From Trigger to Action

Research on risk causes and response measures in Dutch public construction projects

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by

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Preface

This thesis is the final part of my Master's degree in Construction Management and Engineering at Delft University of Technology. The research was conducted in collaboration with the Dutch Central Government Real Estate Agency (*Rijksvastgoedbedrijf*) and focuses on how risks are documented and addressed in Dutch public construction projects. Through the analysis of risk registers and expert input, this study aims to better understand how uncertainty is handled in practice and how structured approaches can support decision-making.

Writing this thesis has been a learning process in many ways. It challenged me to stay focused and keep going during uncertain moments. Along the way, it also helped me to see how important it is to work step by step, ask the right questions, and use feedback to improve my work.

I would like to sincerely thank my graduation committee at TU Delft, Marian Bosch-Rekveldt, Jelle Koolwijk, and Marleen Hermans, for their guidance, feedback, and critical questions throughout the research process. Your input and support helped me develop new ideas and improve the quality and focus of this thesis.

Lastly, I want to thank my supervisor at Rijksvastgoedbedrijf, Stefan Spansier, for this opportunity and for sharing valuable insights along the way. I also would like to thank the three experts who participated in the expert meeting for their time, openness, and thoughtful reflections.

I hope you enjoy reading this thesis and that it helps you better understand how uncertainty and change are handled in Dutch public construction projects, and how risk registers can support more structured responses in practice.

Annelieke Kok

Delft, March 2026

Abstract

Public construction projects take place in dynamic multi-actor environments in which uncertainty, changing conditions, and interdependencies can put project objectives under pressure. Although risk registers are widely used to document and manage risks, they are not always written consistently, and links between causes and response measures are often not made explicit. This limits their comparability, learning potential, and practical usefulness.

This thesis examines how risk causes are related to response measures in Dutch public construction projects, using pre-construction risk registers as the empirical dataset. The study combines a focused literature review, thematic analysis of the risk registers, and an expert meeting with three project control managers.

The findings show that the literature provides a useful starting point for structuring recurring risk causes, but that additional refinement is needed to reflect practice. The thematic analysis resulted in practice-based categorizations for risk causes, risk events, and response measures, and showed that causes and measures are related through recurring links. Rather than pointing to fixed response rules, these recurring links suggest three broader cause–measure pattern types, namely focused cause–measure patterns, dispersed cause–measure patterns, and broad linking patterns.

Overall, the thesis shows that broad recurring cause–measure patterns can be identified in risk registers through structured analysis, and that clearer categorization and recording practices can strengthen the value of the risk registers for comparison, learning, and improvement in public construction projects.

Keywords:

Risk management, Risk registers, Public construction, Risk causes, Response measures

Executive summary

Background and context

Public construction projects are delivered in dynamic settings with many actors, where unexpected events or changing conditions can lead to project changes. These changes often increase coordination needs, put time, cost, and quality under pressure, and can cause rework, delays, and cost overruns. Complex public construction projects often use integrated contracts, where closely connected responsibilities mean that changes in one area can quickly affect others. Managing risks effectively is therefore essential, yet current risk management practices remain inconsistent, as reflected in ongoing delays and budget overruns.

Research objective and question

This thesis aims to strengthen risk management in Dutch public construction projects by clarifying how risk causes and response measures are documented in practice and how they relate to each other. By doing so, the study supports more consistent and practical use of risk registers, so that teams can select and document measures in a clearer and more comparable way across projects. This leads to the main research question:

How are risk causes related to response measures in Dutch public construction projects?

Theoretical background

Project research often distinguishes between foreseen risks (risks that can be identified in advance) and unforeseen risks (risks that arise unexpectedly). Risk registers mainly document the foreseen risks that teams can already describe during planning. This is why this thesis focuses on foreseen risks and on the response measures that are planned to address them.

Project research also notes that causes, events, and effects are often mixed up in the literature. To avoid this, the thesis uses one consistent structure that separates the three elements:

As a result of <definite cause>, <uncertain event> may occur, which would lead to <effect on objective(s)> ~Hillson 2000

Methodology

This research combines a focused literature review, a thematic analysis of risk registers and an expert meeting. The selected risk registers all come from Dutch public construction projects with integrated contracts and are chosen using predefined criteria to ensure a comparable context. The risk registers are coded in Atlas.ti using an iteratively refined codebook that separates causes, risk events, and response measures. The analysis then used both frequency analysis and co-occurrence analysis to identify recurring categories and recurring documented links between causes and measures.

Results

The study shows that the literature provides a useful starting point for structuring recurring risk causes, but that refinement is needed to reflect how causes and response measures are documented in practice. This resulted in practice-based categorizations for risk causes, risk events, and response measures.

The analysis also identified recurring documented links between risk causes and response measures across the risk registers. These links do not suggest fixed response rules, but rather broader cause–measure pattern types, including focused cause–measure patterns, dispersed cause–measure patterns, and broad linking patterns. The expert meeting largely recognised these broader pattern types, while also stressing that they should be interpreted with care, because differences between projects may reflect both actual project context and differences in documentation quality.

Limitations

The findings should be interpreted in light of several limitations. The study uses nine risk registers from integrated contract projects in the pre-construction stage, so results are therefore context-specific and not directly generalisable to other project types, later phases, or other contract forms. Risk registers also differ in structure and level of detail, and writing quality, so some variation may reflect documentation style rather than project conditions. Finally, the analysis relies on qualitative coding and category development, which involves interpretation despite iterative refinement and expert input.

Conclusion

Based on the focused literature review, the thematic analysis of nine risk registers, and the expert meeting, this thesis concludes that risk causes and response measures in Dutch public construction projects are related through recurring documented links that together point to broader cause–measure pattern types in the risk registers. These recurring links become visible when causes and measures are described and grouped in a consistent way. The construction literature provides a useful basis for structuring risk causes, but the risk registers data require a more practice-based refinement to reflect what is documented in a public, pre-construction context. Within that context, the risk registers suggest that causes are followed by specific measures, but inconsistent writing and unclear separation between causes, risks, and measures reduce how well patterns can be identified and compared across projects. Overall, the study shows that risk registers can reveal broad recurring cause–measure patterns, and that clearer categorisation, linking, and recording practices can strengthen their value for comparison, learning, and improvement in public construction projects.

Recommendations for practice

Based on the findings and the expert meeting, five practical improvements are recommended to support a more consistent and comparable use of risk registers in public construction projects:

1. Adopt a shared structure and shared definitions for writing risk registers.
2. Use the developed categorizations as a shared reference list.
3. Make cause–measure links explicit in the risk registers.
4. Link risk causes more explicitly to project phases and types.
5. Set light requirements on the desired level of detail and quality of the risk registers.

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Glossary

(Cause-measure) Pattern: recurring and recognisable regularities across multiple projects in how risk causes are linked to response measures in risk register entries.

Broad linking pattern: a recurring pattern type in which certain response measures are repeatedly linked to many different causes in the analysed risk registers and therefore seem to be broadly applicable responses.

Co-occurrence: an analytical count of a coded cause–measure relation, recorded when a response measure is linked to a coded cause within the same coded risk description.

Codebook: a structured set of coding categories used to code causes, risk events, and response measures consistently across the risk registers.

Dispersed cause–measure pattern: a recurring pattern type in which the same cause is addressed through a wider range of different response measures in the analysed risk registers.

Effects: unplanned variations from project objectives, either positive or negative, which arise as a result of risks occurring.

Focused cause–measure pattern: a recurring pattern type which the same cause is repeatedly linked to only one or a limited number of different response measures in the analysed risk registers.

Foreseen risks: risks that can be identified and described in advance.

Literature-based categorization: a categorization of risk causes developed from peer-reviewed construction literature and used as a structured starting point for the risk register-based categorizations.

Pattern identification approach: the structured analytical approach used in this thesis to identify recurring cause–measure patterns in risk registers.

Response measures: planned actions, controls, or arrangements to address identified risks, by reducing likelihood and/or impact.

Risk causes: definite events or sets of circumstances that exist in the project or its environment, and which give rise to uncertainty.

Risk events: uncertain events or sets of circumstances that, if they occur, would affect the project objectives.

Risk register-based categorization: a categorization developed from the analysed risk register data and refined to fit how causes, risk events, and response measures are documented in the registers.

Risk register: a structured project document used to record, review, and update identified risks over time.

Thematic analysis: a qualitative analysis approach in which text is systematically coded and grouped into categories, using an iteratively refined codebook to support comparison across documents.

Unforeseen risks: risks that arise unexpectedly and cannot be fully anticipated or specified in advance.

1 Introduction

1.1. Background and context

The construction sector delivers the buildings and infrastructure that support daily economic and social activity. Public construction projects translate public ambitions and user needs into physical assets with long life cycles. Such projects take place in dynamic, multi-actor settings, where responsibilities, priorities, and constraints are spread across many parties, and stakeholder influence can shift as the project moves through different phases (Aaltonen and Kujala 2010; Lafhaj et al. 2024). In recent years, projects have also become larger and more complex, which increases the chance that external developments, stakeholder decisions, and technical interfacing issues affect delivery (Lafhaj et al. 2024).

In this dynamic environment, events or conditions can lead to changes in the project. A change refers to any deviation from the agreed scope, specification, or methods that requires adjustments to plans, contracts, or resources. Such changes rarely remain local, they can spread across interfaces, increase coordination work, and slow down information flows (Ismaeil and Sobaih 2024). Because these changes can threaten time, cost, and quality objectives, they are often managed and discussed in terms of project risks.

When such risk events occur, they often generate rework, which is a major cause of time and schedule overruns in projects (Love and Edwards 2004). Even relatively small projects experience these unwanted effects, such as cost and schedule growth (Shrestha and Maharjan 2019). Therefore, delivering these projects successfully is difficult, even when the initial plan is sound, because complexity and uncertainty make planning and control harder during execution (Lafhaj et al. 2024).

1.2. Problem definition

As mentioned, construction projects take place in dynamic multi-actor settings in which project conditions and decisions evolve over time (Sun and Meng 2009). In such settings, risks can emerge in different phases and across interfaces between parties (Nyqvist et al. 2024). These risks are often linked to a wide range of underlying causes, such as changing stakeholder requirements, design clarifications, supply constraints, regulatory updates, and site conditions (Khalifa and Mahamid 2019; Sambasivan and Soon 2007).

It is important for successful delivery to handle these risks as effectively as possible. Some measures can reduce the probability and impact of the risk, while team adaptation is critical for handling risks after they occur (Nyqvist et al. 2024; Baard et al. 2014). However, recent empirical work shows that risk management is still not used in a consistent way. Organizations differ in how they manage risks, and project teams do not always follow risk management steps in a structured way (Masár et al. 2022). In addition, current research argues that risk management can become too focused on individual risk events, while broader evolving uncertainty, and the links between causes, risks and effects remain insufficiently addressed (Nyqvist et al. 2024). These limitations are reflected in continuing schedule delays and budget overruns, suggesting that current practices for identifying, classifying, and responding to risks and their underlying causes remain suboptimal (Khalifa and Mahamid 2019).

1.2.1. Research gap

Despite much research on causes, risks, changes, and their unwanted effects, important gaps remain.

First, the translation of literature-based risk cause taxonomies to practice is still limited. Existing taxonomies in literature group causes at a general level, but there is little empirical evidence on how these categories appear in real project risk registers, and whether these taxonomies align with daily work (Sun and Meng 2009; Birgönül et al. 2024).

Second, structured risk identification in practice remains under-studied and underdeveloped. Prior studies describe that risk identification outcomes can vary strongly between projects and remain rather ad hoc, even when similar tools, such as risk registers, are used (Dicks and Molenaar 2024). However, research on how risk identification and documentation practices can be made more structured and advanced remains limited.

Third, research on risk responses often remains at a high level of abstraction. Common response strategy frameworks describe response intents and types, but provide limited insight into which concrete response measures are implemented and how response measures are formulated and categorised in practice (Hillson 1999; Fan et al. 2008; P. Love et al. 2023).

Finally, the link from specific causes to risk responses is still weak. Prior studies identify common risk causes and report broad response themes, but rarely connect a specific cause to concrete response measures, nor test how consistent those response measures are recorded across projects (Assaf and Al-Hejji 2006; Sambasivan and Soon 2007; Khalifa and Mahamid 2019).

1.2.2. Problem statement

There is insufficient, empirically validated knowledge on how risk causes relate to the concrete response measures recorded in risk registers of Dutch public construction projects.

1.3. Research objective

This research aims to strengthen the way risks are managed in public construction by developing a better understanding of what causes these risks and how teams manage them in practice. It clarifies what is meant by risk causes and response measures in a construction context and relates this to insights from the academic literature. The focus is on making the cause–measure relation more explicit, so that risk handling becomes more specific, consistent, and easier to apply across different projects and teams.

A further objective is to support a shared, construction-specific language for describing risk causes and response measures, so that this information can be interpreted easier and used more consistently.

Because risk registers are widely used to document causes, risks, effects, and response measures, this research also aims to improve the practical value of these registers. The aim is to make them more reliable, more comparable across projects, and more action-oriented by supporting more consistent recording and use of cause–measure information in day-to-day risk management.

Ultimately, the goal is to contribute to better project outcomes of public construction projects, with fewer delays, less rework, and lower avoidable costs.

1.4. Research question

The following main research question can be formulated:

How are risk causes related to response measures in Dutch public construction projects?

The sub-questions to answer the main research questions are:

1. *Which risk causes recur in construction literature, and how can they be categorized?*
2. *Which risk causes recur in risk registers of Dutch public construction projects, and how can they be categorized?*
3. *Which recurring cause-measure patterns can be identified in risk registers of Dutch public construction projects?*
4. *How can recurring cause–measure patterns be identified in risk registers of Dutch public construction projects?*

1.5. Relevance of the study

This study has scientific relevance by contributing to construction risk management literature on how risk information is documented and analysed, and it has practical relevance for clients and project teams that use risk registers in public construction projects with integrated contracts.

1.5.1. Scientific relevance

Scientific relevance relates to how this study contributes to knowledge and research methods on construction risk management.

First, the study contributes empirical evidence on the translation from literature to practice by examining how literature-based cause taxonomies relate to what is actually recorded in real project risk registers. This responds to the gap that taxonomies are often proposed at a general level, while empirical validation in real registers remains limited.

Second, the study contributes to research on risk identification and documentation practices by developing and testing a structured, repeatable approach for analysing risk register data. This adds a methodological basis to the literature for systematically examining how risks, causes, and response measures are documented and linked in practice.

Third, the study extends prior work, that mostly discusses risk responses as high-level strategies, by focusing on concrete response measures, and by showing how these measures can be formulated and categorised. This provides empirical insight into how risk responses are recorded in practice beyond response intent or response type.

Finally, the study addresses the gap that the link from specific causes to responses is often weak by examining documented cause–measure relations in practice. Prior studies identify common risk causes and report broad response themes, but rarely analyse how specific cause types are linked to concrete response measures in project documentation. This study adds empirical evidence on how such links are recorded in risk registers.

1.5.2. Practical relevance

Practical relevance relates to how this study supports public clients and project teams in using risk registers more consistently and comparably.

This research adds practical value by providing actionable insights into how risk causes are recognised and how response measures are recorded and used in practice. It emphasises the importance of using clear terminology, consistently separating causes, risk events, and response measures, and improving the overall consistency and quality of risk register entries. By supporting a more shared and structured way of documenting risks and responses, the study helps reduce ambiguity in how risk register content is formulated across projects and between teams.

These insights can help public construction projects that work with risk registers develop a shared language for causes, risks, and measures, supporting more consistent and effective use of risk registers across projects. This also supports cross-project learning by making it easier to compare projects, recognise recurring situations, and reuse lessons learned in new projects. Overall, this strengthens the potential of risk registers as a practical management instrument and as a basis for learning within public construction projects.

1.6. Research scope and outline

1.6.1. Scope

This research examines risk causes and response measures in Dutch public construction projects. The study focuses on public construction projects that are complex and long in duration, so there is sufficient variety in risk causes and response measures to study.

The analysis concentrates on how risks are handled in public construction projects that are currently still in the pre-construction stages (initiative, definition, and procurement phases). At this early stage, many issues remain uncertain, and risk registers are actively used to identify and document risks. Using risk registers from the same phases supports comparability between projects.

To keep another element consistent, the analysed projects are managed with IPM-teams, a client-side project organisation model used for integrated contracts. An IPM-team combines five roles within one client team: project management, contract management, technical management, environment management, and project control. Each role in an IPM-team faces different interfaces where risk causes can arise, such as scope, stakeholders, procurement, technical quality, planning, and cost.

The findings of the research are intended to be applicable to public construction projects with similar characteristics. These include projects that use risk registers, are of comparable complexity and duration, are still in the early project stages, and use an integrated contract with an IPM setup.

1.6.2. Thesis outline

Figure 1.1 shows the outline of the thesis and how the document is structured. Each analysis step is explained in more detail in the methodology chapter. The research design in the methodology (figure 3.1) shows how these steps relate to the main and sub-research questions and how they are addressed.

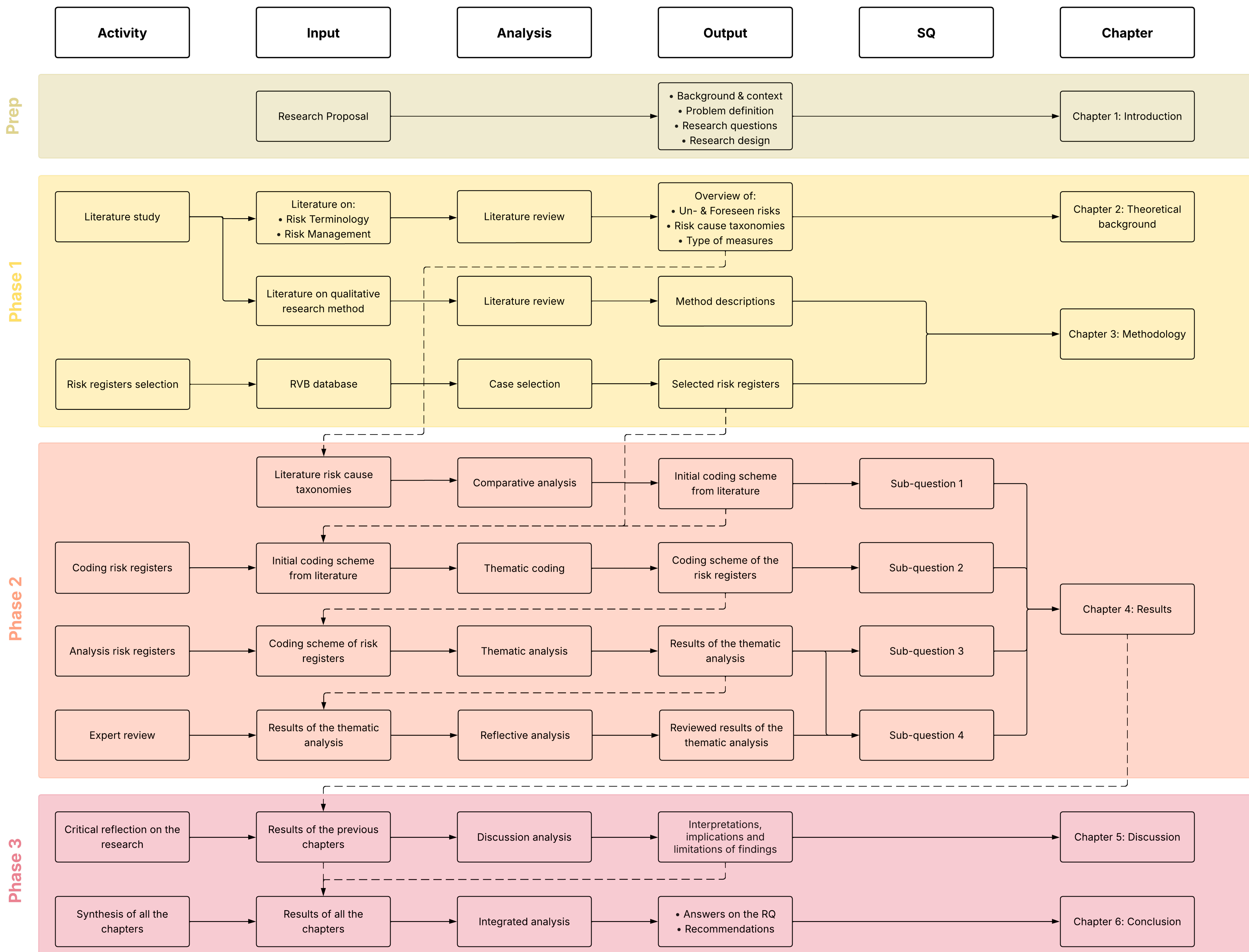

Figure 1.1: Thesis outline

2

Theoretical background

2.1. Risks in the construction industry

Construction projects are widely described as complex systems rather than linear production processes (Baccarini 1996). A classic definition frames project complexity as a function of differentiation (many different elements) and interdependency (many links between elements), which increases the need for coordination and integration (Baccarini 1996). In construction, this complexity comes from a mix of technical work, organisational arrangements, and multiple stakeholders that interact over the project life cycle.

Alongside complexity, construction projects are characterized by uncertainty. Uncertainty arises because conditions can change over time, and not all cause–effect relationships are fully known in advance (Pich et al. 2002). Project uncertainty is therefore not only about the known risks, but also about incomplete knowledge and changing conditions (Ward and Chapman 2003).

Complexity and uncertainty also reinforce each other. As projects become more complex, through more components, interfaces, and actors, there are more pathways for interaction and feedback, making outcomes harder to predict and control (Geraldi et al. 2011). Together, they shape how risks emerge and make it harder to identify all risks upfront (Pich et al. 2002; Ward and Chapman 2003). The construction literature therefore distinguishes between risks that can be identified early (foreseen) and risks that emerge unexpectedly during delivery (unforeseen) (Browning and Ramasesh 2015).

Whether a risk is foreseen or unforeseen depends on information quality, how visible dependencies are, and the maturity of front-end planning (Geraldi et al. 2011). Higher structural and socio-political complexity lowers predictability because more interfaces and actors create more paths for interaction (Geraldi et al. 2011). In short, uncertainty and complexity together make early recognition harder and increase the chances that risks propagate into changes.

This distinction is developed further in section 2.2 (unforeseen risks) and section 2.3 (foreseen risks).

2.1.1. Terminology used in the literature

The literature uses a wide range of terms to describe similar ideas in project risk and change, which can make it difficult to compare findings across studies (Ward and Chapman 2003).

Sun and Meng also report *'a certain degree of confusion in the terminology used by different authors'* when discussing changes in construction projects (Sun and Meng 2009).

A recurring issue is that authors sometimes mix up causes and effects. To address this, Sun and Meng reviewed prior work and developed two separate taxonomies, one for change causes and one for change effects, so that what leads to change is not confused with what happens because of it (Sun and Meng 2009).

More recent work argues that the causes side also needs more standardised categories and a more uniform vocabulary. Birgönül and colleagues propose a taxonomy dedicated for causes of changes in construction projects to improve consistency across contexts and datasets (Birgönül et al. 2024).

In parallel, Ward and Chapman argue that the term *risk* is often used as if it is the event itself (Ward and Chapman 2003). They suggest that this can narrow attention compared to a broader view of project uncertainty, which can affect how terms such as risk, uncertainty, and related concepts are used in research and practice (Ward and Chapman 2003).

Also Hillson argues that risk lists often contain items that are not real *risks* because causes, risks, and effects get mixed up (Hillson 2000). He therefore proposes a fixed wording to separate them:

- **Causes:** *'definite events or sets of circumstances that exist in the project or its environment, and which give rise to uncertainty.'*
- **Risks:** *'uncertain events or sets of circumstances that, if they occur, would affect the project objectives.'*
- **Effects:** *'unplanned variations from project objectives, either positive or negative, which arise as a result of risks occurring.'*

The three elements of the risk structure can be summarized as follows: *'As a result of <definite cause>, <uncertain event> may occur, which would lead to <effect on objective(s)>'* (Hillson 2000).

These definitions will be used throughout this thesis to keep *causes*, *risks*, and *effects* separate and comparable across the coded project documents.

2.2. Unforeseen risks

Building on section 2.1, project research distinguishes foreseen risks that can be identified early and unforeseen risks that appear as surprises during delivery (Browning and Ramasesh 2015; De Meyer et al. 2002). Unforeseen risks are not simply low-probability risks that were overlooked. Instead, they are risks that are difficult to describe and assess in advance, because key information is missing and the project situation can change in unexpected ways (Aven 2014). As a result, it is often not possible to estimate their likelihood and impacts reliably at the planning stage (Aven 2014).

2.2.1. Causes of unforeseen risks

In this thesis, causes are events or conditions that start a risk event. For unforeseen risks, these causes are usually not noticed in advance. They often become clear only after they start to affect the project (Brahma and Wynn 2023).

One type of cause of unforeseen risks relates to late-emerging conditions, such as site or stakeholder circumstances. Reviews of change causes show that some causes become apparent only later in the project, which makes them difficult to foresee at contract award (Sun and Meng 2009).

Another type of cause comes from hidden dependencies within the project. A link between tasks or elements may not be noticed during planning. Once a change occurs in one part of the project, it can create unexpected knock-on effects elsewhere, which then reveals the dependency (Brahma and Wynn 2023).

A third type of cause is an unexpected external change, such as new laws, regulations, or policy decisions. For example, a regulatory change can lead to change orders which then can create major effects on project planning and scheduling (Mattar et al. 2024).

The literature suggests two main ways to deal with unforeseen triggers. First, teams can try to reduce surprises by looking for weak signals and learning during the project, so that *'unknown unknowns'* can become *'known unknowns'* earlier (Browning and Ramasesh 2015). Second, because not all surprises can be prevented, teams should build adaptive capacity so they can respond effectively when unforeseen risks do occur (Baard et al. 2014).

2.2.2. Managing unforeseen risks

Unforeseen risks often require teams to adjust during execution rather than rely only on upfront plans. Team adaptation is therefore seen as an important capability in dynamic project settings (Christian et al. 2017). In construction, this need is especially relevant because projects involve many interacting components and actors, which can create outcomes that planning cannot fully predict (Lafhaj et al. 2024).

Early work on team adaptation used an Input–Process–Output (IPO) view to map the main ideas of adaptation, but later work shifted to Input–Mediator–Outcome–Input (IMOI) views to include time and feedback (Ilgen et al. 2005). In the IMOI view, inputs include factors such as team composition, roles, training, leadership, and the context. Mediators describe how the team functions during work, such as coordination, communication, backup behavior, and shared mental models. Outcomes include task results and team states, that feed back into future inputs (Burke et al. 2006).

Building on this, Burke et al. describe adaptation as a four-phase cycle over time: situation assessment → plan formulation → plan execution → team learning. This framing is important because it shows adaptation as a process rather than a fixed team trait (Burke et al. 2006). Rosen et al. extend this by adding behavioral markers to the four-phase cycle, so each phase in the adaptation process becomes more observable and measurable in practice (Rosen et al. 2011). Later work also suggests that teams do not always follow the phases in a strict linear order (Georganta et al. 2021). The only sequence consistent with theory is from situation assessment to plan execution, and also that team learning relates to and supports the other phases rather than appearing only at the end (Georganta et al. 2021).

2.3. Foreseen risks

Foreseen risks are risks that project teams can identify and describe before they occur, often because similar events have occurred in earlier projects and because the project context allows early assessment (Nikander and Eloranta 2001). In construction projects, many foreseen risks are linked to recurring change-related issues, which makes them suitable for being documented, tracked, and managed through formal project routines rather than only through ad hoc reaction (Browning and Ramasesh 2015).

Empirical work also suggests that more structured change control is associated with better control of the negative effects of changes, which supports the idea that foreseen risks can be managed more effectively when they are addressed early and systematically (Hwang and Low 2012). Foreseen risks are therefore often addressed through front-end planning routines and formal change control processes, which support early preparation of responses and continued monitoring as the project progresses (Nikander and Eloranta 2001).

2.3.1. Identification of foreseen risks in practice

In construction practice, foreseen risks are commonly identified through early-stage workshops and structured discussions in which project stakeholders jointly identify and document potential risks (Dicks and Molenaar 2024). Project teams use risk identification techniques such as expert discussions and inputs collected through questionnaires, surveys, interviews, and round-table sessions (Bahamid et al. 2022; Khodabakhshian et al. 2025).

The outcomes of these identification activities are then translated into a documented overview, most commonly in a risk register. Risk registers provide a structured list or database in which identified risks are recorded, reviewed, and updated over time, so they can be followed up during the project (Leva et al. 2017). However, the literature also shows that risk registers are not always filled in with clear, project-specific content. They may be populated from generic checklists with low-detail, high-level risk categories, which can make it difficult for project teams to understand what a listed item means for the specific project context (Kifokeris and Xenidis 2019). This helps explain why risk identification can still be incomplete or weak, even when a register is used (Dicks and Molenaar 2024).

Risk identification practices can therefore differ strongly between projects. Dicks and Molenaar (2024) show that the results depend on factors such as expertise, experience, participation, communication and alignment, time constraints, process standardization, and the level of detail of the available project information (Dicks and Molenaar 2024). As a result, even when similar tools are used, risk identification can become rather ad hoc in practice and depends heavily on who is involved and what information is available at that time (Dicks and Molenaar 2024).

2.3.2. Causes of foreseen risks

A cause of a risk is *foreseen* when the project team can recognize it upfront or observe it early and use indicators or controls to monitor it before it develops into a problem (Nikander and Eloranta 2001). Whether risk causes can be foreseen also depends strongly on the quality and completeness of available information and on how clearly project dependencies and interfaces are understood. When dependencies are visible and interfaces are well-defined, teams are more able to spot early causes and warning signs and link them to potential risk events (Brahma and Wynn 2023; Ward and Chapman 2003).

