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Steel construction change orders: causes and strategies

An investigation of change orders in a Swedish steel construction company

Master's thesis in Quality and Operations Management

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Abstract

Construction projects are characterised by high uncertainty, making changes and adjustments a recurring feature of project execution. These deviations are commonly formalised through change orders, which alter contracts through additions, omissions, or modifications to the agreed work. Although change orders are often necessary, they can negatively affect project performance through rework, delays, increased administration, cost increases, and strained relationships. This study investigates the main causes and effects of change orders in the steel construction industry and explores strategies for reducing their occurrence and mitigating their negative effects. The study is conducted as a qualitative single-case study at a Swedish steel construction company. Empirical data collection is carried out in three phases through unstructured interviews, observations, a workshop, semi-structured interviews, and a group interview.

A literature review was performed to identify causes and effects of change orders in previous research, which were then combined with empirical findings to develop a taxonomy tailored to the steel construction context. The taxonomy is structured into three levels, consisting of two categories, 10 themes, and 27 factors. To support managerial prioritisation, the causes are assessed in a risk matrix based on the severity of impact and probability of occurrence. This resulted in six high-risk factors critical to address: communication, coordination, inexperienced project manager, client-generated changes, documentation, and controversial change orders. The first three of these factors are identified as preventable and the other three as non-preventable. Strategies are then presented for managing them accordingly. The study contributes by providing an operationally focused taxonomy of change order causes and effects tailored to steel construction, as well as practical strategies for supporting more structured change order management.

Keywords: change orders, steel construction, construction project management, risk management, taxonomy

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1

Introduction

The introduction chapter introduces the topic and context of the research, as well as presents the problem definition and the research questions used to guide the research and formulate conclusions. The conclusion of this chapter is an overview of the thesis, where the overall structure is presented.

1.1 Background

The construction industry is a large industry, accounting for approximately 13% of global gross domestic product and employing around 10% of the global workforce (McKinsey & Company, 2020). As such, its performance has significant economic and societal implications. Construction projects are complex by nature and are seen as temporary organisations that require the involvement and coordinated efforts of multiple actors with specialised knowledge. This creates a strong reliance on effective collaboration and information exchange throughout the project lifecycle.

Despite its scale and importance, the construction industry has long been associated with slow productivity growth relative to other major industries (McKinsey & Company, 2020). Productivity improvements have been limited, partly due to the project-based nature of the industry, difficulties in standardising processes, and strict regulatory conditions (Winch, 2010, ch. 1). Despite increasing digitalisation and technological advancements, Winch (2010, ch. 1) describes how construction activities remain largely dependent on manual labour and on-site coordination. In such environments, uncertainty and variability remain inherent features of construction projects. Accordingly, changes and adjustments are a recurring factor during project implementation despite detailed planning and contractual agreements.

These deviations are commonly formalised through change orders, representing additions, omissions, or modifications to the agreed work (Winch, 2010, ch. 1). Given the number of actors involved and the interconnected nature of project activities, even minor changes can propagate through the project and affect multiple stakeholders.

Change orders are therefore not only common but also critical to project performance. They can lead to rework, delays, increased administrative effort, and cost increases if not effectively managed. At the same time, change is to some degree inevitable due to uncertainty in projects and evolving project conditions, making the management of change orders a central aspect of construction project administration.

Given their recurrence and significant impact on project outcomes, it is critical to understand the underlying causes of change orders and how their effects can be managed. Addressing these factors is essential for construction firms seeking to improve project performance and maintain long-term competitiveness in an increasingly demanding industry.

1.2 Purpose

The purpose of this study is to identify and analyse the main causes and effects of change orders within the steel construction industry, and to organise these into a structured and operationally applicable taxonomy. Based on this, the study also aims to develop strategies for both reducing the occurrence of change orders and mitigating their negative effects, thereby providing a foundation for improved project performance and long-term organisational competitiveness.

1.3 Problem and research questions

Change is identified as a common topic of great impact on the construction business due to its project-based nature. The complex nature of the projects involving many parties creates a significant need to manage change in a structured and effective way to ensure project success and a competitive position. Previous research presents structured taxonomies of change order causes and effects to highlight the problem, however, there is a gap in taxonomies tailored to subcontractors in the steel construction industry. Further, previous research is limited regarding managing the effects and reducing the occurrence of change orders and the link from identifying causes and effects to presenting strategies for mitigation. To close this gap, the following three research questions are examined in this research:

RQ1: What are the main causes and effects of change orders in steel construction projects?

RQ2: Which types of change orders should be prioritised for reduction or mitigation, based on their frequency and related effects?

RQ3: What managerial and interorganisational strategies can be used to reduce the occurrence and mitigate the negative effects of change orders?

1.4 Delimitations

This thesis is limited to examining change orders between the steel contractor and their client. Change orders on the opposite side, between the steel contractor and their suppliers are excluded from the research. While this delimitation may limit the applicability of the findings to the full spectrum of change orders, it is not expected to influence the conclusions drawn regarding the contractor-client relationship.

The study is based on a single case company operating within a specific context in the Swedish market, which may limit the generalisability of the findings. The focus is on developing an in-depth understanding of this particular context rather than validating the results across multiple cases or markets.

1.5 Overview of the thesis

The structure of the thesis is as follows. The introduction in Chapter 1 provides a background to the topic and presents the purpose, research questions and limitations of the research. In Chapter 2, relevant theory on the construction business, change orders, project management and risk management is presented, together with the literature review on change orders and related taxonomies. Chapter 3 presents the research methods and provides an introduction to the case company. The empirical data collection of the thesis is divided into three consecutive phases presented in the chapter. The results are divided into three chapters, representing each phase of data collection, and these are presented in Chapters 4, 5 and 6. Chapter 7 then presents a synthesis of the three results, presenting our final taxonomy. Chapter 8 contains a discussion linking findings to theory and presenting discussions for each research question. Finally, in Chapter 9, the conclusions of the research are presented together with recommendations for future research.

2

Theory

This chapter provides a theoretical basis for the research, including information on construction projects and relevant stakeholders involved, as well as related practices such as project management, risk management, communication and relationships. Additionally, change orders and their causes and effects are introduced, providing a basis for identified categories used further in the research.

2.1 Construction projects

Projects are defined as temporary organisations without autonomy (Winch, 2010, ch. 1). Construction project requires human and equipment resources supplied by the firms on the supply side, called the resource bases of the construction industry, and includes for example contractors, engineers, machines, material and knowledge. These resources are mobilised from multiple firms and coordinated within the project to achieve specific project objectives. As projects do not possess permanent internal resources, they rely on the collaboration of various organisations that contribute with specialised capabilities. At the same time, firms typically participate in several projects concurrently and must allocate and coordinate their resources across a portfolio of projects. Consequently, construction projects represent temporary organisational arrangements formed by a coalition of firms commissioned by a client, exhibiting characteristics that are not fully captured by traditional organisational theories.

Winch (2010, p. 51) defines the key criterion for project success as the realised asset fully matching the needs of the client at the time of execution, rather than the project mission being fully achieved. A project mission is inherently changing, but still needs to be formulated to facilitate direction and coordination. This is important for several reasons. First, the process of defining the mission enables participants to articulate their understanding, thereby testing the underlying intuition and analysis for consistency and viability. Second, a clearly defined mission allows the communication of strategic intent to the diverse project stakeholders. Finally, it helps align both those actively involved in delivering the project and those who have the power to influence or disrupt it.

Winch (2010, ch.1 & ch. 8) argues that the construction industry faces two interrelated challenges: low profitability and limited organisational learning. The link between these lies in the project-based nature of the industry, where learning remains largely tacit and individual rather than being captured and reused across projects. As a result, firms struggle to improve productivity over time, which contributes to persistently low profitability. At the same time, low margins reduce the incentives and available resources for investing in knowledge management activities, reinforcing the problem.

Projects in the construction industry typically follow a standard set of phases (Winch, 2010, ch. 5). These may overlap to varying degrees and include a varying number of actors, but can generally be recognised across projects. They usually start with the briefing phase, focused on defining the project mission and translating the customer needs into a clear project brief. Here, requirements are identified and technical information is collected. These project briefs vary in detail and can be anything from a few bullet points to an almost finished building design. The project brief is also most commonly used as a basis for bidding between different contractors. This part of the process can be seen as a sales phase, where details are clarified, negotiations are made, and the end goal is to have an offer for a contract to be signed. Several contractors can be involved in this process in parallel.

When a contractor has won the project, the design phase starts (Winch, 2010, ch. 5). Here, more detailed design and calculations are conducted by structural engineers and architects to completely define what the building will look like. With the design finished, the project moves into the planning phase. In this phase, a detailed execution plan is developed, covering schedules, budgets, and procurement solutions. Contact between the client, contractor, and suppliers is frequent and iterative, with the desirable outcome of the planning phase being a clear plan for the execution of the project. In practice, design and planning activities are highly dependent on each other and commonly performed simultaneously rather than in sequence. Therefore, they are often treated as a single phase. In this thesis, the planning activities are seen as a part of the design phase and will be included in that term.

Lastly, there is the execution phase (Winch, 2010, ch. 5). This is where the construction of the building is executed according to the plans and designs developed earlier. These phases represent a progressive reduction of uncertainty, where the beginning of a project is explorative and iterative, and as the project progresses, it becomes more structured and focused on execution.

Pennetti et al. (2025, ch. 3) complement this by introducing the project pursuit process, focusing on the early, pre-contract stages of construction projects. During this process, contractors engage closely with clients to shape the scope of the project and clarify requirements. In contrast to the more linear phase description by Winch (2010), Pennetti et al. (2025) emphasise how this process is highly iterative and how continuous discussions between stakeholders are made to establish the key aspects of the project before a contract is signed. Central to this process is the strategic decision-making regarding whether and how to pursue a project. As not all project pursuits result in a secured contract, contractors need to identify risks and gather information as effectively as they can to offer a good contract, but also avoid over-investing time and energy before they get the assurance of a contract. This process is, in this thesis, referred to as the sales phase, as it captures the activities related to bidding and negotiating before a formal contract is signed.

Given this description of the project phases, it is relevant to describe the different actors involved in a construction project. Figure 2.1 presents the relevant stakeholders and their relationships. Winch (2010, ch. 4) proposes a classification of internal and external stakeholders. Internally, a distinction can be made between the demand side and the supply side of the project. On the demand side, the owner is the main actor, including their employees and possibly supported by financiers and tenants. The demand side represents the interest of the owner and the users of the finished building. On the supply side, the contractor is found, including its architects and engineers as well as subcontractors and suppliers. Examples of suppliers are the steel and concrete producers. The supply side is responsible for the delivery of the project, fulfilling the interests of the owner. Apart from these internal actors, there are also external stakeholders that affect and are affected by the project. Examples of these include private actors such as local residents, landowners, and non-governmental organisations, as well as public actors like the local government and regulatory agencies. All these actors, both internal and external, need to be considered in a project and create a complex relationship structure that can affect the project in more or less expected ways.

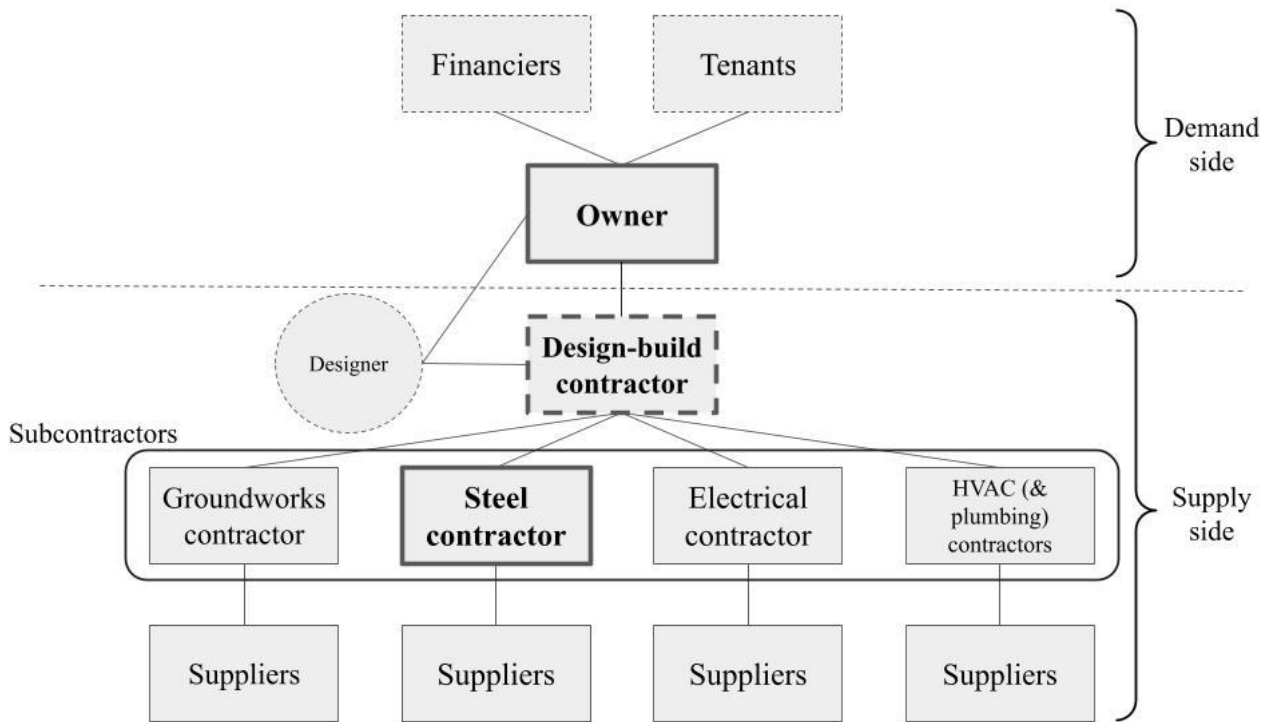


Figure 2.1. Main stakeholders in construction projects.

The most relevant actors in this thesis are the internal actors, more specifically the owner, the design-build contractor, and the steel subcontractor, highlighted in bold in Figure 2.1. This is because these are the main actors involved in causing and handling change orders. Here, the owner bears the financial burden and long-term responsibility for the building, being the one who will use it after completion. The design-build contractor is the contractor that the owner has hired to complete the project. They handle the majority of the contact with the owner and are responsible for the overall planning and execution of construction. In turn, the design-build contractor hires subcontractors, such as a steel contractor who is responsible for the erection of the framework of the building. In parallel, the design-build contractor also hires other subcontractors to handle aspects like groundwork, electrical components, and plumbing, but these will not be focused on in this thesis. Not all projects follow this structure. In some cases, the owner contracts multiple contractors directly, meaning that subcontractors instead have a direct contractual relation with the owner. In these cases, the terms “client” and “owner” refer to the same actor. In this thesis, the term “client” is used for both the design-build contractor and the owner, since the difference is not of interest in this research. In some projects, the contractual relation is between the design-build contractor and the steel contractor, and in some cases it occurs between the owner and the steel contractor.

Further, Winch (2010, ch. 13) discusses the role uncertainty plays in projects. At the start of a construction project, the uncertainty is high, often with only an idea and a few sketches. In

construction projects, uncertainty arises from two main sources: complexity and predictability. In a project with high complexity, information and competence exist but are difficult or costly to collect and analyse. In a project with low predictability, there is an absence of information and competence, often because past experiences cannot be applied. When a project progresses and more information is gained along the way, complexity decreases and predictability increases. This creates a difference in uncertainty between the beginning and end of a project, and the project process can thereby be described as a continuous decrease in uncertainty. Understanding this difference and how to work with it is essential for a project manager. There is always an apparent risk in decision-making when uncertainty is high.

