert interviews

Optimism bias / over optimism

- *Filter 1:* Both in case 1 and 2 it has been observed that wishful thinking potentially has had influence on the surveillance for EW signs. Furthermore, in the expert interviews it has been mentioned that tunnel vision can influence the surveillance for EW signs (i1). For this filter, it can be concluded that EW signs can be missed due to wishful thinking and tunnel vision on the project.
- *Filter 2:* In both case 1 and 2 signs of optimistic perception towards EW signs has been observed, leading to either missing, underestimating, or neglecting of signals. In case 3 it was noted that signals were not always communicated, linked to optimism. In the expert interviews it has been explicitly noted as well that optimism can have influence on the way we receive and communicate EW signs (i3, i5, i7). For this filter, it can be concluded that EW signs can be overlooked, underestimated or neglected due to an optimistic perspective
- *Filter 3:* In case 1,2 and 3 it has been observed that EW signs potentially can be neglected or underestimated in decision-making due to optimism bias. In expert interviews this has been remarked as well (i5, i6). For this filter, it can be concluded that EW signs can be underestimated or neglected in decision-making, while optimisation possibilities are overestimated.
- *Filter 4:* In case 1,2 and 3 signs have been observed of either optimism bias putting pressure on decision making, desire for consensus or planning feasibility. In can be concluded that optimism bias can influence the decision-making process by pressure on decision making or planning feasibility, or desire for consensus.

Client-contractor relation

- *Filter 1:* In expert interviews it has been remarked that when too much emphasis is based on mutual trust in the relation, EW signs can be missed (i2). This is linked to the surveillance filter.
- *Filter 2:* In case 1 it was noted that potentially emphasis on mutual trust influenced perception on EW signs. In case 2 a difference in perception between client and contractor in project status has been noted. Furthermore, in the interviews it was noted that mistrust in this relation steers the perception on EW signs. For this filter, it can be concluded that perception on observed EW signs can be influenced by a difference in project status, mistrust, or too much emphasis on mutual trust.
- *Filter 3:* In case 1 it was remarked that EW signs could have been neglected in order to preserve a good relation with the contractor. In case 2 it was noted that EW signs from contractor side have been interpreted as opportunistic behaviour. The latter was mentioned by an expert as well as influencing for EW signs (i6). For this filter it can be concluded that EW signs can be neglected due to interpretation as opportunistic behaviour, or to preserve relation a good relation.
- *Filter 4:* In an expert interview it has been remarked that the relation between client and contractor can have influence on the response on EW signs. In order to follow-up a response at the contractor's side, a healthy relation is required (i7). It can be concluded that decision making on a response can be influenced by the client-contractor relation.

Uncertainty Avoidance

- *Filter 2:* In case 1, a hesitance to share signals due to personal considerations has been noted, as well as a choice to wait with EW signs for more certainty. This hesitance in communication was recognised in interviews as well (i2, i6, i7). In case 2 this waiting is noted as well. Furthermore, communication on EW signs lacked in some cases. For this filter, it can be concluded that a hesitance or reluctance to share EW signs can exist due to personal consequences, uncertainties about consequences, or deliberately waiting.
- *Filter 3:* In case 2 it was noted that issues were pushed to the next project phase. Furthermore, EW signs were perceived as unwanted messages and avoided or neglected. The latter was recognised in interviews with experts as well (i1, i2, i6). In case 1 declining trust potentially had influence on EW signs to come up to line organisation. For this filter it can be concluded that EW signs can be neglected or avoided by the decision maker due to the uncertainties they bring, or simply pushed to later project stages.
- *Filter 2:* In case 2 uncertainty avoidance was linked to filter 4 by pressure from politics. It can be concluded that pressure on decision making by higher management can cause uncertainties of EW signs to become unwanted messages and therefore avoided.

Time pressure

- *Filter 1:* In case 1 a lack of openness to EW signs was noted, in case 2, a lack of overview of the situation. Time pressure causing less time to reflect on EW signs was noted by an expert as well (i6, i7). It can be concluded that EW signs can be missed due to lack of time taken for reflection.
- *Filter 2:* In case 1 it was noted that time pressure can influence communication of EW signs. It can be concluded that
- *Filter 3:* It was noted in case 1 that EW signs can be neglected due to time pressure. This has been remarked in interviews as well (i1).
- *Filter 4:* In case 2 and 3 it has been observed that final responses to EW signs can be blocked due to time pressure. This was noted in interviews as well (i2).

Fragmentation

- *Filter 1:* In case 1 the effect of fragmentation was noted on learnings of EW signs. This was noted in interviews as well (i4, i5, i6). In case 2 it was observed that both fragmentation of projects and fragmentation of the project can influence surveillance for EW signs. Fragmentation of the project was indicated as limiting in interviews as well (i6). For this filter, it can be concluded that both fragmentation of projects as fragmentation of the project can limit surveillance for EW signs.
- *Filter 2:* In case 3 it was observed that fragmentation of the client organisation can influence communication on EW signs. For this filter, it can be concluded that fragmentation can hamper communication on EW signs.

Management style

- *Filter 1:* In case 2 it was observed that a management style can limit the organisation of reflection.
- *Filter 2:* In case 2 it was observed that management style can influence the communication of EW signs. Furthermore, in interviews was noted that communication can be hampered by to too much focus on consensus, or employees not feeling heard (i2, i5, i6).
- *Filter 3:* In case 1 it was observed that a management style can influence the perception of the decision maker (project manager) in decision making, by not enough top-down project management. Furthermore, in interviews it was noted that too much top down steering can limit EW signs to come up (i4, i7).