Front-end definition and planning maturity also matter. Stronger front-end definition improves clarity about requirements, scope, and interfaces, which can help with earlier recognition of causes that might develop into risks or changes (Wang and Gibson 2010).

Categorizations

Researchers group many detailed risk causes into categorizations so that they are easier to manage and compare across projects (Sun and Meng 2009). A commonly used starting point is the cause–effect split proposed by Sun and Meng, which separates change causes from change effects to reduce confusion and enable cross-study comparison (Sun and Meng 2009).

More recent work refines the causes side. Birgönül et al. (2024) build a causes-of-change categorization based on literature review, expert sessions, and a multi-project survey, aiming for a categorization that teams can use in risk registers and change logs (Birgönül et al. 2024).

There are several useful lenses found in the literature for categorizing causes:

- **Origin lens:** Many construction research distinguishes internal causes from external causes. Internal risk causes come from inside the team or its direct structure and include changes in roles, rewards, or dynamics, such as disagreements or debates (Georganta et al. 2019; Christian et al. 2017). External risk causes come from outside the team's direct control and relate to the broader environment in which the project is delivered, such as shifts in resources, interventions by higher authorities, or changes in the environment (Georganta et al. 2019; Christian et al. 2017). A similar distinction is made by Maynard et al. (2015), who differentiate between teamwork-based causes (within-team processes) and task-based causes (driven by the task environment) (Maynard et al. 2015). This lens is useful because it highlights controllability. Internal causes can often be influenced through team design and working methods, while external causes typically require monitoring, stakeholder coordination, or adaptive responses (Christian et al. 2017).
- **Stakeholder lens:** Another widely used way to group causes is by stakeholder, because different parties influence different parts of the project and have different control. Studies distinguish client-related causes, consultant-related causes, contractor-related causes, and regulator/external causes (Sun and Meng 2009; Bitamba and An 2020; Marzouk and El-Rasas 2014). Systematic review work on change orders also shows that these stakeholder-related cause groups are repeatedly associated with time and cost impacts (Amzafi et al. 2024). This lens is practical because it links the cause category directly to responsibility and potential response ownership, it helps clarify who is best positioned to prevent the cause, who needs to be involved in decisions, and where coordination is required (Birgönül et al. 2024).
- **Phase lens:** A third lens focuses on timing across the project life cycle. Causes do not occur evenly over time, so phase-based grouping helps teams understand when certain causes are more likely to appear (Sun and Meng 2009). For example, early phases often involve causes linked to definition work, such as scope ambiguity and design coordination issues, while later phases may show more causes such as specification gaps, market-related factors, and interface management problems between parties and disciplines (Sun and Meng 2009). This lens is useful because it links causes to the moments when teams still have room to prevent them, rather than only reacting after they become formal changes (Amzafi et al. 2024).

2.3.3. Response measures for foreseen risks

Response measures for foreseen risks refer to the planned actions, controls, or arrangements that a project team records to manage identified risks (Leva et al. 2017). In practice, these measures are documented together with the risk information needed for follow-up, such as a risk description, assessments of likelihood and consequences, and the current and planned mitigating actions (Leva et al. 2017).

A common way to apply *risk reduction* in projects is to reduce the probability of the risk occurring and/or the size of the impact if the risk occurs (Fan et al. 2008). At the same time, several authors warn that treating risk purely as *'probability × impact'* can be too narrow. While it is useful for prioritization in the risk registers, it can hide broader uncertainty and the different ways risks can arise and develop (Ward and Chapman 2003).

To clarify where a measure acts in the risk chain, it helps to separate cause-focused measures from consequence-focused measures (Sklet 2006). Both contribute to overall risk reduction, but they imply different controls and follow-ups (Leva et al. 2017). The bow-tie framing makes this explicit by distinguishing measures that target the risks probability from measures that target the risks impact (figure 2.1) (Aust and Pons 2020; Badreddine et al. 2014) .

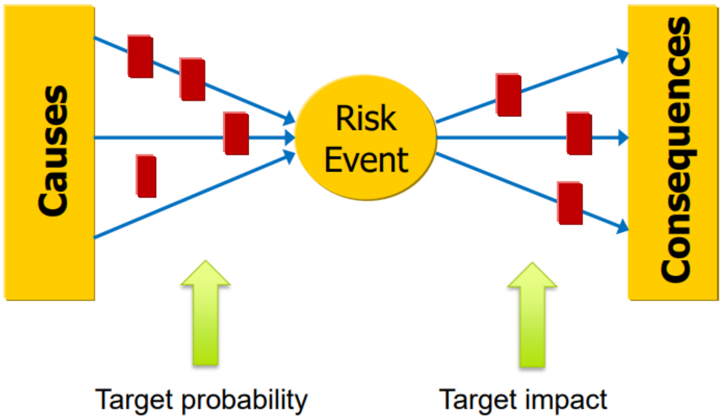

Figure 2.1: Bow-tie diagram for risk events
(Delft University of Technology (TU Delft) 2025, slide 25).

A bow-tie describes a risk scenario as a chain from causes to a risk event (left side) and from a risk event to consequences (right side), and places response measures (often called *barriers*) before or after the risk event (Aust and Pons 2020). This left–right structure is widely used in the literature to separate measures that mainly target probability from measures that mainly target impact (Badreddine et al. 2014; Ruijter and Guldenmund 2016).

This leads to two main types of measures:

- **Preventive measures** (left side) reduce the likelihood or frequency of the risk event by acting on threats or causes (Aust and Pons 2020; Sklet 2006; Badreddine et al. 2014).
- **Mitigative/Protective measures** (right side) reduce the severity of consequences if the event occurs, by limiting or containing impacts (Aust and Pons 2020; Sklet 2006; Badreddine et al. 2014).

The bow-tie method is also often explained as a combination of a fault-tree logic on the left (how the event can happen) and an event-tree logic on the right (what can happen after the event) (figure 2.2) (Ferdous et al. 2013; Dianous and Fiévez 2006). Because it combines these two logics in one overview, bow-tie is commonly used as a qualitative decision-support and communication tool, especially when teams need a shared view of how risks develop and which controls are in place (Aust and Pons 2020; Ferdous et al. 2013).

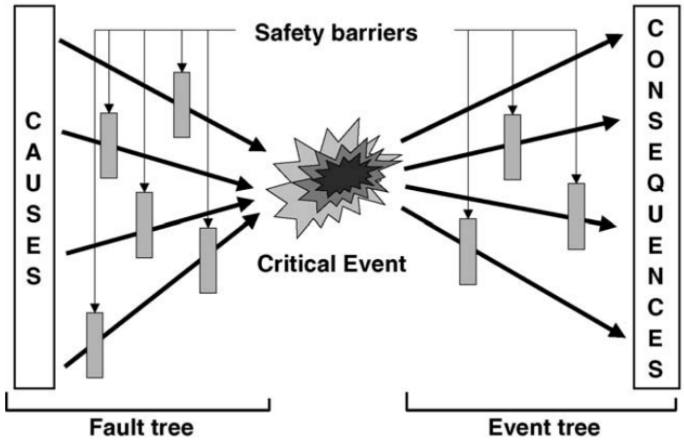

Figure 2.2: Bow-tie diagram with fault- and event tree logic (Dianous and Fiévez 2006, Fig. 1).

After a risk has been identified and assessed, project teams still need to decide on how they will respond. For threats (negative risks), a widely used set of response strategies is Avoid, Transfer, Mitigate, and Accept (Hillson 1999; Fan et al. 2008; P. Love et al. 2023). Hillson defines these four threat strategies as follows (Hillson 1999):

- **Avoid:** *'seeking to eliminate uncertainty.'*
- **Transfer:** *'seeking to transfer ownership and/or liability to a third party.'*
- **Mitigate:** *'seeking to reduce the size of the risk exposure to below an acceptable threshold.'*
- **Accept:** *'recognising residual risks and devising responses to control and monitor them.'*

In public-sector risk management, the same four options are often labeled as the *4Ts*: Terminate, Transfer, Treat, and Tolerate, mapping directly onto the Avoid-Transfer-Mitigate-Accept framework (Hillson 1999).

For opportunities (positive risks) a parallel set of response strategies is used. Exploit, Share, Enhance, and Accept, which mirror threat responses but aim to increase the likelihood and/or benefits rather than reduce losses (Hillson 2002).

These response measure strategies provide high-level categories for how projects can respond to risk, but they mainly remain at the level of response intent and response type (Hillson 1999; Fan et al. 2008; P. Love et al. 2023). They describe what kind of response is chosen (avoid, transfer, mitigate, or accept) and where the response acts in the risk chain (before or after the event), but they do not specify which concrete response measures are implemented or how response measures are formulated and categorised in practice.

2.4. Implications for the thesis

This theoretical background results in several concrete implications for how this thesis defines concepts and analyses the empirical material. First, the thesis uses consistent terminology to avoid mixing concepts. Specifically, the risk structure proposed by Hillson (2000) is adopted to structure each risk description into causes, risks, and effects. This provides a stable basis for comparison across projects and across documents.

Second, the thesis uses the distinction between foreseen and unforeseen risks. Risk registers capture the risks that teams can identify and discuss in advance, and because this thesis uses risk registers as its main data source, the empirical analysis focuses on foreseen risks and the measures that are planned for them.

Third, the thesis uses the literature on causes and taxonomies as a starting point for creating an operational coding scheme for risk causes.

Finally, although the literature distinguishes preventive measures from mitigative/protective measures, the risk registers do not label measures in this way. Therefore, this thesis uses *'response measures'* to describe how the measures are recorded in the risk registers.

2.4.1. Conceptual model

Together, these choices are combined into the conceptual model used in the thesis (figure 2.3). Causes can lead to a risk event which can have (unwanted) effects, while response measures can intervene either before or after the risk event. This model guides the empirical analysis by structuring what is coded, how codes are grouped, and how possible patterns between causes and measures are interpreted across the project dataset.

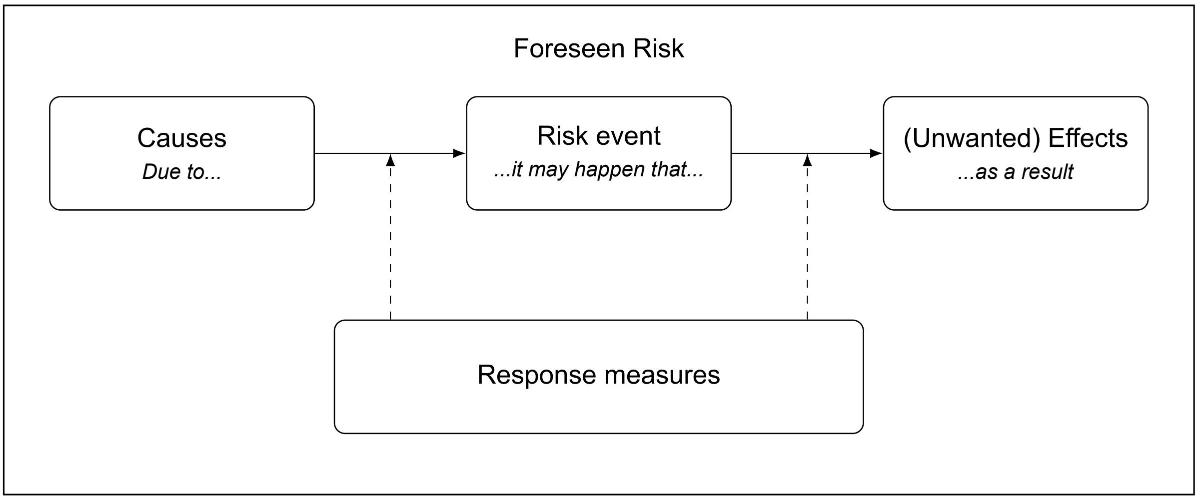

Figure 2.3: Conceptual model

3 Methodology

3.1. Research aim and approach

This study aims to clarify how risk causes and response measures are defined in the academic literature and how they are recorded and used in public construction practice. The goal is to understand how causes relate to response measures in projects and to assess whether practice matches, or differs from, the way these concepts are structured in the literature.

A qualitative approach is used because the core data consist of written project records, namely risk registers. These risk registers capture how project teams formulate risk causes, risk events, effects, and response measures in their own words. Analysing such project documents is a recognized qualitative approach, as it allows the study of both what is recorded and how information is framed in practice (Bowen 2009). A qualitative approach also supports comparison across multiple projects while keeping the documented context intact, which is important when studying complex projects with many interfaces and stakeholders (Yin 2018).

3.2. Research design

This section describes the research design and the sequence of steps used to answer the main research question. It explains how the study moves from building the theoretical basis to analysing the risk registers and interpreting the findings. Figure 3.1 provides an overview of how each research step contributes to the sub-questions and how the sub-questions together address the main research question. The following sections describe each step in more detail and clarify the main choices made in the design.

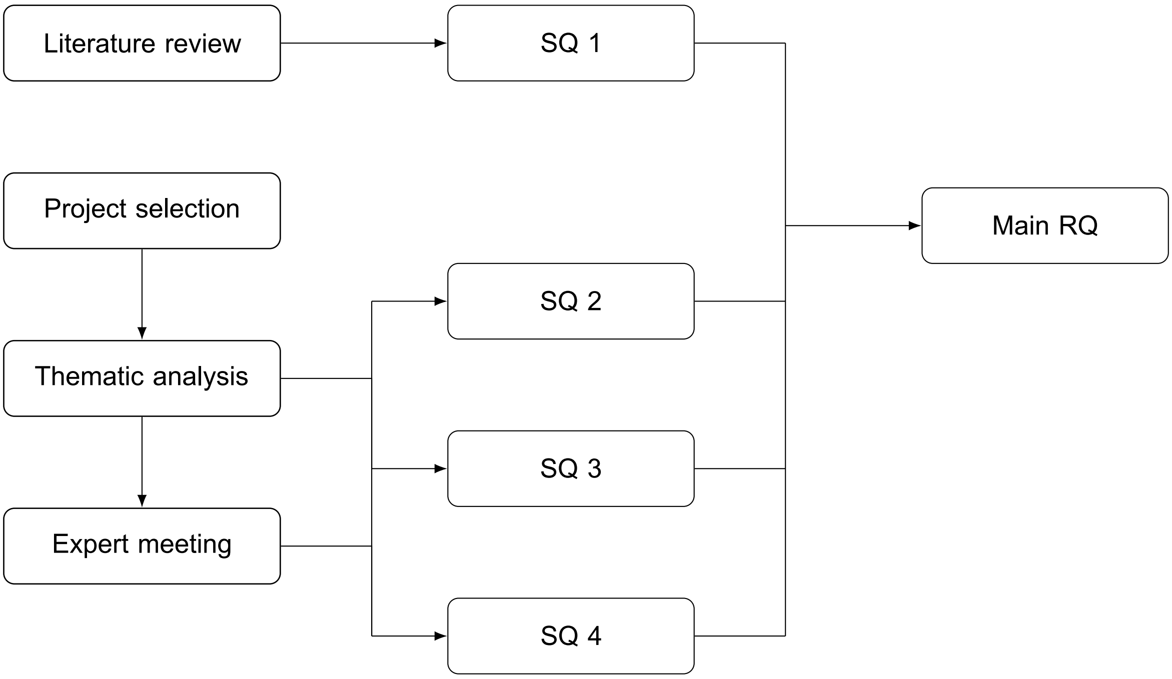

Figure 3.1: Overview of research design and its relation to the research questions

3.2.1. Literature review

The literature review consists of two parts, a broad literature search and a focused categorization search. For both parts, a structured and transparent search and screening procedure is used, following common guidance for evidence-informed literature reviews (Snyder 2019).

Broad literature search

The broad literature search provides the basis for the theoretical background by mapping how the field describes risk-related concepts such as risk causes, risk events, effects, and response measures, and by summarizing what is already known about these topics in construction project contexts. This broader review also informs the problem definition, helps identify the research gap, and supports choices on the scope and context of the study.

To support this, a structured Scopus search is conducted using a broad query. Filters are applied to focus on English peer-reviewed journal articles and reviews within the engineering and construction domain. In addition, IT- and data-science-related contexts are excluded to reduce irrelevant results.

An example of a broad query string used is:

> (construction OR infrastructure OR ”AEC industry”) AND (”cause* of change*” OR trigger* OR ”change order*” OR ”variation order*” OR ”project change*” OR ”risk event*” OR ”unwanted effect*” OR ”rework” OR ”risk response*” OR ”mitigation measure*” OR ”control measure*” OR ”adaptation”) AND NOT (software OR ”information system*” OR ”machine learning” OR ”deep learning” OR ”supply chain” OR logistic* OR security OR algorithm* OR cyber* OR blockchain OR ”digital twin*” OR ”artificial intelligence” OR ”data mining”)

In addition, the reference lists of key papers identified through the Scopus search are screened to identify further relevant studies (backward snowballing). This backward snowballing helps find papers that use different terminology or keywords and might therefore not appear in the initial database search results (Wohlin 2014).

Focused categorizations search

The focused literature review directly supports the research by answering sub-question 1: *Which risk causes recur in construction literature, and how can they be categorized?* To do so, the review focuses on studies that propose or apply categorizations of risk causes in construction projects. These studies are then used to identify recurring cause categories, clarify how they are defined, and assess the level of detail at which they are described. Based on this comparison, the studies are combined into a literature-based risk cause categorization in order to answer the first sub-question of the thesis.

This resulting literature-based categorization provides a structured starting point for the empirical analysis. It is used as an initial structure for interpreting and organizing the risk register data, and therefore also supports sub-question 2: *Which risk causes recur in risk registers of Dutch public construction projects, and how can they be categorized?*

To identify relevant studies, a structured search is conducted in Scopus using focused query blocks on risk causes and classifications. Filters are applied to focus on English peer-reviewed journal articles and reviews within the engineering and construction domain, published from 2005 onwards. In addition, IT- and data-science-related contexts are excluded to reduce irrelevant results.

The focused query string used is:

> (construction OR infrastructure OR ”built environment” OR ”construction project” OR ”infrastructure project” OR ”AEC industr*”) AND (”risk cause*” OR ”cause*” OR ”cause* of change” OR trigger*) AND (taxonomy OR classification OR categorization OR typology) AND NOT (software OR ”information system”* OR ”machine learning” OR ”deep learning” OR ”supply chain”* OR logistic* OR security OR algorithm* OR cyber* OR blockchain OR ”digital twin*” OR ”artificial intelligence” OR ”data mining”)

The focused Scopus search returned 274 records. After removing duplicates, 240 records were screened based on title and abstract, of which 209 were excluded. Next, 31 full texts were assessed, of which 23 were excluded. In total, 8 studies were included (figure 3.2).

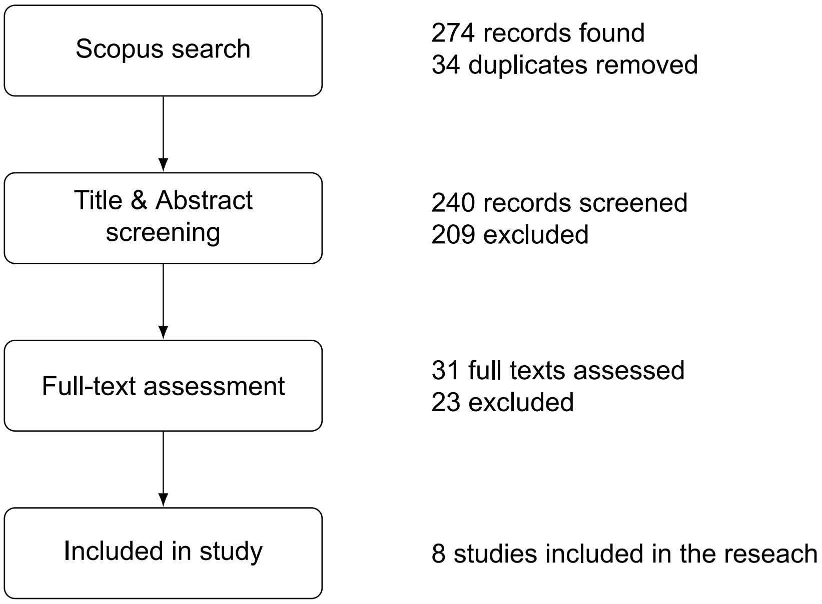

Figure 3.2: Output of focused Scopus search

In addition, just like with the broad literature review, the reference lists of key papers identified through the Scopus search are screened to identify further relevant studies (backward snowballing).

3.2.2. Case selection

Together with the Central Government Real Estate Agency (*Rijksvastgoedbedrijf*), a set of nine public pre-construction project risk registers are selected for this study. Each selected risk register belongs to a different complex public construction project. The aim of the selection is to obtain a set of risk registers, that is comparable in context and documentation, while still offering sufficient variation in risk causes and response measures to support cross-case comparison.

The risk registers are obtained and collected in several batches during the data collection period. Table 3.1 provides an overview of the received risk registers and shows how many registers are ultimately used in the study. In total, 31 risk registers were received, of which nine are used for the analysis. Some risk registers are excluded because they are duplicates or because they do not meet the selection criteria.

Table 3.1: Overview of received and used risk registers

Date	# Risk registers received	# Risk registers used	Risk registers used	# Risk registers double	# Risk registers not used
10 Oct (21 Nov)	1	1	Risk Register of project 1 (updated version)	0	0
12 Nov	4	3	Risk Register of project 4 Risk Register of project 6 Risk Register of project 8	1	0
18 Nov	2	1	Risk Register of project 2	0	1
18 Nov	12	2	Risk Register of project 5 Risk Register of project 9	1	9
03 Dec	12	2	Risk Register of project 3 Risk Register of project 7	1	9
Total	**31**	**9**		**3**	**19**

A criteria-based selection strategy is applied using predefined selection criteria to ensure that all included risk registers represent a comparable setting. Risk registers are selected to be similar in project complexity, contract form, and project phase, so that observable differences in the data are more likely to reflect variation in recorded risk causes and response measures rather than random project characteristics.

The selection criteria are as follows:

- **Project phase**: Projects are included only if it is in the pre-construction stage (initiative, definition, and procurement).

This criterion is used because in the pre-construction stage, risk identification and response planning are most active and forward-looking. In this stage, risk registers describe foreseen risk causes and planned responses, before execution issues and changes become more dominant.

- **Contracting and governance**: Projects are included only if they use an integrated contract and are managed by an IPM team.

These criteria are used because, integrated contracts with IPM governance are typically used for large and complex public construction projects, and focusing on such projects increases the likelihood of a broad and diverse set of risks. An integrated contract was chosen to keep the contract form consistent across cases, since risk allocation and responsibilities can differ between contract types. IPM teams were selected because they assign a dedicated manager to risk management, which supports consistent use of risk registers. This consistency is needed for reliable comparison and coding across cases.

- **Project scope**: Projects are included only if they are not part of a programme.

This criterion is used because programme projects include programme-level risks that differ from risks in individual projects. They also create dependencies between projects, which is not the focus of this research. This study therefore looks only at risks that belong to single projects.

- **Document recency**: Projects are included only if their risk registers were updated within the last quarter.

This criterion is used to make sure the material reflects current practice and to reduce the chance that the analysis is based on outdated documents or ways of working.

- **Document completeness**: Projects are included only if their risk registers are complete.

This criterion is used because the study relies on consistent coding of risk causes and response measures across projects. The risk registers therefore need to be complete and clear. Incomplete or inconsistent risk registers may lead to missing information and less reliable results.

After applying the selection criteria, nine risk registers are included in the analysis, representing nine projects. Table 3.2 provides an overview of these projects and summarizes their main characteristics, including the project phase, contract type, project type and purpose, and, where available the projects size and costs.

Table 3.2: Overview of projects of selected risk registers

Project	Phase	Contract	Type	Purpose	Size	Costs
1	Procurement	Integrated	New construction	Office complex	40.000 m^2	250 million
2	Procurement	Integrated	New construction	Office complex	22.000 m^2	160 million
3	Definition	Integrated	Renovation	Courthouse	20.000 m^2	42 million
4	Initiative	Integrated	Redevelopment	Office complex	N/A	N/A
5	Initiative	Integrated	Redevelopment	Military complex	N/A	N/A
6	Procurement	Integrated	Renovation	Office complex	14.000 m^2	140 million
7	Initiative	Integrated	New construction	Military complex	N/A	N/A
8	Definition	Integrated	New construction	Campus building	15.000 m^2	75 million
9	Procurement	Integrated	New construction	Office complex	20.000 m^2	120 million

3.2.3. Thematic analysis

After the literature review and the case selection, the nine risk registers are analysed using thematic analysis. Thematic analysis is a qualitative method for systematically identifying and organising patterns of meaning (themes) across a dataset, meaning the focus is on recurring regularities across multiple documents rather than on single entries (V. Braun and Clarke 2006). In this thesis, thematic analysis covers the full qualitative analysis process, including preparation of the risk register data, developing and refining a shared codebook, systematically coding the risk registers, and producing frequency and co-occurrence outputs from the coded dataset (Virginia Braun et al. 2020).

Data preparation

For data preparation, each risk register is treated as one qualitative project document and imported as a separate document in Atlas.ti. This enables project-level comparison later, because all codes can be traced back to a specific risk register. In addition, the imported risk registers are checked for completeness and readability, to make sure risk descriptions can be selected at quotation level in Atlas.ti. In practice, this means that the text in each risk description can be selected as separate quotations for causes, risk events, and measures. Where a risk description contains multiple causes or measures, the text is prepared so that these can be selected as separate quotations during coding. This supports later frequency and co-occurrence analysis, because it allows distinct causes and response actions to be captured as separate coded items.

Codebook development

To code the risk registers in a consistent way, one shared codebook is developed and used for all nine projects. The codebook is based on the conceptual model (figure 2.3) in this thesis and separates each risk description into three elements. Causes capture why the risk may occur (*'Due to …'*), risk events capture what may happen (*'it may happen that …'*), and measures capture what is planned to manage the risk. This separation is used to prevent overlap between cause, risk event, and measure content.

The codebook development is iterative and follows a hybrid approach. It starts with the literature-based cause categorization from sub-question 1, and is then refined to fit the wording and level of detail used in the risk registers. This results in a hybrid approach that combines deductive and inductive coding, so the codebook is guided by the literature but still fits the data (Fereday and Muir-Cochrane 2006). In practice, this is done in three steps. First, three code types are defined upfront, namely causes, risk events, and measures. Second, the risk registers are coded using this initial structure and the codes are then refined multiple times during coding, following the idea that coding is carried out in multiple cycles and may require recoding as code definitions become clearer (Saldaña 2021). In this step, codes are merged, split, or reworded to reduce overlap and to ensure that similar formulations are coded in the same way across projects. Third, after the codebook is stabilized, it is finalized and used as the fixed structure for coding the full dataset and for the analyses reported in chapter 4.

Systematic coding

With the final codebook, all nine risk registers are imported into Atlas.ti and coded using the same definitions. Coding is performed at quotation level, meaning that codes are assigned to specific text fragments. The unit of analysis is one risk description, but risk descriptions often contain more than one cause or more than one measure. Therefore, a single risk description can generate multiple quotations and multiple codes, so that each distinct cause, risk event, and response measure is captured as a separate coded item. Throughout this process, cause and measure codes are structured in main categories and subcategories to support later reporting at different levels of detail. Risk events are coded as a single-level set to keep the risks comparable across projects.

The label structure and an example are provided in table 3.3. Each quotation is labeled with its type and the associated risk event. Cause quotations also include the assigned cause categories, and measure quotations additionally include the linked cause label and the assigned measure categories, so the risk context and the cause–measure link remains traceable.

Table 3.3: Coding label structure used in Atlas.ti (with example)

Code type	**Label structure used**
Risk events	TYPE | RISK RISK | (a)
Causes	TYPE | CAUSE RISK | (a) CAUSE | (Main cat..) | (Sub cat.)
Measures	TYPE | MEASURE RISK | (a) CAUSE | (Main cat..) | (Sub cat.) MEASURE | (Main cat..) | (Sub cat.)
Example	
Risk event: Partijen afhaken	TYPE | RISK RISK | Failed tender
Cause: Risicoverdeling niet helder	TYPE | CAUSE RISK | Failed tender CAUSE | Contract | Unclear role and risk allocations
Measure: Proportionele risicoverdeling vaststellen	TYPE | MEASURE RISK | Failed tender CAUSE | Contract | Unclear role and risk allocations MEASURE | Stakeholder | Discuss role responsibilities and risk allocations

Output analysis

After all nine risk registers are coded using the fixed codebook, the coded dataset is analyzed to produce the results presented in chapter 4. The coded quotations are summarized into descriptive outputs, such as frequencies and co-occurrences, to support pattern identification and comparison across cases, which is a common step in qualitative analysis (Miles et al. 2014).

First, the final risk register-based categorizations for risk causes, response measures, and risk events are established and used as the fixed structure for the rest of the analysis. This step addresses sub-question 2: *Which risk causes recur in risk registers of Dutch public construction projects, and how can they be categorized?*, because it produces an empirical categorization of recurring risk causes that can be applied consistently across the nine risk registers.

Second, frequency outputs are generated to show how often different cause and measure categories occur per risk register. These overviews are produced at both subcategory level and main-category level. The frequency results are used to examine which categories occur most often, which are rare, and whether certain categories are concentrated in a small number of projects or recur across multiple projects.