Winch (2010, ch. 13) separates uncertainty into mission uncertainty and dynamic uncertainty. Dynamic uncertainty means the uncertainty in a particular point in the project life cycle relative to earlier or later points in the project life cycle, with the uncertainty reducing with time as described above. This creates a temporal dimension of uncertainty, with a trade-off between acting early with limited information and delaying decisions to reduce uncertainty. Mission uncertainty is the uncertainty inherent in the project, depending on the extent of standardised components and solutions possible to use, the extent of requirements for new technologies needed, and the extent to which the project is a copy of an already existing one. This means each project has a unique starting level of uncertainty.

2.2 Project management in construction

Managing a construction project requires balancing multiple, often competing demands. As described by Winch (2010, ch. 16), construction projects involve a coalition of stakeholders with different objectives, incentives, and areas of expertise, all of which need to be aligned toward a common goal. At the same time, the project must be delivered according to time, cost, and quality constraints, requiring structured planning and control. This dual challenge means that project management in construction is not only about following plans, but also about coordinating actors, interpreting information, and continuously aligning expectations. Consequently, project managers need a combination of technical skills and soft skills, particularly in coordination, communication, and relationship management.

Building on the need for coordination, Demirkesen and Ozorhon (2017) emphasise that integration management is a core element of construction project management, as it ensures that different activities, stakeholders, and sources of information are aligned throughout the project lifecycle.

Rather than viewing project management as a set of separate functions, integration management focuses on combining them into a coherent whole. This includes aligning planning, execution, and decision-making so that actions taken in one part of the project are consistent with others. In this sense, integration management is an ongoing effort to coordinate people, processes, and information. It involves establishing clear roles and responsibilities, ensuring that workflows between phases are connected, and facilitating communication between actors. Through this, project managers can create a shared understanding and reduce the risk of misalignment between stakeholders. A key implication of this perspective is that insufficient integration can lead to gaps in information, unclear responsibilities, and inconsistencies between project phases. Such misalignments are closely linked to issues such as rework, delays, and cost overruns.

While integration management highlights the need to connect processes and actors, it also raises the question of how knowledge is actually created and shared within projects. In construction projects, focus is often placed on formal processes and documented procedures. However, Senaratne and Sexton (2009) argue that the role of knowledge in managing projects is often overlooked. They say that the nature of knowledge can be seen with three key characteristics: it is largely more tacit rather than explicit, collective rather than individual, and situational rather than predefined. This implies that effective project management does not rely solely on documented procedures or formal systems, but rather on the ability of project participants to use experience and interact with others to handle situations and solve problems that emerge.

Further, knowledge in construction projects is primarily created and shared through social interaction such as meetings, discussions, and collaboration between team members (Senaratne & Sexton, 2009). Through these interactions, individual experiences are combined to develop solutions to project issues, particularly in response to unexpected changes. This sharing of knowledge is rarely fully documented through formal processes, but tends to remain with the individuals and is transferred to future projects through personal experience rather than structured systems. This highlights that knowledge sharing and transfer in construction projects are heavily dependent on communication, relationships, and informal processes, reinforcing the importance of soft skills in project management. It also suggests that the facilitation of communication through natural interactions and knowledge exchange should be of high priority for project managers, not only coordinating tasks and resources.

Pennetti et al. (2025, ch. 9) build on this perspective by emphasising the communication capabilities required in project management. While engineers often develop strong technical communication

skills through formal education and project experience, managerial roles require broader competencies, including coordinating teams, engaging with clients and actively listening to different perspectives. Traits that should be aspired to develop include clarity, empathy, adaptability, and respect. Consequently, traits such as blame, poor documentation, overcomplication, second-guessing, and hasty decision-making should be avoided.

Furthermore, Pennetti et al. (2025, pp 386-390) distinguish between management and leadership as complementary aspects of project management. Managers usually employ a structural approach, emphasising planning and control, following the rules, and doing things efficiently. They delegate tasks and are conservative in their risk-taking. Leaders, on the other hand, employ a more inspiring approach, focusing on motivation, flexibility with rules, and effectiveness in doing the right things. They empower team members, participate, and are willing to take calculated risks. In construction projects, the clarity and structure of the manager is needed to make progress in projects and make the construction site safe. Complementing this, the influence and motivation of the leader can inspire team members to do the right things, supporting the handling of uncertain situations and fostering effective collaboration.

2.2.1 Managing uncertainty and risk in construction projects

Risk management is an important aspect of construction project management due to the large number of uncertainties and interdependencies present throughout construction projects. According to Schieg (2006), risk management should not be treated as a separate activity, but rather as an integrated and continuous process embedded throughout all phases and functions of a project. Construction projects are exposed to risks throughout their lifecycle, and because projects continuously evolve, not all risks are identifiable at the start of a project. Instead, new risks can emerge during project execution, creating a need for continuous reassessment and monitoring throughout the project lifecycle.

Schieg (2006) further describes risk management as consisting of several connected activities, including the identification, analysis, assessment, control, and monitoring of risks. Together, these activities aim to improve preparedness and reduce the negative effects of project risks through proactive management. A key aspect is that risks need to be identified as early as possible, since risks that are not identified cannot be analysed or controlled. However, complete identification of all risks is considered impossible, meaning that the objective instead is to identify and control the most significant risks affecting project activities.

Another important aspect highlighted by Schieg (2006) is that risk management should be adapted to different project phases. Early project phases focus more on identifying uncertainties related to project goals and stakeholder responsibilities, while later phases focus more on monitoring known risks and managing emerging issues during execution. In this sense, risk management is described as an iterative and adaptive process rather than a one-time assessment activity. Further, the organisational aspects of risk management are emphasised. Effective risk management depends on communication structures, reporting routines, and clearly assigned responsibilities within projects. Through continuous communication and monitoring, project organisations can improve transparency, identify problems earlier, and maintain better control over project risks and uncertainties.

While Schieg (2006) mainly focuses on the practical implementation and organisational integration of risk management, Winch (2010, ch. 13) provides a more conceptual perspective on the nature of uncertainty and risk in construction projects. As described in section 2.1, Winch (2010) suggests that projects can be seen as processes of uncertainty reduction over time, where decisions need to be made with incomplete information early in projects. Therefore, the ability to identify, interpret, and manage uncertainty is fundamental to successfully achieve the objectives of the projects. Here, a distinction is made between risk and uncertainty in projects. Uncertainty relates to the absence of information required for decision-making, while risk relates to situations where potential consequences of actions can be identified, even if their likelihood or impact is difficult to estimate. In construction projects, it is common that decisions must be made before complete information is available, and in such situations, project managers often need to rely on experience and judgment to handle them well.

Further, Winch (2010, p. 347) describes how risk sources should be separated from risk events. A risk source is an underlying condition in the project environment, for example unclear design documentation, while a risk event is an occurrence arising from that condition, like a change order coming from misinterpretation. With this distinction, it is clear that risk management needs to address the underlying risk causes (pre-event response) and not only react to risk events (post-event response). When it comes to pre-event strategies, focus is on reducing or eliminating risk sources before they materialise, for example through improved information gathering, design development, or stakeholder involvement. On the other hand, post-event strategies focus on mitigating the impact of risk events once they occur through contingency planning, budget reserves, and schedule flexibility. A combination of both approaches is usually needed for effective risk management.

When it comes to managing risk, Winch (2010, ch. 13) suggests that risks should be allocated to the actors that are best positioned to handle them. The actors who are closest to the risk source are the ones most likely to have the information and capability required to manage them effectively. However, the capacity and capabilities of the actors involved also need to be considered, since allocating high-stake risks to weak actors can lead to unwanted consequences like project disruption and failures.

Here, the cognitive approach is an important perspective. According to Winch (2010, pp. 347-354), the cognitive approach suggests that uncertainty is shaped by the knowledge, experience, and interpretations of the people involved in the project. This means that uncertainty is not purely objective, but rather that two individuals may interpret the same situation differently depending on their background and prior experience. Within this perspective, uncertainty can be divided into known unknowns and unknown unknowns. Known unknowns refer to uncertainties that are recognised but not fully understood, and the management of them is usually about actively seeking information and asking the right questions. On the other hand, unknown unknowns refer to uncertainties that are not yet identified, and handling them requires flexibility and adaptability in the organisation.

The cognitive approach highlights the important role experience and learning have in managing risks and uncertainty. Tools and methods are helpful, but it ultimately comes down to the ability of individuals to anticipate potential issues, identify critical uncertainties, and interpret incomplete information. This is particularly relevant in construction projects, where many uncertainties are not fully specified in early documentation and must instead be identified through interaction between stakeholders. This emphasises how important communication and coordination are in reducing uncertainty. Different actors will hold different pieces of information and structured communication is essential to be able to lay the puzzle of those pieces of information into a full picture. If that alignment is missing, misunderstandings may persist and lead to disruptions and change orders.

Building further on these perspectives, Pennetti et al. (2025, ch. 8) provide a structured way of analysing, prioritising, and responding to risks in construction projects. They describe how risk management is a continuous and iterative process that spans the entire project cycle. It involves identifying potential risks early, continuously reassessing them as the project evolves, and adapting responses accordingly. A key aspect is also that risk management is limited by resources, which makes prioritisation essential. Not all risks in a project can be addressed, which means that focus needs to be on those that pose the highest risk for project objectives.

Risk assessment focuses on identifying risk sources and potential risk events. In line with the distinction made by Winch (2010, p. 347), Pennetti et al. (2025, ch. 8) emphasise the importance of identifying underlying conditions that may lead to undesirable outcomes, rather than only focusing on the outcomes themselves. This step involves asking what can go wrong in a project and identifying areas where uncertainty is present. In construction projects, this often relates to incomplete information, unclear requirements, or a lack of coordination between stakeholders. Therefore, effective risk assessment relies heavily on communication, experience, and the ability to interpret incomplete information.

When it comes to analysing risks, Pennetti et al. (2025, ch. 8) further describe how the magnitude is determined by the probability of occurrence and potential impact for a specific risk. This forms the basis for prioritising risks and deciding where to allocate resources. Building on that foundation, risk analysis should consider additional factors like the timing of risks, their interdependencies, and the degree of controllability. Risks occurring later in a project often have more severe consequences due to reduced flexibility, and risks that are connected to each other can amplify effects. Further, reserve studies are described as a way of establishing contingency reserves to manage uncertainties in projects. These reserves can include both cost and schedule reserves, which function as buffers against identified risks by allocating additional financial or time-related resources. The purpose is to improve the ability to handle disruptions and uncertainties in the project without jeopardising project objectives. The final step in the risk management process is then to select appropriate strategies for responding to risks. This can include both prevention and mitigation, but also transferring or accepting risks. The choice of strategy depends on the resources available, the magnitude, and the controllability of the risk.

Overall, the management of risk and uncertainty in construction projects involves a combination of organisational integration, interpretation of uncertainty, and structured risk assessment. While Schieg (2006) describes risk management as a continuous and integrated process that relies on communication and monitoring throughout the project lifecycle, Winch (2010) provides a conceptual understanding of uncertainty and risk, emphasising the role of interpretation, experience, and stakeholder knowledge. In addition to these perspectives, Pennetti et al. (2025) provide a more structured framework for analysing, prioritising, and responding to risks based on their probability, impact, and controllability. Together, these perspectives show that effective risk management in construction projects is both organisational and analytical in nature, requiring continuous coordination, communication, and adaptation throughout projects.

2.3 Communication and relationships in construction

Communication is a central aspect of construction project management due to the large number of actors, interfaces, and uncertainties involved throughout a project. As described in Sections 2.1 and 2.2, construction projects rely heavily on continuous discussions and information exchange between stakeholders (Pennetti et al., 2025, ch. 3, 9 & 10). This is particularly during the early project pursuit process, where project scope, requirements, and risks are clarified. In this iterative process, contractors and clients continuously exchange information to shape a shared understanding of the project while balancing uncertainty, resource constraints, and varying stakeholder standpoints. Communication is therefore not only important for transferring information, but also for enabling coordination, alignment of expectations, and collaborative decision-making throughout the entire project lifecycle.

Pennetti et al. (2025, ch. 9) further highlight that effective project management requires strong communication capabilities alongside technical expertise. Since construction projects involve actors with different responsibilities and perspectives, project managers need the ability to coordinate teams, engage stakeholders, and actively listen to different viewpoints. Clear communication, adaptability, empathy, and respect are emphasised as important traits for managing projects in a way that supports collaboration. This becomes particularly important in situations where decisions need to be made despite incomplete information, requiring project actors to continuously interpret and communicate changing project conditions. In this sense, communication functions both as a coordination mechanism and as a way of reducing uncertainty in projects.

The importance of communication in managing projects is further emphasised by Butt et al. (2016), who examine the role of stakeholder communication in managing project changes and mitigating their impact. They argue that insufficient communication and poor stakeholder integration are among the most common causes of unmanaged changes and uncontrolled outcomes in projects. According to Butt et al. (2016), effective communication routines and clear communication structures throughout a project contribute to easier mitigation of negative change effects such as delays, rework, and cost increases. These routines include interactive communication, regular and structured meetings, and stakeholder involvement in decision-making. Communication established early in projects enables potential issues to be identified before their full effects are known, or even before they occur at all. In this way, communication contributes to more proactive rather than reactive management of project changes.

Butt et al. (2016) further explain that communication effectiveness not only depends on the existence of routines and structures, but also on the capabilities of the actors involved. This is captured in the concept of stakeholder know-how, which includes experience, communication skills, and the ability to interpret and act upon shared information. Even well-designed communication structures may therefore become less effective if stakeholders lack the ability to understand or utilise the information being communicated. The authors also highlight the importance of interactive communication, as multidirectional information exchange enables stakeholders to develop shared understandings and coordinate decisions more effectively. At the same time, communication routines influence stakeholder engagement and project culture over time, affecting how collaborative and adaptive project environments become.

Senaratne and Sexton (2009) further highlight that communication in construction projects often extends beyond formal documentation and structured reporting systems. During situations when changes occur in projects, the project teams rely heavily on interactive and face-to-face communication to collectively interpret problems and develop solutions. Regular meetings, discussions, and informal interactions become important forums for coordinating activities and sharing project experience between stakeholders. The authors also emphasise the role of visualisation techniques, such as sketches, diagrams, and examples from previous projects, as tools for expressing and communicating ideas during problem-solving activities.

Another important aspect noted by Senaratne and Sexton (2009) is that communication during project change is highly dependent on dialogue and social interaction rather than solely on formal written records. Their findings suggest that formal project documentation often captures decisions and outcomes, but not necessarily the reasoning, discussions, and interpretations that led to them. As a result, communication through interactive settings becomes important for developing shared understanding and coordinating responses to uncertain and changing project conditions.

These findings suggest that communication in construction projects is not only dependent on formal communication structures, but also on the relationships between stakeholders. Since communication during uncertain and changing project conditions relies heavily on dialogue and knowledge sharing, the degree of trust, continuity, and collaboration between actors can affect how effectively such communication functions in practice.

In this context, Errasti et al. (2007) make a distinction between short-term relationships and long-term relationships. Short-term relationships are typically transactional and project-specific, focusing on defining delivery objectives, responsibilities, and risk allocation to ensure efficient project execution. While such arrangements provide clarity, they tend to prioritise contractual compliance over deeper collaboration, which can limit knowledge sharing and coordination. In contrast, long-term relationships often concern developing cooperative practices to maximise long-term benefits and collaboration. This continuity enables learning effects, knowledge sharing, and process integration between stakeholders, contributing to improved performance in terms of cost, quality, and delivery. Long-term relationships therefore create opportunities for coordination and collaboration that extend beyond what can be formally specified in a contract.