Project complexity

- *Filter 1:* In case 2 it was indicated that the surveillance for EW signs can be limited due to underestimation of complexity, when for example stakeholders are not mapped. In interviews it was noted as well that complexity can influence surveillance for EW signs (i2, i4, i6). For this filter it can be concluded that EW signs can be missed due to underestimation of complexity.
- *Filter 2:* Both in case 1 and 2 it was observed that complexity can have influence on the interpretation and communication of EW signs. It was remarked in an expert interview that complexity can block an EW sign to come up via the right organisational lines (i5), and influence interpretation of the signs (i7). For this filter, it can be concluded that interpretation and communication of EW signs can be complicated by organisational complexity.
- *Filter 3:* In case 3 it was noted that decision making on EW signs can be complicated due to difference in stakeholder interests, therefore difficult to reach a decision. It can be concluded for this filter that decision making on EW signs can be complicated due to stakeholder complexity.

Effects of politics

- *Filter 2:* In case 1 it was noted that political effects can cause a hesitance to report signals. In case 3 it was observed that political effects can cause consideration in the moment of communication of EW signs. Furthermore, an expert indicated that political effects can limit communication of EW signs in front-end of the project (i5). For this filter, it can be concluded that political effects can influence EW signs to be reported or the moment chosen to be reported.
- *Filter 3:* In case 1 it was observed that political effects can influence the perception of the decision maker on EW signs. In case 2 it was noted that the EW signs can be perceived as unwanted message by politics, therefore influencing decision-making. In case 3 it was noted that political effects can put pressure on decision making on EW signs in front-end of the project. An expert noted that political

effects determine if an EW sign find 'political breeding ground' (i5), thus the perception of the decision maker. Another expert noted that if EW signs are taken into account depends on organisational politics in the project as well (i6). For this filter, it can be concluded that political effects can influence the decision-making process as unwanted message, internal politics, or no political window.

- *Filter 4:* In case 1 it was observed that political pressure can influence actions taken regarding EW signs. In case 3 it was noted that absence of a political window can limit the ability to take action. Furthermore, in an interview it was noted that in order to take action on EW signs, political will is necessary by for example aldermen (i7). For this filter, it can be concluded that political effects can influence the ability to take action on EW signs.

APPENDIX G:
Expert session 2

G1 Participants

	Name	Organisation
1	Pelle de Wit	AT Osborne
2	Frank Jacobsen	AT Osborne
3	Pau Lian Staal	AT Osborne
4	Mark Roelofsen	AT Osborne
5	Werner Plekkenpol	AT Osborne
6	Sandra Brouwer	AT Osborne
7	Alex Miggelenbrink	AT Osborne
8	Eddy Westerveld	AT Osborne
9	Jeroen Brinkman	AT Osborne
10	Reijer Baas	AT Osborne
11	Gerard Scheffrahn	AT Osborne
12	Floris Bakemans	AT Osborne
13	Tom Kremers	AT Osborne

Table 33: Participants of expert session 2

G2 Program

Programma – Sessie: Omgaan met Early Warning signs						
Tijd	***Leerdoel/Onderwerp***	***Wie***	***Werkvorm***	***Hulpmiddel***	***Aandachtspunten***	***Extra***
09:30	Voorbereiden					
10:00 [5 min]	Inloop					
15:05 [5 min]	Uitleg doel vandaag, en introductie onderzoek	N	Presentatie	Ppt		
15:10 [10 min]	Uitleggen werkvormen	N	Presentatie	Ppt		
10:20 [5 min]	Presentatie ronde 1	N	Presentatie			
10:25 [25 min]	Ronde 1 *Doel: aanbevelingen voor ophalen van EW signs*	D	Markt rotonde; 4 groepjes van 3. Door wisselen langs 2 posters.	4 posters: Per poster: 2 minuten brainstorm 3 minuten discussie Dan 1 punt opschrijven	Na 5 minuten doordraaien (2 rondes, dus 1x doordraaien)	Bij tijd over: mini wrap up aan het eind ronde
10:50 [5 min]	Presentatie ronde 2	N	Presentatie			
10:55 [25 min]	Ronde 2 *Doel: aanbevelingen in communiceren van EW signs*	D	Markt rotonde; 4 groepjes van 3. Door wisselen langs 2 posters.	4 posters: Per poster: 2 minuten brainstorm 3 minuten discussie Dan 1 punt opschrijven	Na 5 minuten doordraaien (2 rondes, dus 1x doordraaien)	Bij tijd over: mini wrap up aan het eind ronde
11:20 [5 min]	Presentatie ronde 3	N	Presentatie			
11:25 [25 min]	Ronde 3 *Doel: aanbevelingen in actie op EW signs*	D	Markt rotonde; Vrij: poster kiezen waar je iets over kan zeggen; dit doen we 2 keer.	2x3 posters: Per poster: 2 minuten brainstorm 3 minuten discussie Dan 1 punt opschrijven	Na 5 minuten doordraaien (2 rondes, dus 1x doordraaien). Bij meer tijd doen we er nog een	Bij tijd over: mini wrap up aan het eind ronde
11:50 [5 min]	Wrap-up - Samenvatten - Terugkomen op random poster	ND				

Table 34: Program of session 2

G3 Impression

Figure 36: Impression of expert session 2

Early Warning signs are indications for future project problems. Project organisations typically struggle in acting upon these signs. Barriers such as time pressure and optimism bias limit the ability to respond. How do these barriers work, and how can we make better use of early warning signs?

These questions are the subject of this research. It is conducted in order to receive the degree of MSc Construction Management and Engineering at the Delft University of Technology, and in collaboration with AT Osborne. I want to thank my supervisors and all others involved in the process to shape this thesis, and I hope you will enjoy reading it!

Noud Wijtenburg
Construction Management and Engineering
Delft University of Technology
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