Third, cause–measure relationships are analyzed using co-occurrence analysis. A co-occurrence is counted when a cause code and a measure code are both assigned within the same coded risk description. This step adds a relational layer and is used to identify which measures are most often recorded together with which causes. Co-occurrence outputs are generated at both subcategory level and main-category level. The most frequent combinations are then compared across the dataset to identify recurring and recognisable regularities in how certain causes are linked to certain measures. In this study, these recurring regularities are treated as cause–measure patterns. This step addresses sub-question 3: *Which recurring cause-measure patterns can be identified in risk registers of Dutch public construction projects?*, because it enables the systematic identification of repeated links between categories of causes and categories of response measures

Together, the structured separation of risk register entries into causes, risk events, and response measures, the use of a shared and iteratively refined codebook, and the combination of frequency outputs with co-occurrence analysis form the analytical approach used to address sub-question 4: *How can recurring cause–measure patterns be identified in risk registers of Dutch public construction projects?*

3.2.4. Expert meeting

An expert meeting is conducted as a final step, after the completion of the thematic analyses. The purpose of the meeting is to assess whether the identified categories, links and patterns are recognizable in public construction practice, and to add context to the findings through expert explanations and additional insights (Soest 2023). These inputs are used to enrich the interpretations of the results and to reflect on the applied pattern identification approach. In that way, the expert meeting does not answer a sub-question directly, but supports the interpretation of findings related to sub-questions 3 and 4.

The experts are three project control managers at the Central Government Real Estate Agency (*Rijksvastgoedbedrijf*). Their daily work includes using risk registers, and they are directly involved in risk management in integrated contract projects. This ensures strong domain knowledge and familiarity with the type of data that is analyzed in this study. To reduce bias, all data is anonymized before the meeting, and the experts are not informed about which projects or project teams are included.

Before the meeting, the experts receive a short agenda and a brief description of the goal of the session. During the meeting, questions are asked in a fixed order (appendix C). First some specific questions about risk causes (table 4.5), then specific questions about response measures (table 4.8), followed by specific questions about the relationships and co-occurrences between them (table 4.11), and finally some more general questions.

The results of the specific expert meeting questions are integrated into sections 4.2.2 and 4.2.3, where they are discussed alongside the results of the frequency analysis, and into section section 4.2.4, where they are discussed alongside the results of the co-occurrence analysis. The experts broader reflections regarding the overall interpretation of the findings, current documentation practices, and the implications and added value of the study are reported separately in section 4.3. Their reflections also provide input for the methodological evaluation of the pattern identification approach in section section 4.4.

3.3. Research validity and trustworthiness

This study uses a qualitative and interpretive approach. In qualitative research, quality is commonly ensured through criteria for trustworthiness rather than through statistical validity. Following Shenton (2004), the quality of this study is addressed through four trustworthiness criteria: credibility, transferability, dependability and confirmability. These criteria are often presented as qualitative parallels to internal validity, external validity, reliability, and objectivity in more positivist research traditions (Shenton 2004).

- **Credibility** concerns whether the findings are a credible representation of the data (Shenton 2004; Ahmed 2024). In this study, credibility is supported in four ways. First, key concepts are defined based on the literature and translated into a shared coding structure. Second, a structured codebook with explicit coding rules is developed and iteratively refined, after which the final codebook is applied consistently across all nine risk registers. Third, the analysis is built step by step from coded text fragments to categories and recurring cause–measure relations, and interpretations are repeatedly checked against the original risk register text. Fourth, an expert meeting is used to question, contextualise, and refine key interpretations and to assess whether results are recognisable in practice.
- **Transferability** concerns whether the findings can be applied to other, similar contexts (Shenton 2004; Ahmed 2024). This study does not aim for statistical generalisation. Instead, it supports transferability by clearly defining the scope and study context, describing the project selection criteria, and explaining the characteristics of the selected projects and risk registers. By making these boundaries explicit, readers can assess whether the findings are applicable to other public construction projects with comparable characteristics
- **Dependability** concerns whether the research process is consistent, logical, traceable, and sufficiently documented (Shenton 2004; Ahmed 2024). Dependability is supported by transparent documentation of the methodology, including the selection procedure, the preparation of the dataset, the development and refinement of the codebook, and the coding procedure. The codebook development follows an iterative process and coding is performed at quotation level, so that each code remains traceable to a specific text fragment and risk register. In addition, results are generated in a consistent way from the coded dataset, using frequency overviews and co-occurrence analysis, which makes the analysis steps clear and repeatable.
- **Confirmability** concerns whether findings are shaped by the data rather than by researcher interpretations (Shenton 2004; Ahmed 2024). Confirmability is supported by maintaining a clear chain of evidence from raw text fragments to codes, categories, and reported cause–measure relations. The use of software (Atlas.ti) supports this traceability by keeping quotations, codes, and outputs linked to their source documents. Furthermore, the main analytical choices are made explicit, such as the use of a fixed structure to separate causes, risk events, and response measures, and the focus on patterns that recur across multiple risk registers rather than one-off observations. The expert meeting provides an additional check by challenging interpretations from a practitioner perspective.

3.3.1. Position of the researcher

This study uses a qualitative and interpretive approach, which requires reflection on the researcher's role, due to its active role in interpreting and coding the data.

The researcher is a master's student in Construction Management and Engineering at TU Delft and conducted the study in collaboration with the Central Government Real Estate Agency (*Rijksvastgoedbedrijf*). This position can influence interpretation, for example through familiarity with construction terminology and assumptions about what is *'normal'* in risk registers. To manage this, the study relies on explicit coding rules, a structured codebook, and traceable links from interpretations back to source text fragments. The expert meeting provides an additional opportunity to challenge interpretations from a practitioner perspective and to refine conclusions where needed. These measures help maintain objectivity throughout the research process.

Additionally, this study follows the principles of ethical research conduct and has been approved by the TU Delft Human Research Ethics Committee (HREC).

4

Results

4.1. Literature study

This section reports the results of the focused literature study. The goal of this focused search was not to build new theory, but to identify which risk cause categories are used in peer-reviewed construction research and to combine them into one literature-based overview. The studies were selected through a structured Scopus search, described in section 3.2.1, resulting in eight included studies.

4.1.1. Categorization from the literature

Table 4.1 presents these eight studies and the literature-based categorization that follows from them. The studies are: Sun and Meng 2009; Birgönül et al. 2024; Amzafi et al. 2024; Khalifa and Mahamid 2019; Bitamba and An 2020; Sambasivan and Soon 2007; Assaf and Al-Hejji 2006; Marzouk and El-Rasas 2014. Together, these studies result in 13 risk cause categories. The table also shows whether each study reports a category explicitly (✓), indirectly/partially (○), or not at all (–).

Table 4.1: Categorization of risk causes from the literature

A = Sun and Meng (2009) B = Birgönül et al. (2024) C = Amzafi et al. (2024) D = Khalifa and Mahamid (2019) E = Bitamba and An (2020) F = Sambasivan and Soon (2007) G = Assaf and Al-Hejji (2006) H = Marzouk and El-Rasas (2014)

#	Risk cause categories	A	B	C	D	E	F	G	H
1	Client-Related	✓	○	✓	✓	✓	✓	✓	✓
2	Contractor-Related	✓	○	✓	✓	✓	✓	✓	✓
3	Consultant-Related	✓	○	✓	–	–	✓	✓	✓
4	Contract-Related	–	✓	○	✓	–	✓	✓	○
5	Design-Related	✓	✓	○	✓	✓	–	✓	○
6	Labor-Related	○	✓	○	✓	○	✓	✓	✓
7	Equipment-Related	–	✓	○	✓	✓	✓	✓	✓
8	Material-Related	–	✓	○	✓	✓	✓	✓	✓
9	Safety-Related	–	✓	✓	✓	–	–	✓	○
10	Organizational Management-Related	✓	○	○	✓	✓	✓	○	✓
11	Government & Regulatory-Related	✓	✓	✓	✓	✓	✓	✓	✓
12	Financial & Economic-Related	✓	✓	✓	✓	✓	–	○	✓
13	Environment & Site Conditions-Related	✓	✓	✓	✓	✓	✓	✓	✓

Legend: ✓ = explicitly reported; ○ = indirectly/partially reported; – = not reported.

The 13 risk cause categories identified in table 4.1 are described one by one, to clarify what each category covers and to make the literature-based categorization directly usable for the empirical analysis:

1. Client-related causes covers causes that originate from the client/owner side, such as client decisions, requirements, approvals, and changes initiated by the client (Assaf and Al-Hejji 2006).
2. Contractor-related causes captures causes that originate from the contractor side, such as execution approach, site management, planning and control, productivity issues, and contractor decision-making (Sambasivan and Soon 2007).
3. Consultant-related causes includes causes linked to consultants/designers/advisors, such as design coordination, consultant performance, information provision, and advisory or design-management issues attributed to consultants (Assaf and Al-Hejji 2006).
4. Contract-related causes refers to causes connected to the contract and contractual arrangements, such as allocation of responsibilities, unclear contract clauses, contract administration, and contract conditions that create or amplify risks (Birgönül et al. 2024).
5. Design-related causes covers causes related to design content and design process, including design changes, design errors and incomplete design information that are

recorded as design-based sources of risk (Birgönül et al. 2024).

6. Labor-related causes includes causes related to labor input, such as labor availability, labor productivity, labor skills, and workforce-related constraints that affect project delivery (Assaf and Al-Hejji 2006).
7. Equipment-related causes captures causes related to equipment and machinery, such as equipment availability, breakdowns, suitability, and access to required equipment affecting progress (Marzouk and El-Rasas 2014; Birgönül et al. 2024).
8. Material-related causes covers causes related to materials, such as supply delays, shortages, quality problems, and price or availability issues recorded as material-driven sources of risk (Assaf and Al-Hejji 2006).
9. Safety-related causes includes causes linked to safety conditions and safety management, such as unsafe site conditions, accidents, safety procedures, and safety constraints recorded as risk causes (Birgönül et al. 2024).
10. Organizational management-related causes captures causes related to organization and management, such as internal management processes, team organization, and communication or coordination issues (Bitamba and An 2020).
11. Government & regulatory-related causes refers to causes linked to public authorities and regulation, such as policy requirements, regulatory change, and constraints created by government processes (Bitamba and An 2020).
12. Financial & economic-related causes captures causes related to finance and the economic environment, such as market conditions, cost escalation, financing constraints, and broader economic uncertainty affecting the project (Birgönül et al. 2024).
13. Environment & site conditions-related causes covers causes linked to physical site conditions and environmental context, such as ground conditions, spatial constraints, environmental limitations, and other site-related constraints that act as risk causes (Assaf and Al-Hejji 2006).

Overall, table 4.1 shows a clear 'core' set of categories that recur across the eight mentioned studies. These results provide the literature-based cause structure that is used as the starting point for the empirical categorization of risk causes from the risk registers in section 4.2.

4.2. Thematic analysis

This section reports the results of the thematic coding and analysis of nine risk registers of public construction projects. The aim of this section is not only to present the codebook outcomes, but also to report the observed relationships and patterns that seem to emerge from the coded dataset.

Appendix B provides an overview of how much material is coded per risk register. Across the nine projects, the dataset contains 491 coded cause quotations, 251 coded measure quotations, and 87 coded risk event quotations (table B.1).

The thematic analysis results are presented in three parts. First, the section introduces the risk register-based categorizations for causes, measures, and risk events (tables 4.2 – 4.4). Next, it reports how often risk cause- and response measure categories occur per risk register (tables 4.5 - 4.10). Third, it reports the relationships between causes and measures using co-occurrences (table 4.11). Additional supporting overviews are provided in appendix B.

4.2.1. Categorizations from the risk registers

Tables 4.2, 4.3 and 4.4 present the three categorizations that are developed from the risk registers and used as the fixed structure for the following analyses. The categorizations follow the structure used in the conceptual model (figure 2.3): causes describe the *'Due to…'* part, risk events describe the *'it may happen that…'* part, and measures describe the response actions recorded for that risk. This structure ensures that causes, events, and measures are consistently separated during coding and remain comparable across projects.

Risk causes

Table 4.2 shows the categorization of risk causes derived from the risk registers. It consists of 10 main cause categories and 27 cause subcategories (C1 – C27). The main categories group causes by their main origin in the risk registers, while the subcategories capture the more specific recurring cause types within each main category. This two-level structure is chosen to balance detail and comparability. Subcategories are used to show detailed frequencies and specific cause–measure relations, while main categories are used to describe more broader relations across projects.

Table 4.2: Categorization of risk causes from the risk registers

#	Cause categories	#	Cause subcategories
1	Client-Related	1	Unclear scope definition
		2	Changing requirements and scope
2	Communication & Relations-Related	3	Conflicting interests and priorities
		4	Difference in interpretation
		5	Strained stakeholder relationships
3	Contract & Procurement-Related	6	Limited or insufficient tender applications
		7	Unclear role and risk allocations
4	Contractor-Related	8	Inadequate efforts or results
		9	Underestimation of projects complexity and risks
		10	Inadequate planning and unforeseen delays
5	Economic & Financial-Related	11	Cost inflation and market volatility
		12	Insufficient financial resources or feasibility
6	Government & Regulatory-Related	13	Limited public authority capacity and priorities
		14	Regulatory changes
		15	Zoning and spacial policy constraints
7	Organizational & Governance-Related	16	Governance and steering issues
		17	Slow decision processes
		18	Unstable project team
8	Project & Asset-Related	19	Complex dependencies between projects and phases
		20	Incomplete or incorrect data and information

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#	Cause categories	#	Cause subcategories
		21	Insufficient functional or physical requirements
9	Resources-Related	22	Insufficient labor capacity
		23	Limited material and equipment available
		24	Shortage of skills and expertise
10	Site & Surrounding-Related	25	Limited grid capacity or congestion
		26	Nature and environment constraints
		27	Resistance from users and environment

Response measures

Table 4.3 shows the categorization of response measures derived from the risk registers. It consists of 6 main measure categories and 23 measure subcategories (M1 – M23). Where the cause categorization groups items by where a cause originates, the measure categorization groups items by the type of response that is recorded in the risk registers, it reflect what project teams do to manage the risk. Using the same two-level structure as for causes supports reporting at different levels of detail in later sections. The subcategories are used for detailed frequencies and specific cause–measure relations, while the main categories are used to describe broader response relations across projects.

Table 4.3: Categorization of response measures from the risk registers

#	Measure categories	#	Measure subcategories
1	Design and Scope Changes	1	Alternative location
		2	Change Freeze and Control
		3	Changes to structure, installations and materials
		4	Enhancing scope definition
2	Stakeholder Management and Communication Enhancements	5	Discuss role responsibilities and risk allocations
		6	Enhancing stakeholder collaboration and communication
		7	Holding stakeholder sessions
		8	Inform or engage users and environment
		9	Involving external advisors
3	Investigations and Inspections	10	Analyses of environmental, regulatory and legal constraints
		11	Research and inspections of assets safety and performance
		12	Studies on market options and financial feasibility
4	Governance and Planning Adjustments	13	Adding time or money buffers and contingency
		14	Changing project phasing and construction sequence
		15	Reviewing work or plans of contractor
		16	Setting governance structure and processes

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#	Measure categories	#	Measure subcategories
		17	Strengthening resources and expertise
5	Requirement and Contract Arrangements	18	Refining (tender) requirements and specifications
		19	Setting contract conditions
		20	Timely (permit) requests
6	Risk Attitude and Strategy Setting	21	Adjusting procurement strategy and tender phasing
		22	Calculating change impact
		23	Waiting and monitoring the risk

Risk events

Table 4.4 shows the categorization of risk events derived from the risk registers. It consists of 34 risk event categories (R1 – R34). While causes describe why a risk may occur (*'Due to…'*), risk events describe what may happen (*'it may happen that…'*), following the structure of the conceptual model (figure 2.3). This categorization is used in the remainder of the analysis to keep the content comparable across projects and to support traceability. Appendix B (table B.2) therefore provides a table that links each risk event category to the underlying risk event formulations found in the nine risk registers.

Table 4.4: Categorization of risk events from the risk registers

#	Risk event categories	#	Risk event categories
1	(IPM) Project-team is not stable	18	Insufficient or delayed decision making
2	Ambitions are not feasible	19	Insufficient procurement strategy
3	Complex operations and maintenance	20	Insufficient quality of external advisory parties
4	Construction work is halted	21	Insufficient stakeholders involvement
5	Critical dependencies on other activities or projects are not ready in time	22	Lack of storage capacity
6	Disappointing tender results	23	Late project completion
7	Environmental and underground limitations	24	Missing preparatory analyses
8	Existing building not available in time	25	Negative collaboration between parties
9	Facilities are not feasible	26	Noise disturbance
10	Failed nitrogen requirements	27	Permit request not granted
11	Failed tender	28	Permit request not in order
12	Fire safety constraints	29	Problematic dependencies on other parties
13	Housing is canceled or delayed	30	Project does not meet the functional needs

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#	Risk event categories	#	Risk event categories
14	Insufficient acquisition of land and building rights	31	Scope changes during the project
15	Insufficient electrical connection	32	Slow permit process
16	Insufficient financial resources or feasibility	33	Unclear scope
17	Insufficient labor capacity	34	User resistance or dissatisfaction

In summary, tables 4.2 , 4.3 and 4.4 present the full categorization structure that is used for the following analyses. The next sections (4.2.2- 4.2.4) use these categories to report how frequently these risk causes and response measures occur across the nine risk registers, and how risk causes and response measures are related through co-occurrences.

Appendix B (table B.3) provides an additional overview of the top 10 most frequently coded causes, measures, and risk events, and therefore provides a quick overview of the most dominant codes in the dataset.

4.2.2. Frequencies of risk cause categories per risk register

Table 4.5 shows how often each risk cause subcategory (C1 – C27) is coded in each of the nine risk registers. Tables 4.6 and 4.7 present the same frequencies, but reorganised to highlight differences in how these causes are distributed across project types and project phases.

Table 4.5: Frequencies of risk cause subcategories per risk register

	Unclear scope definition	Changing requirements and scope	Conflicting interests and priorities	Difference in interpretation	Strained stakeholder relationships	Limited or insufficient tender applications	Unclear role and risk allocations	Inadequate efforts or results	Underestimation of projects complexity and risks	Inadequate planning and unforeseen delays	Cost inflation and market volatility	Insufficient financial resources or feasibility	Limited public authority capacity and priorities	Regulatory changes	Zoning and spacial policy constraints	Governance and steering issues	Slow decision processes	Unstable project team	Complex dependencies between projects and phases	Incomplete or incorrect data and information	Insufficient functional or physical requirements	Insufficient labor capacity	Limited material and equipment available	Shortage of skills and expertise	Limited grid capacity or congestion	Nature and environment constraints	Resistance from users and environment
	Client -		Comm. & Rela.			Contr.		Contractor			Eco. & Fin.		Gov. & Regul.			Orga. & Govnc.			Project & Asset			Resourc.			Site & Surr.		
	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16	C17	C18	C19	C20	C21	C22	C23	C24	C25	C26	C27
Project 1	2	12	0	0	0	4	0	5	4	0	3	0	4	11	5	0	0	5	1	0	2	5	8	0	2	3	0
Project 2	0	3	3	0	0	0	0	0	4	8	0	0	1	9	7	0	0	0	0	0	5	0	2	3	5	5	20
Project 3	1	3	4	5	0	0	0	0	6	5	0	0	2	0	4	2	2	5	14	13	1	0	0	0	1	5	9
Project 4	0	0	0	0	5	0	0	0	5	0	0	2	2	0	0	3	5	0	0	0	6	2	0	0	0	2	0
Project 5	0	0	0	0	0	0	0	2	0	0	0	0	0	0	2	0	0	0	2	6	0	2	0	0	0	0	0
Project 6	9	3	2	0	4	2	1	0	4	9	7	5	3	2	5	2	0	0	2	8	5	3	0	0	7	0	0
Project 7	0	0	0	2	0	0	0	0	0	0	0	5	0	6	3	5	4	0	0	0	0	0	0	2	2	2	7
Project 8	5	0	0	4	3	0	6	0	0	2	0	0	0	0	0	0	6	6	0	2	0	5	0	6	0	0	0
Project 9	7	3	2	0	0	0	2	2	0	6	3	0	0	0	1	0	3	0	0	6	7	0	0	0	0	0	6
Total	24	24	10	10	12	6	9	9	23	30	13	12	12	28	27	12	20	16	19	35	26	17	10	11	17	17	42

Table 4.5 shows differences between risk cause subcategories and differences in how these risk causes are distributed across projects. These differences are discussed in detail below, complemented by the experts' observations and reflections on the specific differences.

Differences between categories

First, the coded causes do not seem to be evenly distributed across the subcategories. Some cause subcategories occur significantly more frequently than others. The most noticeable contrasts are:

- *'Resistance from users and environment'* (C27) is coded 42 times in total.
- *'Limited or insufficient tender applications'* (C6) is coded 6 times in total.

Although *'Resistance from users and environment'* (C27) appears in only a few risk registers, it is coded many times within those registers, which may suggest that it only becomes a dominant issue when it is relevant. The reason for *'Limited or insufficient tender applications'* (C6) being coded only in two risk registers will be discussed later, as it is likely related to the project phase in which this cause becomes relevant.

Experts recognize *'Resistance from users and environment'* (C27) as a relevant cause, but note that it does not occur in every project. They explain that it occurs most common in projects with major user impact (e.g., phased execution and temporary relocation), in inner-city locations where neighbours are affected, and when an environmental permit is needed (appendix C.1.1).

Second, some cause subcategories seem to recur broadly, while others are rare or project specific. The most noticeable contrasts are:

- *'Zoning and spatial policy constraints'* (C15) appears in 7 out of 9 risk registers
- *'Limited or insufficient tender applications'* (C6) and *'Limited material and equipment available'* (C23) appears in 2 out of 9 risk registers.

'Zoning and spatial policy constraints' (C15) appears in many risk registers, which may indicate that this type of cause can arise under many different project conditions and therefore may be regularly recognized and recorded. In contrast, causes that appear in only a few risk registers may require more specific circumstances to occur, or may only be recorded when they become very explicit in a project.

Differences between projects

Table 4.5 also seems to show differences between the nine risk registers in how cause-dense they are. This may suggest that some risk registers describe risks with more cause descriptions than others. The most noticeable contrasts are:

- Project 6 contains a high number of coded cause quotations (83), making it the most cause-dense risk register.
- Project 5 contains a very low number of coded cause quotations (14), making it the least cause-dense risk register.

The projects phase may partly explain this difference in density. Projects 4 and 5 have the fewest coded causes per risk register, and both are in the initiative phase. This may suggest that initiative-phase risk registers are less detailed, and that perhaps not all causes can be identified yet in that phase. However, it seems that risk registers of definition and procurement phases, still differ in cause density. This may suggest that, besides the influence of phases, there are also influences in how risk registers are written, such as the level of detail used to document risk causes.

Experts note that it is difficult to judge whether a denser risk register is 'better'. They explain that cause descriptions are often more unique and case-specific than other elements in the risk register. As a result, some registers may contain many different cause descriptions without necessarily being more usable or clearer (appendix C.1.1).

Second, the distribution of cause subcategories seem to differ per project. In some risk registers, causes are concentrated in only a few subcategories, while other risk registers show a broader spread across many cause subcategories. The most noticeable contrasts are:

- In project 2, the distribution of causes seems to be strongly concentrated, with *'Resistance from users and environment'* (C27) standing out clearly compared to other cause subcategories.

- In project 6, the distribution of causes seems to be more evenly spread, with several cause subcategories occurring at similar levels rather than one single dominant cause.

Project 2 seems to have mostly one dominant cause subcategory, which may indicate that several different risks are being linked back to the same cause. In Project 6, causes are more evenly spread, which could reflect a more mixed project context, or it could reflect a documentation style where causes are described in more specific terms instead of being grouped under one dominant label.

Table 4.6: Frequencies of risk cause subcategories per risk register (sorted by phase)

	Unclear scope definition	Changing requirements and scope	Conflicting interests and priorities	Difference in interpretation	Strained stakeholder relationships	Limited or insufficient tender applications	Unclear role and risk allocations	Inadequate efforts or results	Underestimation of projects complexity and risks	Inadequate planning and unforeseen delays	Cost inflation and market volatility	Insufficient financial resources or feasibility	Limited public authority capacity and priorities	Regulatory changes	Zoning and spacial policy constraints	Governance and steering issues	Slow decision processes	Unstable project team	Complex dependencies between projects and phases	Incomplete or incorrect data and information	Insufficient functional or physical requirements	Insufficient labor capacity	Limited material and equipment available	Shortage of skills and expertise	Limited grid capacity or congestion	Nature and environment constraints	Resistance from users and environment
	Client -		Comm. & Rela.			Contr.		Contractor			Eco. & Fin.		Gov. & Regul.			Orga. & Govnc.			Project & Asset			Resourc.			Site & Surr.		
	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16	C17	C18	C19	C20	C21	C22	C23	C24	C25	C26	C27
Project 4	0	0	0	0	5	0	0	0	5	0	0	2	2	0	0	3	5	0	0	0	6	2	0	0	0	2	0
Project 5	0	0	0	0	0	0	0	2	0	0	0	0	0	0	2	0	0	0	2	6	0	2	0	0	0	0	0
Project 7	0	0	0	2	0	0	0	0	0	0	0	5	0	6	3	5	4	0	0	0	0	0	0	2	2	2	7
Project 3	1	3	4	5	0	0	0	0	6	5	0	0	2	0	4	2	2	5	14	13	1	0	0	0	1	5	9
Project 8	5	0	0	4	3	0	6	0	0	2	0	0	0	0	0	0	6	6	0	2	0	5	0	6	0	0	0
Project 1	2	12	0	0	0	4	0	5	4	0	3	0	4	11	5	0	0	5	1	0	2	5	8	0	2	3	0
Project 2	0	3	3	0	0	0	0	0	4	8	0	0	1	9	7	0	0	0	0	0	5	0	2	3	5	5	20
Project 6	9	3	2	0	4	2	1	0	4	9	7	5	3	2	5	2	0	0	2	8	5	3	0	0	7	0	0
Project 9	7	3	2	0	0	0	2	2	0	6	3	0	0	0	1	0	3	0	0	6	7	0	0	0	0	0	6
Total	24	24	10	10	12	6	9	9	23	30	13	12	12	28	27	12	20	16	19	35	26	17	10	11	17	17	42

Projects 4, 5, 7 = Initiative phase; Projects 3, 8 = Definition phase; Projects 1, 2, 6, 9 = Procurement phase

Table 4.6 shows differences between project phases and differences in how these risk causes are distributed across phases. These differences are discussed in detail below, complemented by the experts' observations and reflections on the specific differences.

Differences between phases

Overall, many cause categories appear in all phases, but the emphasis may slightly differ between phase groups. The most noticeable contrasts are:

- Initiative-phase projects (4, 5, 7) do not seem to show one dominant category, the cause distribution appears to vary more between risk registers in this phase.
- Definition-phase projects (3 and 8) seem to show a slight emphasis on communication-related issues (table 4.6). Asset-related issues, which seems to appear the highest in this phase, are excluded from this comparison because they are only represented by project risk register, which is insufficient to link this difference directly to the project phase.
- Procurement-phase projects (1, 2, 6, 9) also seem to show a wide spread, with relatively more causes related to scope and requirement changes, contractor-related issues, and external constraints.

These phase differences may be linked to how uncertainty and information change over time. In early phases, projects still have limited concrete details, which may lead to teams describing causes in a more exploratory way, which can result in a varied cause-mix across the risk registers. In the definition phase, aligning roles, decisions, and stakeholder expectations become more central. This may make organizational and communication-related causes stand out more. In the procurement phase, projects become more dependent on external parties and on having a clear and stable scope, which may make those causes more visible and therefore documented.

Experts confirm that it is logical for organizational and communication-related causes to stand out in the definition phase (appendix C.1.1).

Beyond these main contrasts, some additional insights seem to stand out across the different project phases:

- Table 4.6 seems to show a gradual increase in coded causes as the project progresses into later phases.
- Table 4.6 seems to suggest that some causes do not occur in a specific phase. For example, scope-related causes (C1 and C2) or *'Unclear role and risk allocations'* (C7) do not appear in the initiative phase, while causes such as *'Limited or insufficient tender applications'* (C6) or *'Limited material and equipment available'* (C23) are absent in both the initiative and definition phases.

The gradual increase in coded causes may reflect that risk registers function as living documents that expand as the project develops. As more information becomes available, issues that were previously unnoticed or unclear can become clear and are then added as explicit causes.

The results also seem to suggest that some causes are phase-specific and only become relevant later in the process. For example, scope-related causes (C1 and C2) or *'Unclear role and risk allocations'* (C7) may be less visible in the initiative phase because scope boundaries and responsibilities are still being shaped and are not yet documented in detail. Additionally, *'Limited or insufficient tender applications'* (C6) and *'Limited material and equipment available'* (C23) may depend on procurement outcomes and market responses, so they only appear in the procurement phase, when tendering becomes relevant.

Experts explain that later phases involve more project aspects and therefore more risk themes, which can increase the number of recorded causes. They also note that risk priorities can shift over time, meaning some early-phase risks may be resolved while other risks become more important later. Finally, they point out that the number of documented causes depends on the team's approach. Some teams focus only on the current and next phase, while others assess the full project, which can affect how many causes are captured at each stage (appendix C.1.1).