To further understand this distinction, Winch (2010, p. 95) presents two aspects of governance: contractual and relational. The contractual aspect captures the legal basis of the relationship by agreeing on terms before the start of a project. These are formal agreements that define roles and responsibilities, providing the necessary information for collaboration and the execution of construction projects. On the other hand, the relational aspect concerns trust, mutual understanding, and perceived fairness between stakeholders. It includes the informal, social dimension of collaboration, evolving over time through interaction and learning from each other. While contractual governance provides the framework for collaboration, relational governance enables flexibility and effective coordination when unforeseen situations arise. In this way, the two aspects are complementary, where contracts establish the conditions for collaboration, and relationships determine how well it functions in practice.

While communication concerns the exchange and interpretation of information between project actors, it does not necessarily imply the existence of strong relationships between them. Communication can occur within both transactional and collaborative project settings, regardless of the depth of cooperation between stakeholders. However, the nature of the relationships between actors influences how communication functions in practice, particularly in situations characterised by uncertainty or changing project conditions. In this sense, communication and relationships are closely connected, but they should not be viewed as the same concept.

2.4 Project change

A change is any revision, addition or deletion of the general scope of a project (Ibbs, 1997). Changes are inherent to projects due to the uncertainty and evolving understanding of requirements throughout

the project lifecycle. They occur regularly and hinder project success for both the client and the contractor. This shows the amount of change is negatively correlated with productivity and project cost, meaning more change contributes to reduced productivity and higher overall project costs. The study by Ibbs (1997) focused on changes occurring during both the design phase and the execution phase, with consistent results observed across both stages. While changes are often associated with negative impacts on efficiency, they may also increase the value of the project by better aligning the deliverables with user needs. It is obvious that change is inevitable, and the focus should be on managing it to reduce the negative effects.

Late project changes lead to a greater reduction in labour productivity than changes that occur earlier in the project (Ibbs, 2005). As project execution progresses, completed work becomes increasingly interdependent, meaning that modifications often require rework, additional mobilisation, and adjustments to tasks that have already been finalised. It is even suggested that the type of change is not as impactful as the mere existence and timing of it. If changes are necessary, they should be recognised as early as possible. Postponing the solution of change is also more disruptive and costly, suggesting that change should be dealt with right after its occurrence. To support early identification and implementation of changes, financial hurdle rates, such as benefit-cost ratios, can be used to evaluate proposed changes. By applying lower thresholds early in the project, changes are encouraged to be addressed at an earlier stage, when their impact is less severe.

2.5 Change orders in construction

In construction, a change order is a formal document that proposes a change to the original contract. When approved by the owner, all its terms become as binding as the contract (Fisk & Reynolds, 2010, pp. 309-311). The change can be regarding cost, time frame, order of work, method of construction, or technical requirements. They might also be corrections to errors in plans or specifications, or suggestions for improvement from the contractor. A change order can be initiated by any party and must be approved by the client before implementation. It can involve a price change, either in favour of the contractor or the client, or no price change at all. Most construction projects contain change orders.

Despite the requirements of a formal written document, practice does not always follow this procedure. Fisk and Reynolds (2010, p. 310) highlight the occurrence of oral change orders where instructions are given and acted upon without formal documentation. The behaviour of both the representative of the client and the contractor may constructively waive the requirement for written

approval, creating an uncertain situation that might lead to disputes regarding scope, cost, and responsibility.

2.5.1 Causes of change orders

Change orders are often driven by incomplete or preliminary design information at the time of contract award, as construction projects commonly rely on progressively elaborated designs (Winch, 2010, p. 51). Contracts are typically based on preliminary tender documents to ensure fair and comparable bidding between contractors. As these documents are often developed before the design is fully mature, this creates a structural need for change orders as design details are clarified during later project phases. According to Bröchner and Badenfelt (2011), this process can also be understood as a form of project learning, where increased understanding of technical conditions and client requirements over time leads to necessary adjustments.

Other reasons for change orders are poor communication or unforeseen external factors, such as unexpected weather conditions or differing site conditions (Fisk & Reynolds, 2010, pp. 317-318). Often, delays are caused by the client rather than the project team, resulting in changes in the specifications of work. Change orders often appear early in the project phase, but may also arise at any time during project execution.

Fisk & Reynolds (2010, p. 317) list six categories of causes that result in change orders: “differing site conditions”, “errors and omissions in plans and specs”, “changes instituted by regulatory agencies”, “design changes”, “overruns/underruns in quantities beyond limits”, and “factors affecting time of completion”. They further state that reasons may fall outside of these but are often similar and can be treated as one of the categories, meaning this can be seen as a comprehensive categorisation of causes. Although a comprehensive categorisation, it lacks detail and interpretability to be seen as a taxonomy, which is why these categories are not to be treated as a direct basis for our taxonomy.

Bröchner and Badenfelt (2011) structure their research around nine identified categories of change reasons. Two of which are client-related: “errors, omissions and contradictions in the original specification documents” and “changes in clients’ core activities (or in demand from their customers)”. Three categories are associated with the supply side: “better understanding of client needs”, “changes in provider technology”, and “changes suggested to the client by a subcontractor with technology change (supplier to the provider)”. Additionally, two categories originate from a

joint sphere between client and provider: “the ex-ante unknown state of the system (IT, geotechnical conditions, etc.)” and “lack of communication between parties during the contract period”. Lastly, two external reasons related to environmental uncertainty are included: “unexpected natural events” and “unexpected societal influences on the project”. The authors provide a new perspective on structuring categories after origin, where the joint client and provider origin is particularly interesting, suggesting that reasons for change can be interrelated. Findings suggest that external causes appear less frequently and are often handled already in the contract, suggesting that they may require less managerial focus. Their research further highlights how construction projects have a high frequency of changes due to errors and contradictions in initial documentation. At the same time, early involvement of contractors has been shown to reduce the frequency of changes, as it enables better alignment of requirements and improved understanding of project conditions at an early stage.

While both Fisk and Reynolds (2010) and Bröchner and Badenfelt (2011) provide a descriptive overview of common causes, other research has developed more structured taxonomies of change order causes and effects in construction. Based on a systematic literature review, Sun and Meng (2009) propose two taxonomies, one for change causes and one for change effects. Their framework is structured in three levels, offering a structured overview with increasing detail for each level. On level one, it categorises causes into “external causes”, “organisational causes”, and “project internal causes” with subcategories. External causes include, on the second level: “environmental”, “political”, “social”, “economic” and “technological” factors. Given Bröchner and Badenfelt’s (2011) findings about external factors being less frequent, “political”, “social”, “economic” and “technological” causes are treated as too rare and outside of our scope and therefore irrelevant for this thesis. “Environmental causes” are still considered within our scope. Organisational causes are “process”, “people” or “technology” related, while project internal causes are divided by “client-generated”, “design consultant-generated”, “subcontractor-generated”, or “others”. Each of these contains several more precise categories on the third level.

Padala et al. (2020) also propose a classification of change causes at three levels. The main difference between the classification of Padala et al. (2020) and that of Sun and Meng (2009) is that it consists of six main categories at the highest level. These are causes related to client, design, interface, construction, external, or performance. Padala et al. use a methodology that consist of a systematic literature review as well as a multiple case study utilising semi-structured interviews and a survey. Sun and Meng’s (2009) article is one of the 105 articles studied in their research. They mix the extensive overview with empirical findings, providing a broad taxonomy and identifying an extensive

number of categories that they found absent in previous literature. Some examples of these categories on level two are “design” and “construction” under “interface works” on level one, as well as “safety”, “procurement” and “execution” under “performance-related” on level one. Other categories on level three found by the case studies are “inadequate time given for design”, “infeasible design solutions”, “lack of working space around equipment”, and “process standardisation”. With the same argument as for Sun and Meng, “political”, “social” and “technology” on level 3 under “external” on level 2 are treated as irrelevant for this thesis and discarded. Technological advancements like “introduction of new design tools” and “introduction of new interface works” on level 3 included in the discarded categories are only relevant on rare occasions where a new technology is introduced. Given the limited time of the case study for this thesis, these categories are not in the scope of this study and not common enough to include in an operational taxonomy.

Furthermore, Padala et al. (2020) introduce a distinction between changes that are avoidable and changes that are not. Changes that originate from errors are explained as avoidable by managing the design and construction process, while requirement changes are unavoidable and must be handled by planning early to instead minimise the negative effects. In a frequency analysis, 57% of their causes were identified as errors and 43% as requirement changes, which highlights the common occurrence of both types. This distinction will be important in addressing RQ2 and RQ3 and will be discussed in Chapter 7.

Birgönül et al. (2024) provide a taxonomy based on a methodology similar to that of Padala et al. (2020), containing a literature review as well as six case studies, including focus group discussions and interviews with experts. Both Sun and Meng (2009) and Padala et al. (2020) are included in the literature review. The final taxonomy is also structured in three levels, but provides 13 categories on level one, 50 subcategories on level two and 52 change causes on level three. The categories on level one are “human resources”, “material”, “other resources”, “financial factors”, “external factors”, “health and safety concerns”, “project location”, “project stakeholders”, “project management”, “contractual document” and “contract management”, “design process”, “project implementation” and “macro factors”. “Health and safety concerns” are excluded from this study, as they primarily relate to regulatory compliance and site safety management rather than the contractual and organisational causes of change orders between the contractor and client, which constitute the focus of this research. Further, “financial factors” and “macro factors” are also treated as irrelevant. Examples of categories on level 2 that are relevant for this thesis are “capabilities”, “availability of materials”, “construction site conditions”, “project stakeholders’ competence and experience”, “project communication

management” and “changes in design”. The categories on level 3 are concrete examples and will not be used as a basis for this research, since they are considered too specific for our taxonomy.

Apart from the three consecutive taxonomies, Memon et al. (2014) identify 18 categories of variation orders based on a literature review, with the aim of identifying which causes are significant. The five most significant causes are shown to be “unavailability of equipment”, “poor workmanship”, “design complexity”, “change of schedule” and “impediment to prompt decision-making process”.

Existing taxonomies are typically developed at a general industry level, highlighting the need for context-specific adaptations. Sun and Meng (2009) describe how their proposed taxonomies can be used by construction professionals in different areas to proactively manage project risks. Padala et al. (2020) suggest the taxonomy can be used to support project teams to help develop strategies to minimise or eliminate causes for changes in construction projects. While not exhaustive, the taxonomies are comprehensive by listing all factors found in previous studies. Therefore, it leaves a gap to be filled when it comes to applicability in specific contexts. When applied, a screening needs to be made, where relevant factors for the specific projects are identified. Birgönül et al. (2024) claim their taxonomy is more comprehensive than the previous ones and can be used by all parties to monitor and control the changes in any type of project and any location. However, it seems their taxonomy is very broad, making it more difficult and time-consuming to apply to a specific context. This thesis aims to create a taxonomy that is more adapted to the specific context of steel construction and easier to utilise in day-to-day work.

2.5.2 Effects of change orders

Although change orders are common and widely accepted, they frequently lead to numerous problems such as rework, time delays, and increased cost (Sun & Meng, 2009). Over 50% of construction projects suffer from delays and overspending. The total cost of a change often exceeds the direct cost of the modification itself, as additional expenses may arise from rework, reduced productivity, and the need for rescheduling and replanning (Fisk & Reynolds, 2010, ch. 19). Many change order documents include clauses that prevent the contractor from claiming compensation for indirect or impact-related costs. They may expose the contractor to financial risk if the broader consequences of the change are not yet fully known. In situations where future impacts are uncertain, contractors may therefore seek to reserve the right to claim additional costs. If the client does not accept such a reservation, a dilemma arises, which can increase the risk of disputes and strained relationships between the parties. At times, it might lead to formal claims and litigation. Change orders create

additional work for every party involved, and a critical factor affecting impact is the time between a proposed contract modification and the rejection or approval of a change order. Memon et al. (2014) compile nine categories of effects of change orders. These are: “increased project cost”, “delay in completion”, “logistics delays”, “slower project progress”, “reduced project quality”, “rework”, “unnecessary procurement”, “non-value-adding activities”, and “loss of productivity”. They conclude that the increase in cost is significant and the most common effect, followed by delay in completion and logistics delays.

Sun and Meng (2009) provide a taxonomy of effects, structured with “time effect”, “cost effect” and “relationship and people effect” on level 1. Time effects include “time extension”, “loss of productivity” and “increased risk (e.g. interruption of flow of work)”. Cost effects include “direct” and “indirect costs”, and relationship and people effects include “relationship-related”, “working conditions”, “staff-related” and “quality”. “Working conditions” is considered irrelevant for this thesis for the same reason as “health and safety”. Similarly, Padala et al. (2020) structure the effects after “time”, “cost” and “other”. Here, “other” contains “quality” and “relationship effects”, as well as “delays” and “site conditions”. These two taxonomies, together with the categories from Memon et al. (2014), provide the perspective that effects are more easily defined than causes and that the main effects are related to time, cost and relations. These three are therefore the categories used in this thesis.

2.5.3 Synthesis of taxonomy categories

Table 2.1 shows a broad overview of relevant categories identified in the previous research on common causes and effects of change orders. Note that while most literature numbers the levels as 1, 2 and 3, the abstraction and detail of each level vary between taxonomies. Taxonomies only listing causes for example start on a lower abstraction level than in our case where the first level is needed to divide causes from effects. Further on in the thesis, level 1 will be referred to as categories, level 2 as themes and level 3 as factors. This prevents any confusion regarding abstraction of levels compared to previous taxonomies. It also reduces the need to write about categories on several levels, making the reading experience easier.

Some categories identified in the literature have been synthesised into the broader categories and themes presented in Table 2.1. As a result, several literature-based categories are not explicitly listed in the table but are nevertheless incorporated within the aggregated categories rather than being excluded. For example, the category “project-related” encompasses categories such as “project

stakeholders” and “project location” as proposed by Birgönül et al (2024). Similarly, “project implementation” is treated as synonymous with “construction” and is therefore included within that category, even though it is not explicitly labelled as such. The categories and themes form a basis for the empirical research and combined with empirical findings create our final taxonomy.

Table 2.1. Relevant categories and themes identified from previous research on taxonomies.

Categories	Themes
Causes	Client-related
	Project-related
	Project management
	Construction
	External factors
Effects	Time
	Cost
	Relational

2.6 Change orders in Swedish standard contracts

Swedish construction relies heavily on standardised contracts. For turnkey contracts, actors follow a standard contract, ABT06 (Allmänna Bestämmelser Totalentreprenad) issued by Bygghandels Kontraktskommitté (2007). While this standard contract is not mandatory by law, it has become widely accepted as a set of rules to follow. The purpose of the standard is to regulate rights, obligations, risk allocation, and procedures between clients and contractors. It aims to clarify the responsibilities allocated to the clients and the contractor to reduce legal uncertainty and minimise conflicts. Contractors generally carry the functional responsibility for the result of the project, while the client is responsible for providing adequate information about the order. Contracts are signed based on a tender document that the client submits to the contractor at the start of a project. The ABT06 standard instructs what aspects to include in a contract and works as a checklist for the participating actors.

In addition to traditional contractual arrangements, collaborative contracting approaches, in Sweden called “samverkansentreprenad”, have become increasingly common in Swedish construction projects (Byggherrarna, n.d.). Rather than constituting a separate contract form, collaborative contracting is a business arrangement aimed at improving cooperation between clients and contractors, often within the framework of standard contracts such as ABT06. A common setup is a two-phase structure, where the first phase focuses on jointly developing project documentation,

planning, and cost calculations, before the project moves into the execution phase. This setup particularly emphasises early stakeholder involvement through having the contractor involved in the first phase of the project, making the approach a way of reducing uncertainty and improving coordination already during early project stages.

When it comes to contradictions between project documentation, ABT06 provides a prioritisation order to address. The signed contract is on top of the hierarchy, giving it the power to override any information stored elsewhere. If any deviations are to be made, a change order is created. The Swedish term for change order is ÄTA (Ändring, Tillägg och Avgående arbeten), which stands for formally regulated changes, additions, and omissions to the originally agreed scope of work.

ABT06 provides rules on what can qualify as a change order, when the contractor can expect to get payment for them and the exceptions that exist. The standard states that change orders are changes that are closely connected to the original contract work and contribute to the same technical whole as originally planned. ABT06 classifies the reasons for change orders into three categories: incomplete information provided by the client, unforeseen site conditions, or deviations from conditions that could have been anticipated during contract negotiation. According to the standard, change orders should be identified, documented, priced, and approved before execution when possible. If they are, the contractor is generally obligated to carry out the change.

A revision named AB25 is announced with no specific release date (Svensk Byggtjänst, 2026). AB25 will replace ABT06 for new projects but still be in use for already ongoing projects. At the time of publication of this thesis, ABT06 remains in force. An important update is that the term ÄTA will be replaced by “ändring av entreprenaden” (change to the contract works) and “avvikande förhållande” (deviating conditions).

3

Method

This chapter presents the methods used in this thesis as well as introduces the case company. The execution of the research is described and visualised in Section 3.4.

3.1 Research strategy and research design

This study adopted a qualitative research strategy, as it aims to develop an in-depth understanding of the causes and effects of change orders within a specific organisational context. Qualitative research is particularly suitable when the objective is to explore complex social phenomena, emphasising context, processes, and the perspectives of participants rather than quantification (Bell et al., 2019, pp. 35-37). In this study, change orders were not viewed as isolated events but as outcomes of interactions between multiple stakeholders, organisational practices, and project conditions. A qualitative strategy therefore enabled a richer and more nuanced understanding of these dynamics.

The study followed an abductive research approach, combining elements of both inductive and deductive reasoning. Abductive reasoning involves an iterative process where empirical observations and existing theory are continuously compared and refined (Bell et al., 2019, p. 24). This is suitable for exploratory research where neither purely theory-driven (deductive) nor purely data-driven (inductive) approaches are sufficient. In this study, initial insights from literature on change orders and construction project management informed early data collection, while empirical findings from interviews and project data were subsequently used to refine and extend theoretical understanding. This back-and-forth process enabled the development of a taxonomy and strategies that are grounded in empirical observations while still being connected to existing theory.

Given the complex and exploratory nature of the research questions of this study, it was designed as a case study conducted at one organisation. Case study research is particularly suitable for investigating contemporary phenomena within their real-life context, especially when the boundaries between the phenomenon and the context are unclear (Yin, p. 15). In the context of construction projects, change orders are influenced by a wide range of organisational, contractual, and

communicational factors that cannot easily be separated from the environment in which they occur, making a case study suitable.

According to Yin (2018, p. 49), a single-case design is suitable when the case is unique, revelatory, or representative of a broader phenomenon. The selected case in this study provided an in-depth access to processes and practices within a steel construction company, offering detailed insights into how change orders arise and are managed in practice. While the case is context-specific, it reflects common characteristics of similar organisations within the steel construction industry, which enables generalisation to an extent where findings might be transferable.

Further, the case study design allowed for triangulation of data sources, which strengthens the credibility of the findings. Combining multiple sources of data, such as interviews, observations, and documents, enables a more comprehensive understanding of the studied phenomenon and reduces the risk of relying on a single perspective (Bell et al., 2019, pp. 574-575). In this study, insights from interviews were complemented with project data and documentation, allowing patterns to be identified and interpretations to be supported across different types of evidence.

3.2 Company background

The case company is a steel construction firm based in Sweden with approximately 100 employees. It operates as a steel subcontractor, responsible for delivering and assembling the structural steel frame of large industrial buildings such as factories, warehouses, and commercial facilities, typically ranging from 10,000 to 100,000 m². In most projects, the company is contracted by a design-build contractor, who holds the main contract with the end client and is responsible for overall project delivery. As part of a broader project network, the company interacts with other subcontractors across the project lifecycle, including groundworks contractors in earlier stages and MEP (Mechanical, Electrical, Plumbing) contractors in later stages. This positioning means that the company is both dependent on upstream information and directly affected by downstream coordination, making it particularly exposed to changes occurring throughout projects.

Internally, the organisation is functionally structured, with clearly defined roles and workflows. The main functions include sales, project management, engineering, procurement, and assembly. In addition, cross-functional roles such as strategic management and quality management provide organisational support across these functions.

3.3 Literature review

At the beginning of the research, an initial literature review was conducted to explore existing research on the construction industry, change orders, and related taxonomies. This initial review was subsequently updated and continued in parallel with the empirical data collection, allowing the literature and empirical findings to inform one another throughout the research process. According to Bell et al. (2019, p. 8), reviewing prior research is essential in business studies to understand what is already known, identify existing debates, and recognise key contributors within the field. Given the qualitative and inductive nature of this study, a narrative literature review was deemed appropriate, as it allows for a flexible and interpretative synthesis of existing research (Bell et al., 2019, p. 97). This approach enabled the identification of key concepts and relationships relevant to the research topic. However, as narrative reviews are not fully systematic, the selection and interpretation of sources rely on the judgement of the researchers.

Google Scholar and Chalmers Library were used as search engines. Initially, the search terms were: “steel construction”, “change orders”, “variation orders”, “change orders” AND prevention, “change orders” AND management, to gain an understanding of the context. The main literature review was then performed on the topic of taxonomies using the search terms (“change order” OR “variation order” AND taxonomy AND construction), which gave a result of 1530 articles. Bell et al. (2019, p. 8) explain how it is unlikely to be able to perform an exhaustive review of all literature and that it is important to identify key books and articles. Therefore, the most cited articles were reviewed and five of them were chosen as the main reference articles for the taxonomy of this thesis, providing a comprehensive complement to the broader literature found in the books found on the topic in the initial searches. Three of the articles provided full taxonomies and two identified categories providing extra support for the taxonomy categories. The taxonomies in the chosen articles varied in detail but had in common that they included an exhaustive literature review. They provided a progressive perspective with each newer review including the older.

3.4 Empirical data collection

Data was collected using a combination of qualitative and quantitative sources with a heavier focus on the qualitative data collection. The qualitative data primarily consisted of semi-structured interviews with project managers, other relevant stakeholders in the company, and representatives from client organisations. In addition, archival project data and documented change orders from

completed projects were collected and analysed. This historical dataset enabled a descriptive quantitative analysis of the frequency and distribution of change orders across different categories.

The data collection process was structured into three phases, visualised in Figure 3.1. The first phase aimed to establish a clear research focus and develop an initial understanding of the operations of the company and the role of change orders within its projects. The second and main phase consisted of semi-structured interviews with the goal of identifying recurring causes and effects of change orders. The third phase focused on developing strategies for mitigating the negative effects of change orders, based on the key causes identified in the second phase. Together, these phases were designed to build contextual understanding, identify patterns, and finally translate the insights into practical implications. All phases are explained in more detail in the following sections.

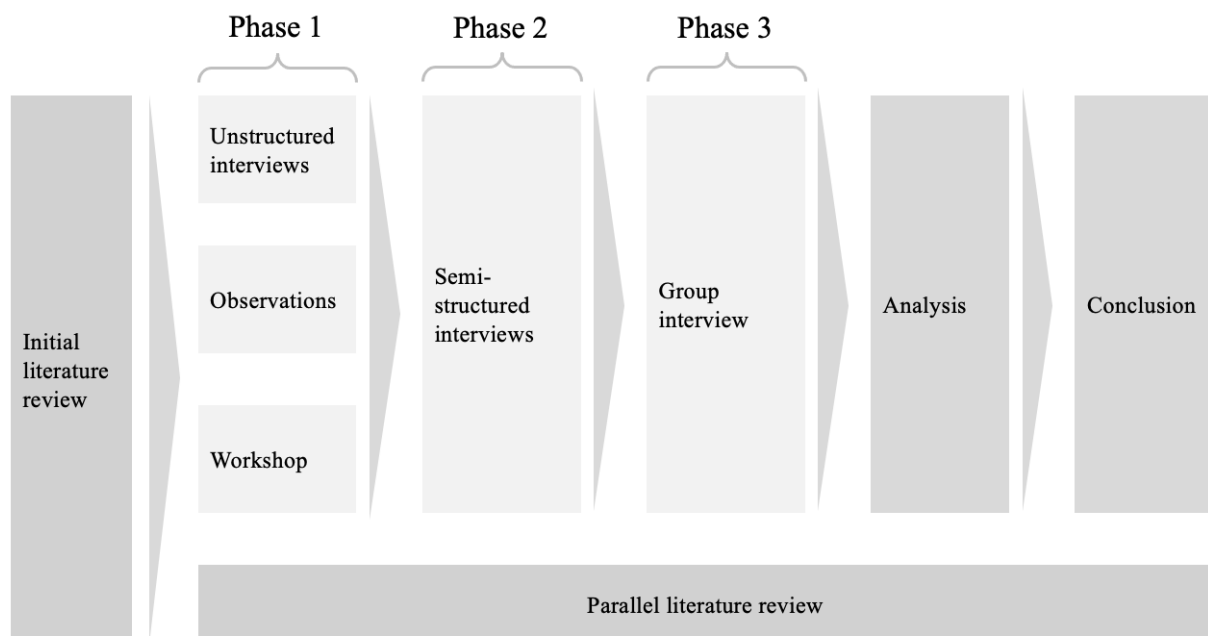


Figure 3.1. Overview of the process of the research, including the three phases of data collection.

3.4.1 Phase 1: unstructured interviews, observations and a workshop

Twelve unstructured interviews were conducted during the initial two weeks of the study in January 2026. Unstructured interviews are characterised by open-ended questioning, allowing for the exploration of perceptions of participants with minimal prior structuring, which makes them particularly suitable for the initial exploration and scoping of a research topic in qualitative research (Bell et al., 2019, p. 211). The aim of these interviews was to gain an understanding of the industry and the case company, and to define the scope for the thesis. To ensure broad representation and a comprehensive understanding of organisational processes and the industry context, participants were

selected from a range of roles within the company. The interviews also helped establish relationships with key individuals and supported the identification of relevant participants for later phases in the research. Throughout the process of these interviews, the focus went from initially being on broad discussions of the company and its operations before gradually narrowing towards the topic of change orders. As understanding increased, the interviews became more focused on identifying key factors related to the research topic, thereby informing the design of questions for the following phases. The first interviews were performed without precisely defined questions, whereas later interviews included more preparations in the form of broad guiding questions or prompts tailored to the role of the person. The roles of each participant and the number of interviews performed with them are presented in Table 3.1. Nine individuals were interviewed in total, and three of them were interviewed twice.

Table 3.1. Roles and number of interviews in unstructured interviews in Phase 1.

Role of interviewee	Number of interviews
CEO	2
Construction manager	1
People & culture manager	1
Project manager	1
Purchaser	2
Software developer	2
Strategy & quality manager	1
Structural engineering manager	1
Technical sales engineer	1

In addition to the interviews, two overt non-participant observations were conducted in February 2026 at a construction site to complement the interview data. Observation enables the researcher to capture actual behaviours and interactions in practice, providing contextual insights that may not be fully articulated in interviews (Bell et al., 2019, ch. 19). The observations were unstructured in nature and aimed at developing a deeper understanding of workflows, coordination and how change orders materialise in practice. Both observations took place at the same construction site, where passive observation was combined with guided walkthroughs and informal discussions with stakeholders on site. These included the construction manager from the case company and the site manager from the design-build contractor. Before the visits, a digital safety course was completed to ensure compliance

with site regulations. During the observations, all safety procedures were followed, and appropriate protective equipment was used.

To conclude the initial phase, a KJ method workshop, as described by Scupin (1997), was performed at the main office of the case company in February 2026. The KJ method is a qualitative technique originating from Japan, where ideas or observations are grouped into categories based on their natural relationships, making it particularly suitable for structuring unorganised data and identifying underlying patterns. The aim of the workshop was to gain an initial understanding of occurring change orders and their causes, as well as to provide a first step towards a taxonomy of causes. The goal was to familiarise with real historical examples of change orders and start putting them together in categories. Project 17 and Project 19 from Table 4.1 were chosen as appropriate examples in discussion with one of the project managers. The workshop was prepared and facilitated by us, and performed with two additional participants, one project manager and one sales engineer, who both were familiar with the example projects chosen. All reported change orders from the example projects were printed out on paper and cut into notes. These notes were read one at a time by one of the participants, discussed so everyone understood the change order and the background, and then placed on the table. The next note was read and discussed, and later placed either in the same pile as the first if they had similar causes, or in a new pile if they had a cause not yet identified. This kept going until all notes were sorted. After that, the piles were named and the name was written on a sticky note and placed above the pile. After each pile was named, these names were placed in larger groups and named on a higher level with a different coloured sticky note. From this, a taxonomy in three levels arose.

3.4.2 Phase 2: semi-structured interviews

The interviews in phase two were semi-structured. This allowed for systematic answers and structure as well as exploration of new themes and insights (Bell et al., 2019, p. 436). Eleven interviews were performed, nine with people from the case company and two with clients. By interviewing two parties and different roles within the company, triangulation was made possible. A compiled list of the participants and their roles can be found in Table 3.2. By having all interviews led by the same person, the risk of inter-interviewer variability was reduced (Bell et al. 2019, p. 209). The other person participated in the interviews by taking notes on important findings and listening. All interviews were recorded and later transcribed for further analysis. The interviews took place in March 2026 and were 45-60 minutes long. The majority of the interviews took place in person in a calm environment for

the convenience of the participant. The three people wishing to perform the interviews digitally had their interviews performed through a digital meeting.

Table 3.2. Roles and number of interviewees for each role in phase 2.

Role of participants	Number of interviewees
CFO	1
Client	2
Design engineer	1
Project manager	4
Purchaser	1
Technical sales engineer	2

The questions for the interviews are found in Table 3.3. The semi-structured nature of the interviews allowed for additional follow-up questions that were not present in the documentation and varied between the interviews. The questions were derived from the literature, with hypothetical answers in mind, providing relevant theory for each question. Before the interviews were performed, the questions were discussed with a project manager at the case company. This ensured the questions could easily be understood and answered by the participants. The extra question at the end was asked if there was time left after the main questions and was created to give extra opportunity for suggesting categories in the taxonomy, complementing the workshop and the thematic analysis in this phase. It was only asked to three interviewees.

An interview-based approach was preferred over a survey in this phase, as the complexity of the studied phenomenon required flexibility, discussion, and probing to gain a deeper understanding of the underlying causes. Surveys generally have a low response rate related to time constraints and lack of trust (Bell et al., 2019, pp. 244-245). Relying on them would jeopardise the depth and reliability of the results, given that the population of relevant people is relatively small to begin with in the case company.

Table 3.3. The interview questions asked during the semi-structured interviews.

Question 1	Can you describe your role within the company? What are your main responsibilities?
Question 2	To what extent do you work with change orders?

Question 3	Is it desirable to eliminate all change orders? If not, why?
Question 4	What are typical change orders that arise early versus late in projects? At what stage do most change orders occur?
Question 5	What are the main causes of change orders in your projects?
Question 6	For example, are deficiencies in communication with the design-build contractor a key cause of change orders, or are there other important causes?
Question 7	Which effects of change orders impact your work the most? Which impact the project the most? Why?
Question 8	Which types of change orders can be prevented? Which cannot be prevented?
Question 9	What is the difference between a project with many change orders and one with few change orders?
Question 10	What kinds of discussions or disputes may arise between parties regarding change orders?
Extra	When we analysed two projects in a workshop, we found that all causes seemed to fall within the “project internal” category. Why do you think that is? Can you identify any potential causes that would fall into other categories?