Table 4.7: Frequencies of risk cause subcategories per risk register (sorted by type)

	Unclear scope definition	Changing requirements and scope	Conflicting interests and priorities	Difference in interpretation	Strained stakeholder relationships	Limited or insufficient tender applications	Unclear role and risk allocations	Inadequate efforts or results	Underestimation of projects complexity and risks	Inadequate planning and unforeseen delays	Cost inflation and market volatility	Insufficient financial resources or feasibility	Limited public authority capacity and priorities	Regulatory changes	Zoning and spacial policy constraints	Governance and steering issues	Slow decision processes	Unstable project team	Complex dependencies between projects and phases	Incomplete or incorrect data and information	Insufficient functional or physical requirements	Insufficient labor capacity	Limited material and equipment available	Shortage of skills and expertise	Limited grid capacity or congestion	Nature and environment constraints	Resistance from users and environment
	Client -		Comm. & Rela.			Contr.		Contractor			Eco. & Fin.		Gov. & Regul.			Orga. & Govnc.			Project & Asset			Resourc.			Site & Surr.		
	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16	C17	C18	C19	C20	C21	C22	C23	C24	C25	C26	C27
Project 3	1	3	4	5	0	0	0	0	6	5	0	0	2	0	4	2	2	5	14	13	1	0	0	0	1	5	9
Project 6	9	3	2	0	4	2	1	0	4	9	7	5	3	2	5	2	0	0	2	8	5	3	0	0	7	0	0
Project 4	0	0	0	0	5	0	0	0	5	0	0	2	2	0	0	3	5	0	0	0	6	2	0	0	0	2	0
Project 5	0	0	0	0	0	0	0	2	0	0	0	0	0	0	2	0	0	0	2	6	0	2	0	0	0	0	0
Project 1	2	12	0	0	0	4	0	5	4	0	3	0	4	11	5	0	0	5	1	0	2	5	8	0	2	3	0
Project 2	0	3	3	0	0	0	0	0	4	8	0	0	1	9	7	0	0	0	0	0	5	0	2	3	5	5	20
Project 7	0	0	0	2	0	0	0	0	0	0	0	5	0	6	3	5	4	0	0	0	0	0	0	2	2	2	7
Project 8	5	0	0	4	3	0	6	0	0	2	0	0	0	0	0	0	6	6	0	2	0	5	0	6	0	0	0
Project 9	7	3	2	0	0	0	2	2	0	6	3	0	0	0	1	0	3	0	0	6	7	0	0	0	0	0	6
Total	24	24	10	10	12	6	9	9	23	30	13	12	12	28	27	12	20	16	19	35	26	17	10	11	17	17	42

Projects 3, 6 = Renovation; Projects 4, 5 = Redevelopment; Projects 1, 2, 7, 8, 9 = New construction

Table 4.7 shows differences between project types and differences in how these risk causes are distributed across types. These differences are discussed in detail below, complemented by the experts' observations and reflections on the specific differences.

Differences between types

There are again some small differences in which cause categories stand out between the different project types. The most noticeable contrasts are:

- Renovation projects (3 and 6) seem to be slightly more shaped by project-related causes, client- and contractor-related issues, and some site and surrounding issues, while still showing a substantial number of causes across all categories.
- Redevelopment projects (4 and 5) also seem to show a more broad spread of causes, with no single dominant category.
- New construction projects (1, 2, 7, 8, 9) seem to include slightly more external- and scope-related causes, while still covering most cause categories.

These small differences by project types may relate to the main uncertainties that typically dominate each type of project. Renovation projects may focus more on project and execution causes because existing conditions are less predictable. Redevelopment projects may be more spread because they often combine elements of new build, renovation, and restructuring, so causes come from different sources. New construction projects may show relatively more external and scope-related causes because they depend more on permits, planning conditions, and defining requirements from the start.

Beyond these main contrasts, some additional insights stand out across the different project types:

- Table 4.7 seems to show that renovation projects have significantly more coded causes than redevelopment projects.

The higher number of coded causes in the renovation projects may indicate that renovations involve more uncertainty and constraints, because they depend on an existing building and its condition. Redevelopment projects often have a broader, mixed scope, so causes may be written down more generally and therefore appear as fewer separate cause statements.

Experts note that the two redevelopment projects in this dataset are both in the initiative phase. In this phase, the scope is typically still being defined and risks are often described at a more general level, which may lead to fewer and less detailed causes. They also point out that renovation projects can involve more uncertainty about the condition of the existing asset, which may lead to different risk themes and more documented causes (appendix C.1.1).

4.2.3. Frequencies of response measure categories per risk register

Table 4.8 shows how often each response measure subcategory (M1 – M23) is coded in each of the nine risk registers. Tables 4.9 and 4.10 present the same frequencies, but reorganised to highlight differences in how these measures are distributed across project types and project phases.

Table 4.8: Frequencies of response measure subcategories per risk register

	Alternative location	Change Freeze and Control	Changes to structure, installations and materials	Enhancing scope definition	Discuss role responsibilities and risk allocations	Enhancing stakeholder collaboration and communication	Holding stakeholder sessions	Inform or engage users and environment	Involving external advisors	Analyses of environmental, regulatory and legal constraints	Research and inspections of assets safety and performance	Studies on market options and financial feasibility	Adding time or money buffers and contingency	Changing project phasing and construction sequence	Reviewing work or plans of contractor	Setting governance structure and processes	Strengthening resources and expertise	Refining (tender) requirements and specifications	Setting contract conditions	Timely (permit) requests	Adjusting procurement strategy and tender phasing	Calculating change impact	Waiting and monitoring the risk
	Design & Scope				Stakeholder & Comm.					Investig. & Inspections			Governc. & Planning					Requirement & Contract			Risk & Strategy		
	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13	M14	M15	M16	M17	M18	M19	M20	M21	M22	M23
Project 1	0	2	3	1	2	5	0	2	2	0	0	0	1	1	1	3	1	2	4	1	3	0	3
Project 2	0	0	0	0	0	3	4	3	6	2	2	2	1	1	3	1	0	2	2	3	0	0	4
Project 3	1	0	0	0	0	7	1	4	4	2	2	1	0	3	3	3	1	4	1	1	1	0	1
Project 4	2	0	0	1	2	5	2	0	0	0	0	2	0	0	0	2	1	0	2	0	1	0	2
Project 5	0	0	1	0	0	1	0	0	0	0	0	0	1	0	0	2	0	1	0	0	0	0	1
Project 6	0	0	3	0	0	8	1	2	3	0	0	1	3	1	1	4	0	7	3	1	1	1	1
Project 7	0	0	1	2	0	4	1	3	0	0	0	2	1	0	0	4	0	1	0	0	0	0	1
Project 8	0	0	0	5	2	5	0	0	1	0	0	2	1	0	0	1	2	1	0	0	0	1	1
Project 9	0	1	0	1	1	3	0	2	2	0	3	2	0	2	0	1	1	2	0	0	0	1	0
Total	3	3	8	10	7	41	9	16	18	4	7	12	8	8	8	21	6	20	12	6	6	3	14

Table 4.8 shows differences between response measure subcategories and differences in how these response measures are distributed across projects. These differences are discussed in detail below.

Differences between categories

First, similarly to the causes, the coded measures do not seem to be evenly distributed across the subcategories, some measure subcategories occur significantly more frequently than others. The most noticeable contrasts are:

- *'Enhancing stakeholder collaboration and communication'* (M6) is coded 41 times in total.
- *'Alternative location'* (M1), *'Change Freeze and Control'* (M2), and *'Calculating change*

impact' (M22) are each coded only 3 times in total.

These results suggest that *'Enhancing stakeholder collaboration and communication'* (M6) is a broad 'default' measure, that can be used for many different risks. In contrast, *'Alternative location'* (M1), *'Change Freeze and Control'* (M2), and *'Calculating change impact'* (M22) seem to be more specific measures. It suggests that they may only fit certain situations, so they are recorded less often.

Second, some response measure subcategories appear in many projects, while others seem to be rare or project specific. The most noticeable contrasts are:

- *'Enhancing stakeholder collaboration and communication'* (M6) and *'Setting governance structure and processes'* (M16) appear in all 9 risk registers.
- *'Alternative location'* (M1) and *'Change Freeze and Control'* (M2) appear only in 2 out of 9 risk registers.

Similar to the explanation above, the number of risk registers in which a measure appears may reflect how broadly applicable that measure is. *'Enhancing stakeholder collaboration and communication'* (M6) and *'Setting governance structure and processes'* (M16) occur in all projects, which may indicate that they fit many different risks and may be part of standard project control. In contrast, *'Alternative location'* (M1) and *'Change Freeze and Control'* (M2) appear in only a few projects, which may indicate that they are only needed in specific situations and may be therefore more project-specific.

Differences between projects

Similar to the cause frequencies, table 4.8 seem to shows differences between the nine risk registers in how measure-dense they are. This suggests that some risk registers describe risks with more measure descriptions than others. The most noticeable contrasts are:

- Project 6 contains a high number of coded measure quotations (41), making it the most measure-dense risk register.
- Project 5 contains a very low number of coded measure quotations (7), making it the least measure-dense risk register.

This difference in measure density seems to follow the same tendency as for causes, meaning that the same risk registers seem to score high or low on coded quotations. This suggests that the contrast is also driven by differences in how the risk registers are documented, rather than only by project content. Table B.1 in appendix B also shows that not only the total number of coded quotations differs per register, but that the balance between coded risks, causes, and measures also seems to vary between risk registers as well. This may indicate that teams differ not only in how many risks they record, but also in how many causes and measures they link to those risks.

Second, the distribution of response measure subcategories seem to differs per project, but the contrasts are less extreme than with the causes. In some risk registers, measures seem to be slightly more concentrated in one or two dominant measure subcategories, while other risk registers seem to show a broader spread across multiple measures. The most noticeable contrasts are:

- In project 6, measures seem to be relatively more concentrated, with *'Enhancing stakeholder collaboration and communication'* (M6) and *'Adjusting governance and planning'* (M18), standing out compared to other measure subcategories.

- In projects 1 and 9, the measure distribution seems to be more evenly spread, with several measure subcategories occurring at similar levels rather than one single measure clearly dominating.

These differences in distributions may suggest that projects often use a more shared or standard set of response measures, which makes the measure distributions more gradual than the cause distributions.

Table 4.9: Frequencies of response measure subcategories per risk register (sorted by phase)

	Alternative location	Change Freeze and Control	Changes to structure, installations and materials	Enhancing scope definition	Discuss role responsibilities and risk allocations	Enhancing stakeholder collaboration and communication	Holding stakeholder sessions	Inform or engage users and environment	Involving external advisors	Analyses of environmental, regulatory and legal constraints	Research and inspections of assets safety and performance	Studies on market options and financial feasibility	Adding time or money buffers and contingency	Changing project phasing and construction sequence	Reviewing work or plans of contractor	Setting governance structure and processes	Strengthening resources and expertise	Refining (tender) requirements and specifications	Setting contract conditions	Timely (permit) requests	Adjusting procurement strategy and tender phasing	Calculating change impact	Waiting and monitoring the risk
	Design & Scope				Stakeholder & Comm.					Investig. & Inspections			Governc. & Planning					Requirement & Contract			Risk & Strategy		
	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13	M14	M15	M16	M17	M18	M19	M20	M21	M22	M23
Project 4	2	0	0	1	2	5	2	0	0	0	0	2	0	0	0	2	1	0	2	0	1	0	2
Project 5	0	0	1	0	0	1	0	0	0	0	0	0	1	0	0	2	0	1	0	0	0	0	1
Project 7	0	0	1	2	0	4	1	3	0	0	0	2	1	0	0	4	0	1	0	0	0	0	1
Project 3	1	0	0	0	0	7	1	4	4	2	2	1	0	3	3	3	1	4	1	1	1	0	1
Project 8	0	0	0	5	2	5	0	0	1	0	0	2	1	0	0	1	2	1	0	0	0	1	1
Project 1	0	2	3	1	2	5	0	2	2	0	0	0	1	1	1	3	1	2	4	1	3	0	3
Project 2	0	0	0	0	0	3	4	3	6	2	2	2	1	1	3	1	0	2	2	3	0	0	4
Project 6	0	0	3	0	0	8	1	2	3	0	0	1	3	1	1	4	0	7	3	1	1	1	1
Project 9	0	1	0	1	1	3	0	2	2	0	3	2	0	2	0	1	1	2	0	0	0	1	0
Total	3	3	8	10	7	41	9	16	18	4	7	12	8	8	8	21	6	20	12	6	6	3	14

Projects 4, 5, 7 = Initiative phase; Projects 3, 8 = Definition phase; Projects 1, 2, 6, 9 = Procurement phase

Table 4.9 shows differences between project phases and differences in how these response measures are distributed across phases. These differences are discussed in detail below, complemented by the experts' observations and reflections on the specific differences.

Differences between phases

When comparing projects by phase, there are again only small differences in which measure themes stand out, and these differences are even smaller than with the cause frequencies. The most noticeable contrasts are:

- Initiative-phase projects (4, 5, 7) seem to show a slight dominance of stakeholder- and communication-related measures.
- Definition-phase projects (3 and 8) also seem to show a slight dominance of stakeholder- and communication-related measures.
- Procurement-phase projects (1, 2, 6, 9) seem to rely on stakeholder-related and contract-related measures, while remaining relatively dispersed across the full set of measure categories.

These small phase differences may indicate that many response measures are useful throughout the whole project. In the initiative and definition phases, stakeholder and communication measures may stand out because teams focus on alignment, expectations, and support while plans are still being shaped. In the procurement phase, stakeholder measures still remain important, but contract-related measures may also become more visible because tender documents, requirements, and agreements become central in this phase.

Experts give different views on whether contract-related measures should mainly appear in the procurement phase. One expert notes that contract-related points should ideally be handled before procurement. Another expert says it depends on what is meant by a contract measure, because adding items to the specifications can logically happen during procurement. They also note that it can depend on how the phase boundaries are defined, because the procurement phase can cover different periods in practice (appendix C.1.2).

Table 4.10: Frequencies of response measure subcategories per risk register (sorted by type)

	Alternative location	Change Freeze and Control	Changes to structure, installations and materials	Enhancing scope definition	Discuss role responsibilities and risk allocations	Enhancing stakeholder collaboration and communication	Holding stakeholder sessions	Inform or engage users and environment	Involving external advisors	Analyses of environmental, regulatory and legal constraints	Research and inspections of assets safety and performance	Studies on market options and financial feasibility	Adding time or money buffers and contingency	Changing project phasing and construction sequence	Reviewing work or plans of contractor	Setting governance structure and processes	Strengthening resources and expertise	Refining (tender) requirements and specifications	Setting contract conditions	Timely (permit) requests	Adjusting procurement strategy and tender phasing	Calculating change impact	Waiting and monitoring the risk
	Design & Scope				Stakeholder & Comm.					Investig. & Inspections			Governc. & Planning					Requirement & Contract			Risk & Strategy		
	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13	M14	M15	M16	M17	M18	M19	M20	M21	M22	M23
Project 3	1	0	0	0	0	7	1	4	4	2	2	1	0	3	3	3	1	4	1	1	1	0	1
Project 6	0	0	3	0	0	8	1	2	3	0	0	1	3	1	1	4	0	7	3	1	1	1	1
Project 4	2	0	0	1	2	5	2	0	0	0	0	2	0	0	0	2	1	0	2	0	1	0	2
Project 5	0	0	1	0	0	1	0	0	0	0	0	0	1	0	0	2	0	1	0	0	0	0	1
Project 1	0	2	3	1	2	5	0	2	2	0	0	0	1	1	1	3	1	2	4	1	3	0	3
Project 2	0	0	0	0	0	3	4	3	6	2	2	2	1	1	3	1	0	2	2	3	0	0	4
Project 7	0	0	1	2	0	4	1	3	0	0	0	2	1	0	0	4	0	1	0	0	0	0	1
Project 8	0	0	0	5	2	5	0	0	1	0	0	2	1	0	0	1	2	1	0	0	0	1	1
Project 9	0	1	0	1	1	3	0	2	2	0	3	2	0	2	0	1	1	2	0	0	0	1	0
Total	3	3	8	10	7	41	9	16	18	4	7	12	8	8	8	21	6	20	12	6	6	3	14

Projects 3, 6 = Renovation; Projects 4, 5 = Redevelopment; Projects 1, 2, 7, 8, 9 = New construction

Table 4.10 shows differences between project types and differences in how these response measures are distributed across types. These differences are discussed in detail below, complemented by the experts' observations and reflections on the specific differences.

Differences between types

When comparing the response measure frequencies by project type, there are again small differences in which measure themes stand out. The most noticeable contrasts are:

- Renovation projects (3 and 6) seem to show relatively more stakeholder-related and requirement-related measures

- Redevelopment projects (4 and 5) seem to show a narrower measure spread, with fewer outspoken measure categories.
- New construction projects (1, 2, 7, 8, 9) seem to include measures across all categories, while stakeholder measures remain the main response measure category.

These small differences may reflect the main focus areas of each project type. Renovation projects may need more requirement and specification work because the existing assets condition is not fully known. Redevelopment projects may show a more narrow measure spread because both of the risk registers are in the initiative phase, where the documentation may be more limited. New construction projects may show a wider spread of measures because the project starts from scratch, which may make it more likely for teams to use a broader range of different measures.

Experts say that the higher use of requirement- and specification-related measures in renovation projects can make sense. They explain that renovations work with an existing building, and its condition is never fully known upfront. This can create extra risks, which may lead teams to take more control measures, such as *'Refining requirements and specifications'* (M18) (appendix C.1.2).

Beyond these main contrasts, some additional insights stand out across the different project types as well as across the project phases:

- Tables 4.9 and 4.10 seem to show that regardless of project phase or project type, stakeholder and communication-related measures are consistently the most used category.

This may suggest that stakeholder and communication-related measures may often be used as a default response that fits many risk situations. In particular, *'Enhancing stakeholder collaboration and communication'* (M6) supports this, as discussed earlier.

Experts explain that stakeholder and communication measures can dominate because they are standard, non-specific actions that are easy to include and easy to monitor. They also suggest these measures are often used because stakeholder management is still remains difficult in practice and many issues can come from it. Finally, experts note that communication is often included as part of a broader response sets together with other measures (appendix C.1.2).

4.2.4. Co-occurrences of risk cause subcategories and response measure subcategories

After describing how often causes and measures occur, the next step is to examine how causes and measures are connected within the same risk statements. In this study, a co-occurrence means that a cause code and a measure code were applied to the same coded risk event in Atlas.ti. This indicates that the risk register records that measure as a response to that cause for that specific risk, rather than the two codes only appearing somewhere in the same risk register. Co-occurrences therefore capture cause–measure links as they are documented in the risk registers, and add information beyond frequency alone.

Table 4.11 provides the full subcategory level co-occurrence matrix (27 cause subcategories × 23 measure subcategories). Each cell shows how many times a specific cause subcategory is linked to a specific measure subcategory across the dataset. This overview makes it possible to see which combinations occur most often and whether recurring cause-measure patterns can be observed.

Table 4.11: Co-occurrences of risk causes (sub cat.) and response measures (sub cat.)

			Alternative location	Change Freeze and Control	Changes to structure, installations and materials	Enhancing scope definition	Discuss role responsibilities and risk allocations	Enhancing stakeholder collaboration and communication	Holding stakeholder sessions	Inform or engage users and environment	Involving external advisors	Analyses of environmental, regulatory and legal constraints	Research and inspections of assets safety and performance	Studies on market options and financial feasibility	Adding time or money buffers and contingency	Changing project phasing and construction sequence	Reviewing work or plans of contractor	Setting governance structure and processes	Strengthening resources and expertise	Refining (tender) requirements and specifications	Setting contract conditions	Timely (permit) requests	Adjusting procurement strategy and tender phasing	Calculating change impact	Waiting and monitoring the risk
			Design & Scope				Stakeholder & Comm.					Investig. & Inspections			Governance & Planning					Requirement & Contract			Risk & Strategy		
			M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13	M14	M15	M16	M17	M18	M19	M20	M21	M22	M23
Unclear scope definition	Client	C1	0	0	0	4	0	0	1	1	2	0	2	0	0	0	1	0	0	5	0	0	0	0	0
Changing requirements and scope		C2	0	3	0	0	0	0	0	3	0	0	1	0	2	1	0	1	0	2	0	0	0	2	0
Conflicting interests and priorities	Comm. & Rela.	C3	0	0	0	0	0	1	0	1	2	0	0	0	0	0	1	1	0	0	1	0	0	0	0
Difference in interpretation		C4	0	0	0	1	0	1	1	2	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Strained stakeholder relationships		C5	0	0	0	1	2	2	2	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
Limited or insufficient tender applications	Contr.	C6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	3	0	0
Unclear role and risk allocations		C7	0	0	0	1	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Inadequate efforts or results	Contr.or.	C8	0	0	0	0	0	2	0	0	1	0	0	0	0	0	0	0	0	1	0	1	0	0	1
Underestimation of projects complexity and risks		C9	0	0	1	0	1	0	1	2	2	0	0	2	0	0	0	1	0	4	0	0	2	0	0
Inadequate planning and unforeseen delays		C10	0	0	0	1	0	1	0	0	2	0	0	0	3	4	3	2	1	1	0	1	0	0	2
Cost inflation and market volatility	Eco. & Fin.	C11	0	0	0	0	0	1	0	0	1	0	0	2	1	0	0	0	0	1	4	0	0	0	1
Insufficient financial resources or feasibility		C12	0	0	0	0	0	3	0	0	0	0	0	2	1	0	0	1	0	0	0	0	0	0	0
Limited public authority capacity and priorities	Gov. & Regul.	C13	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regulatory changes		C14	0	0	1	2	1	2	1	0	1	1	0	1	0	0	0	1	0	2	1	0	0	1	4
Zoning and spacial policy constraints		C15	0	0	1	0	0	4	0	0	2	1	0	1	0	0	0	0	0	1	2	2	0	0	2
Governance and steering issues	Orga. & Govnc.	C16	0	0	0	0	0	1	0	1	0	0	0	0	0	0	1	3	0	1	0	0	0	0	0
Slow decision processes		C17	0	0	0	0	0	3	0	0	0	0	0	2	0	2	0	2	0	0	2	0	0	1	1
Unstable project team		C18	0	0	0	0	0	6	0	0	2	0	0	0	0	0	0	1	1	0	0	0	1	0	1
Complex dependencies between projects and phases	Project & Asset	C19	0	0	0	0	0	1	0	0	1	0	0	0	0	4	1	2	0	1	1	0	0	0	1
Incomplete or incorrect data and information		C20	0	0	0	1	0	3	1	1	3	0	1	1	1	0	2	4	0	3	0	0	0	0	0
Insufficient functional or physical requirements		C21	2	0	2	0	1	1	3	0	2	0	0	0	0	0	0	0	1	2	0	1	0	0	1
Insufficient labor capacity	Resourc.	C22	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	3	1	1	0	0	0	0
Limited material and equipment available		C23	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	1	2	0	0	0	0
Shortage of skills and expertise		C24	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	2	0	0	0	0	0	2
Limited grid capacity or congestion	Site & Surr.	C25	0	0	2	0	0	3	0	1	3	0	0	0	2	1	0	0	0	0	0	0	0	0	0
Nature and environment constraints		C26	0	0	1	0	0	1	0	0	0	2	1	1	1	0	0	1	1	0	1	0	0	0	0
Resistance from users and environment		C27	1	0	0	0	0	4	2	9	3	0	2	0	0	0	0	2	1	0	0	1	0	0	0

General observations

The co-occurrence matrix (table 4.11) shows some overall results in how causes and measures are linked. The most noticeable general observations are:

- A large number of cells in the matrix are zero, which means that many cause–measure combinations do not occur in the dataset.

These missing combinations seem to indicate that teams do not link every cause to every measure. Instead, teams seem to use a selective number of cause–measure combinations that they find suitable, while many other combinations do not occur, possibly because they are not considered a good fit for the situation.

- Causes differ in how 'focused' they are linked to measures. For many cause subcategories, only a limited number of measures is linked to that cause. At the same time, some causes are linked to a broader spread of measures, meaning that multiple response measures are recorded for the same cause type.

This seems to suggest two cause–measure pattern types. Some causes seem to show a focused cause–measure pattern, where only a limited number of different response measures is recorded each time the cause appears, which may indicate that these causes have a relatively clear or typical response in the registers. Other causes seem to show a dispersed cause–measure pattern, where a wider range of different response measures is recorded for that cause, which may suggest that these causes may be broader, more complex, or more open to different approaches.

- Almost all causes are linked to at least one stakeholder-related measure. Only three exceptions show no co-occurrences with stakeholder measures, namely *'Limited or insufficient tender applications'* (C6), *'Limited labor capacity'* (C22), and *'Limited material and equipment available'* (C23).

These results seem to suggest a broad linking pattern, where stakeholder-related measures are linked to many different causes and therefore appear to function as a broadly applicable response category in the risk registers. The three exceptions (C6, C22, C23) may depend more on the market or resource availability. For these issues, stakeholder measures may be seen as less applicable.

Experts say that it is logical that these three causes are not linked to stakeholder measures. They explain that issues such as *'Limited material and equipment available'* (C23) are mainly contractor-side risks, and therefore not strongly linked to stakeholder actions from the client side (appendix C.1.3).

Specific observations

Within these general tendencies, table 4.11 also contains a few specific combinations that stand out more clearly than others. The most noticeable specific observations are:

- *'Resistance from users and environment'* (C27) and *'Inform or engage users and environment'* (M8) is the most frequent cause–measure co-occurrence in the dataset. It recurs in four of the risk registers, across different phases and different project types (tables B.13 - B.16).

This high co-occurrence seems to suggest a strong cause–measure link, where the recorded response directly targets the same stakeholder group described in the cause. The high frequency may be partly explained by the fact that *'Resistance from users and environment'* (C27) is the most frequently coded cause in the dataset, which may increase the likelihood that co-occurrences involving C27 appear more often. In addition, the link between C27 and *'Inform or engage users and environment'* (M8) seems particularly direct. If there is resistance from users or the environment, a logical response seems to inform and engage those same groups, which may explain why teams repeatedly record this combination.

- *'Limited public authority capacity and priorities'* (C13) is linked to only one measure, *'Enhancing stakeholder collaboration and communication'* (M6). Looking at tables B.4 - B.12 in appendix B, this link appears across five different risk registers, which seems to suggest a strongly focused cause–measure pattern rather than a one-project exception.
- *'Regulatory changes'* (C14) is linked to the broadest range of different measures, including measures from every main measure category, which seems to suggest a dispersed cause–measure pattern. Notably, this cause appears only in risk registers 1 (table B.4), 7 (table B.10), and 8 (table B.11), which are all new construction projects (table B.16).

Both C13 and C14 are external causes that are largely outside the project's control. However, they seem to show different response pattern types. For *'Limited public authority capacity and priorities'* (C13), the main response seems to focus on managing the relationship with the authority, because the risk may depend on their capacity and priorities, which seems to align with a focused cause–measure pattern. For *'Regulatory changes'* (C14), the project team also cannot control the change itself, but it can adapt the project to its effects. Because regulatory changes can affect many parts of the project, the risk registers seem to document a wider spread of measures for this cause, which seems to align with a dispersed cause–measure pattern.

Experts support this explanation and point to the difference between anticipating and depending on another party. For *'Regulatory changes'* (C14), they explain that even though the team cannot influence the change itself, they can think ahead and choose to anticipate possible changes. For *'Limited public authority capacity and priorities'* (C13), they explain that the team has almost no influence and cannot really solve it internally. The main option is therefore to involve the authority as much as possible, communicate urgency, and try to make progress through cooperation (appendix C.1.3).

Experts also explain why *'Regulatory changes'* (C14) may appear mainly in new construction projects. They note that renovation projects deal with existing assets and therefore mostly with existing regulations, so regulatory changes are less likely to be recorded. For redevelopment projects, they point out that the redevelopment projects in this dataset are in the initiative phase, where teams may not yet be dealing with regulatory requirements. In contrast, new construction projects typically have to meet the newest rules, which makes regulatory updates more relevant and more likely to be written down in the risk register (appendix C.1.3).

- *'Enhancing stakeholder collaboration and communication'* (M6) is linked to the widest range of different cause categories across the dataset.

This spread seems to suggest a broad linking pattern, where *'Enhancing stakeholder collaboration and communication'* (M6) is linked to many different causes and therefore appears to function as a broadly applicable response measure in the risk registers. This high number of co-occurrences may be partly influenced by its overall frequency in the dataset, since it is the most frequently coded measure. At the same time, the content of M6 is broad and supportive, as it refers to improving collaboration and communication with stakeholders. This may help explain why project teams repeatedly record this measure across a wide range of different causes and risk situations.

4.3. Expert meeting insights

This section summarizes insights from the expert meeting. It outlines the experts' overall interpretations of the findings, their reflections on current public construction practices in risk analysis and documentation, and their views on the implications and added value of this study. Where the experts provided interpretations on specific findings, these insights are already integrated into the relevant descriptions of the frequency analysis results in sections 4.2.2 and 4.2.3, and the co-occurrence analysis results in section 4.2.4. The full list of questions and answers from the expert meeting is included in appendix C.

4.3.1. Expert's general interpretations of the findings

In the expert meeting, the experts largely recognize the overall picture of the results and consider the identified pattern types plausible for practice. At the same time, they emphasize that the results should be read with care. They note that differences between projects can reflect real differences in context, but can also reflect how teams choose to write and structure the risk register.

When discussing results over time, experts describe risk registers as documents that grow as the project develops. As projects progress, more topics become relevant and uncertainties become clearer, which makes it logical that more causes are recorded. They also note that this development depends on how teams define and use phase boundaries. Some teams focus on the current and next phase, while others already look at the full project for documenting risks. This difference affects what is recorded at each stage and when causes and measures become visible in the risk registers.