3.4.3 Phase 3: group interview

After analysing the results of the second phase, it was evident that additional findings were needed on mitigation of negative effects to be able to answer RQ3. The three participants providing the most valuable information in phase two were selected to participate in an additional group interview. According to Bell et al. (2019, pp. 463-464), group interviews enable interaction between participants, allowing them to build on each other’s responses and generate richer and more nuanced insights than individual interviews. The themes for the group interview were chosen by frequency during the semi-structured interviews. The five factors from phase two which emerged more frequently in the interviews were chosen as they appeared as the most important causes linked to important effects. The topics chosen were: client-generated changes, initial uncertainties, documentation, communication and inexperienced project manager.

Background information was explained for each topic based on findings from the interviews to set a basis for discussion. Then the same question was asked for each topic: *How can you work to ensure that (theme) does not affect you negatively?* Each question was discussed for approximately 20

minutes among the three participants, moderated by one of us. The other one took notes. The group interview was recorded to allow for later review.

3.5 Sampling strategy

The sampling strategy in this study evolved across the different phases of data collection and was guided by the exploratory nature of the research. In the initial phase, a combination of convenience sampling and snowball sampling was employed. According to Bell et al. (2019, pp. 197-198), convenience sampling involves selecting participants based on their accessibility and availability, making it particularly suitable for exploratory studies where initial access to the field is required. Snowball sampling, in turn, refers to a process where existing participants suggest additional relevant individuals, allowing the sample to expand through social and professional networks (Bell et al., 2019, pp. 395-396).

The first interview was conducted with the contact person for the thesis, selected based on convenience. At the end of this interview, the participant provided a list of relevant individuals within the organisation, which served as the starting point for the snowball sampling process. These individuals were subsequently contacted, and most agreed to participate. During several of the interviews, additional recommendations for relevant participants emerged, which were followed up, further extending the sample. This iterative approach enabled the identification of key actors across different roles and functions within the organisation. Following the initial interviews, two participants who demonstrated strong engagement and provided particularly insightful perspectives were selected to take part in the initial workshop.

For the semi-structured interview phase, purposive sampling was applied. As described by Bell et al. (2019, p. 391), purposive sampling involves selecting participants based on their relevance to the research questions and their ability to provide rich, detailed information. The selection of participants was therefore informed by insights gained during the initial unstructured interviews, ensuring that individuals with relevant knowledge and experience related to change orders were included. In addition, further participants were identified through snowball sampling based on recommendations from interviewees, allowing the sample to be refined and expanded as the study progressed.

To strengthen the validity of the findings through triangulation, two participants from two companies on the client side, external to the case company, were included in the study. These participants were selected based on recommendations from a project manager within the case company who had prior

experience collaborating with them, ensuring their relevance and familiarity with similar project contexts.

Finally, the participants for the group interview were selected using purposive sampling, focusing on expertise and experience. The two most experienced project managers, together with the most experienced technical sales representative, were included. By deliberately selecting highly experienced participants, the group interview was designed to facilitate in-depth discussions and generate well-grounded insights, consistent with the recommendations of Bell et al. (2019) regarding the value of information-rich cases in qualitative research.

3.6 Data analysis

Bell et al. (2019, p. 518) say that a main difficulty with qualitative research is that it contains a large, complex dataset consisting of interview transcripts, documents, and field notes. This thesis utilised thematic analysis, which is one of the most common ways to analyse qualitative data (Bell et al., 2019, p. 519). It means going through the collected data and searching for repetitions, patterns, similarities and differences. The goal with this method was to end up with a list of themes that summarised and explained the collected data.

The thematic analysis was done following the six steps described by Braun & Clarke (2006). The first step was to become familiar with the data through active engagement. In this study, all interviews were transcribed verbatim, which also served as an initial step of analysis, as transcription itself is an interpretative process. The transcripts were then read through multiple times, and initial thoughts and ideas were noted to be used in the subsequent coding. The second step was to systematically code the data by identifying interesting factors across the entire dataset. Codes represent the most basic elements of meaning relevant to the research questions. In this study, initial codes were generated through discussions between the authors with support from the initial notes from the first step, and organised in a structured table on a whiteboard. Codes were generated for each interviewee and each question, ensuring that all data were given equal attention. The third step was to compile these codes into broader themes by identifying similarities and relationships between them. This process was conducted using the Miro digital collaboration tool, where codes were grouped, rearranged, and visually mapped. This enabled an iterative exploration of how different codes could combine into more overarching themes. The fourth step was to refine these themes to ensure coherence and validity. The codes within each theme were reviewed to assess whether they formed a consistent pattern. Then, the themes were evaluated in relation to the entire dataset to ensure they accurately represented the

data. The fifth step was to further refine the themes to clearly define their scope and meaning. This involved identifying the essence of each theme and determining what aspect of the data it captured, and then giving it a descriptive name. When naming the themes and factors, categories found from the literature review were used where relevant, creating coherence and connections between theory and empirical results. Relationships between themes were also identified and noted. The sixth and final step was to synthesise these themes into a structured table, which later would be used as a foundation for the results presented in Chapter 5, where selected data extracts were used to illustrate each theme.

As mentioned, relevant categories from the literature review were used as themes for the thematic analysis. These were: client-related causes, project-related causes, project management, construction, external factors, time effects, cost effects and relational effects. In addition, one “other” was added to causes and one to effects. This was done to leave room for factors not belonging in any of the predefined categories. All topics that were brought up and discussed during the interviews within each theme were identified as factors. 27 factors were found and categorised into the 10 categories from the literature presented in Table 2.1.

To address RQ2 regarding the prioritisation of risk factors, a risk assessment matrix was used. A risk matrix is a commonly applied tool for evaluating and visualising risk by combining the likelihood of an event with the severity of its consequences (Hill & Cole, 2025). It simplifies more complex quantitative risk analysis methods by categorising likelihood and impact into qualitative scales, making it more accessible and practical for decision-making in more qualitative contexts. The matrix is typically built as a probability-impact grid, where likelihood is represented on the y-axis and impact on the x-axis. In this study, both dimensions were divided into five levels, ranging from very unlikely to very likely for probability, and from negligible to severe for impact, resulting in a 5x5 matrix. Each combination of likelihood and impact corresponds to a risk category, often visualised through a heatmap ranging from low to high risk.

Rather than providing precise quantitative estimates, the risk matrix serves as a structured tool for comparing and prioritising risks, allowing decision-makers to distinguish between tolerable and critical risks (Hill & Cole, 2025). While risk here is expressed as the product of likelihood and impact, such numerical representations should be interpreted with caution, as they are based on simplified qualitative interpretations rather than exact measurements. In this thesis, the positioning of risks was based on empirical findings, with the aim of reflecting their relative likelihood and impact as

accurately as possible. The matrix was used as a comparative tool to support prioritisation, rather than as a precise calculation of risk magnitude.

3.7 Quality of research

Assessing the quality of qualitative research differs from that of quantitative research, which can be seen as more intuitive. For qualitative approaches, the focus lies on understanding context and meaning rather than measurement and generalisation. Instead of relying on traditional criteria such as reliability and validity, qualitative research is more commonly evaluated based on trustworthiness, which in turn consists of the criteria of credibility, transferability, dependability, and confirmability (Bell et al., 2019, pp. 362-365). Overall, these measures contribute to strengthening the trustworthiness of the study. However, it is important to recognise that qualitative research does not aim for complete objectivity, but rather for a well-grounded and transparent interpretation of a complex phenomenon.

Credibility means the extent to which findings provide a believable and accurate presentation of the studied phenomenon (Bell et al., 2019, pp. 363-364). The credibility of this study has been strengthened through triangulation, where multiple data sources have been used, including interviews, project data, and documentation. In addition, interviews were conducted with respondents from different roles within the organisation as well as with clients, providing a broad perspective on the subject of change orders. Continuous discussions between the researchers and company representatives throughout the analysis have further contributed to ensuring that interpretations are grounded in the data rather than individual assumptions.

Transferability is the extent to which the findings are applicable to other contexts (Bell et al., 2019, p. 365). Rather than aiming for statistical generalisation, this study seeks to provide analytical insights that may be relevant to similar organisations and settings. However, as the study is based on a single case, the findings should be interpreted with an understanding of their context-specific nature. By providing a detailed description of the case company and the context, readers are able to assess the relevance of the findings to other construction firms or project-based organisations.

Dependability is the consistency and transparency of the research process (Bell et al., 2019, p. 365). To address this, the study followed a structured approach to data collection and analysis, which is described in detail in this methodology chapter. The use of interview guides, thematic coding, and

documented data analysis contributes to making the process traceable. Efforts have thereby been made to ensure that decisions taken throughout the study were clearly motivated and documented.

Confirmability is the extent to which the findings are shaped by the data rather than researcher bias (Bell et al., 2019, p. 365). In this study, confirmability has been addressed by maintaining a clear link between empirical data and the analysis, for example through the use of interview quotes in the results section. The abductive approach also supports this by requiring continuous comparison between theory and data. At the same time, it is acknowledged that interpretations inevitably influence the analysis. Efforts have therefore been made to remain critical and assess how assumptions and prior knowledge may have affected the findings.

3.8 Ethical considerations

Bell et al. (2019, pp. 114-124) present four main principles that should be considered in business research: avoidance of harm, informed consent, privacy, and preventing deception. To follow these principles, data collected from interviews was handled according to GDPR, and all participation was voluntary and with informed consent. Interview data was stored securely on password-protected devices and was only accessible to the authors. All personal data was deleted after the completion of the thesis. All participants were also guaranteed anonymity. Participants were informed of their right to withdraw from the study at any time without providing a reason. Interviewing different parties comes with the responsibility of handling the relations with respect for all parties and avoiding harming them by sharing sensitive information or appearing confrontational. This was carefully considered during the preparation and conduction of the interviews. During observations at worksites, informed consent was challenging to get from everyone. However, no personal data was stored from those visits, and everyone present at the site was informed beforehand of our presence and the aim of the visit.

Furthermore, the research was conducted in a way that no harm, physical or psychological, was done to any participant. During visits to worksites, close attention was paid to safety precautions to protect all present at the site. Questions during interviews were formulated to focus on problems and solutions, not personal attributes, to avoid being damaging to any participant's self-esteem. The research was also planned in a way that protects all participants from damage to their career prospects. The aim of the study is to help and guide the company forward, rather than pointing out flaws and individual errors. The interviews aimed to be performed in a way that caused minimal stress for

participants, by being well planned, not too long, and having a clear goal. They were also spread out over multiple participants to avoid causing stress to one or a few individuals.

3.9 Use of Artificial Intelligence

Artificial Intelligence (AI) has been used as a writing support tool to improve the language and readability of the text in this thesis. AI has not been used to analyse data or develop findings. All ideas, reasoning, and conclusions are the authors' own. When AI has been used, all suggested edits have been carefully reviewed and critically evaluated before being incorporated.

4

Results from phase 1

This chapter contains the results of the first phase, including empirical findings from the unstructured interviews, observations and a workshop. An overview of change orders in projects at the case company is found in Table 4.1. The table summarises change orders from the last finished 36 projects, ranging from November 2023 to November 2025. The table shows that the number of change orders and the cost of them vary significantly between projects. It is clear, though, that they always are present and clearly contribute to cost effects for the projects.

Table 4.1. Overview of change orders in the case company.

Project number	Number of change orders	Total cost of change orders (SEK)	Average cost of change orders (SEK)
1	5	234 538	46 908
2	35	4 066 172	116 176
3	17	267 312	15 724
4	3	8 158	2 719
5	3	31 776	10 592
6	2	563 784	281 892
7	15	1 365 971	91 065
8	4	344 261	86 065
9	2	55 000	27 500
10	10	241 117	24 112
11	14	301 148	21 511
12	1	117 300	117 300
13	13	157 941	12 149
14	16	1 899 697	118 731
15	16	2 654 116	165 882
16	25	713 249	28 530
17	21	1 278 548	60 883
18	7	159 324	22 761
19	11	719 605	65 419
20	13	24 896	1 915
21	11	270 773	24 616
22	55	1 891 465	34 390
23	1	154 518	154 518
24	10	230 351	23 035
25	13	451 000	34 692
26	3	33 457	11 152
27	13	293 598	22 584
28	3	25 000	8 333
29	14	34 392	2 457
30	7	89 458	12 780

31	4	4 034 528	1 008 632
32	2	35 000	17 500
33	3	230 750	76 917
34	8	166 311	20 789
35	13	138 624	10 663
36	8	359 489	44 936

4.1 Unstructured interviews

The results from this phase primarily support a more precise definition of the scope and theme of the thesis, which emerged from discussing problem areas. Change orders are found to be a topic causing a lot of frustration, as well as being an area of limited focus within the case company. Many participants bring up the topic as something they want to reduce. The CEO talks about the handling of change orders as an area of improvement for the company, and something they lack data analysis regarding. Further, the topic is described as something that causes stress and rework that should be strived to reduce. Another important result is further knowledge of the industry as well as processes and mindsets within the case company, helping to plan the two subsequent phases in the research.

4.2 Observations

The primary result from the observations is a deeper understanding of assembly during the execution phase. The observations contributed to comprehension of the material and components used, as well as the processes performed on construction sites. They further contributed with an understanding of the collaboration and communication on site, as well as the extent of problems that arise despite the thorough planning. Several aspects identified from the literature could be observed from the visits, giving a sense that appropriate literature has been identified during the literature review.

During the visits, problems arose caused by winter weather, faulty documentation and a lack of coordination between different parties operating on site simultaneously. An example regarding site layout was that an unexpected scaffolding structure had been erected around the steel frame, preventing the crane from being positioned as planned. As a result, a larger crane was required to carry out the erection from a greater distance. Additionally, the crane had to lift following a suboptimal route to avoid lifting above an excavator that was working due to delays from another party on site. Cold weather and snow contributed to significant time spent on shovelling snow and removing ice. Construction workers on site confirmed that these are frequent problems occurring on construction sites.

4.3 Workshop

Table 4.2 presents the results from the KJ-method workshop conducted during this phase. The workshop contributed to developing a contextualised understanding of change orders, as each example was discussed collectively among participants. By working with real change orders from two completed projects, the workshop enabled the identification of both recurring patterns and context-specific cases, thereby capturing the variation inherent in the studied environment. This provided a valuable empirical grounding for the study and informed the formulation of interview questions for the subsequent phase.

Rather than being directly adopted as categories, the workshop results served as a means of linking the emerging taxonomy to the empirical context. The identified groupings were used as inspiration and as a point of comparison when developing the final taxonomy, ensuring that it remained both theoretically informed and empirically relevant. In addition, the workshop supported triangulation with other data sources, facilitated the articulation of tacit knowledge, and revealed interdependencies between different types of change orders, thereby strengthening both the validity and practical relevance of the subsequent analysis.

Table 4.2. Results from the KJ-method workshop.

Level 1	Level 2	Level 3	Change order
Internal parties	Purchasing	Mistakes from subcontractors of the company	Damaged gate (vehicle impact)
		Not included in the contract	Plywood roofing
	Sales	Planned change orders	Call-off of option 2: working platforms
			Adjustment of special colour for sandwich wall panels
			Redesigned column to withstand impact
			Call-off of option: stairs
			Call-off of option: roof cladding
		Sales related	Safety guardrails (roof)
		Ambiguities between the company and the design-build contractor	Temporary bracing
			Steel plates / timber mats for ground protection
			Floor bracing

External parties	Design and engineering	Better solutions proposed by the company	Change from painted underside to condensation insulation
			Omitted steel frame for rectifier
		Change orders from construction	Change orders arising from erection works
			Incorrectly cast-in weld plates
		Errors from other subcontractors	Incorrectly cast-in bolt groups
			Adjustment of weld plates
		Additional services performed for compensation	Recycling of sandwich panels
	Client	Quantity adjustment initiated by the design-build contractor (during the design phase)	Omitted lift steel
			Omitted fire protection coating
			Secondary steelwork for roof windows
			Wall adjustments
			Omitted canopy
		Errors in documentation from design-build contractor	L-sections for canopy
			Sheet metal for door
	Tenant/end client	Change suggested from tenants or end client	Modified overhead crane
			Steelwork for door
			Modification of steel frame for cooling unit
			Deeper foundation
			IM3 coating
			Change from roller door to folding door (wash hall)
			Modification of truss structure (office section)

5

Results from phase 2

This chapter presents the findings from the second phase of empirical data collection, consisting of semi-structured interviews. The result from the thematic analysis is presented in Table 5.1 and the numbering on the factors F1-F27 are used in presenting the interview results for each factor. The opinions of the interviewees are presented with a mix of summaries and direct quotes from the participants, with the factors and numberings highlighted in bold writing. The word “new” in the table indicates that factor is found through the interviews but missing in previous research. “Identified in phase 1” indicates this factor is a result from the observations in phase 1 and not discussed in the semi-structured interviews.

Table 5.1. Resulting themes and factors from the thematic analysis.

Category	Theme	Factor	#
Causes	Client-related	Client-generated	F1
		Documentation	F2
		Inexperienced client	F3
	Project-related	Number of actors involved	F4
		Unclear responsibility allocation	F5
		Complexity in project	F6
		Initial uncertainties	F7
	Project management	Communication	F8
		Coordination	F9
		Inexperienced project manager	F10
	Construction	Mistakes on construction site	F11
		Provisional aids	F12
		Site layout & conditions	F13 Identified in Phase 1
	External factors	Weather	F14
		Geopolitical factors	F15 new
		Change of supplier	F16 new
Effects	Others	e.g. Controversial change orders	F17 new
	Time	Rework	F18
		Delay	F19
		Loss of productivity	F20
		Increased administration	F21 new
	Cost	Stress	F22
		Cost	F23

Relational	Conflict	F24	
	Affected relations	F25	
	Lower morale	F26	
Other	e.g. Risk for errors	F27	new

5.1 Perspectives on the role of change orders in projects

It is evident that the perspectives on the role of change orders vary between interviewees. Three interviewees describe change orders as something solely negative which should be eliminated. Three interviewees express how they welcome changes, and five argue for both of the two extremes. Two people negative towards change orders argue that change orders are errors that could have been foreseen and prevented. One of them says:

Yes, definitely [change orders should be eliminated]. In my view, when change orders occur, it indicates that something has gone wrong or has not been properly considered. I see them essentially as disruptions, issues that could have been prevented. (Interview 9)

One interviewee who works in the sales phase says he wants to hand over a project that is fully defined because it feels better.

Yes, from my perspective definitely [change orders should be eliminated]. It feels better to deliver something where the scope is clearly defined and that one can fully stand behind. There are strategies where aspects are deliberately left open to be handled as change orders later, but that is not how we operate.” (Interview 3)

Two of the interviewees who see change orders as favourable argue that change orders can be profitable for the company, especially when talking about additional work that is relatively easy to add and is rewarded with good payment. At the same time, it becomes apparent that some types of changes cause more work and effort than what is awarded, and these changes are more desirable to avoid. The third interviewee talks about how trying to eliminate change orders delays the contract signing and therefore gives less time for the project. This is explained in the quote below.

No, I would not necessarily say that I wish to eliminate them, it would likely be difficult. One important aspect concerns the sales phase, where there is often a significant time gap between a verbal agreement and a formal contract. During this period, uncertainties regarding scope, such as options or additional work, can delay finalisation, as parties wait to clarify what should be included. In such cases, I would argue that these elements can instead be handled as change orders. (Interview 8)

Most interviewees arguing for both sides talk about how it would be nice in a dream world to eliminate all change orders, but impossible to execute. This is because it is desirable to offer the flexibility towards the client to perform changes, providing agility in the projects. One client has a strong opinion that working towards eliminating all change orders is a misallocation of effort, and that it creates difficulties in the coordination towards other parties. It is perceived as a natural part of the process and not something worth resisting.

A short answer is that it may be possible [to eliminate all change orders], but I believe it is the wrong approach to treat it as an explicit ambition. It can serve as a general mindset, but should not be taken to that extent. Change orders are to some extent inevitable, but they should be managed professionally, and if no changes occur, there should be no change orders. Furthermore, I believe that most actors, when careful in selecting contractors, aim to ensure that the right people are involved from the outset. (Interview 7)

The same person continues by saying:

In my view, change orders are not inherently problematic, as long as all parties act properly. It is when actors become overly strategic, or when someone feels misled or taken advantage of, that discussions tend to escalate. (Interview 7)

The quote above highlights an important finding that the negative view on change orders widely spread in the company stems from the type of change orders that seem and feel controversial. When further asking the interviewees about their negative views towards the phenomenon, it becomes clear that they are not referring to all change orders, but rather to this controversial kind of change orders that are presented as a factor in Section 5.2.6. When asked about simpler additional work, these people answer that these are not as disturbing and can actually be profitable. This gives the impression that the interviewees agree with each other more than initially understood, but some have a stronger negative opinion about this common problem found in the business, affecting the answer to the question. It becomes clear that there are two basic types of change orders: the honest change orders that arise because of extra work that are priced in a fair and correct way, and those that are tactically used to increase compensation beyond what can be considered justified. The controversial change orders are the type that almost everyone wishes to eliminate. As to the other type, the opinions of the interviewees are more divided regarding the view on elimination.

5.2 Causes of change orders

From the interviews, several frequently occurring causes of change orders are identified and discussed. The causes are grouped into relevant categories from the literature: client-related, project-related, project manager, construction, external factors and other.

5.2.1 Client-related

Most participants bring up **client-generated changes (F1)** as the most common cause of change orders.

Most often, it is the client who makes changes, as the project is not fully defined when we receive it. (Interview 1)

In this context, “generated” refers to requesting a change, not only the formal initiation of a change order. Two underlying causes are mentioned: the client changes their mind from the original plan due to new opinions or a change in taste, and the client has gained more knowledge than during contract writing and needs to update the specifications. The two contrasting underlying causes are exemplified in the quotes below.

It becomes challenging when the client suddenly changes their mind, for instance after seeing another building they found visually appealing. (Interview 9)

They (=the clients) do put thought into preparing the tender documents, but they rarely carry out a fully comprehensive analysis of how the operations will function, what each space should contain, how the spaces will be used, and similar aspects. In virtually every project, something comes up, such as the need to add an extra door or similar adjustment. (Interview 2)

The change in opinions is explained as impossible to foresee. Late changes caused by knowledge gain can be foreseen and prevented to some extent by asking the right questions and coordinating the design phase among all parties involved. Furthermore, in this context, client-initiated changes include changes that originate from both the client itself and from future tenants. Sometimes projects are speculative, requiring adaptations later when tenants are decided.

Several interviewees talk about faulty, insufficient or ambiguous **documentation (F2)** as a reason for changes. It is often in relation to communication and the importance of the project manager knowing what questions to ask and when.

It is common for tender documents to be unclear or misleading, and for the right questions not to have been raised. To a large extent, this is because of inexperience, not knowing which questions to ask. (Interview 3)

At the same time, many talk about the limited time to spend on asking these questions, as well as a balance of not boring the clients with too many questions in an early stage, as highlighted in the quote below.

There is also a limit where one shifts from being thorough and diligent to simply becoming perceived as difficult. If I were to question every detail, asking 'are you sure about this?' or 'do we really need that?', the typical response would be: 'You are the experts in what you do, you know this best.' (Interview 5)

One mentions how it can be a tactic from clients to provide unclear documents, hoping that the contractor takes on unclear responsibilities and provides a valid interpretation.

So sometimes I think they (=the clients) also try to leave things a bit vague, hoping that we will take responsibility for that part. That is my impression." (Interview 1)

Another problem identified is that tender documents tend to be copied from project to project, leading to errors or ambiguities.

And a lot is copied from one set of tender documents to another, rather than being written anew each time, which leads to things being overlooked." (Interview 3)

Asking the interviewees what drives the number of change orders often led to answers that it is client-dependent, most often related to an **inexperienced client (F3)**. Experienced clients and especially project managers on the client side have a better understanding of the project as a whole and are better at coordination.

A skilled project manager on the client side helps keep change orders to a minimum. They understand our challenges, as well as those of the electrician and other stakeholders, and are therefore aware of the consequences of their decisions. With sufficient knowledge of each party, they avoid making decisions that negatively impact others. (Interview 6)

Another participant highlights that an experienced project manager on the client side makes firmer judgments and is willing to reject decisions that are introduced too late or have a significant impact on other stakeholders.

This is perhaps where a more junior or inexperienced project manager may struggle, lacking the necessary understanding of interdependencies. By allowing the tenant too much influence, issues may arise elsewhere in the project." (Interview 7)

More experienced clients or tenants are also more prepared and therefore provide better documentation and make faster decisions.

One interviewee also brings up that it depends on the relation to the company and that a long-term collaboration generates fewer change orders than a new or temporary client. Another mentions how personal relations with the project manager working for the client is an important factor, as good personal chemistry leads to fewer discussions and fewer difficult change orders.

5.2.2 Project-related

Four other factors affecting the number of changes are: number of actors involved, unclear responsibility allocation, complexity in projects and initial uncertainties. The **number of actors involved (F4)** relates to the number of parties involved in communication and coordination. A large number of involved parties often leads to more changes. **Unclear responsibility allocation (F5)** stems from unclear documentation and creates change orders when certain details have been forgotten and later need to be added to the contract.

Complexity in project (F6) is described as the extent of responsibilities awarded to the company. One interviewee talks about how projects where only the shell of the building is delivered are much simpler and therefore generate much fewer change orders. As more elements and details are added, for example windows and smaller details, the complexity of the project increases and the risk for changes increases.

I believe it is closely linked to the scope of responsibility the client assigns to us, and how involved we are expected to be in the project. Projects where our scope is limited naturally generate fewer change orders, as our involvement is minimal. However, when the client expects us to take on a broader role, essentially 'handling everything', a much larger share of responsibility falls on us, increasing the likelihood of change orders. (Interview 1)

The same person then goes on explaining that more complexity in the project leads to additional work related to unclear responsibility allocation.

The more responsibilities we take on, the more the client tends to assume that these fall within our remit. When issues arise that have not been considered, the client may realise that certain tasks were not included in the tender documents and then turn to us, asking whether we can take on these additional items as well. (Interview 1)

Another interviewee has a feeling that windows and details outside of the pure steel structure are the main drivers of change orders and that simpler projects therefore are more profitable, since sufficient compensation for the time spent on a change is rarely provided.

Much related to complexity in projects and documentation is **initial uncertainties (F7)**, which stem from the client not having sufficient knowledge about the project in an early phase. Either because not all contractors have been procured yet, not all contractors are done with their design phase, or the building is built in speculation.

The internal organisation is not always able to absorb and make full use of all available information; the necessary expertise and competencies may not be in place, and all contractors have typically not yet been engaged. (Interview 7)

It is a theme highlighting the uncertain nature of a construction project and the difficulty of knowing details in an early stage.

5.2.3 Project management

Communication (F8) is highlighted as an important factor in several aspects. Firstly, asking the right questions during project planning:

In the design phase, much of the focus is on loads, structural dimensioning, and decisions such as whether to incorporate solar panels. At this stage, it is essential to raise the right questions early in the process. (Interview 3)

Secondly, communicating on construction sites:

And miscommunication is another factor. One party means one thing, while another interprets it differently, and this continues until it eventually becomes a problem. (Interview 11)

One person also mentioned language barriers as a cause of misunderstandings, mainly on construction sites and occasionally when a project manager does not speak Swedish.

An interesting dilemma one interviewee highlights is communication channels. Email is the primary channel of communication between project stakeholders, as it provides clear documentation and evidence of agreements. However, it is also described as a slow form of communication prone to misinterpretation, whereas phone calls or meetings can be more efficient in certain situations.

A common view among the interviewees is that change orders originate from a lack of **coordination (F9)** in projects.

That the project is not in sync. Required documentation is not available when needed. Plumbing and ventilation have not completed their design when we are scheduled to begin. (Interview 6)

Many factors in steel construction projects are dependent on all subsequent actors. These often enter the project much later and therefore provide important details after decisions are made, creating a need for changes. One person highlights the possibility for a reduced amount of change orders if all parties are included from the project start and are performing project planning at the same time, and that this varies between clients, where some are better at coordinating and demanding that documents are delivered early.

One person talks about coordination in another sense, related to time being wasted due to internal processes of the client.

It is also common for the procurement process to be prolonged. One or two months may pass from being close to agreement until the contract is signed, and that time is effectively lost. Once the contract is signed, however, everything is expected immediately. We submit our documentation, and then there may be a long period of silence, often due to internal processes within the client or between the client and the developer. (Interview 6)

Three interviewees mention that an **inexperienced project manager (F10)** on the contractor side is a cause of change orders. This is because the project manager is the one responsible for managing several of the common causes for a change order. Experience helps in knowing what questions to ask and when, and being clearer in communication.

In principle, a well-executed project should not generate any change orders. This implies that the project management has been clear about requirements, as well as about what can be delivered. (Interview 1)

5.2.4 Construction

Two interviewees bring up **mistakes on construction site (F11)** as a cause for change orders. One client interviewee says:

I try not to raise change orders for minor issues; instead, there is a degree of give-and-take with this company, but that depends on the relationship. It is primarily in cases of more significant mistakes on site that a change order is raised. (Interview 10)

One project manager agrees that while on-site mistakes occur frequently, they seldom give rise to formal change orders. Instead, they are documented for potential future reference, particularly if the client later seeks compensation for minor additional work.

There is a degree of give-and-take, we avoid issuing change orders for minor amounts of time and instead resolve such issues on site. However, it can be useful to document extra work in case the other party later submits minor change orders in return. This may involve, for example, borrowing equipment or assisting each other on site. (Interview 2)

Overall, mistakes on-site are described as frequently occurring. However, the cost effects are small in comparison to other changes, resulting in them often being overlooked instead of formalised into a change order.

Provisional aids (F12), such as temporary bracing for stabilisation or safety guardrails that are used during construction but are not part of the building, are brought up as a cause for change orders and a reason for discussions. The provisional nature of them makes it easier for misunderstandings regarding the responsibility of payment.

Temporary bracing, safety guardrails, and similar measures could likely be avoided as change orders if they were planned early and consistently followed. Since these elements are always required, it would be most efficient if all subcontractors included them in their bids from the outset. (Interview 2)

5.2.5 External factors

One interviewee talks about **weather (F14)** in relation to planning and delays. Although not often leading to change orders, weather is still something that surprises year after year and is rarely considered when planning a project.

Design-build contractors are often too aggressive in scheduling groundworks and concrete works, and they seem equally surprised every winter when frost conditions occur. (Interview 6)

Geopolitical factors (F15) are brought up by two interviewees who had time to answer the extra question and discuss more hypothetical scenarios for external change orders. Wars and broader global uncertainties are a potential source for spiralling prices and insecure supply, and therefore change orders if the price changes from the original contract. Significantly higher prices could also lead to changes in size or details of the project if the client can no longer afford the original plan. **Change of supplier (F16)** due to unforeseen problems or a lack of supply was brought up as another potential cause, changing prices as well as technical solutions.