A recurring theme discussed in the expert meeting is the strong presence of stakeholder and communication-related measures. The experts explain that these are standard project actions, which makes them easy to apply and easy to record. They also note that stakeholder management often remains difficult in practice, so teams keep relying on these measures. Finally, they suggest that it is often added as a supporting step next to other measures, which helps explain why it appears across many different cause types.

4.3.2. Expert's reflections on current practices

Experts reflect that the risk registers are not yet strongly standardized, and that both the structure and the writing quality can differ between teams and projects. In their view, this makes it harder to compare risk registers and shows a need for a more consistent way of documenting risks. They note that these documentation differences can also hide or blur cause–measure links in the risk register texts.

They also point out that public construction project teams sometimes mix up risks, causes and measure, or describe them in a similar way, which can lead to overlap or mixing of these elements in the register.

Another reflection is that public construction project teams could improve on how links between causes and measures are recorded in the risk registers. Experts note that listing causes and measures is not enough, because without explicit linking, it remains unclear which measure responds to which cause.

4.3.3. Expert's views on implications and added value of this study

The experts say that this study adds value because it turns separate, project-specific risk registers into one structured overview of recurring cause types, measure types, and the links between them. In their view, this can support public construction projects that work with risk registers, because it shows where the registers currently use different wording, different levels of detail, and different ways of linking causes and measures.

They also suggest that the study can be a starting point for improving documentation quality. They note that teams sometimes struggle to separate risks, causes, and measures, and therefore see value in clear separate definitions. They mention that using shared terminology could help teams describe risks more consistently and make risk registers more useful over time.

Finally, the experts explain the value of looking at relationships, not only lists. They say that it already helps when teams start thinking in explicit cause–measure links, because that improves completeness and makes the risk register more actionable.

4.4. Pattern identification approach

Where sections 4.2 and 4.3 report what is found in the risk registers and how experts interpret these findings, this section reports what was observed when applying the approach used to produce the results of the thematic analysis. It shows what the applied approach produces and under which conditions the resulting pattern signals become stronger or weaker.

The approach, described in chapter 3, is based on the development and application of a shared codebook and the identification of documented cause–measure links through co-occurrence analysis. In practice, this approach translates unstructured risk register text into comparable cause and measure categories and produces a documented set of cause–measure links, which provides a basis for examining whether links recur across projects and for describing them as pattern types rather than only as isolated examples.

When applied to the dataset, the approach seems to show that recurring cause–measure pattern types can be found in the risk registers. At the same time, the dataset remains limited for drawing strong conclusions about more specific cause–measure patterns. The following subsections therefore focus on what appears to limit the approach in this dataset and which refinements to the analytical approach could strengthen future applications. In other words, the results below describe the conditions under which broader cause–measure pattern types can be recognised more clearly and, potentially, more specific patterns can be identified in the future.

4.4.1. Constraints on identifying cause–measure patterns

Applying the approach to the nine risk registers shows that the visibility and strength of observed cause–measure patterns are constrained by several characteristics of the dataset and the underlying risk register documentation. As a result, the findings should be read as an indication that broader cause–measure pattern types can be identified and explored, while more specific cause–measure patterns would require stronger data and further analysis.

Documentation-related constraints mainly reduce the visibility of cause–measure patterns in the co-occurrence outputs. In this dataset, visibility appears to be reduced by variation in documentation across risk registers, including differences in level of detail and writing style. In addition, risk register elements are not always clearly separated in the source text, which can blur whether text refers to a cause, a risk event, or a response measure. Moreover, cause–

measure links are not explicitly documented as such in the registers. As a result, links have to be reconstructed through co-occurrence, which can leave relations less visible or more ambiguous when entries are generic or loosely formulated.

Dataset-related constraints mainly reduce the strength of the cause–measure patterns and, in some cases, also limit visibility. The dataset is relatively small for drawing conclusions about specific cause-measure patterns, especially when recurrence is expected across multiple projects. Moreover, the number of projects per phase and per project type is limited, which limits how strongly phase- or type-specific differences can be interpreted as stable patterns.

4.4.2. Conditions and refinements to the approach

Section 4.4.1 suggests that the approach seems able to identify broader cause–measure pattern types, but that the visibility and strength of the observed patterns are constrained by documentation quality and dataset composition.

Two conditions therefore appear particularly important for obtaining stronger pattern results. First, patterns are likely to become more pronounced when risk entries are documented more consistently, with clearer separation of causes, events, and measures and more explicit recording of which measures respond to which causes. Second, pattern identification is likely to become stronger with a larger and more comparable dataset. With more projects, and more projects within the same phase or project type, recurrence can be assessed within represented groups, which supports more stable phase- and type-related interpretations.

Together, these conditions would likely make the broader cause–measure pattern types that currently seem to emerge more distinct, and the conditions may also support the identification of more specific cause–measure patterns in the future. In that sense, the current approach appears to show that broader cause–measure pattern types can be identified in the risk registers, while stronger data and further analysis may allow the same approach to identify more specific cause-measure patterns.

In addition to these conditions, the application suggests a refinement within the analytical approach itself. During coding, each coded cause may be tagged to its project phase and/or project type. This would allow patterns to be examined within phase-specific or type-specific subsets directly, rather than relying mainly on project-level grouping. As patterns could be explored in a more targeted way for specific phases or project types, while keeping the analysis aligned with how the risk statements are documented.

4.5. Summary of results

The main results from sections 4.1 - 4.4 are summarised here and related back to the sub-questions of this research.

Section 4.1.1 presents the literature study results related to sub-question 1: *Which risk causes recur in construction literature, and how can they be categorized?*. Eight peer-reviewed studies are combined into a literature-based categorisation of 13 recurring risk cause categories (table 4.1). This categorisation functions as the initial, literature-grounded structure for organising and interpreting the empirical risk register results.

Section 4.2 presents the thematic analysis results related to sub-questions 2 and 3. First, section 4.2.1 reports the results related to sub-question 2: *Which risk causes recur in risk registers of Dutch public construction projects, and how can they be categorized?* Three risk register-based categorizations are developed from the dataset, namely a cause categorization (table 4.2), a measures categorization table 4.3) and a risk events categorization (table 4.4).

Second, sections 4.2.2 and 4.2.3 report the frequencies of how causes and measures are documented across projects, phases, and types (tables 4.5 - 4.10).The results show clear differences in both the distribution of categories and the level of detail across risk registers. Some cause and measure categories recur broadly across multiple projects, while others appear only in a limited number of registers. In addition, the number of coded causes and measures differs strongly between projects, which suggests that risk registers vary in how extensively causes and measures are described and recorded.

Third, section 4.2.4 reports the results related to Sub-question 3: *Which recurring cause-measure patterns can be identified in risk registers of Dutch public construction projects?*. The results suggest three broad recurring cause–measure pattern types in how causes and measures are linked in the risk registers. These include a focused cause-measure pattern, in which the same cause is repeatedly linked to only one or a limited number of different response measures in the analysed risk registers, a dispersed cause-measure pattern, in which the same cause is addressed through a wider range of different response measures in the analysed risk registers, and a broad linking pattern, in which certain response measures are repeatedly linked to many different causes in the analysed risk registers and therefore seem to be broadly applicable responses.

Section 4.3 presents the expert meeting results. These results are not directly related to a sub-question, but they inform the interpretation of findings related to sub-questions 3 and 4. Experts largely recognise the overall picture of the results and consider the pattern types plausible, while emphasising that the results should be read with care, because differences between projects may reflect both project context and differences in how teams write and structure their risk registers. They also reflect on current documentation practices, including variation in standardisation, mixing of register elements, and the limited explicit recording of cause–measure links.

Section 4.4 reports the results related to sub-question 4: *How can recurring cause–measure patterns be identified in risk registers of Dutch public construction projects?* It presents what was observed when applying the pattern identification approach developed in this research and described in chapter 3 to the nine risk registers. The results suggest that, when applying this approach, it seems like broader cause–measure pattern types can be identified in the risk register data. At the same time, the clarity and strength of these patterns may depend on how consistently cause–measure relations are documented in the registers and on the size and comparability of the available dataset, including the distribution across phases and project types. The findings also suggest that the same approach may support the identification of more specific cause–measure patterns, although this would require stronger data and further analysis. Conditions under which the same approach is likely to yield clearer and stronger pattern results are therefore highlighted, together with one analytical refinement, namely tagging coded entries by project phase and/or project type at entry level to enable more targeted subset analyses.

5 Discussion

5.1. Interpretation and reflection on the key findings

The main finding of this study is not simply which risk causes and response measures occur most often, but that a structured coding and linking approach seems to make broader cause–measure pattern types visible in public construction risk registers. At the same time, these pattern types should be interpreted with care. Within this exploratory dataset, they provide a first structured indication rather than evidence of fixed or generalisable response rules. Their visibility appears to depend on the consistency of risk register documentation and on the size and comparability of the dataset across projects, phases, and project types.

This interpretation also suggests a different way of looking at risk register content. Instead of treating causes and measures mainly as separate lists, the findings indicate that they can also be studied as related elements within one documented risk entry. In that sense, the findings support a more relational reading of risk register content.

The literature-based categorization should therefore mainly be seen as a useful starting point rather than as a final model. It helps structure the analysis, offers a shared language, and supports systematic coding, but the results suggest that the broad literature categories alone are often not detailed enough to capture meaningful differences. The risk register-based categorization seems to strengthen this interpretation by suggesting that further refinement was needed to better reflect practice and to make differences between projects more visible. The introduction of subcategories can therefore be seen as a data-driven refinement that improved the fit between the coding framework and the empirical material.

At the same time, this refinement creates an interpretive trade-off. More detailed coding can make important differences between projects more visible, but it can also make consistent coding across projects more difficult, while less detail may hide relevant differences.

In addition, cause and measure categories do not all have the same level of specificity. Some categories are broad and can capture many different descriptions, while others are much narrower. This means that more frequently occurring categories are not necessarily more important in practice, but may also reflect broader category boundaries or more generic wording in the risk registers. The findings should therefore be read as indications of recurring documentation tendencies rather than as direct signs of practical importance.

The pattern results themselves also call for interpretation. The results suggest that broader cause–measure pattern types can be recognised in the risk registers, and these broader pattern types were largely considered plausible by the experts. At the same time, the dataset remains too limited for strong conclusions about more specific cause–measure patterns. This is partly because the observed differences between projects may reflect actual contextual differences, but may also result from variation in writing style, documentation quality, and the extent to which cause–measure relations are recorded explicitly. For that reason, the observed pattern types are best understood as broader recurring regularities that become visible through structured analysis. The findings therefore support looking at risk registers through a pattern lens.

A further reflection concerns the project phases and the project types. The findings seem to suggest that some cause categories may become more visible in particular project phases or project types. This is in line with the observation that later project phases contained more coded causes and measures, which may indicate that certain categories only become relevant or easier to recognize once the project develops further and more interfaces become active. From that perspective, future use of the approach could benefit from linking coded entries more directly to project phase and project type at entry level, instead of treating these only as general project characteristics. This could help distinguish between causes that recur broadly and causes that seem more specific to a certain phase or type.

The findings of the expert seem to suggest that not all response measures play the same role. Some measures appear to function as more direct responses to a specific cause, while stakeholder- and communication-related measures often seem to play a broader and more supportive role across different situations. This may help explain why such measures recur across many different cause categories. A possible interpretation is therefore that some measures operate as primary responses, while others function more as secondary or enabling measures that support substantive responses. Although this distinction was not formally tested in the current study, it appears to be a plausible interpretation of the observed data and expert reflections.

5.2. Contributions and Implications

5.2.1. Theoretical contributions

A first theoretical contribution of this study is the translation from literature to practice. The literature-based categorization provided a useful starting point, but the empirical analysis showed that further refinement was needed to fit how causes are actually documented in public construction risk registers. The resulting risk register-based categorization therefore does not replace the literature, but extends it by showing how literature-based taxonomies can be made more usable for practice-based analysis.

A second theoretical contribution is that the study adds to research on structured risk identification and documentation practices. Earlier literature suggests that risk identification in practice often remains ad hoc, even when similar tools are used. This study contributes by developing and applying a structured pattern identification approach that combines the separation of causes, risk events, and response measures, iterative codebook development, and co-occurrence analysis. In doing so, it adds a more explicit methodological basis for analysing how risk information is documented and related in practice.

A third theoretical contribution is that the study extends response literature beyond high-level response strategies. Existing frameworks often remain at the level of response intent or response type, whereas this study focuses on concrete response measures as they are written down in risk registers and groups them into a practice-based categorization. This provides a more detailed view of how responses are documented in practice.

A fourth theoretical contribution of this study is that it narrows the knowledge gap identified in the problem statement by providing a first empirical view of how risk causes relate to concrete response measures in risk registers of Dutch public construction projects. Prior literature often identifies common causes and broad response themes, but less often examines how specific causes are related to concrete recorded measures in project documentation. This study adds that empirical perspective by showing that such relations can be analysed systematically in risk register data.

5.2.2. Practical implications

A first practical implication is that the study offers a structured picture of current risk registration practices and a basis for improvement. It shows how risks, causes, and measures are currently documented across projects using one consistent framework. Public clients can use this to reflect on their current approach and to identify where greater consistency or clarity is needed. In that sense, the study can serve as a baseline for improving risk register use over time.

A second practical implication is that this study helps address the practical problem that cause–measure relations in risk registers are often not recorded and interpreted in a clear and consistent way. By offering clearer terminology and a more structured distinction between causes, risk events, and response measures, the study provides project teams in public construction with a shared reference for writing and reading risk registers. The expert meeting suggests that teams sometimes mix up these elements, so using clearer definitions can support more consistent descriptions and improve risk register quality over time.

A third practical implication is that the risk register-based categorizations can be used as a shared reference list across projects. Used in this way, they can support cross-project comparison and help teams recognise recurring types of causes and response measures in similar contexts. At the same time, these categorizations should be used as a starting point rather than a fixed set, since projects still require context-specific wording and additions.

A fourth practical implication is that the study highlights the value of recording relationships, rather than only separate categories. The experts noted that simply listing causes and measures can leave it unclear which measure responds to which cause. Making cause–measure links more explicit can therefore improve completeness and make the risk register more actionable by clarifying what is being done and why. It can also support later review and learning, because recurring relations become easier to identify directly from the register.

A final practical implication is that the pattern identification approach used in this study can be reused as a practical instrument. Public construction projects that work with risk registers can apply the same coding logic and co-occurrence method to new risk registers. This provides a structured way to analyse how causes, risk events, and response measures are documented, to compare how cause–measure relations are recorded across projects, and to look at risk registers through a pattern lens rather than only as isolated entries. In this way, the approach can support more repeatable analysis, make differences in wording, level of detail, and linking practices more visible, and strengthen continuous learning across projects over time.

5.3. Limitations

A first limitation is that the findings are context-specific. The study focuses on large public construction projects with integrated contracts and uses risk registers from the pre-construction stage. The cases are selected from a larger set and filtered for completeness and readability to enable consistent coding. As a result, the findings may not apply in the same way to other project types, other contract forms, or later project phases.

A second dataset limitation is that the sample does not allow strong comparisons across project phases and project types. Although the dataset includes different phases and types, the distribution is uneven and some subgroups are small. This means that phase- or type-specific patterns should be interpreted cautiously, because observed differences may be driven by a small number of projects rather than stable relations.

Another limitation relates to category detail, which is also discussed in the interpretations on the findings in section 5.1. Some cause and measure categories are more general than others. More general categories can fit a wider range of descriptions than more specific categories, which can make them appear more frequent or more widely linked in the results. As a result, the measured differences between categories may partly reflect level of detail, rather than only underlying differences in project practice.

A fourth limitation is that cause–measure links are not explicitly recorded in the risk registers, but are created through the coding approach. This means that the analysis depends on how text fragments are interpreted and split during coding. As a result, some links may be missed if they are implied but not written down clearly, and some links may be sensitive to interpretation.

A final limitation is that the study uses qualitative coding, so the results depend partly on the researcher's judgment when assigning categories. Even with a structured codebook and systematic steps, coding decisions and category boundaries can influence the observed frequencies and patterns, especially when register descriptions are short or unclear. In addition, since the coding was performed by a single researcher, the results may also be sensitive to individual interpretation, especially for unclear entries.

6 Conclusion and Recommendations

6.1. Answering the sub-questions

6.1.1. Sub-question 1

Which risk causes recur in construction literature, and how can they be categorized?

Based on a focused literature review, this research concludes that there are recurring risk causes discussed in the construction literature. Based on eight peer-reviewed categorization studies, these recurring causes can be grouped into a literature-based categorization of 13 main cause categories, shown in table 4.1.

These categories include causes related to key project actors, such as the client, contractor, and consultants, as well as causes related to project organization, contracts, and design. In addition, the categorization includes resource- and safety-related causes and broader external causes, such as regulation, economic conditions, and site or surrounding factors. Together, these categories provide a structured overview of the main ways in which construction literature explains the origins of project risks.

Together, this combined literature-based categorization answers sub-question 1 by identifying which risk causes recur in the reviewed construction literature and summarizing them in a clear set of categories.

6.1.2. Sub-question 2

Which risk causes recur in risk registers of Dutch public construction projects, and how can they be categorized?

Based on the thematic analysis of the nine risk registers of Dutch public construction projects, this research concludes that there are recurring risk causes that can be identified in the risk registers. These recurring risk causes can be grouped into a risk register-based categorization of 10 main cause categories and 27 cause subcategories, presented in table 4.2.

This risk register-based categorisation is developed by starting with the literature-based categorization in table 4.1, and then iteratively adjusting and refining it based on the content of the analysed risk registers. Compared with the literature-based categorization, the risk register-based categorisation covers mainly the same main themes, but makes them more explicit by distinguishing additional subcategories.

Together, this risk register-based categorization answers sub-question 2 by identifying which risk causes recur in the analysed risk registers and summarizing them in a clear set of categories that better fits Dutch public construction practice.

6.1.3. Sub-question 3

Which recurring cause-measure patterns can be identified in risk registers of Dutch public construction projects?

Based on the co-occurrence analysis of risk registers from Dutch public construction projects, this research concludes that there seem to be broader recurring cause–measure pattern types in the risk registers.

The findings seem to show recurring structure in how certain causes are related to certain response measures in the analysed risk registers. At the same time, the dataset remains too limited for strong conclusions about more specific cause–measure patterns. Instead, the findings suggest that broader cause–measure pattern types can be recognised in the risk registers.

Three broader cause-measure pattern types seem to emerge from the findings. First, a focused cause–measure pattern, in which the same cause is repeatedly linked to only one or a limited number of different response measures in the analysed risk registers. Second, a dispersed cause–measure pattern, in which the same cause is addressed through a wider range of different response measures in the analysed risk registers. Third, a broad linking pattern, in which certain response measures are repeatedly linked to many different causes in the analysed risk registers and therefore 115 responses.

Together, these findings answer sub-question 3 by suggesting that broader cause–measure pattern types can be recognised in the analysed risk registers.

6.1.4. Sub-question 4

How can recurring cause–measure patterns be identified in risk registers of Dutch public construction projects?

Based on the application of the pattern identification approach developed in this study to the risk registers of Dutch public construction projects, this research concludes that broader recurring cause–measure pattern types can be identified through a structured coding and linking procedure.

This pattern identification approach consists of four steps. First, each risk description is separated into causes, risk events, and response measures. Second, a shared codebook is developed and iteratively refined to fit the wording and level of detail used in the risk registers. Third, the full dataset is coded using this stabilized codebook, so that unstructured risk register text is translated into comparable cause and measure categories across the analysed risk registers. Fourth, frequency outputs and co-occurrence analysis are used to identify which causes and measures recur and which links between them appear repeatedly in the analysed risk registers.

Applied to the current dataset, this approach appears to enable the identification of broader cause–measure pattern types. At the same time, the current findings suggest that the same approach may also support the identification of more specific cause–measure patterns, although this would require stronger data and further analysis.

Together, this pattern identification approach answers sub-question 4 by showing how recurring cause–measure patterns can be identified in a structured and transparent way in risk register data.

6.2. Answering the main research question

How are risk causes related to response measures in Dutch public construction projects?

Based on the focused literature review, the thematic analysis of nine risk registers, and the expert meeting, this research concludes that risk causes and response measures in Dutch public construction projects are related through recurring documented links in the risk registers.

These links do not seem random. Instead, the findings suggest that certain risk causes are repeatedly associated with certain response measures, and that these recurring relations can be grouped into broader cause–measure pattern types. The construction literature provides a useful basis for structuring recurring risk causes, but the empirical analysis shows that further practice-based refinement is needed to reflect how causes and measures are actually documented in Dutch public construction projects. In addition, current risk registers differ in wording, level of detail, and the extent to which causes, risk events, and response measures are clearly separated and explicitly linked. These differences reduce the extent to which cause–measure relations can be identified and compared across projects.

Together, these findings answer the main research question by suggesting that risk causes are related to response measures through recurring cause–measure links that can be identified through a structured approach and understood as broader cause-measure pattern types in Dutch public construction risk registers.

6.3. Recommendations

6.3.1. Recommendations for future research

Based on the findings and limitations of this study, several directions for future research can be identified.

1. Test the research approach in other contexts.

Future research can apply this study's approach to risk registers in different contexts, such as other contract forms, later project phases, or projects outside the public sector. This can show how risks, causes, and response measures are documented in these settings and will allow comparison with the public context.

2. Use larger or more focused datasets for stronger comparisons.

Future research can use larger datasets to make stronger comparisons and draw more reliable conclusions. This can be done either by using more projects overall, or by building a dataset more focused on specific project phase or project type. A larger overall dataset supports broader comparisons, while a focused dataset helps to study phase- or type-specific patterns in more detail.

3. Use longitudinal data to study changes over time.

Future research can use longitudinal risk register data to study how risks, causes, and response measures change over the course of a project. By comparing risk registers from the early phases with risk registers in the later phases, researchers can examine what findings stay the same during the process and what findings shift as the project progresses.

4. Investigate whether different response measures can have different roles.

In the expert meeting, it was suggested that some stakeholder- and communication-related measures may play a supportive role, rather than functioning as separate responses on their own. However, this was not examined in this research. Future research is therefore needed to investigate whether different types of response measures play different roles in practice, and whether such distinctions can be identified more systematically before practical recommendations are made about how these measures should be documented or used in risk registers.

5. Investigate how recorded response measures are implemented and relate to project outcomes

Future research can look beyond what is documented in the risk register and examine how recorded response measures are implemented during the project, and how they relate to project outcomes. This can show whether documented response measures are implemented as written, and whether some types of measures are linked to better project performance.

6. Investigate how unforeseen risks emerge and are responded to during execution.

This study focuses mainly on foreseen risks that are documented in the risk registers. Future research can therefore examine how unforeseen risks emerge during later project phases, how they are recognised in practice, and how response measures are documented and adjusted once projects move beyond the planning stage. This can help clarify how the relation between causes and response measures differs between foreseen and unforeseen risks.

6.3.2. Recommendations for practice

Based on the findings and the expert meeting, this research concludes that a more consistent and comparable use of risk registers can be supported through five practical improvements.

1. Adopt a shared structure and shared definitions for writing risk registers.

Clients of public construction projects can improve register quality by adopting one standard structure for writing risk entries and by using shared terminology. A fixed structure helps teams separate the key elements of a risk and reduces the chance that causes, events, and measures are mixed in one description. This makes registers easier to read, easier to compare across projects, and easier to maintain over time.

2. Use the categorizations as a shared reference list.

Clients of public construction projects can use the risk register-based categorizations as a common list of categories to use across projects. This supports cross-project comparison and helps teams recognise typical causes and measure options in similar contexts. At the same time, the categorisations should be used as a starting point, not as a fixed set, since projects still require project-specific adaptations.

3. Make cause–measure links explicit in the risk registers.

Clients of public construction projects can go beyond listing causes and measures as separate items and also record which measure responds to which cause. This can be implemented through a simple link field, reference ID, or a dedicated column in the register template. Making links explicit improves completeness and makes the register more actionable, because it shows what is being done for each cause and why. It also supports later review and learning, because recurring patterns can be seen directly from the recorded links instead of being reconstructed afterwards.

4. Link risk causes to project phase and type in the risk registers.

Clients of public construction projects can improve the usefulness of risk registers by structuring or tagging entries more explicitly by project phase and, where relevant, by project type. The findings suggest that some causes and measures become more visible in particular phases, while others recur more broadly across projects. Organising risk information in this way can help teams review phase-specific risks more systematically and make it easier to compare which causes and measures are most relevant in similar project contexts.

5. Set light requirements on the desired level of detail and quality of the risk registers.

Clients of public construction projects can set light requirements for how much detail is needed in the descriptions. Simple writing rules can help teams avoid very broad or vague wording when a more specific description is possible. In addition, they can add quick quality checks, for example short peer reviews, for clarity and completeness. This supports more consistent and comparable risk registers and increases what can be learned from them across projects.

References

Aaltonen, Kirsi and Jaakko Kujala (Dec. 2010). “A project lifecycle perspective on stakeholder influence strategies in global projects”. In: *Scandinavian Journal of Management* 26.4, pp. 381–397. DOI: 10.1016/j.scaman.2010.09.001. URL: https://www.sciencedirect.com/science/article/pii/S0956522110000941.

Ahmed, Sirwan Khalid (Apr. 2024). “The pillars of trustworthiness in qualitative research”. In: *Journal of Medicine, Surgery, and Public Health* 2, p. 100051. DOI: 10.1016/j.glmedi.2024.100051. URL: https://www.sciencedirect.com/science/article/pii/S2949916X24000045.

Amzafi, Nur Hadirah et al. (2024). “A Systematic Review of the Causes and Effects of Variation Orders in Sustainable Construction in Developing Countries”. In: *International Journal of Integrated Engineering* 16.4, pp. 188–203. DOI: 10.30880/ijie.2024.16.04.023. URL: https://publisher.uthm.edu.my/ojs/index.php/ijie/article/view/16252.

Assaf, Sadi A. and Sadiq Al-Hejji (2006). “Causes of Delay in Large Construction Projects”. In: *International Journal of Project Management* 24.4, pp. 349–357. DOI: 10.1016/j.ijproman.2005.11.010.

Aust, Jonas and Dirk Pons (2020). “A Systematic Methodology for Developing Bowtie in Risk Assessment: Application to Borescope Inspection”. In: *Aerospace* 7.7, p. 86. DOI: 10.3390/aerospace7070086. URL: https://www.mdpi.com/2226-4310/7/7/86.

Aven, Terje (2014). “What is missing in risk conceptualization? A new perspective on how to understand, assess and manage risk and the unforeseen”. In: *Reliability Engineering & System Safety* 121, pp. 1–10. DOI: 10.1016/j.ress.2013.07.005. URL: https://www.sciencedirect.com/science/article/pii/S0951832013002159.

Baard, S. K., T. A. Rench, and S. W. J. Kozlowski (2014). “Performance adaptation: A theoretical integration and review”. In: *Journal of Management* 40.1, pp. 48–99. DOI: 10.1177/0149206313488210.

Baccarini, David (Aug. 1996). “The concept of project complexity—a review”. In: *International Journal of Project Management* 14.4, pp. 201–204. DOI: 10.1016/0263-7863(95)00093-3. URL: https://www.sciencedirect.com/science/article/pii/0263786395000933.

Badreddine, Ahmed et al. (Nov. 2014). “A new multi-objectives approach to implement preventive and protective barriers in bow tie diagram”. In: *Journal of Loss Prevention in the Process Industries* 32, pp. 238–253. DOI: 10.1016/j.jlp.2014.09.012. URL: https://www.sciencedirect.com/science/article/pii/S0950423014001557.

Bahamid, R. A. et al. (2022). “The Current Risk Management Practices and Knowledge in the Construction Industry”. In: *Buildings* 12.7, p. 1016. DOI: 10.3390/buildings12071016. URL: https://www.mdpi.com/2075-5309/12/7/1016.

Birgönül, Zülfikar, Cenk Budayan, and Kübra Koç (2024). “Development of a Taxonomy for Causes of Changes in Construction Projects”. In: *Buildings* 14.1, p. 278. DOI: 10.3390/buildings14010278. URL: https://www.mdpi.com/2075-5309/14/1/278.

Bitamba, Bauma Frigeant and Sung-Hoon An (2020). “Construction Project Change Management in the Democratic Republic of the Congo: Status, Causes, and Impacts”. In: *Sustainability* 12.22, p. 9766. DOI: 10.3390/su12229766. URL: https://www.mdpi.com/2071-1050/12/22/9766.

Bowen, Glenn A. (2009). “Document Analysis as a Qualitative Research Method”. In: *Qualitative Research Journal* 9.2, pp. 27–40. DOI: 10.3316/QRJ0902027.

Brahma, Arindam and David C. Wynn (2023). “Concepts of change propagation analysis in engineering design”. In: *Research in Engineering Design* 34, pp. 117–151. DOI: 10.1007/s00163-022-00395-y. URL: https://link.springer.com/article/10.1007/s00163-022-00395-y.

Braun, V. and V. Clarke (2006). “Using thematic analysis in psychology”. In: *Qualitative Research in Psychology* 3.2, pp. 77–101. DOI: 10.1191/1478088706qp063oa.

Braun, Virginia et al. (2020). “One Size Fits All? What Counts as Quality Practice in (Reflexive) Thematic Analysis”. In: *Qualitative Research in Psychology* 17.4, pp. 528–554. DOI: 10.1080/14780887.2020.1769238.

Browning, Tyson R. and Ranga V. Ramasesh (2015). “Reducing Unwelcome Surprises in Project Management”. In: *MIT Sloan Management Review* 56.3, pp. 53–62. URL: https://www.researchgate.net/publication/283878132_Reducing_unwelcome_surprises_in_project_management.

Burke, C. S. et al. (2006). “Understanding team adaptation: A conceptual analysis and model”. In: *Journal of Applied Psychology* 91.6, pp. 1189–1207. DOI: 10.1037/0021-9010.91.6.1189.

Christian, J. S. et al. (2017). “Team adaptation in context: An integrated conceptual model and meta□analytic review”. In: *Organizational Behavior and Human Decision Processes* 140, pp. 85–103. URL: https://mikechristian.web.unc.edu/wp-content/uploads/sites/13307/2018/04/J.-Christian-et-al-2017_final.pdf.

De Meyer, Arnoud, Christoph H. Loch, and Michael T. Pich (2002). “Managing Project Uncertainty: From Variation to Chaos”. In: *MIT Sloan Management Review* 43.2, pp. 60–67. URL: https://files.core.ac.uk/download/pdf/155249394.pdf.

Delft University of Technology (TU Delft) (Dec. 17, 2025). *CME4001 – Project Management: Complexity. Qualitative and Quantitative Risk Analysis and Management*. Lecture slides (PDF). Slide 25: “Response Planning – The Bow Tie”.

Dianous, Valérie de and Cécile Fiévez (Mar. 2006). “ARAMIS project: A more explicit demonstration of risk control through the use of bow-tie diagrams and the evaluation of safety barrier performance”. In: *Journal of Hazardous Materials* 130.3, pp. 220–233. DOI: 10.1016/j.jhazmat.2005.07.010. URL: https://www.sciencedirect.com/science/article/pii/S0304389405003808.

Dicks, Evan P. and Keith R. Molenaar (2024). “Causes of Incomplete Risk Identification in Major Transportation Engineering and Construction Projects”. In: *Transportation Research Record: Journal of the Transportation Research Board* 2679.2, pp. 619–628. DOI: 10.1177/03611981241263565. URL: https://journals.sagepub.com/doi/10.1177/03611981241263565.

Fan, Miao, Neng-Pai Lin, and Chwen Sheu (Apr. 2008). “Choosing a project risk-handling strategy: An analytical model”. In: *International Journal of Production Economics* 112.2, pp. 700–713. DOI: 10.1016/j.ijpe.2007.06.006. URL: https://www.sciencedirect.com/science/article/pii/S092552730700240X.

Ferdous, Refaul et al. (2013). “Analyzing system safety and risks under uncertainty using a bow-tie diagram: An innovative approach”. In: *Process Safety and Environmental Protection* 91.1-2, pp. 1–18. DOI: 10.1016/j.psep.2011.08.010.

Fereday, Jennifer and Eimear Muir-Cochrane (2006). “Demonstrating Rigor Using Thematic Analysis: A Hybrid Approach of Inductive and Deductive Coding and Theme Development”. In: *International Journal of Qualitative Methods* 5.1, pp. 80–92. DOI: 10.1177/160940690600500107. URL: https://doi.org/10.1177/160940690600500107.

Georganta, E., T. F. Wölfl, and F. C. Brodbeck (2019). “Team adaptation triggers: A categorization scheme”. In: *Gruppe. Interaktion. Organisation. Zeitschrift für Angewandte Organisationspsychologie (GIO)* 50.2, pp. 229–238. DOI: 10.1007/s11612-019-00454-4.

Georganta, E. et al. (2021). “The four-phase team adaptation process: A first empirical investigation”. In: *Team Performance Management* 27.5/6, pp. 313–331. URL: https://www.psy.lmu.de/wirtschaftspsychologie/team/wissenschaftliche_mitarbeiter/katharina_kugler/georganta-et-al_2021_4_phase.pdf.

Geraldi, Joana, Harvey Maylor, and Terry Williams (2011). “Now, let’s make it really complex (complicated). A systematic review of the complexities of projects”. In: *International Journal of Operations & Production Management* 31.9, pp. 966–990. URL: https://www.emerald.com/ijopm/article-abstract/31/9/966/139943/.

Hillson, David (Oct. 1999). “Developing Effective Risk Responses”. In: *Proceedings of the 30th Annual Project Management Institute 1999 Seminars & Symposium*. Papers presented October 10–16, 1999. Project Management Institute. Philadelphia, Pennsylvania, USA. URL: https://risk-doctor.com/wp-content/uploads/2020/09/Hillson-Developing-risk-responses-PMI-Oct1999.pdf.

— (Sept. 2000). “Project risks: Identifying causes, risks, and effects”. In: *PM Network* 14.9, pp. 48–51. URL: https://www.pmi.org/learning/library/project-risks-causes-risks-effects-4663.

— (Apr. 2002). “Extending the risk process to manage opportunities”. In: *International Journal of Project Management* 20.3, pp. 235–240. DOI: 10.1016/S0263-7863(01)00074-6. URL: https://www.sciencedirect.com/science/article/pii/S0263786301000746.

Hwang, Bon-Gang and Lee Kian Low (2012). “Construction project change management in Singapore: Status, importance and impact”. In: *International Journal of Project Management* 30.7, pp. 817–826. DOI: 10.1016/j.ijproman.2011.11.001. URL: https://www.sciencedirect.com/science/article/abs/pii/S0263786311001475.

Ilgen, D. R. et al. (2005). “Teams in organizations: From input–process–output models to IMOI models”. In: *Annual Review of Psychology* 56, pp. 517–543. DOI: 10.1146/annurev.psych.56.091103.070250.

Ismaeil, Esam M. H. and Abu Elnasr E. Sobaih (2024). “A Proposed Model for Variation Order Management in Construction Projects”. In: *Buildings* 14.3, p. 726. DOI: 10.3390/buildings14030726. URL: https://www.mdpi.com/2075-5309/14/3/726.

Khalifa, Walid M. A. and Ibrahim Mahamid (2019). “Causes of Change Orders in Construction Projects”. In: *Engineering, Technology & Applied Science Research* 9.6, pp. 4956–4961. DOI: 10.48084/etasr.3168. URL: https://www.researchgate.net/publication/346751362_Causes_of_Change_Orders_in_Construction_Projects.

Khodabakhshian, Ania, Fulvio Re Cecconi, and Enrique Lopez Droguett (2025). “Probabilistic risk identification and assessment model for construction projects using elicitation based Bayesian network”. In: *Journal of Information Technology in Construction (ITcon)* 30, pp. 185–212. DOI: 10.36680/j.itcon.2025.009. URL: https://www.itcon.org/papers/2025_09-ITcon-Khodabakhshian.pdf.

Kifokeris, Dimosthenis and Yiannis Xenidis (2019). “Analysis of Impartial Implementation in Practice of Risk Identification in Technical Projects”. In: *ASCE-ASME Journal of Risk and Uncertainty in Engineering Systems, Part A: Civil Engineering* 5.3, p. 04019010. DOI: 10.1061/AJRUA6.0001015. URL: https://ascelibrary.org/doi/10.1061/AJRUA6.0001015.

Lafhaj, Z. et al. (2024). “Complexity in construction projects: A literature review”. In: *Buildings* 14.3, p. 680. DOI: 10.3390/buildings14030680.

Leva, Maria Chiara et al. (Dec. 2017). "Risk registers: Structuring data collection to develop risk intelligence". In: *Safety Science* 100, pp. 143–156. DOI: 10.1016/j.ssci.2017.05.009. URL: https://arrow.tudublin.ie/schfsehart/270/.

Love and D. J. Edwards (2004). "Determinants of rework in building construction projects". In: *Engineering, Construction and Architectural Management* 11.4, pp. 259–274. DOI: 10.1108/09699980410547612.

Love, Peter et al. (2023). *Risk response incorporating risk preferences*. Accepted manuscript. URL: https://pure.bond.edu.au/ws/portalfiles/portal/115209648/AM_Risk_response_incorporating_risk_preferences.pdf.

Marzouk, M. M. and T. I. El-Rasas (2014). "Analyzing delay causes in Egyptian construction projects". In: *Journal of Engineering, Design and Technology* 12.1, pp. 49–55. DOI: 10.1108/JEDT-12-2012-0040.

Masár, Matej et al. (2022). "Global survey of current barriers to project risk management and their impact on projects". In: *Journal of Business Economics and Management* 23.5, pp. 1194–1210. DOI: 10.3846/jbem.2022.17784. URL: https://journals.vilniustech.lt/index.php/JBEM/article/download/17784/11384/68862.

Mattar, Yara et al. (2024). "The Impact of Change Orders Caused by Legislative Changes on Program Management in the UAE Construction Industry". In: *Buildings* 14.5, p. 1294. DOI: 10.3390/buildings14051294. URL: https://www.mdpi.com/2075-5309/14/5/1294.

Maynard, M. T., D. M. Kennedy, and S. A. Sommer (2015). "Team adaptation: A fifteen-year synthesis (1998–2013) and framework for how this literature needs to "adapt" going forward". In: *European Journal of Work and Organizational Psychology* 24.5, pp. 652–677. DOI: 10.1080/1359432X.2014.1001376.

Miles, Matthew B., A. Michael Huberman, and Johnny Saldaña (2014). *Qualitative Data Analysis: A Methods Sourcebook*. 3rd ed. PDF copy. Thousand Oaks, CA: SAGE Publications, Inc. ISBN: 978-1-4522-5787-7. URL: https://www.metodos.work/wp-content/uploads/2024/01/Qualitative-Data-Analysis.pdf (visited on 01/30/2026).

Nikander, Ilmari O. and Eero Eloranta (2001). "Project management by early warnings". In: *International Journal of Project Management* 19.7, pp. 385–399. ISSN: 0263-7863. DOI: 10.1016/S0263-7863(00)00021-1. URL: https://www.sciencedirect.com/science/article/pii/S0263786300000211.

Nyqvist, Roope, Antti Peltokorpi, and Olli Seppänen (2024). "Uncertainty network modeling method for construction risk management". In: *Construction Management and Economics* 42.4, pp. 346–365. DOI: 10.1080/01446193.2023.2266760. URL: https://www.tandfonline.com/doi/full/10.1080/01446193.2023.2266760.

Pich, Michael T., Christoph H. Loch, and Arnoud De Meyer (2002). "On Uncertainty, Ambiguity, and Complexity in Project Management". In: *Management Science* 48.8, pp. 1008–1023. DOI: 10.1287/mnsc.48.8.1008.163. URL: https://pubsonline.informs.org/doi/10.1287/mnsc.48.8.1008.163.

Rosen, M. A. et al. (2011). "Managing adaptive performance in teams: Guiding principles and behavioral markers for measurement". In: *Human Resource Management Review* 21.2, pp. 107–122. DOI: 10.1016/j.hrmr.2010.09.003.

Ruijter, Alex de and Frank Guldenmund (2016). "The bowtie method: A review". In: *Safety Science* 88, pp. 211–218. DOI: 10.1016/j.ssci.2016.03.001. URL: https://www.sciencedirect.com/science/article/pii/S0925753516300078.

Saldaña, Johnny (2021). *The Coding Manual for Qualitative Researchers*. 4th ed. SAGE Publications. ISBN: 978-1529731743.

Sambasivan, Mohan and Y. W. Soon (2007). “Causes and Effects of Delays in Malaysian Construction Industry”. In: *International Journal of Project Management* 25.5, pp. 517–526. DOI: 10.1016/j.ijproman.2006.11.007.

Shenton, A. K. (2004). “Strategies for ensuring trustworthiness in qualitative research projects”. In: *Education for Information* 22.2, pp. 63–75. DOI: 10.3233/EFI-2004-22201.

Shrestha, P. P. and R. Maharjan (2019). “Effect of change orders on cost and schedule for small low-bid highway contracts”. In: *Journal of Legal Affairs and Dispute Resolution in Engineering and Construction* 11.4, p. 05019004. DOI: 10.1061/(ASCE)LA.1943-4170.0000323.

Sklet, Snorre (Sept. 2006). “Safety barriers: Definition, classification, and performance”. In: *Journal of Loss Prevention in the Process Industries* 19.5, pp. 494–506. DOI: 10.1016/j.jlp.2005.12.004. URL: https://www.sciencedirect.com/science/article/pii/S0950423005001968.

Snyder, Hannah (2019). “Literature review as a research methodology: An overview and guidelines”. In: *Journal of Business Research* 104, pp. 333–339. DOI: 10.1016/j.jbusres.2019.07.039. URL: https://doi.org/10.1016/j.jbusres.2019.07.039.

Soest, Christian von (Mar. 2023). “Why Do We Speak to Experts? Reviving the Strength of the Expert Interview Method”. In: *Perspectives on Politics* 21.1. Published online 21 June 2022, pp. 277–287. DOI: 10.1017/S1537592722001116. URL: https://doi.org/10.1017/S1537592722001116.

Sun, Ming and Xianhai Meng (2009). “Taxonomy for Change Causes and Effects in Construction Projects”. In: *International Journal of Project Management* 27.6, pp. 560–572. DOI: 10.1016/j.ijproman.2008.10.005. URL: https://www.sciencedirect.com/science/article/pii/S0263786308001506.

Wang, Yelin and G. Edward Gibson (2010). “A study of preproject planning and project success using ANNs and regression models”. In: *Automation in Construction* 19.3, pp. 341–346. DOI: 10.1016/j.autcon.2009.12.007. URL: https://www.sciencedirect.com/science/article/pii/S0926580509001964.

Ward, Stephen and Chris Chapman (2003). “Transforming project risk management into project uncertainty management”. In: *International Journal of Project Management* 21.2, pp. 97–105. DOI: 10.1016/S0263-7863(01)00080-1. URL: https://www.sciencedirect.com/science/article/pii/S0263786301000801.

Wohlin, Claes (2014). “Guidelines for Snowballing in Systematic Literature Studies and a Replication in Software Engineering”. In: *Proceedings of the 18th International Conference on Evaluation and Assessment in Software Engineering (EASE ’14)*. Association for Computing Machinery, pp. 1–10. DOI: 10.1145/2601248.2601268.

Yin, R. K. (2018). *Case study research and applications: Design and methods*. 6th. SAGE. URL: https://us.sagepub.com/en-us/nam/case-study-research-and-applications/book250150.

A

Usage of AI

An AI assistant (ChatGPT) was used during the writing of the report, for text editing (f.e. rephrasing and translating), outline refinement, and checking the consistency of the terminology, style and formatting. The tool was only used as a writing aid to improve clarity and readability, it was not used for literature selection, evidence gathering, data analysis or to draw conclusions. Also, no sensitive or personally identifiable information was provided to the tool.

The author is solely responsible for the content presented in this report.

B

Thematic analysis

B.1. Additional tables of results

B.1.1. Overview of coded causes, measures and risk per risk register

Table B.1: Overview of coded causes, measures and risk events per risk register

	Causes			Measures			Risk events	
Risk registers	**Main cat.**	**Sub cat.**	**Total**	**Main cat.**	**Sub cat.**	**Total**	**Main cat.**	**Total**
Project 1	9	16	76	5	17	37	8	10
Project 2	8	13	75	5	15	40	9	10
Project 3	7	17	80	6	17	40	8	10
Project 4	8	9	32	6	11	22	9	10
Project 5	6	5	14	5	6	7	4	7
Project 6	10	19	83	6	16	41	10	10
Project 7	6	10	38	6	10	20	8	10
Project 8	7	10	45	6	11	22	7	10
Project 9	9	12	48	6	13	22	7	10
Total	10	27	491	6	23	251	34	87

B.1.2. Risk events from the risk registers

Table B.2: Risk events from the risk registers

#	Risk event categories	Underlying risk events
1	(IPM) Project-team is not stable	Project 1: Invulling (IPM-)team niet stabiel
2	Ambitions are not feasible	Project 6: RVB kan ambities functiemix plinten niet waarmaken.
3	Complex operations and maintenance	Project 6: Beheer, onderhoud en facilitaire werkzaamheden worden bemoeilijkt, onmogelijk of zeer kostbaar.
4	Construction work is halted	Project 3: De uitvoering van het werk wordt al na enkele dagen/weken langdurig stilgelegd
5	Critical dependencies on other activities or projects are not ready in time	Project 2: Huidige WKO bron is niet tijdig verplaatst voor start bouw
		Project 3: Renovatie dakkapellen en renovatie zittingszalen verstoren elkaar
		Project 3: VB krijgt de waterproblematiek niet op tijd voor het project opgelost
		Project 6: Afhankelijkheden tussen verschillende (deel)projecten (oplevering H280 en daarna H310) voor Zwolsche schuif.
		Project 8: Projecten buiten (de Scope van) het masterplan, waar dit project van afhankelijk is, vinden niet of te laat plaats
		Project 8: Onderzoeken huidige situatie zijn niet op tijd gereed voor geplande PID afronding
		Project 8: Landgoed (terrein) wordt niet integraal bekeken in samenhang met het bouwproject (gebouwen)
6	Disappointing tender results	Project 1: Tegenvallend aanbestedingsresultaat (prijs vs budget) en haalbaarheid aanbesteding.
		Project 6: Aanbestedingsresultaat is teleurstellend.
		Project 9: Beste inschrijver te duur is (omdat deze bijv. wel gevel impregneert, en andere inschrijver niet).
7	Environmental and underground limitations	Project 5: Sanering van asbest in gebouwen is niet opgenomen in de raming
		Project 5: Verontreinigde grond.
		Project 5: Het raken van onbekende kabels- en leidingen.
		Project 7: Beperkingen door omgevingsinvloeden
8	Existing building not available in time	Project 1: Het gebouw wordt aan een andere gebruiker gegeven voorafgaand aan uitvoering (bijv. IND) en niet tijdig vrijgegeven.
9	Facilities are not feasible	Project 4: Beveiligingsmaatregelen zijn niet mogelijk
		Project 3: WKO-voorzieningen zijn niet haalbaar
		Project 9: Tekort aan parkeervoorzieningen
10	Failed nitrogen requirements	Project 2: Planning loopt uit om aan stikstofeisen te voldoen

11	Failed tender	Project 4: Aanbestedingen mislukken Project 9: Inschrijvers zien af van aanmelden of inschrijven Project 9: Aanbesteding wordt als mislukt aangemerkt Project 9: Partijen afhaken
12	Fire safety constraints	Project 1: Brandveiligheid kan niet worden aangetoond. Project 2: PV panelen mogen vanuit brandveiligheid niet in de gevel komen
13	Housing is canceled or delayed	Project 4: Europol ziet af van huisvesting op CP1 Project 8: Onderhoudswerkzaamheden worden nu nog opgedragen om huidige huisvesting 'in de lucht' te houden. Desinvesteringen
14	Insufficient acquisition of land and building rights	Project 6: De gronden en opstalrecht onder het gebouw kunnen niet verworven worden. Project 7: Rijk biedt grond niet eerst aan Gemeente Roosendaal
15	Insufficient electrical connection	Project 1: De gewenste uitbreiding elektrische gebouwaansluiting t.o.v. huidige is niet op tijd leverbaar. Project 2: E aansluiting onvoldoende tijdens bouwfase Project 6: Netcongestie
16	Insufficient financial resources or feasibility	Project 4: De investering voor CP1 is onredelijk hoog Project 6: Prijsstijgingen tijdens aanebsting en/of uitvoering (beide). Project 7: Onvoldoende financiële middelen Project 8: Benodigd budget voor ambities en PvE is niet beschikbaar Project 8: RVB invest kan niet scherp opgesteld worden
17	Insufficient labor capacity	Project 4: Onredelijk grote inzet van het projectteam Project 4: Personele capaciteit voor CP1 is een aandachtspunt Project 7: Geen tot beperkt capaciteit in de keten Project 8: Continuïteit en behoud expertise binnen het project wordt niet gewaarborgd
18	Insufficient or delayed decision making	Project 4: Besluitvorming komt niet of langzaam tot stand Project 7: Projectbesluit vertraagd Project 7: Projectbesluit wordt NIET-onherroepelijk Project 7: Vormfouten of juridische achterstand bij Voorbereidingsbesluit Defensie
19	Insufficient procurement strategy	Project 2: Twee fase aanpak werkt niet zoals beoogd
20	Insufficient quality of external advisory parties	Project 2: Kwaliteitsborging van ON is ontoereikend.

		Project 6: Betrokken externe ROK partij levert onvoldoende kwaliteit (projectdefinitie, vraagspecificatie, aanbestedingsadvies, etc.).
21	Insufficient stakeholders involvement	Project 8: Stakeholders onvoldoende geïnformeerd / betrokken
22	Lack of storage capacity	Project 5: Geen beschikbare opslagruimte op de kazerne.
23	Late project completion	Project 1: Realisatie loopt uit op oplevermijlpaal. Project 1: GCMK niet tijdig gerealiseerd. Project 2: Geen tijdige oplevering voor Haagse Schuif (oplevering pand aug 2029) Project 9: De gestelde oplevering van het werk vindt later plaats dan geëist.
24	Missing preparatory analyses	Project 5: Ontbreken impactanalyses JIVC voor te slopen gebouwen Project 5: Ontbreken analyse beveiliging voor gebouwen met TBB-en
25	Negative collaboration between parties	Project 4: Partijen zijn negatief en gesloten tegenover elkaar
26	Noise disturbance	Project 3: Het beperken van geluidsoverlast tijdens kantooruren blijkt onvoldoende uitvoerbaar
27	Permit request not granted	Project 2: De BOPA vergunning wordt ingetrokken (herstelbesluit) door de gemeente Project 2: Gemeente geeft geen (niet tijdig) omgevingsvergunning af
28	Permit request not in order	Project 3: Gebruiksmelding is complexbreed niet op orde
29	Problematic dependencies on other parties	Project 1: Rol gemeente Amsterdam onvoorspelbaar. (Grote externe afhankelijkheid.) Project 5: Gelijktijdige aanwezigheid van verschillende aannemers op het object Project 6: Gemeente erkent belang RVB te weinig ten opzichte van belangen overige gebiedspartners in de spoorzone. Project 7: Grote afhankelijkheid van diverse ministeries, provincie, waterschappen en Defensieonderdelen
30	Project does not meet the functional needs	Project 4: Het ontwerp kan niet voorzien in de functionele behoefte
31	Scope changes during the project	Project 1: Wijzigingen na gunning. Project 1: De projectscope wijzigt gedurende het project / traject tot gunning. Project 3: De gehanteerde uitgangspunten worden tijdens het project gewijzigd Project 6: Scopewijziging of scopecreep (functioneel, ruimtelijk, technisch). Project 7: Scope wijzigt Project 9: Het vastgestelde ontwerp moet worden gewijzigd (na acceptatie RVB)
32	Slow permit process	Project 4: Vergunningprocedure levert vertragingen

		Project 3: Lang vergunningenproces
33	Unclear scope	Project 8: Niet alles wordt beschreven, hiaten in de uitvraag ICT Project 8: Scope / afbakening van wat wel en niet in het project zit is niet of onvoldoende helder op het juiste moment Project 9: Gegadigden (inschrijvers) kunnen geen goede inschatting van werkzaamheden maken. Scope onduidelijk
34	User resistance or dissatisfaction	Project 2: Bezwaren uit de omgeving op de omgevingsvergunning bouw/uitwegvergunning Project 3: Gebruikers verzetten zich tegen het uitplaatsen van zittingen naar andere locatie Project 3: Ontevreden gebruikers/klant Project 7: Maatschappelijk en bestuurlijk sentiment na bekendmaking Project 9: Gebruiker (belastingdienst via DGDOO) blijft vasthouden aan flexnorm van 0,7 (i.p.v. passend binnen huidig gebouwvorm) Project 9: Weerstand vanuit gebruikers tov verhuizing naar een nieuw gebouw (hybride werken).

B.1.3. Top 10 most frequently coded causes, measures, and risk events

Table B.3: Top 10 most frequently coded causes, measures, and risk events

Rank	#		Frequency
		Causes	
1	C27	CAUSE | Site & Surrounding | Resistance from users and environment	17
2	C20	CAUSE | Project | Incomplete or incorrect data and information	13
3	C15	CAUSE | Government | Zoning and spatial policy constraints	11
4	C21	CAUSE | Project | Insufficient functional or physical requirements	10
5	C14	CAUSE | Government | Regulatory changes	9
6	C22	CAUSE | Resources | Insufficient labor capacity	9
7	C1	CAUSE | Client | Unclear scope definition	8
8	C10	CAUSE | Contractor | Inadequate planning and unforeseen delays	8
9	CC2	CAUSE | Client | Changing requirements and scope	8
10	C9	CAUSE | Contractor | Underestimation of projects complexity and risks	7
		Measures	
1	M6	MEASURE | Enhancing stakeholder collaboration and communication	41
2	M16	MEASURE | Governance | Setting governance structure and processes	21
3	M18	MEASURE | Contract | Refining (tender) requirements and specifications	20
4	M9	MEASURE | Stakeholder | Involving external advisors	18
5	M8	MEASURE | Stakeholder | Inform or engage users and environment	16
6	M23	MEASURE | Strategy | Waiting and monitoring the risk	14
7	M19	MEASURE | Contract | Setting contract conditions	12
8	M12	MEASURE | Investigations | Studies on market options and financial feasibility	12
9	M4	MEASURE | Scope | Enhancing scope definition	10
10	M7	MEASURE | Stakeholder | Holding stakeholder sessions	9
		Risk events	
1	R5	RISK | Critical dependencies on other activities or projects are not ready in time	7
2	R31	RISK | Scope changes during the project	6
3	R34	RISK | User resistance or dissatisfaction	6
4	R16	RISK | Insufficient financial resources or feasibility	5
5	R23	RISK | Late project completion	4
6	R11	RISK | Failed tender	4
7	R7	RISK | Environmental and underground limitations	4
8	R17	RISK | Insufficient labor capacity	4
9	R29	RISK | Problematic dependencies on other parties	4
10	R18	RISK | Insufficient or delayed decision making	4

B.1.4. Co-occurrences of risk causes and response measures per risk register

Table B.4: Co-occurrences of risk causes and response measures of Risk Register 1

			Alternative location	Change Freeze and Control	Changes to structure, installations and materials	Enhancing scope definition	Discuss role responsibilities and risk allocations	Enhancing stakeholder collaboration and communication	Holding stakeholder sessions	Inform or engage users and environment	Involving external advisors	Analyses of environmental, regulatory and legal constraints	Research and inspections of assets safety and performance	Studies on market options and financial feasibility	Adding time or money buffers and contingency	Changing project phasing and construction sequence	Reviewing work or plans of contractor	Setting governance structure and processes	Strengthening resources and expertise	Refining (tender) requirements and specifications	Setting contract conditions	Timely (permit) requests	Adjusting procurement strategy and tender phasing	Calculating change impact	Waiting and monitoring the risk
			Design & Scope				Stakeholder & Comm.					Investig. & Inspections			Governance & Planning					Requirement & Contract			Risk & Strategy		
			M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13	M14	M15	M16	M17	M18	M19	M20	M21	M22	M23
Unclear scope definition	Client	C1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Changing requirements and scope		C2	0	2	0	0	0	0	0	2	0	0	0	0	1	1	0	1	0	1	0	0	0	0	0
Conflicting interests and priorities	Comm. & Rela.	C3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Difference in interpretation		C4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Strained stakeholder relationships		C5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Limited or insufficient tender applications	Contr.	C6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0
Unclear role and risk allocations		C7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Inadequate efforts or results	Contr.or.	C8	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0
Underestimation of projects complexity and risks		C9	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Inadequate planning and unforeseen delays		C10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cost inflation and market volatility	Eco. & Fin.	C11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0
Insufficient financial resources or feasibility		C12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Limited public authority capacity and priorities	Gov. & Regul.	C13	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regulatory changes		C14	0	0	1	0	1	2	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	2
Zoning and spacial policy constraints		C15	0	0	0	0	0	2	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Governance and steering issues	Orga. & Govnc.	C16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Slow decision processes		C17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Unstable project team		C18	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1
Complex dependencies between projects and phases	Project & Asset	C19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Incomplete or incorrect data and information		C20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Insufficient functional or physical requirements		C21	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Insufficient labor capacity	Resourc.	C22	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	1	0	0	0	0
Limited material and equipment available		C23	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	2	0	0	0	0
Shortage of skills and expertise		C24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Limited grid capacity or congestion	Site & Surr.	C25	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nature and environment constraints		C26	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0
Resistance from users and environment		C27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table B.5: Co-occurrences of risk causes and response measures of Risk Register 2