5.2.6 Other

A topic that seems unavoidable when speaking about change orders is **controversial change orders (F17)**. There is a consensus among the interviewees that there is a problem in the industry of contractors taking advantage of the change order process to earn money by actively seeking opportunities to initiate change orders, as well as pricing them higher than necessary. It is described how, at the case company, they try to avoid doing this, sometimes at the expense of their own profitability.

Many actors adopt tactical pricing strategies or deliberately inflate prices, but this is not our approach. However, we are sometimes too accommodating, carrying out work before formal approval to keep the project moving. This can backfire if the client later refuses to pay, leaving us in a weaker position towards the end of the project. (Interview 6)

One person had a specific example of another company taking advantage of this.

I have heard from colleagues in the industry, friends working at other companies, often involved in preparing tender documents or cost calculations, that some actors approach projects with the explicit intention of identifying potential change orders. In one example, this was openly discussed in a meeting, where items not included in the original scope were immediately framed as opportunities for additional work. In this sense, change orders were treated as part of a business model. (Interview 5)

One client mentioned controversial change orders as annoying and a reason for avoiding working with these companies. One person from the case company also mentioned this factor as a reason for ending a partnership with a supplier. We can conclude from these findings that this cause is linked to severe relational effects.

5.3 Effects of change orders

In the interviews, several different effects of change orders are mentioned. These are structured into the relevant categories found in the theory section: *time effects*, *cost effects*, *relational effects*, and *other*. Together, these effects show that change orders impact both the actual work and the collaboration between actors.

5.3.1 Time effects

The first group of effects are time effects. Here, the effect of **increased administration (F21)** was highlighted in the interviews, requiring additional work in terms of recalculations and adjustments:

The effect of it is that it takes time administratively. You need to calculate a price and redraw and adjust. It is a lot of manual labour, sitting and fixing things back and forth. (Interview 2)

Closely related to this is **rework (F18)**, where interviewees explain that change orders force work considered completed to be revisited, taking time and reducing efficiency:

The unforeseen work [affects the most]. When you think you are done but have to redo things. Everything is tied together, so a small change can affect several things. A change of the layout of a window can mean that 10 elements around it have to be revised. (Interview 6)

Together, increased administration and rework contribute to a **loss of productivity (F20)**, as time needs to be spent on revisiting previous work instead of moving forward to new tasks. One interviewee exemplifies this by saying:

It is not really value-creating when you sit and do those things that need to be changed, redrawing and such. You can use those hours a lot better than working on changes. (Interview 5)

Interviewees explain how interrupting planned activities also leads to **delays (F19)** when they need to be rescheduled to be done later than planned. The effects are explained as especially severe when changes come up late in projects.

Changes take time from other things, which leads to extra work, creating stress and leading to delays. You want to be able to plan your work, and it is disturbing when a change comes up late in a project. If changes are caught early, you can usually plan your work better. (Interview 1)

Interviewees describe how it causes **stress (F22)** when they are interrupted in their daily work because of change orders coming up, which creates a ripple effect on other projects:

...and it (=change orders) affects me in the way that I cannot plan my time very well. Let's say that I have planned to calculate and deliver something for modelling on a certain day. Then, the client calls and says that they need to change something in a project that was already delivered. Then I have to stop everything and handle that change. It affects other projects and the general planning... ... Then there is also a risk for mistakes because of changes... ... And my top priority is always safety, so it becomes stressful when things change. (Interview 11)

5.3.2 Cost effects

The second group of effects are **cost effects (F23)**. While some costs directly impact the bottom line of the project, another impact identified in the interviews arises from the additional working hours spent on handling changes:

Of course, it takes longer time [when changes occur] compared to if you can simply calculate the project without having to redo things. The efficiency becomes a lot higher if you do not need to go back and forth. Then, of course, it also costs more. It does not mean it has to be extremely large sums, but it is working time that we could have done something more valuable with. (Interview 5)

This suggests that a critical cost of change orders is the time and resources it takes to handle them. On the other hand, those changes can also lead to a positive cost effect, where they generate additional revenue:

No, I do not think it is desirable [to eliminate all change orders]. If we have the opportunity, we want to have work to do, because we can also earn money on those changes. In certain cases we have a percentage of surcharge on material for example, which can be quite a lot of money. So sometimes we want them. (Interview 1)

5.3.3 Relational effects

The third important group of effects is connected to the relationship between actors, where **conflict (F24)** is an example. The findings show that the conflicts between actors often arise because of different interpretations of responsibility allocation, and actors want to avoid additional costs:

Discussions that arise are, for example, when we initiate a change order towards a client, then we have concluded that this was not included in our responsibilities in the contract and drawings. Then the client might think that we are responsible for doing that thing, and from there it becomes a discussion... ...Everyone always tries to avoid extra costs, and if it is not clear who the responsible party is in the documentation, there will be discussions. (Interview 1)

The other party always thinks that everything should be included in the already negotiated contract. So you always come from two different directions, and the discussions are about meeting somewhere in the middle. Sometimes project leaders are changed throughout a project, and if the responsibilities are unclear in the contract, the discussion will arise again. (Interview 3)

The discussions can go as far as being about pure dishonesty, where it is not only about money but also about principles and relationships:

It can be pretty heated discussions about really small sums of money. There is one example where a supplier sent a change order for a small sum. I think that if they want to become a long-term supplier to us, they should be able to be less greedy in such situations. (Interview 9)

Over time, these conflicts affect relationships between actors:

Change orders can also create frustration and affect relationships. It often becomes discussions about money, who is responsible for the cost, and the relationship can become a bit infected. (Interview 4)

Conflict in turn contributes to a **lower morale (F26)**, where repeated discussions and conflicts create frustration among the actors in projects:

People lose their spark if you are discussing about changing things all the time. (Interview 7)

5.3.4 Other effects

The last effect identified in the interviews is the increased **risk for errors (F27)**. When a change order leads to a certain solution being changed, it simultaneously impacts all elements connected to it. This is particularly important in steel construction, where individual components are highly interdependent and changes in one part of the structure may require several related elements to be revised. As one interviewee explained:

Revisions are a major risk for errors. Things are missed, old drawings are used, or consequential effects are forgotten. (Interview 6)

This shows that change orders can increase the risk of errors by creating a need to revisit and revise already completed work. If all connected elements are not identified and updated, inconsistencies may be introduced into drawings, calculations, or production documents. Particularly in structural load calculations, changes made under time pressure increase the risk of overlooking dependencies or failing to adjust related elements. Therefore, the risk for errors is not only connected to the change itself, but also to the difficulty of ensuring that all consequences of the change are captured throughout the project.

6

Results from phase 3

In this chapter, the results from the group interview are presented. They are divided into five sections representing the five themes discussed: client-generated change orders, initial uncertainties, documentation, communication and inexperienced project managers. The results are focused on contextualising the themes as well as brainstorming potential strategies for mitigating the effects of these types of change orders.

6.1 Client-generated change orders

Client-generated changes are consistently described by group participants as a common type of change orders, and are in many cases also seen as unavoidable. When discussing the mitigation of negative effects from changes of this type, it is evident that clarity in the early communication between client and contractor is where most prevention work can be done. It is asserted, though, that there is a balance between asking sufficient questions and being perceived as overly demanding. The participants highlight that, in theory, all questions could be asked at the beginning of a project to clarify all details and not let the client change their mind along the way. However, clients are often unwilling to answer that many questions so early in projects, and it may also slow down the process and risk creating friction.

To handle this, the case company is using an approach that is focused on creating long-term relationships and recurring customers. The participants describe how the first project with a new client often consists of more discussions and misunderstandings, leading to changes from the client. In contrast, with recurring clients, it is easier to find the balance of how demanding they can be with questions, and ambiguity around scope and expectations is reduced. With this view, they mean that it is not worth bringing up a small cost of a few thousand SEK, which could be from a quick extra task on the work site, as a change order. They do not think that money is worth it in the big picture, since projects usually cost several million SEK, and they value a good relationship with the client higher than that small cost.

A structured way of managing client-generated changes, and especially preventing them, is to use a checklist of key aspects that should be clarified in early project stages. This is a list that has been built over time and addresses aspects that need to be clarified in all projects, such as dimensions for joists or wall materials. It is an extensive list that sometimes can be seen as overwhelming by new clients, but generally leads to a reduction of issues and changes later in projects. Recurring clients have also expressed that even though they thought the list was overwhelming at first, they have now learned to appreciate it and the clarity that it provides. Another thing that the participants mention is how learnings from previous projects are not fully leveraged in the list, and that there is potential to improve it by incorporating recurring issues to further reduce the impact of changes.

6.2 Initial uncertainties

It is agreed among the participants that construction projects inherently contain a degree of uncertainty and that it is important to reduce it as much as possible. However, as several participants emphasise, not all uncertainties can be eliminated in the early stages of a project. When aspects cannot be clarified, they need to be explicitly highlighted so that all actors are aware of them and can act accordingly.

One way of managing such uncertainties is through the use of contract options. Participants describe how options can function as a way to handle uncertain elements by pre-defining alternative solutions and associated costs. This reduces the impact of potential changes later in the project, as decisions can be made based on already established conditions rather than requiring entirely new calculations. In this sense, options are described as a way to “absorb” uncertainty and prevent it from turning into more disruptive, unplanned changes. At the same time, the discussions also highlight that when contract options are exercised, it is common that details need to be changed to better suit the current status of the project, leading to even more rework. Therefore, options are often requested by clients rather than initiated by the contractor, and while they are useful, they are not always seen as efficient from a contractor perspective.

Another recurring problem is how contractors need to make assumptions in early project stages. Participants describe how projects are often initiated with limited or vague information, for example when clients request a rough estimate based on a brief with high-level descriptions. In such cases, contractors rely on assumptions and standard solutions to produce a reasonable estimate. These assumptions are typically based on experience and commonly used configurations. However, the importance of clearly communicating the level of generalisation is emphasised. If the degree of

“guesswork” is not made explicit, it may lead to misunderstandings and unrealistic expectations later in the project. Being transparent about assumptions, for example by clearly stating them in the offer, is therefore described as critical for aligning expectations between actors.

Another way of working with the initial uncertainty in projects is the collaborative contracting “samverkansentreprenad” mentioned in Section 2.6, an approach to project design and planning where the contractor is actively involved in the early stages of the design phase. Interviewees describe this approach as an effective way of reducing uncertainty, as it allows the contractor to influence design decisions, clarify requirements, and align expectations early on. By participating in the design phase, the contractor gains a deeper understanding of the project and can ensure that key uncertainties are addressed before entering the execution phase. Although this approach requires a greater time investment in the early stages of a project, it is described as contributing to a smoother and more efficient execution phase, with fewer unexpected changes. It also reduces uncertainty for the contractor, as they receive compensation for the design and planning work undertaken, even in cases where they are not awarded the execution phase. However, the interviewees also emphasised that this way of working is not applicable to all projects, as the project setup and contractual conditions do not always allow for early contractor involvement.

6.3 Documentation

Unclear, faulty, or ambiguous tender documents are described as a common source of change orders. The participants in the group interview emphasise that deficiencies in documentation are often not intentional, but rather a result of time constraints or a “good enough” approach from the client side. As a result, it is expected that tender documents contain gaps, inconsistencies, or missing information, and that these need to be addressed during the project.

Participants highlight that the sales division plays a critical role in reviewing tender documents, identifying gaps, and ensuring that as much relevant information as possible is clarified early. If this is not done, uncertainties and missing information are transferred into the design phase, where they become more difficult and costly to handle. It is also mentioned that tools such as Artificial Intelligence are beginning to be used to support this process, particularly in identifying inconsistencies or ambiguities in documentation.

A strategy the case company is using for managing unclear documentation is to explicitly state deviations and assumptions in the offer. Since contractors often need to interpret incomplete or

inconsistent tender documents, they rely on their own expertise to propose realistic solutions. These deviations from the original documents must then be clearly communicated to the client. One participant describes that highlighting such deviations in a structured way helps ensure that both parties have a shared understanding of what is included in the project. Without this clarity, there is a high risk of misunderstandings that might result in change orders.

The findings also reinforce that the level of clarity required from the contractor increases with the level of uncertainty in the documentation. In cases where tender documents are particularly weak or incomplete, it becomes even more important for the contractor to be explicit in both the offer and the early project stages. This includes clearly defining scope, assumptions, and interpretations, as well as ensuring alignment with the client through dialogue and clarification.

Early involvement through collaborative contracting, as described in Section 2.6, is also highlighted as a way to improve documentation quality. By participating in the design phase, the contractor can contribute to refining and clarifying the project scope before execution begins. This reduces the reliance on incomplete tender documents and creates a more solid foundation for the later stages of the project.

In conclusion, improving documentation quality is not simply about eliminating deficiencies but rather about managing them. Of course, it would be desirable to eliminate all deficiencies in documentation provided by the client, but that is beyond their control. Therefore, strategies need to focus on managing deficient documentation. This places a particular importance on the sales phase, where it is important to identify and manage deficiencies in documentation before the project is handed over to the project team. Clear communication about deviations and interpretations is critical for creating a shared understanding between actors, thereby reducing the risk of misunderstandings and change orders. Furthermore, early involvement of the project team enables uncertainties to be addressed before they become disruptions, highlighting that documentation is a key aspect when managing uncertainty in projects.

6.4 Communication

The participants were asked to talk about communication from two separate perspectives, internal and external communication. Internal communication is predominantly carried out through face-to-face interactions rather than written channels, as this enables more immediate responses and minimises the risk of misinterpretation. Documentation is primarily carried out on the company

Kanban board. The participants report few issues with internal communication channels. Instead, challenges arise during handovers between stakeholders. In these situations, it is crucial that all relevant details are properly documented and that a structured handover process is followed, particularly in the transition from sales to the design phase. Involving project managers earlier in the sales phase, overlapping the phases, is discussed as a way of improving the handover and avoiding miscommunication internally.

External communication is perceived as more challenging. A key dilemma lies in the trade-off between the speed and clarity of verbal communication and the need to maintain written documentation, for example through email, to ensure traceability and accountability. The participants generally prefer to communicate orally because of the speed and clarity it allows. Waiting for a written response can be stressful, not knowing when answers will be provided. They explain that in a dream world, all communication would take place face-to-face, but that would be inconvenient because of the time consumption as well as geographical distance.

The participants describe how a strategy to mitigate this problem is to systematically document all verbal communication. Written documentation is very important, no matter how conversations have been carried out, for the company and for other parties. Formal project meetings are often recorded through meeting minutes that are sent out to participants afterwards and should be checked and supplemented if decisions are missed. Informal verbal communication, however, provides greater challenges. Two main documentation strategies are identified: recording decisions in private notes, which may serve as a sufficient reference in later discussions, and sending a follow-up email summarising the conversation and requesting confirmation. The latter approach is described as somewhat uncomfortable to apply initially but becomes more natural with experience. The practice of sending follow-up emails has largely developed as a response to previous negative experiences when such documentation was not performed. All participants have experienced situations where decisions were not properly documented, resulting in a lack of compensation due to insufficient evidence. One participant highlights that written confirmation can serve as an effective means of ensuring mutual agreement. In one instance, the participant initially believed that there was alignment during a phone call, but the response to a subsequent confirmation message revealed that this was not the case.

Most communication is carried out on a person-to-person basis and is primarily documented in private emails. Only final decisions are typically recorded in formal documents such as offers, contracts or

other official documentation. This creates challenges when stakeholders are replaced or when projects are handed over, both internally within the company and across external parties. Interviewees describe situations where agreements have been reached with a specific individual, but where the underlying reasoning or context is not transferred when that individual is replaced. As a result, important information may be lost, leading to misunderstandings and inefficiencies. There is a shared view that documentation practices could be improved, particularly regarding the recording of the reasoning and background behind decisions and changes. Providing such context in official documentation would facilitate knowledge transfer, support continuity in projects, and clarify points of contact in cases where further information is required.