			Alternative location	Change Freeze and Control	Changes to structure, installations and materials	Enhancing scope definition	Discuss role responsibilities and risk allocations	Enhancing stakeholder collaboration and communication	Holding stakeholder sessions	Inform or engage users and environment	Involving external advisors	Analyses of environmental, regulatory and legal constraints	Research and inspections of assets safety and performance	Studies on market options and financial feasibility	Adding time or money buffers and contingency	Changing project phasing and construction sequence	Reviewing work or plans of contractor	Setting governance structure and processes	Strengthening resources and expertise	Refining (tender) requirements and specifications	Setting contract conditions	Timely (permit) requests	Adjusting procurement strategy and tender phasing	Calculating change impact	Waiting and monitoring the risk
			Design & Scope				Stakeholder & Comm.					Investig. & Inspections			Governance & Planning					Requirement & Contract			Risk & Strategy		
			M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13	M14	M15	M16	M17	M18	M19	M20	M21	M22	M23
Unclear scope definition	Client	C1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Changing requirements and scope	Client	C2	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Conflicting interests and priorities	Comm. & Rela.	C3	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Difference in interpretation	Comm. & Rela.	C4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Strained stakeholder relationships	Comm. & Rela.	C5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Limited or insufficient tender applications	Contr.	C6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Unclear role and risk allocations	Contr.	C7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Inadequate efforts or results	Contr.or.	C8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Underestimation of projects complexity and risks	Contr.or.	C9	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Inadequate planning and unforeseen delays	Contr.or.	C10	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2	0	0	1	0	0	0	0	1
Cost inflation and market volatility	Eco. & Fin.	C11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Insufficient financial resources or feasibility	Eco. & Fin.	C12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Limited public authority capacity and priorities	Gov. & Regul.	C13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regulatory changes	Gov. & Regul.	C14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Zoning and spacial policy constraints	Gov. & Regul.	C15	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	2	0	0	0	0	2
Governance and steering issues	Orga. & Govnc.	C16	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	1	1	0	0	1
Slow decision processes	Orga. & Govnc.	C17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Unstable project team	Orga. & Govnc.	C18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Complex dependencies between projects and phases	Project & Asset	C19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Incomplete or incorrect data and information	Project & Asset	C20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Insufficient functional or physical requirements	Project & Asset	C21	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Insufficient labor capacity	Resourc.	C22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Limited material and equipment available	Resourc.	C23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Shortage of skills and expertise	Resourc.	C24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Limited grid capacity or congestion	Site & Surr.	C25	0	0	0	0	0	1	0	0	2	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Nature and environment constraints	Site & Surr.	C26	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	1	0	0	0	0
Resistance from users and environment	Site & Surr.	C27	0	0	0	0	0	2	2	2	3	0	2	0	0	0	0	1	0	0	0	1	0	0	0

Table B.6: Co-occurrences of risk causes and response measures of Risk Register 3

			Alternative location	Change Freeze and Control	Changes to structure, installations and materials	Enhancing scope definition	Discuss role responsibilities and risk allocations	Enhancing stakeholder collaboration and communication	Holding stakeholder sessions	Inform or engage users and environment	Involving external advisors	Analyses of environmental, regulatory and legal constraints	Research and inspections of assets safety and performance	Studies on market options and financial feasibility	Adding time or money buffers and contingency	Changing project phasing and construction sequence	Reviewing work or plans of contractor	Setting governance structure and processes	Strengthening resources and expertise	Refining (tender) requirements and specifications	Setting contract conditions	Timely (permit) requests	Adjusting procurement strategy and tender phasing	Calculating change impact	Waiting and monitoring the risk
			Design & Scope				Stakeholder & Comm.					Investig. & Inspections			Governance & Planning					Requirement & Contract			Risk & Strategy		
			M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13	M14	M15	M16	M17	M18	M19	M20	M21	M22	M23
Unclear scope definition	Client	C1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Changing requirements and scope		C2	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0
Conflicting interests and priorities	Comm. & Rela.	C3	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Difference in interpretation		C4	0	0	0	0	0	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Strained stakeholder relationships		C5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Limited or insufficient tender applications	Contr.	C6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Unclear role and risk allocations		C7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Inadequate efforts or results	Contr.or.	C8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Underestimation of projects complexity and risks		C9	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	2	0	0	0	0	0
Inadequate planning and unforeseen delays		C10	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	1
Cost inflation and market volatility	Eco. & Fin.	C11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Insufficient financial resources or feasibility		C12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Limited public authority capacity and priorities	Gov. & Regul.	C13	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regulatory changes		C14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Zoning and spacial policy constraints		C15	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Governance and steering issues	Orga. & Govnc.	C16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Slow decision processes		C17	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0
Unstable project team		C18	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Complex dependencies between projects and phases	Project & Asset	C19	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Incomplete or incorrect data and information		C20	0	0	0	0	0	2	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Insufficient functional or physical requirements		C21	0	0	0	0	0	1	0	0	1	0	0	0	0	3	1	1	0	1	1	0	0	0	1
Insufficient labor capacity	Resourc.	C22	0	0	0	0	0	2	0	0	1	0	0	0	0	0	2	2	0	2	0	0	0	0	0
Limited material and equipment available		C23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Shortage of skills and expertise		C24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Limited grid capacity or congestion	Site & Surr.	C25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nature and environment constraints		C26	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1	0	0	0	0	0	0
Resistance from users and environment		C27	1	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0

Table B.7: Co-occurrences of risk causes and response measures of Risk Register 4

			Alternative location	Change Freeze and Control	Changes to structure, installations and materials	Enhancing scope definition	Discuss role responsibilities and risk allocations	Enhancing stakeholder collaboration and communication	Holding stakeholder sessions	Inform or engage users and environment	Involving external advisors	Analyses of environmental, regulatory and legal constraints	Research and inspections of assets safety and performance	Studies on market options and financial feasibility	Adding time or money buffers and contingency	Changing project phasing and construction sequence	Reviewing work or plans of contractor	Setting governance structure and processes	Strengthening resources and expertise	Refining (tender) requirements and specifications	Setting contract conditions	Timely (permit) requests	Adjusting procurement strategy and tender phasing	Calculating change impact	Waiting and monitoring the risk
			Design & Scope				Stakeholder & Comm.					Investig. & Inspections			Governance & Planning					Requirement & Contract			Risk & Strategy		
			M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13	M14	M15	M16	M17	M18	M19	M20	M21	M22	M23
Unclear scope definition	Client	C1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Changing requirements and scope		C2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Conflicting interests and priorities	Comm. & Rela.	C3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Difference in interpretation		C4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Strained stakeholder relationships		C5	0	0	0	1	1	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Limited or insufficient tender applications	Contr.	C6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Unclear role and risk allocations		C7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Inadequate efforts or results	Contr.or.	C8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Underestimation of projects complexity and risks		C9	0	0	0	0	1	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	1	0	0
Inadequate planning and unforeseen delays		C10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cost inflation and market volatility	Eco. & Fin.	C11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Insufficient financial resources or feasibility		C12	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Limited public authority capacity and priorities	Gov. & Regul.	C13	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regulatory changes		C14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Zoning and spacial policy constraints		C15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Governance and steering issues	Orga. & Govnc.	C16	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Slow decision processes		C17	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	1
Unstable project team		C18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Complex dependencies between projects and phases	Project & Asset	C19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Incomplete or incorrect data and information		C20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Insufficient functional or physical requirements		C21	2	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Insufficient labor capacity	Resourc.	C22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Limited material and equipment available		C23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Shortage of skills and expertise		C24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Limited grid capacity or congestion	Site & Surr.	C25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nature and environment constraints		C26	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Resistance from users and environment		C27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table B.8: Co-occurrences of risk causes and response measures of Risk Register 5

			Alternative location	Change Freeze and Control	Changes to structure, installations and materials	Enhancing scope definition	Discuss role responsibilities and risk allocations	Enhancing stakeholder collaboration and communication	Holding stakeholder sessions	Inform or engage users and environment	Involving external advisors	Analyses of environmental, regulatory and legal constraints	Research and inspections of assets safety and performance	Studies on market options and financial feasibility	Adding time or money buffers and contingency	Changing project phasing and construction sequence	Reviewing work or plans of contractor	Setting governance structure and processes	Strengthening resources and expertise	Refining (tender) requirements and specifications	Setting contract conditions	Timely (permit) requests	Adjusting procurement strategy and tender phasing	Calculating change impact	Waiting and monitoring the risk
			Design & Scope				Stakeholder & Comm.					Investig. & Inspections			Governance & Planning					Requirement & Contract			Risk & Strategy		
			M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13	M14	M15	M16	M17	M18	M19	M20	M21	M22	M23
Unclear scope definition	Client	C1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Changing requirements and scope	Client	C2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Conflicting interests and priorities	Comm. & Rela.	C3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Difference in interpretation	Comm. & Rela.	C4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Strained stakeholder relationships	Comm. & Rela.	C5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Limited or insufficient tender applications	Contr.	C6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Unclear role and risk allocations	Contr.	C7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Inadequate efforts or results	Contr.or.	C8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Underestimation of projects complexity and risks	Contr.or.	C9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Inadequate planning and unforeseen delays	Contr.or.	C10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cost inflation and market volatility	Eco. & Fin.	C11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Insufficient financial resources or feasibility	Eco. & Fin.	C12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Limited public authority capacity and priorities	Gov. & Regul.	C13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regulatory changes	Gov. & Regul.	C14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Zoning and spacial policy constraints	Gov. & Regul.	C15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Governance and steering issues	Orga. & Govnc.	C16	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Slow decision processes	Orga. & Govnc.	C17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Unstable project team	Orga. & Govnc.	C18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Complex dependencies between projects and phases	Project & Asset	C19	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0
Incomplete or incorrect data and information	Project & Asset	C20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Insufficient functional or physical requirements	Project & Asset	C21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Insufficient labor capacity	Resourc.	C22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Limited material and equipment available	Resourc.	C23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Shortage of skills and expertise	Resourc.	C24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Limited grid capacity or congestion	Site & Surr.	C25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nature and environment constraints	Site & Surr.	C26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Resistance from users and environment	Site & Surr.	C27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table B.9: Co-occurrences of risk causes and response measures of Risk Register 6

			Alternative location	Change Freeze and Control	Changes to structure, installations and materials	Enhancing scope definition	Discuss role responsibilities and risk allocations	Enhancing stakeholder collaboration and communication	Holding stakeholder sessions	Inform or engage users and environment	Involving external advisors	Analyses of environmental, regulatory and legal constraints	Research and inspections of assets safety and performance	Studies on market options and financial feasibility	Adding time or money buffers and contingency	Changing project phasing and construction sequence	Reviewing work or plans of contractor	Setting governance structure and processes	Strengthening resources and expertise	Refining (tender) requirements and specifications	Setting contract conditions	Timely (permit) requests	Adjusting procurement strategy and tender phasing	Calculating change impact	Waiting and monitoring the risk
			Design & Scope				Stakeholder & Comm.					Investig. & Inspections			Governance & Planning					Requirement & Contract			Risk & Strategy		
			M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13	M14	M15	M16	M17	M18	M19	M20	M21	M22	M23
Unclear scope definition	Client	C1	0	0	0	0	0	0	1	1	1	0	0	0	0	0	1	0	0	3	0	0	0	0	0
Changing requirements and scope		C2	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Conflicting interests and priorities	Comm. & Rela.	C3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0
Difference in interpretation		C4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Strained stakeholder relationships		C5	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Limited or insufficient tender applications	Contr.	C6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Unclear role and risk allocations		C7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Inadequate efforts or results	Contr.or.	C8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Underestimation of projects complexity and risks		C9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0
Inadequate planning and unforeseen delays		C10	0	0	0	0	0	1	0	0	1	0	0	0	2	1	0	1	0	0	0	1	0	0	0
Cost inflation and market volatility	Eco. & Fin.	C11	0	0	0	0	0	1	0	0	1	0	0	0	1	0	0	0	0	0	2	0	0	0	1
Insufficient financial resources or feasibility		C12	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Limited public authority capacity and priorities	Gov. & Regul.	C13	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Regulatory changes		C14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Zoning and spacial policy constraints		C15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Governance and steering issues	Orga. & Govnc.	C16	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0
Slow decision processes		C17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Unstable project team		C18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Complex dependencies between projects and phases	Project & Asset	C19	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Incomplete or incorrect data and information		C20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Insufficient functional or physical requirements		C21	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	1	0	1	0	0	1	0	0
Insufficient labor capacity	Resourc.	C22	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0
Limited material and equipment available		C23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Shortage of skills and expertise		C24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Limited grid capacity or congestion	Site & Surr.	C25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nature and environment constraints		C26	0	0	0	0	0	1	0	1	1	0	0	0	2	0	0	0	0	0	0	0	0	0	0
Resistance from users and environment		C27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table B.10: Co-occurrences of risk causes and response measures of Risk Register 7

			Alternative location	Change Freeze and Control	Changes to structure, installations and materials	Enhancing scope definition	Discuss role responsibilities and risk allocations	Enhancing stakeholder collaboration and communication	Holding stakeholder sessions	Inform or engage users and environment	Involving external advisors	Analyses of environmental, regulatory and legal constraints	Research and inspections of assets safety and performance	Studies on market options and financial feasibility	Adding time or money buffers and contingency	Changing project phasing and construction sequence	Reviewing work or plans of contractor	Setting governance structure and processes	Strengthening resources and expertise	Refining (tender) requirements and specifications	Setting contract conditions	Timely (permit) requests	Adjusting procurement strategy and tender phasing	Calculating change impact	Waiting and monitoring the risk
			Design & Scope				Stakeholder & Comm.					Investig. & Inspections			Governance & Planning					Requirement & Contract			Risk & Strategy		
			M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13	M14	M15	M16	M17	M18	M19	M20	M21	M22	M23
Unclear scope definition	Client	C1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Changing requirements and scope	Client	C2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Conflicting interests and priorities	Comm. & Rela.	C3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Difference in interpretation	Comm. & Rela.	C4	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Strained stakeholder relationships	Comm. & Rela.	C5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Limited or insufficient tender applications	Contr.	C6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Unclear role and risk allocations	Contr.	C7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Inadequate efforts or results	Contr.or.	C8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Underestimation of projects complexity and risks	Contr.or.	C9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Inadequate planning and unforeseen delays	Contr.or.	C10	0	0	0	0	0	0	0	0	0	0	0	2	1	0	0	0	0	0	0	0	0	0	0
Cost inflation and market volatility	Eco. & Fin.	C11	0	0	0	2	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Insufficient financial resources or feasibility	Eco. & Fin.	C12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Limited public authority capacity and priorities	Gov. & Regul.	C13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	1	0	0	0	0	0
Regulatory changes	Gov. & Regul.	C14	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Zoning and spacial policy constraints	Gov. & Regul.	C15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Governance and steering issues	Orga. & Govnc.	C16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Slow decision processes	Orga. & Govnc.	C17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Unstable project team	Orga. & Govnc.	C18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Complex dependencies between projects and phases	Project & Asset	C19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Incomplete or incorrect data and information	Project & Asset	C20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Insufficient functional or physical requirements	Project & Asset	C21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Insufficient labor capacity	Resourc.	C22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Limited material and equipment available	Resourc.	C23	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Shortage of skills and expertise	Resourc.	C24	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Limited grid capacity or congestion	Site & Surr.	C25	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nature and environment constraints	Site & Surr.	C26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Resistance from users and environment	Site & Surr.	C27	0	0	0	0	0	1	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table B.11: Co-occurrences of risk causes and response measures of Risk Register 8

			Alternative location	Change Freeze and Control	Changes to structure, installations and materials	Enhancing scope definition	Discuss role responsibilities and risk allocations	Enhancing stakeholder collaboration and communication	Holding stakeholder sessions	Inform or engage users and environment	Involving external advisors	Analyses of environmental, regulatory and legal constraints	Research and inspections of assets safety and performance	Studies on market options and financial feasibility	Adding time or money buffers and contingency	Changing project phasing and construction sequence	Reviewing work or plans of contractor	Setting governance structure and processes	Strengthening resources and expertise	Refining (tender) requirements and specifications	Setting contract conditions	Timely (permit) requests	Adjusting procurement strategy and tender phasing	Calculating change impact	Waiting and monitoring the risk
			Design & Scope				Stakeholder & Comm.					Investig. & Inspections			Governance & Planning					Requirement & Contract			Risk & Strategy		
			M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13	M14	M15	M16	M17	M18	M19	M20	M21	M22	M23
Unclear scope definition	Client	C1	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Changing requirements and scope		C2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Conflicting interests and priorities	Comm. & Rela.	C3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Difference in interpretation		C4	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Strained stakeholder relationships		C5	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Limited or insufficient tender applications	Contr.	C6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Unclear role and risk allocations		C7	0	0	0	1	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Inadequate efforts or results	Contr.or.	C8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Underestimation of projects complexity and risks		C9	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Inadequate planning and unforeseen delays		C10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cost inflation and market volatility	Eco. & Fin.	C11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Insufficient financial resources or feasibility		C12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Limited public authority capacity and priorities	Gov. & Regul.	C13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regulatory changes		C14	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	1	0
Zoning and spacial policy constraints		C15	0	0	0	0	0	3	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Governance and steering issues	Orga. & Govnc.	C16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Slow decision processes		C17	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Unstable project team		C18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Complex dependencies between projects and phases	Project & Asset	C19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Incomplete or incorrect data and information		C20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0
Insufficient functional or physical requirements		C21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Insufficient labor capacity	Resourc.	C22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Limited material and equipment available		C23	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	2	0	0	0	0	0	1
Shortage of skills and expertise		C24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Limited grid capacity or congestion	Site & Surr.	C25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nature and environment constraints		C26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Resistance from users and environment		C27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table B.12: Co-occurrences of risk causes and response measures of Risk Register 9

			Alternative location	Change Freeze and Control	Changes to structure, installations and materials	Enhancing scope definition	Discuss role responsibilities and risk allocations	Enhancing stakeholder collaboration and communication	Holding stakeholder sessions	Inform or engage users and environment	Involving external advisors	Analyses of environmental, regulatory and legal constraints	Research and inspections of assets safety and performance	Studies on market options and financial feasibility	Adding time or money buffers and contingency	Changing project phasing and construction sequence	Reviewing work or plans of contractor	Setting governance structure and processes	Strengthening resources and expertise	Refining (tender) requirements and specifications	Setting contract conditions	Timely (permit) requests	Adjusting procurement strategy and tender phasing	Calculating change impact	Waiting and monitoring the risk
			Design & Scope				Stakeholder & Comm.					Investig. & Inspections			Governance & Planning					Requirement & Contract			Risk & Strategy		
			M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13	M14	M15	M16	M17	M18	M19	M20	M21	M22	M23
Unclear scope definition	Client	C1	0	0	0	0	0	0	0	0	1	0	2	0	0	0	0	0	0	2	0	0	0	0	0
Changing requirements and scope		C2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Conflicting interests and priorities	Comm. & Rela.	C3	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Difference in interpretation		C4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Strained stakeholder relationships		C5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Limited or insufficient tender applications	Contr.	C6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Unclear role and risk allocations		C7	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Inadequate efforts or results	Contr.or.	C8	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Underestimation of projects complexity and risks		C9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Inadequate planning and unforeseen delays		C10	0	0	0	0	0	0	0	0	1	0	0	0	0	2	0	0	1	0	0	0	0	0	0
Cost inflation and market volatility	Eco. & Fin.	C11	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
Insufficient financial resources or feasibility		C12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Limited public authority capacity and priorities	Gov. & Regul.	C13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regulatory changes		C14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Zoning and spacial policy constraints		C15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Governance and steering issues	Orga. & Govnc.	C16	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0
Slow decision processes		C17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Unstable project team		C18	0	0	0	1	0	0	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Complex dependencies between projects and phases	Project & Asset	C19	0	0	0	0	0	1	0	0	2	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Incomplete or incorrect data and information		C20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Insufficient functional or physical requirements		C21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Insufficient labor capacity	Resourc.	C22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Limited material and equipment available		C23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Shortage of skills and expertise		C24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Limited grid capacity or congestion	Site & Surr.	C25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nature and environment constraints		C26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Resistance from users and environment		C27	0	0	0	0	0	1	0	2	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0

B.1.5. Co-occurrences of risk causes and response measures between phases

Table B.13: Co-occurrences of risk causes and response measures of projects in the initiative phase

			Alternative location	Change Freeze and Control	Changes to structure, installations and materials	Enhancing scope definition	Discuss role responsibilities and risk allocations	Enhancing stakeholder collaboration and communication	Holding stakeholder sessions	Inform or engage users and environment	Involving external advisors	Analyses of environmental, regulatory and legal constraints	Research and inspections of assets safety and performance	Studies on market options and financial feasibility	Adding time or money buffers and contingency	Changing project phasing and construction sequence	Reviewing work or plans of contractor	Setting governance structure and processes	Strengthening resources and expertise	Refining (tender) requirements and specifications	Setting contract conditions	Timely (permit) requests	Adjusting procurement strategy and tender phasing	Calculating change impact	Waiting and monitoring the risk
			Design & Scope				Stakeholder & Comm.					Investig. & Inspections			Governance & Planning					Requirement & Contract			Risk & Strategy		
			M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13	M14	M15	M16	M17	M18	M19	M20	M21	M22	M23
Unclear scope definition	Client	C1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Changing requirements and scope		C2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Conflicting interests and priorities	Comm. & Rela.	C3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Difference in interpretation		C4	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Strained stakeholder relationships		C5	0	0	0	1	1	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Limited or insufficient tender applications	Contr.	C6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Unclear role and risk allocations		C7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Inadequate efforts or results	Contr.or.	C8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Underestimation of projects complexity and risks		C9	0	0	0	0	1	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	1	0	0
Inadequate planning and unforeseen delays		C10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cost inflation and market volatility	Eco. & Fin.	C11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Insufficient financial resources or feasibility		C12	0	0	0	0	0	1	0	0	0	0	0	2	1	0	0	0	0	0	0	0	0	0	0
Limited public authority capacity and priorities	Gov. & Regul.	C13	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regulatory changes		C14	0	0	0	2	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Zoning and spacial policy constraints		C15	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Governance and steering issues	Orga. & Govnc.	C16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	1	0	0	0	0	0
Slow decision processes		C17	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	1	0	0	2	0	0	0	1
Unstable project team		C18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Complex dependencies between projects and phases	Project & Asset	C19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Incomplete or incorrect data and information		C20	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0
Insufficient functional or physical requirements		C21	2	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Insufficient labor capacity	Resourc.	C22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0
Limited material and equipment available		C23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Shortage of skills and expertise		C24	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Limited grid capacity or congestion	Site & Surr.	C25	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nature and environment constraints		C26	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Resistance from users and environment		C27	0	0	0	0	0	1	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table B.14: Co-occurrences of risk causes and response measures of projects in the definition phase

			Alternative location	Change Freeze and Control	Changes to structure, installations and materials	Enhancing scope definition	Discuss role responsibilities and risk allocations	Enhancing stakeholder collaboration and communication	Holding stakeholder sessions	Inform or engage users and environment	Involving external advisors	Analyses of environmental, regulatory and legal constraints	Research and inspections of assets safety and performance	Studies on market options and financial feasibility	Adding time or money buffers and contingency	Changing project phasing and construction sequence	Reviewing work or plans of contractor	Setting governance structure and processes	Strengthening resources and expertise	Refining (tender) requirements and specifications	Setting contract conditions	Timely (permit) requests	Adjusting procurement strategy and tender phasing	Calculating change impact	Waiting and monitoring the risk
			Design & Scope				Stakeholder & Comm.					Investig. & Inspections			Governance & Planning					Requirement & Contract			Risk & Strategy		
			M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13	M14	M15	M16	M17	M18	M19	M20	M21	M22	M23
Unclear scope definition	Client	C1	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Changing requirements and scope		C2	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0
Conflicting interests and priorities	Comm. & Rela.	C3	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Difference in interpretation		C4	0	0	0	1	0	0	1	2	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Strained stakeholder relationships		C5	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Limited or insufficient tender applications	Contr.	C6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Unclear role and risk allocations		C7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Inadequate efforts or results	Contr.or.	C8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Underestimation of projects complexity and risks		C9	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	2	0	0	0	0	0
Inadequate planning and unforeseen delays		C10	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	1
Cost inflation and market volatility	Eco. & Fin.	C11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Insufficient financial resources or feasibility		C12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Limited public authority capacity and priorities	Gov. & Regul.	C13	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regulatory changes		C14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Zoning and spacial policy constraints		C15	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0
Governance and steering issues	Orga. & Govnc.	C16	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Slow decision processes		C17	0	0	0	0	0	1	0	0	0	0	0	2	0	0	0	1	0	0	0	0	0	1	0
Unstable project team		C18	0	0	0	0	0	3	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	1	0
Complex dependencies between projects and phases	Project & Asset	C19	0	0	0	0	0	1	0	0	1	0	0	0	0	3	1	1	0	1	1	0	0	0	0
Incomplete or incorrect data and information		C20	0	0	0	0	0	2	0	0	1	0	0	0	0	0	2	2	0	2	0	0	0	0	0
Insufficient functional or physical requirements		C21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Insufficient labor capacity	Resourc.	C22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Limited material and equipment available		C23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Shortage of skills and expertise		C24	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	2	0	0	0	0	0	1
Limited grid capacity or congestion	Site & Surr.	C25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nature and environment constraints		C26	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1	0	0	0	0	0	0
Resistance from users and environment		C27	1	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0

Table B.15: Co-occurrences of risk causes and response measures of projects in the procurement phase

			Alternative location	Change Freeze and Control	Changes to structure, installations and materials	Enhancing scope definition	Discuss role responsibilities and risk allocations	Enhancing stakeholder collaboration and communication	Holding stakeholder sessions	Inform or engage users and environment	Involving external advisors	Analyses of environmental, regulatory and legal constraints	Research and inspections of assets safety and performance	Studies on market options and financial feasibility	Adding time or money buffers and contingency	Changing project phasing and construction sequence	Reviewing work or plans of contractor	Setting governance structure and processes	Strengthening resources and expertise	Refining (tender) requirements and specifications	Setting contract conditions	Timely (permit) requests	Adjusting procurement strategy and tender phasing	Calculating change impact	Waiting and monitoring the risk
			Design & Scope				Stakeholder & Comm.					Investig. & Inspections			Governance & Planning					Requirement & Contract			Risk & Strategy		
			M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13	M14	M15	M16	M17	M18	M19	M20	M21	M22	M23
Unclear scope definition	Client	C1	0	0	0	1	0	0	1	1	2	0	2	0	0	0	1	0	0	5	0	0	0	0	0
Changing requirements and scope		C2	0	3	0	0	0	0	0	3	0	0	0	0	2	1	0	1	0	1	0	0	0	2	0
Conflicting interests and priorities	Comm. & Rela.	C3	0	0	0	0	0	1	0	1	0	0	0	0	0	0	1	1	0	0	1	0	0	0	0
Difference in interpretation		C4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Strained stakeholder relationships		C5	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Limited or insufficient tender applications	Contr.	C6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	3	0	0
Unclear role and risk allocations		C7	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Inadequate efforts or results	Contr.or.	C8	0	0	0	0	0	2	0	0	1	0	0	0	0	0	0	0	0	1	0	1	0	0	0
Underestimation of projects complexity and risks		C9	0	0	1	0	0	0	1	2	1	0	0	0	0	0	0	0	0	2	0	0	1	0	0
Inadequate planning and unforeseen delays		C10	0	0	0	0	0	1	0	0	2	0	0	0	3	3	2	1	1	1	0	1	0	0	1
Cost inflation and market volatility	Eco. & Fin.	C11	0	0	0	0	0	1	0	0	1	0	0	2	1	0	0	0	0	0	4	0	0	0	1
Insufficient financial resources or feasibility		C12	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Limited public authority capacity and priorities	Gov. & Regul.	C13	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regulatory changes		C14	0	0	1	0	1	2	0	0	1	1	0	1	0	0	0	0	0	2	1	0	0	1	4
Zoning and spacial policy constraints		C15	0	0	0	0	0	3	0	0	2	0	0	1	0	0	0	0	0	1	2	1	0	0	1
Governance and steering issues	Orga. & Govnc.	C16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Slow decision processes		C17	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0
Unstable project team		C18	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1
Complex dependencies between projects and phases	Project & Asset	C19	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Incomplete or incorrect data and information		C20	0	0	0	1	0	0	1	1	2	0	1	0	0	0	0	1	0	1	0	0	1	0	0
Insufficient functional or physical requirements		C21	0	0	2	0	1	1	2	0	2	0	0	0	0	0	0	0	1	2	0	1	0	0	0
Insufficient labor capacity	Resourc.	C22	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	1	0	0	0	0
Limited material and equipment available		C23	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	1	2	0	0	0	0
Shortage of skills and expertise		C24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Limited grid capacity or congestion	Site & Surr.	C25	0	0	2	0	0	2	0	1	3	0	0	0	2	1	0	0	0	0	0	0	0	0	0
Nature and environment constraints		C26	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	1	0	0	1	0	0	0	0
Resistance from users and environment		C27	0	0	0	0	0	3	2	4	3	0	2	0	0	0	0	2	0	0	0	1	0	0	0

B.1.6. Co-occurrences of risk causes and response measures between project types

Table B.16: Co-occurrences of risk causes and response measures of new construction projects

			Alternative location	Change Freeze and Control	Changes to structure, installations and materials	Enhancing scope definition	Discuss role responsibilities and risk allocations	Enhancing stakeholder collaboration and communication	Holding stakeholder sessions	Inform or engage users and environment	Involving external advisors	Analyses of environmental, regulatory and legal constraints	Research and inspections of assets safety and performance	Studies on market options and financial feasibility	Adding time or money buffers and contingency	Changing project phasing and construction sequence	Reviewing work or plans of contractor	Setting governance structure and processes	Strengthening resources and expertise	Refining (tender) requirements and specifications	Setting contract conditions	Timely (permit) requests	Adjusting procurement strategy and tender phasing	Calculating change impact	Waiting and monitoring the risk
			Design & Scope				Stakeholder & Comm.					Investig. & Inspections			Governance & Planning					Requirement & Contract			Risk & Strategy		
			M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13	M14	M15	M16	M17	M18	M19	M20	M21	M22	M23
Unclear scope definition	Client	C1	0	0	0	4	0	0	0	0	1	0	2	0	0	0	0	0	0	2	0	0	0	0	0
Changing requirements and scope	Client	C2	0	3	0	0	0	0	0	2	0	0	0	0	2	1	0	1	0	1	0	0	0	1	0
Conflicting interests and priorities	Comm. & Rela.	C3	0	0	0	0	0	1	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Difference in interpretation	Comm. & Rela.	C4	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Strained stakeholder relationships	Comm. & Rela.	C5	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Limited or insufficient tender applications	Contr.	C6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0
Unclear role and risk allocations	Contr.	C7	0	0	0	1	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Inadequate efforts or results	Contr.or.	C8	0	0	0	0	0	2	0	0	1	0	0	0	0	0	0	0	0	1	0	1	0	0	0
Underestimation of projects complexity and risks	Contr.or.	C9	0	0	1	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Inadequate planning and unforeseen delays	Contr.or.	C10	0	0	0	1	0	0	0	0	1	0	0	0	1	2	2	0	1	1	0	0	0	0	1
Cost inflation and market volatility	Eco. & Fin.	C11	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	2	0	0	0	0
Insufficient financial resources or feasibility	Eco. & Fin.	C12	0	0	0	0	0	0	0	0	0	0	0	2	1	0	0	0	0	0	0	0	0	0	0
Limited public authority capacity and priorities	Gov. & Regul.	C13	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regulatory changes	Gov. & Regul.	C14	0	0	1	2	1	2	1	0	1	1	0	1	0	0	0	1	0	2	1	0	0	0	4
Zoning and spacial policy constraints	Gov. & Regul.	C15	0	0	0	0	0	3	0	0	2	0	0	0	0	0	0	0	0	0	2	1	0	0	2
Governance and steering issues	Orga. & Govnc.	C16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	1	0	0	0	0	0
Slow decision processes	Orga. & Govnc.	C17	0	0	0	0	0	2	0	0	0	0	0	1	0	2	0	2	0	0	0	0	0	1	0
Unstable project team	Orga. & Govnc.	C18	0	0	0	0	0	4	0	0	1	0	0	0	0	0	0	1	1	0	0	0	0	0	1
Complex dependencies between projects and phases	Project & Asset	C19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Incomplete or incorrect data and information	Project & Asset	C20	0	0	0	1	0	0	0	1	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0
Insufficient functional or physical requirements	Project & Asset	C21	0	0	0	0	1	1	2	0	2	0	0	0	0	0	0	0	1	0	0	1	0	0	0
Insufficient labor capacity	Resourc.	C22	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	2	0	1	0	0	0	0
Limited material and equipment available	Resourc.	C23	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	1	2	0	0	0	0
Shortage of skills and expertise	Resourc.	C24	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	2	0	0	0	0	0	2
Limited grid capacity or congestion	Site & Surr.	C25	0	0	1	0	0	2	0	0	2	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Nature and environment constraints	Site & Surr.	C26	0	0	1	0	0	0	0	0	0	1	0	1	1	0	0	1	0	0	1	0	0	0	0
Resistance from users and environment	Site & Surr.	C27	0	0	0	0	0	4	2	6	3	0	2	0	0	0	0	2	0	0	0	1	0	0	0

Table B.17: Co-occurrences of risk causes and response measures of redevelopment projects

			Alternative location	Change Freeze and Control	Changes to structure, installations and materials	Enhancing scope definition	Discuss role responsibilities and risk allocations	Enhancing stakeholder collaboration and communication	Holding stakeholder sessions	Inform or engage users and environment	Involving external advisors	Analyses of environmental, regulatory and legal constraints	Research and inspections of assets safety and performance	Studies on market options and financial feasibility	Adding time or money buffers and contingency	Changing project phasing and construction sequence	Reviewing work or plans of contractor	Setting governance structure and processes	Strengthening resources and expertise	Refining (tender) requirements and specifications	Setting contract conditions	Timely (permit) requests	Adjusting procurement strategy and tender phasing	Calculating change impact	Waiting and monitoring the risk
			Design & Scope				Stakeholder & Comm.					Investig. & Inspections			Governance & Planning					Requirement & Contract			Risk & Strategy		
			M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13	M14	M15	M16	M17	M18	M19	M20	M21	M22	M23
Unclear scope definition	Client	C1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Changing requirements and scope	Client	C2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Conflicting interests and priorities	Comm. & Rela.	C3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Difference in interpretation	Comm. & Rela.	C4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Strained stakeholder relationships	Comm. & Rela.	C5	0	0	0	1	1	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Limited or insufficient tender applications	Contr.	C6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Unclear role and risk allocations	Contr.	C7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Inadequate efforts or results	Contr.or.	C8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Underestimation of projects complexity and risks	Contr.or.	C9	0	0	0	0	1	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	1	0	0
Inadequate planning and unforeseen delays	Contr.or.	C10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cost inflation and market volatility	Eco. & Fin.	C11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Insufficient financial resources or feasibility	Eco. & Fin.	C12	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Limited public authority capacity and priorities	Gov. & Regul.	C13	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regulatory changes	Gov. & Regul.	C14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Zoning and spacial policy constraints	Gov. & Regul.	C15	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Governance and steering issues	Orga. & Govnc.	C16	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Slow decision processes	Orga. & Govnc.	C17	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	1
Unstable project team	Orga. & Govnc.	C18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Complex dependencies between projects and phases	Project & Asset	C19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Incomplete or incorrect data and information	Project & Asset	C20	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0
Insufficient functional or physical requirements	Project & Asset	C21	2	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Insufficient labor capacity	Resourc.	C22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0
Limited material and equipment available	Resourc.	C23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Shortage of skills and expertise	Resourc.	C24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Limited grid capacity or congestion	Site & Surr.	C25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nature and environment constraints	Site & Surr.	C26	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Resistance from users and environment	Site & Surr.	C27	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table B.18: Co-occurrences of risk causes and response measures of renovation projects

			Alternative location	Change Freeze and Control	Changes to structure, installations and materials	Enhancing scope definition	Discuss role responsibilities and risk allocations	Enhancing stakeholder collaboration and communication	Holding stakeholder sessions	Inform or engage users and environment	Involving external advisors	Analyses of environmental, regulatory and legal constraints	Research and inspections of assets safety and performance	Studies on market options and financial feasibility	Adding time or money buffers and contingency	Changing project phasing and construction sequence	Reviewing work or plans of contractor	Setting governance structure and processes	Strengthening resources and expertise	Refining (tender) requirements and specifications	Setting contract conditions	Timely (permit) requests	Adjusting procurement strategy and tender phasing	Calculating change impact	Waiting and monitoring the risk
			Design & Scope				Stakeholder & Comm.					Investig. & Inspections			Governance & Planning					Requirement & Contract			Risk & Strategy		
			M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13	M14	M15	M16	M17	M18	M19	M20	M21	M22	M23
Unclear scope definition	Client	C1	0	0	0	0	0	0	1	1	1	0	0	0	0	0	1	0	0	3	0	0	0	0	0
Changing requirements and scope		C2	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	1	0	0	0	1	0
Conflicting interests and priorities	Comm. & Rela.	C3	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	1	0	0	1	0	0	0	0
Difference in interpretation		C4	0	0	0	0	0	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Strained stakeholder relationships		C5	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Limited or insufficient tender applications	Contr.	C6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Unclear role and risk allocations		C7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Inadequate efforts or results	Contr.or.	C8	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0
Underestimation of projects complexity and risks		C9	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	1	0	4	0	0	0	0	0
Inadequate planning and unforeseen delays		C10	0	0	0	0	0	1	0	0	1	0	0	0	2	2	1	2	0	0	2	1	0	0	1
Cost inflation and market volatility	Eco. & Fin.	C11	0	0	0	0	0	2	0	0	1	0	0	0	1	0	0	1	0	0	2	0	0	0	1
Insufficient financial resources or feasibility		C12	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Limited public authority capacity and priorities	Gov. & Regul.	C13	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regulatory changes		C14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Zoning and spacial policy constraints		C15	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	1	0
Governance and steering issues	Orga. & Govnc.	C16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0
Slow decision processes		C17	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Unstable project team		C18	0	0	0	0	0	2	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Complex dependencies between projects and phases	Project & Asset	C19	0	0	0	0	0	1	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Incomplete or incorrect data and information		C20	0	0	0	0	0	1	1	0	1	0	0	0	0	0	0	1	0	2	0	0	1	0	0
Insufficient functional or physical requirements		C21	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0
Insufficient labor capacity	Resourc.	C22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Limited material and equipment available		C23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Shortage of skills and expertise		C24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Limited grid capacity or congestion	Site & Surr.	C25	0	0	1	0	0	1	0	1	1	1	1	0	2	0	0	0	1	0	0	0	0	0	0
Nature and environment constraints		C26	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1	0	0	0	0	0	0
Resistance from users and environment		C27	1	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0

B.1.7. Most frequently used response measures per risk cause

Table B.19: Most frequently used response measures per risk cause

#	Cause	#	Freq.	Measure
C1	Unclear scope definition	M18	5	Refining (tender) requirements and specifications
C2	Changing requirements and scope	M2	3	Change Freeze and Control
		M8	3	Inform or engage users and environment
C3	Conflicting interests and priorities	M9	2	Involving external advisors
C4	Difference in interpretation	M8	2	Inform or engage users and environment
C5	Strained stakeholder relationships	M5	2	Discuss role responsibilities and risk allocations
		M6	2	Enhancing stakeholder collaboration and communication
		M7	2	Holding stakeholder sessions
		M16	2	Setting governance structure and processes
C6	Limited or insufficient tender applications	M21	3	Adjusting procurement strategy and tender phasing
C7	Unclear role and risk allocations	M5	3	Discuss role responsibilities and risk allocations
C8	Inadequate efforts or results	M6	2	Enhancing stakeholder collaboration and communication
C9	Underestimation of projects complexity and risks	M18	4	Refining (tender) requirements and specifications
C10	Inadequate planning and unforeseen delays	M14	4	Changing project phasing and construction sequence
C11	Cost inflation and market volatility	M19	4	Setting contract conditions
C12	Insufficient financial resources or feasibility	M6	3	Enhancing stakeholder collaboration and communication
C13	Limited public authority capacity and priorities	M6	6	Enhancing stakeholder collaboration and communication
C14	Regulatory changes	M23	4	Waiting and monitoring the risk
C15	Zoning and spacial policy constraints	M6	4	Enhancing stakeholder collaboration and communication
C16	Governance and steering issues	M16	3	Setting governance structure and processes
C17	Slow decision processes	M6	3	Enhancing stakeholder collaboration and communication
C18	Unstable project team	M6	6	Enhancing stakeholder collaboration and communication

C19	Complex dependencies between projects and phases	M14	4	Changing project phasing and construction sequence
C20	Incomplete or incorrect data and information	M16	4	Setting governance structure and processes
C21	Insufficient functional or physical requirements	M7	3	Holding stakeholder sessions
C22	Insufficient labor capacity	M17	3	Strengthening resources and expertise
C23	Limited material and equipment available	M19	2	Setting contract conditions
C24	Shortage of skills and expertise	M17	2	Strengthening resources and expertise
C25	Limited grid capacity or congestion	M6	3	Enhancing stakeholder collaboration and communication
		M9	3	Involving external advisors
C26	Nature and environment constraints	M10	2	Analyses of environmental, regulatory and legal constraints
C27	Resistance from users and environment	M8	9	Inform or engage users and environment

C

Expert meeting

C.1. Questions and Answerers of the Expert Meeting

C.1.1. Frequencies of risk cause subcategories per risk register (Table 4.5)

Differences between categories

First, the coded causes are not evenly distributed across the subcategories. Some cause subcategories occur significantly more frequently than others. The most noticeable contrasts are:

- *'Resistance from users and environment'* (C27) is coded 42 times in total.
- *'Limited or insufficient tender applications'* (C6) is coded 6 times in total.

In your experience, is 'Resistance from users and environment' indeed one of the most common causes in RVB projects? Why/why not?

Expert 2

Als je kijkt naar de verschillende projecten dan zijn er ook best wel projecten waar die natuurlijk niet voorkomt. En er is natuurlijk één project waar die heel veel voorkomt. En ik herken wel heel erg dat in bijvoorbeeld een van mijn projecten, dat is een gecompliceerd project omdat het gefaseerd uitgevoerd moet worden en daardoor moet een gedeelte van de gebruikers moet uitgeplaatst worden en een ander gedeelte moet blijven zitten tijdens de bouw. En daar gaat ongetwijfeld veel weerstand komen omdat ze uitgeplaatst moeten worden, maar ook omdat er waarschijnlijk overlast zal plaatsvinden. Dus ik denk dat het ook heel erg afhankelijk is van wat voor soort project je hebt. Zit het in een binnenstedelijk gebied, dan kan je inderdaad wel meer last hebben van buren of omgeving die dus het niet eens is met bepaalde plannen. Dus ik denk dat het ook wel erg afhankelijk is van wie je gebruiker is, wat je scope van het project is, hoe het wordt uitgevoerd? Dus ik herken het wel, maar het is niet van toepassing op alle projecten zou ik zeggen.

Expert 3

Ik denk wel dat het vooral is als je ook een omgevingsgunning moet verkrijgen.

Differences between projects

First, table 4.5 shows clear differences between the nine risk registers in how cause-dense they are. This suggests that some risk registers describe risks with more cause descriptions than others. The most noticeable contrasts are:

- Project 6 contains a high number of coded cause quotations (83), making it the most cause-dense risk register.
- Project 5 contains a very low number of coded cause quotations (14), making it the least cause-dense risk register.

What typically explains why some risk registers contain much more detailed descriptions than others, and in your view is a denser risk register better or more usable, or can it reduce clarity?

Expert 1

Ik kan niet zeggen of de ene beter is dan de ander, dat vind ik heel lastig. Wat ik wel kan zeggen is dat ik bij gevolgen vaak meer standaard dingen heb staan. Bij gevolgen werk ik meer met standaarden dan dat ik met standaarden werk voor oorzaken. Vaak vind ik de oorzaak wel heel erg alleenstaand, die kan het niet zo makkelijk voor mezelf kopiëren en plakken ofzo. Dus ik zie, althans in mijn risicodossiers, wel meer unieke oorzaken dan unieke gevolgen.

Expert 2

Dat is ook voor mij ook wel herkenbaar ja.

Differences between phases

When comparing projects by phase, there are small differences in which cause themes stand out. Overall, many cause categories appear in all phases, but the emphasis differs between phase groups. The most noticeable contrasts are:

- Initiative-phase projects (4, 5, 7) do not show one dominant category, the cause mix differs more between risk registers in this phase.
- Definition-phase projects (3 and 8) show a slight emphasis on organizational and communication-related issues. Asset-related issues, which appear highest in this phase, are excluded from this comparison because they are represented in only one project risk register, which is insufficient to link this difference to the project phase.
- Procurement-phase projects (1, 2, 6, 9) also show a wide spread, with relatively more causes related to scope and requirement changes, contractor-related issues, and external constraints.

Do you find it logical that, in the definition phase, communication and organizational causes primarily occur?

Expert 2

Ja.

Expert 3

Als je alleen de huidige fase en de komende fase bekijkt, dan snap ik dat heel goed.

Beyond these main contrasts, some additional insights stand out across the different project phases:

- Table 4.6 shows a gradual increase in coded causes as the project progresses into later phases.
- Table 4.6 shows that some causes do not occur because the project is still in a specific phase. For example, scope-related causes (C1 and C2) or 'Unclear role and risk allocations' (C7) do not appear in the initiative phase, while causes such as 'Limited or insufficient tender applications' (C6) or 'Limited material and equipment available' are absent in both the initiative and definition phases.

Is the gradual increase in coded causes due to real shifts in uncertainty over time, or for example because teams document risks differently across project phases?

Expert 1

Ik zou zeggen dat hoe verder je in het project komt, je met meer aspecten te maken hebt, dus ook meer verschillende thema's aan risico's raakt, dus dan ook meer oorzaken hebt. Je gaat veel breder naar het project kijken. In de initiatieffase heb je nog met andere risico's te maken dan als je naar verdere fases kijkt. Dan komen er andere risico's bij, en dat kan er wel voor zorgen dat je oorzaken ook toenemen.

Expert 3

Naarmate je project verder vordert, gaan risico's ook anders optreden. Wat ik in de initiatieffase bijvoorbeeld een groot risico vind, kan in de definitief fase helemaal klaar zijn. Dus dan is er vervallen, zeg maar. En dan gaat er een ander risico voor mij een grote rol spelen. Het is ook een beetje hoe je het doet. Ik ken projecten waar we alleen naar de huidige en de volgende fase kijken, en nog niet zozeer naar de eindfase. En ik ken projecten waar we het totale project gaan bekijken, dus daar zal het ook heel erg van afhangen. Kijk je naar het totaalproject, dan zal je ook andere risico's meenemen, dan als ik alleen kijk naar mijn huidige fase en de fase erna.

Differences between types

When comparing projects by project type, there are again some small differences in which cause themes stand out. The most noticeable contrasts are:

- Renovation projects (3 and 6) are slightly more shaped by project-related causes, client- and contractor-related issues, and some site and surrounding issues, but still include a substantial number of causes across all categories.

- Re-construction projects (4 and 5) also show a more broad spread of causes, with no single dominant category.
- New construction projects (1, 2, 7, 8, 9) include relatively more external- and scope-related causes, while still covering most cause categories.

Beyond these main contrasts, some additional insights stand out across the different project types:

- Table 4.7 shows that renovation projects have significantly more coded causes than redevelopment projects, although they both include only two risk registers.

Are the differences in the number of coded causes between renovation and redevelopment projects primarily due to the project types themselves, or to differences in how the risk registers were documented?

Expert 3

Ik zie dat projectem 4 en 5 in initiatief fase zijn. Dus dat is helemaal aan het begin van het project. Dan ben je nog met de scope afbakening bezig, dus dan heb je met heel andere type risico's te maken, dan bij een renovatie. Bij een renovatie weet je niet wat er uitkomt, want je weet niet hoe het huidige gebouw eruit ziet. Maar dan heb je wel heel andere risico categorieën.

C.1.2. Frequencies of response measure subcategories per risk register (Table 4.8)

Differences between categories

-

Differences between projects

-

Differences between phases

When comparing projects by phase, there are again only small differences in which measure themes stand out, and these differences are even smaller than in the causes table. The most noticeable contrasts are:

- Initiative-phase projects (4, 5, 7) most often show stakeholder and communication-related measures.
- Definition-phase projects (3 and 8) also show mostly stakeholder and communication- related measures, but the measures are still quite spread across all measure categories.
- Procurement-phase projects (1, 2, 6, 9) more often combine stakeholder measures with contract-related measures.

Do you consider it logical that, while stakeholder and communication measures are used across all phases, contract-related measures only start to become more dominant in the procurement phase? Why/why not?

Expert 1

Nee, ik vind het eigenlijk best wel apart. Ik vind juist dat bij de aanbesteding je de risico's al meenemen in het contract. Dus de risico's die contract gerelateerd zijn, die wil ik eigenlijk niet hebben bij mijn aanbesteding, die wil ik daarvoor al hebben, om mee te kunnen nemen met hoe je gaat aanbesteden en wat je gaat meenemen in de documenten daarin.

Expert 3

Het hangt er een beetje vanaf hoe die maatregelen eruit zien. Een maatregel is bijvoorbeeld het opnemen in de vraagspecificaties. En dan kan ik mij voorstellen dat dat best vaak voorkomt, in de aanbesteding. Of genoemd is, neem het op in het contract, dat dat wel tig keer voorkomt in alle projecten of in heel veel projecten, dus dat kan ik me best wel voorstellen.

Expert 2

Ik zat ook te denken, tot waar loopt de aanbestedingsfase. Want de definitiefase loopt voor mij tot en met de PIT, dus dan heb je PIT akkoord. En vanaf dan tot gunning is voor mij de aanbestedingsfase. Dus stel je zou dan deze maatregelen in je vraagspecificaties kunnen tackelen, dan heb je ze. Maar stel je hebt het over start aanbesteding tot en met gunning, dan had je ze allang moeten tackelen. Dus dan is het wel goed om te weten van wanneer tot wanneer lopen de fases op basis van onze planning.

Differences between types

When comparing projects by project type, there are again small differences in which measure themes stand out. The most noticeable contrasts are:

- Renovation projects (3 and 6) show a mix where stakeholder measures are combined with requirement-related measures.
- Redevelopment projects (4 and 5) show a narrower measure set, with fewer outspoken measure categories.
- New construction projects (1, 2, 7, 8, 9) include measures across all categories, but stakeholder measures remain the main response measure category.

Do you recognize the higher use of contract- and requirement-related measures in renovation projects, especially 'Refining requirements and specifications', as renovation-specific, or as more likely a coincidental result of this dataset?

Expert 2

Ik denk op zich dat dat wel iets met elkaar te maken kan hebben omdat je werkt met iets bestaand, maar je weet nooit helemaal volledig wat de staat is van het bestaande. Dus ik denk dat daar wel wat meer risico's in naar voren komen en daardoor ook meer beheersmaatregelen op moeten worden genomen.

Beyond these main contrasts, some additional insights stand out across the different project phases:

- Tables 4.9 and 4.10 show that regardless of project phase or project type, stakeholder and communication measures are consistently the most used category.

In practice, why do stakeholder and communication measures dominate across all project phases and project types? Does this reflect their effectiveness, or are they simply used as a 'default' measures in the risk registers?

Expert 3

Omdat het een hele makkelijke maatregel is. Hij is niet specifiek, heel vaak nee. En is dus vrij makkelijk op te nemen ook. Hij is ook traceerbaar, van wanneer doe je het wel goed. Het is logisch, je moet goede communicatie hebben met je stakeholders, dus je houd het overleggen. Je hebt een communicatieplan, een stakeholders analyse, allemaal standaard maatregelen. Dus ja, ik vind het vrij logisch dat ze altijd terugkomen als beheersmaatregel.

Expert 2

Is dit misschien ook omdat dit misschien nog iets is wat voor het RVB nog iets moeilijks lijkt, en dat daar de meeste issues door volgen? Dat ze hem daarom zo vaak erin zetten.

Expert 1

Ik heb niet vaak één beheersmaatregel, maar vaak is wel een van de beheersmaatregelen toch iets doen in communicatie. Dat je bijvoorbeeld iets regelmatig moet afstemmen om bijvoorbeeld scope wijzigingen tijdig te identificeren en te documenteren. Dat is een voorbeeld. Maar ik zie dat wij best wel vaak iets hebben staan waar ook communicatie in terugkomt ja.

C.1.3. Co-occurrences of risk cause subcategories and response measure subcategories (Table 4.11)

General observations

The co-occurrence matrix (table 4.7) shows some overall results in how causes and measures are linked. The most noticeable general observations are:

- Almost all causes are linked to at least one stakeholder measure. Only three exceptions show no co-occurrences with stakeholder measures, namely 'Limited or insufficient tender applications' (C6), 'Limited labor capacity' (C22), and 'Limited material and equipment available' (C23).

For the exceptions (C6, C22, C23) that are not linked to stakeholder-oriented measures in the risk registers, does this reflect how these issues are actually handled in practice, or could stakeholder measures still be applicable in these cases?

Expert 3

Sommigen snap ik, 'Limited material en de equipment available', dat is namelijk een opdrachtnemers risico, en is niet gebonden aan een stakeholder onzerzijds, tenzij als je de opdrachtnemer als stakeholder ziet. Dus die snap ik heel erg. Ja, ik vind het vrij logisch dat die drie niet gekoppeld zijn aan stakeholder maatregelen.

Specific observations

Within these general tendencies, table 4.7 also contains a few specific combinations that stand out more clearly than others. The most noticeable specific observations are:

- 'Limited public authority capacity and priorities' (C13) is linked to only one measure, namely 'Enhancing stakeholder collaboration and communication' (M6). Looking at tables B.4 - B.12 in appendix B, this link appears across five different risk registers, suggesting it is a common recurring response rather than a one-project exception.
- 'Regulatory changes' (C14) is linked to the broadest mix of measures, including measures from every different main measure category. Notably, this cause appears only in risk registers 1 (table B.4), 7 (table B.10), and 8 (table B.11), which are all new construction projects (table B.16).

Why do you think that 'Limited public authority capacity and priorities' is addressed by only one measure, while 'Regulatory changes' is mitigated through a much broader set of measures, even though both are external causes outside the project's direct control?

Expert 1

Ik denk mate waar je invloed op hebt. Sowieso heb je op beide geen invloed, maar als er iets wijzigt in regelgeving zou je daar wel vooruit over kunnen nadenken, en dat kunnen meenemen in een bepaalde manier. Over bijvoorbeeld hoe je gaat aanbesteden of iets uitvragen of iets technisch al meenemen, omdat je al vooruit kan kijken. Zovan, er zou misschien wel hier iets aan regelgeving kunnen veranderen, dus je kan er op anticiperen. En omdat je erop kan anticiperen of kiest om er niet op te anticiperen, kun je misschien wel meerdere maatregelen treffen. Terwijl als het gaat om een capaciteit van een overheid, daar heb ik eigenlijk helemaal niets over te zeggen of invloed op, dat is puur zoveel mogelijk betrekken en de noodzaak laten weten en daar proberen met samenwerking iets te kunnen bewerkstelligen. Dus daar heb ik iets minder opties in om iets mee te anticiperen of te doen.

Do you see an explanation for why 'Regulatory changes' occur only in risk registers of new-build projects, while this cause does not appear at all in renovation and redevelopment projects?

Expert 3

Bij renovatie project heb je het over bestaande bouw, dus ook bestaande bouw wetgeving. En bij herontwikkeling snap ik dat het er niet tussen staat omdat die in de initiatieffase zitten, dus dan ben je daar nog helemaal niet mee bezig. En bij nieuwbouw kan ik mij het voorstellen, omdat je bij nieuwbouw meestal aan de nieuwste regels moet voldoen. Dus dan meestal wordt dat ook meegegeven in de vragen specificatie, om te voldoen aan de nieuwste wet en regelgeving.

C.1.4. General questions

What do you consider the most surprising result you have seen, and why? And are there also any relationships or patterns that you expected to see but that did not emerge in the results I presented?

Expert 3

Wat ik er wel uit opmaak is dat wij nog ver weg zijn van standaardisatie. Als ik dan toch een conclusie uit dit onderzoek moet trekken. Maar dat wisten we al, maar het is weer een bevestiging van we zijn nog ver weg van standaardisatie van risico's en ik denk ook van de kwaliteit. Het is alleen weer een bevestiging is van wat we eigenlijk al weten.

Can you think of ways in which this research could be useful for RVB? How can this study support RVB's approach to risk analysis and management in practice, or provide added value in any other way?

Expert 3

Dat moet je toch nog een bredere set doen van een bepaalde fase van een bepaald type project, wil je echt er conclusies aan gaan verbinden. Dus alleen alles in de definitiefase van een nieuwbouwproject bijvoorbeeld. Als je het dan breder, of meer projecten erbij betrekt, kan je denk ik ook een beter oordeel erover vellen.

Expert 1

Dat is één, maar het andere is de kwaliteit van omschrijven. Soms worstel ik zelf ook, maar ik merk mijn hele projectteam wel zovan, als je iets als een risico schrijft kan dat ook een oorzaak zijn. Als je daar nou definities van helpt opstellen, of mensen er meer in gaat trainen in de onderscheiding hiervan, het moet hier en hier aan voldoen. Dus echt de kwaliteit gaat verbeteren. Jij hebt uit je literatuurstudie ook al gehaald dat er eigenlijk standaard oorzaken en veel voorkomende oorzaak zijn. Het zou al helpen als je daarmee gaat werken om te kijken of deze oorzaken gebruikt kunnen worden. Zodat je straks wel data hebt wat veel meer gaat opleveren in wat iedereen toewerkt naar wat standaarden in oorzaken en maatregelen zijn. zegt niet dat het altijd.

Je hebt natuurlijk altijd wel dat er misschien niet iets past, maar je gaat wel veel meer naar een percentage om wel te kunnen zeggen dat die verbanden er zijn, want dat gaat nu niet.

Expert 3

Je had 27 subcategorieën, dat soort dingen helpt wel bij standaardisatie, en dus ook bij een omschrijving. Want je weet, als je overal dezelfde communicatiemiddelen gebruikt, dat helpt gewoon heel erg. Dus daarmee zou je het expertteam, denk ik, ook heel erg mee helpen om te standaardiseren.

Beyond focusing on causes, risks, and measures separately, do you think there is also room for improvement in how the relationships between these elements are defined and recorded in practice?

Expert 1

Het zou al helpen als mensen überhaupt op die manier gaan nadenken. Door al op die manier in kaart te brengen dat ze verbanden met elkaar hebben, dat gaat denk ik in de toekomst hier veel meer informatie opleveren. Ik denk dat er überhaupt niet echt op die manier nog gedacht wordt in verbanden. Dus dat als je oorzaak benoemt, dat je het niet zomaar benoemt, maar dat je die ook echt koppelt aan een maatregel. Dus dan helpt dat doordat je compleet bent, dus kwaliteit eigenlijk.

Expert 3

Je moet je afvragen, als je een oorzaak benoemt en je neemt geen maatregel ervoor, is het dan wel een oorzaak? Of ik denk dat dit een maatregel is, maar ik kan hem niet koppelen aan een oorzaak. Is het dan wel een maatregel?

In the literature, a distinction is often made between measures that target the causes of risks and measures that target the consequences. Is this distinction also applied in the risk register, and do teams explicitly consider this when selecting and recording measures?

Expert 2

Er wordt bij ons wel over nagedacht, maar ik zou niet zeggen dat dat standaard zo wordt gedaan.

In your view, is that a meaningful distinction that should be explicitly made?

Expert 2

Zeker. Ik denk wel dat vooral bij top risico's dat het wel benodigd is. Maar bij risico's waar je kans heel laag is, moet je denk ik wel na denken over hoeveel tijd je er überhaupt aan moet besteden

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