Participants also report that they rarely wait for formal written approval of change orders before proceeding with the work. Instead, they prioritise maintaining project progress and avoiding disruptions, rather than pausing activities to obtain confirmation. While this approach may be considered procedurally incorrect and carries certain risks, it is simultaneously described as a pragmatic strategy to mitigate the negative impacts of change orders, such as delays and disruptions.

Finally, communication is described as much easier with recurring clients where personal relationships have been established, and it becomes easier to be honest and firm without appearing mean. Working with long-term relationships is therefore a strategy to improve external communication.

6.5 Project manager experience

The group interview participants reveal several challenges related to inexperience of a project manager. They highlight difficulties in determining which questions need to be addressed and when the corresponding information is required.

The participants bring up that checklists of information to gather in projects exist in the company, and that they are a useful baseline for identifying relevant information. However, they are often perceived as too generic and lacking guidance regarding the timing of information needs. As a result, project managers must rely on their own judgement to interpret and apply these tools in practice. Future support from digital tools is discussed as a potential way to assist project managers in prioritising tasks and tracking deadlines related to specific project details.

Another challenge concerns the ability of less experienced project managers to identify and initiate change orders. Participants highlight that the definition of what constitutes a change order within the case company is not always clear, creating uncertainty in practice. On the one hand, there is a reluctance to initiate change orders for minor amounts; on the other, there is a risk of missing out on compensation for substantial additional work. To address this, participants suggest establishing regular meetings across projects to provide a forum for project managers to discuss such uncertainties. For instance, situations can be raised and collectively assessed in terms of whether they should be treated as change orders.

Stress and time constraints are identified by the participants as key barriers to providing adequate support for less experienced project managers. Although a formal mentoring structure exists, where senior project managers are expected to guide new employees, participants noted that time limitations often prevent this from being effectively implemented. This creates a tension for senior project managers, who must balance the demands of client work and project delivery with the responsibility of supporting junior colleagues. As a result, mentoring activities are deprioritised, which may hinder the opportunities for knowledge transfer and learning within the organisation. To address this issue, participants suggest that reducing individual workloads or introducing measures to free up time could enable more effective knowledge transfer.

In conclusion, the findings highlight that the experience of project managers plays a crucial role in managing uncertainty and mitigating the effect of change orders. While tools like checklists provide a useful baseline, they are insufficient on their own and need to be complemented by experience-based judgement regarding what information is important and when it is required. With this situation, it is important that the organisation creates conditions that enable cross-organisational learning and the transfer of experience. One step to this is to enable sufficient opportunities for mentoring and exchanging experience between senior and junior project managers. Further, structured forums for knowledge-sharing in the organisation provide an opportunity for mitigating the uncertainty that is created through unclear internal definitions and practices.

7

A synthesis of results

The results from the three phases are synthesised into a final taxonomy of causes and effects of change orders, as shown in Table 7.1. Relevant categories from the literature are expanded with empirical results, forming the final taxonomy which is based on both inputs.

Table 7.1. Taxonomy of change order causes and effects.

Category	Theme	Factor
Causes	Client-related	Client-generated
		Documentation
		Inexperienced client
	Project-related	Number of actors involved
		Unclear responsibility allocation
		Complexity in project
		Initial uncertainties
	Project management	Communication
		Coordination
		Inexperienced project manager
	Construction	Mistakes on construction site
		Provisional aids
		Site layout & conditions
	External factors	Weather
		Geopolitical factors
		Change of supplier
	Other	e.g. Controversial change orders
Effects	Time	Rework
		Delay
		Loss of productivity
		Increased administration
		Stress
	Cost	Cost
	Relational	Conflict
		Affected relations
		Lower morale
	Other	e.g. Risk for errors

8

Discussion

This chapter presents a nuanced discussion of the topics included in the research, where empirical findings are linked to relevant theory to explain phenomena and support suggestions for practical applications. The discussion is structured around the three research questions, with Section 8.1 discussing RQ1, Section 8.2 discussing RQ2, and Section 8.3 discussing RQ3. Additionally, limitations of the study are discussed in Section 8.4.

8.1 Understanding the causes and consequences of change orders

The primary contribution of our taxonomy, presented in Table 7.1, is not increased granularity, but improved operational usability within a specific industrial context. This taxonomy prioritises applicability, enabling practitioners to more easily identify, categorise, and act upon change orders in practice. Most themes and factors can be found in various already existing taxonomies, however sometimes in a different structure or with different phrasings, as well as on other levels of abstraction. Comparing the 27 factors in this taxonomy with the corresponding 50 categories on level 2 in the taxonomy proposed by Birgönül et al. (2024), there is an obvious difference in the level of detail. While more detailed taxonomies may capture a wider range of causes, they risk becoming difficult to apply in practice. Conversely, the reduced number of categories in this taxonomy improves usability but may limit its ability to capture unlikely causes.

The reliance on empirical data from a limited number of actors may introduce bias in how categories are defined and prioritised. While triangulation with client perspectives strengthens the validity, the taxonomy may still reflect a biased or partial perspective rather than an objective categorisation of all possible causes. With this in mind, the taxonomy is unlikely to be exhaustive. However, all six categories of causes listed by Fisk & Reynolds (2010) can be included somewhere, and with their argument that all change orders can be treated as one of these categories by similarities, this suggests our taxonomy is sufficiently exhaustive. The taxonomy is created based on the case company only, but the information is triangulated by including two clients in the interviews during phase 2. It is clear from the interviews with the clients that the case company shares a similar understanding with them, as well as with other subcontractors they mention, as they identify the same types of causes. For

example, all four of the most frequently mentioned causes (client-generated changes, controversial change orders, documentation and initial uncertainties) are also mentioned by the two clients as very common causes for change orders. This gives a reason to believe the taxonomy is tailored to the case company but can be seen as applicable for a wider audience. Especially for other steel contractors, but probably other subcontractors as well, working in these types of construction projects.

Using the categories “causes” and “effects” on the first level was a natural choice given their different nature, and they can be found in all previous taxonomies that include both causes and effects. The second level of themes are mostly found in previous research but sometimes renamed to better fit the context. The theme “client-related” can be found in Sun & Meng (2009) as well as Padala et al. (2020) but is not included by Birgönül et al. (2024). This omission does not imply that client-related changes are absent in their findings, but rather that these causes can be fit under other categories, such as “changes in design” under “design process”.

The “client-generated” factor in this study inevitably overlaps with other factors. However, this is a deliberate design choice. This factor is included because it gives a more practically relevant perspective on strategies for mitigation. It enables the strategies to be chosen based on the initiating actor rather than solely on the underlying cause. “Client-generated” is explained in Section 5.2.1 as partly when a client changes its mind, and partly when information is unknown in the beginning of a project. Looking at the categories identified by Bröchner and Badenfelt (2011), the first part of the factor can be compared to their “changes in clients’ core activities”. However, the second aspect relates closer to their joint category “lack of communication between parties during the contract period”. This further explains the overlap this factor possesses, since it is not only affected by a single party, but rather a complex interrelation between client and provider. The lack of mutual exclusivity reflects the complex and interrelated nature of change order causes. Rather than being a limitation, this can be seen as a more realistic representation of practice, where single change orders often emerge from multiple interacting factors.

Furthermore, “documentation” is comparable to the other client-related category by Bröchner and Badenfelt (2011): “errors, omissions and contradictions in the original specification documents”, while “inexperienced client” can be found as “project stakeholders’ competence and experience” by Birgönül et al. (2024).

The theme “project-related” is unique to our taxonomy, but is based on other existing categories such as “design process” from Birgönül et al. (2024) and Padala et al. (2020). The new name is inspired by the level one category “project internal causes” found in Sun & Meng (2009), as well as the initial workshop where this emerged as an important category. Included in “project-related” are the factors inherent in a project affecting the occurrence and the frequency of change orders: “number of actors involved”, “unclear responsibility allocation”, “complexity in projects” and “initial uncertainties”, all of which can be interpreted as factors of “impediment to prompt decision-making” by Memon et al. (2014). These factors mainly increase the mission uncertainty explained by Winch (2010) with a positive correlation. For example, more actors involved increases the mission uncertainty inherent in the project, creating a higher chance of generating more change orders. “Number of actors involved” and “unclear responsibility allocation” could not be found in previous taxonomies and are added to this one from the empirical findings. It is worth noting that other authors may argue for placing these under a different category, which does not imply that they are any less significant. However, in this research, the discussions around these themes both occurred frequently and seemed to give large effects, giving support for including them as their own factors. “Complexity in projects” can be seen as related to “design complexity” provided by Memon et al. (2014), while “initial uncertainties” can be compared to “better understanding of clients' needs” by Bröchner and Badenfelt (2011). Overall, the factors in the “project-related” theme are quite different from categories in previous taxonomies as well as this one, given that they include the perspective of frequency and probability of change orders arising.

The theme “project management” is found in the taxonomy created by Birgönül et al. (2024), and highly supported by principles from Winch (2010). “Communication”, “coordination” and “inexperienced project manager” are placed as factors in here because in the case company, these are largely influenced by the actions and capabilities of the project manager. The factors mentioned are all present in the previous taxonomies, but not placed under project management. With the heavy focus on project management of this thesis, and through support from Winch (2010) and other authors on preventing or mitigating the effects of these change orders, we found this theme appropriate to include explicitly. Looking at the category “unavailability of equipment” provided by Memon et al. (2014), “coordination” is closely related and can be seen as a root cause for the category. Good coordination during the whole project hinder unavailability of equipment during execution.

“Construction” is present as a category in all previous taxonomies, although it is sometimes named execution or project implementation. This theme includes “mistakes on construction site”,

“provisional aids” and “site layout & conditions”. “Provisional aids” is added from the empirical findings and cannot be found explicitly in the previous taxonomies. Given the findings that discussions around change orders from provisional aids such as guardrails and temporary bracing appear in almost every project, this was included as a factor, making the taxonomy highly adapted to this context.

“External factors” are also present in all previous taxonomies and therefore used as a theme in this one. In previous research, this theme often includes subcategories such as natural disasters, environmental problems and unforeseen ground conditions. Unforeseen ground conditions would, in our taxonomy, be placed under “site layout & conditions”, and in this context, most of these categories were shown to be irrelevant because of the unlikelihood. Instead, this theme in our taxonomy includes: weather, geopolitical factors and change of suppliers. Geopolitical factors is a factor that cannot be explicitly found in the others that came up during a discussion on potential change orders that have not yet occurred, but could be seen as somewhat likely and could give large effects if it would occur. Given the increased instability in global markets experienced lately, it is understandable that this is a factor of change orders that comes to mind and the probability of it occurring can be treated as higher than for example a natural disaster affecting the local area, therefore giving support for being a factor in the taxonomy. Even though it is added as a new factor, it is not unique for this specific context but would rather affect most businesses negatively.

Lastly, an “other” theme was added to house the unique level three category: “controversial change orders”, along with any other potential factors identified while applying this taxonomy to another context. The identification of this factor represents an important and unexpected contribution not explicitly addressed in previous taxonomies. No similar concepts are operationalised as a category in any article of the literature review, despite its significant impact on both project performance and inter-organisational trust the findings suggest in the case company. The findings suggest this factor represents not only a cause of change orders but also a distinct type of change order itself. It is clear from the findings that this type of change order is seen as solely negative, and that this type even affects the attitude towards change orders overall for many interviewees. All participants from the case company share the understanding that they should avoid these types of change orders, as well as avoid partnering with clients and other parties using them. The clients share a negative opinion about them and confirm that the case company has proven itself to be very honest and avoidant of controversial change orders. However, one of the clients also mentions that aiming for total avoidance of change orders is unnecessary and might risk making the company too complicated to work with.

This research confirms that the case company is on the right track with the avoidance of controversial change orders, but having a goal of eliminating all change orders is both unrealistic and would counteract the goal of being collaborative. This suggests that distinguishing between desirable and undesirable change orders is essential, rather than treating all change orders as inherently negative.

The findings also indicate that in the effort to act as a collaborative partner, some actors refrain from issuing change orders for additional work, despite the negative impact on their profitability. This highlights a tension between relational and contractual governance mechanisms, as described by Winch (2010). While such behaviour may strengthen relationships in the short term, it can undermine contractual clarity and lead to imbalanced outcomes between parties. From a risk management perspective, this can be interpreted as the acceptance of unmanaged financial risk, where additional work is absorbed without formal compensation, contrary to principles outlined by Pennetti et al. (2025). Furthermore, this behaviour may unintentionally create expectations that encourage opportunistic actions from other stakeholders.

Regarding the categorisation of effects, the choice of time, cost and relational effects as themes was more straightforward. The three categories are present in both Sun and Meng (2009) and Padala et al. (2020), but naturally not in Birgönül et al. (2024), who only categorise causes. These three are the main effects both in the literature and in the empirical research, making them obvious to use. The addition in our taxonomy is the “other” category containing the added factor “risk for errors”. Errors occurring because of change orders might, in turn, affect all three other themes. The choice of making it a factor for its own helps highlight the severity of it, as well as making it more visible as a reason for mitigation.

Identifying both causes and effects of change orders enables the assessment of both the frequency and impact of different categories of change orders. Frequency is defined as how often a category of change orders occurs, and impact relates to how severe the effects are. According to Pennetti et al. (2025), a risk management perspective can be used to manage potential risk sources by identifying underlying conditions, which has been done in the categorisation. Pennetti et al (2025) further emphasise how risk sources should be prioritised, which will be done and discussed in section 8.2, using the risk assessment matrix.

8.2 Prioritising change order causes for managerial attention

This section addresses RQ2 by making a prioritisation of the cause factors for change orders that were found through the interviews. The prioritisation is made with support from the theory presented in Chapter 2 and focuses on laying a foundation for the strategies that will be presented in Section 8.3.

Building on the classification of change order causes and effects presented in Section 8.1, the next step in providing practical implications for managing change is to assess which factors are critical to address. This prioritisation is important since, as Shieg (2006) argues, complete identification of all risks is considered impossible. Organisations should therefore focus on identifying and controlling the most significant risks affecting project activities. The prioritisation in this study is based on two main considerations. First, the degree to which a cause can be prevented is considered. This is connected to the distinction of Padala et al. (2020), who assign the change orders to two generic categories of causes: requirement changes that are difficult to prevent, and errors that arise from deficiencies in processes and therefore are possible to prevent. Second, the level of risk associated with each cause is assessed using a risk matrix, as described by Hill and Cole (2025). The matrix evaluates both the likelihood that a factor will generate a change order and the severity of its impact on project performance. This follows established risk management principles, where risk is understood as a function of probability and impact, often referred to as risk magnitude (Winch, 2010; Pennetti et al., 2025). As highlighted by Pennetti et al. (2025), this type of assessment with probability and impact forms the basis for risk analysis and prioritisation, enabling the allocation of limited resources to the risks that pose the greatest risk for project objectives.

The concepts of frequency and impact are used as a foundation for the risk assessment, where frequency represents the likelihood of occurrence and the identified effects of change orders represent their severity. From a risk management perspective, this corresponds to the step from risk assessment to risk analysis, where identified risk sources are evaluated in terms of their likelihood and impact (Pennetti et al., 2025). The positioning of the factors in the matrix is based on the interview results and allows for a structured comparison of their relative importance. The matrix with all cause factors included can be found in Figure 8.1. It should, however, be noted that the placement of factors is not exact, but rather based on interpretations of qualitative data. Several factors could reasonably be positioned in adjacent rows and columns depending on how individual interview statements are weighted. The matrix should therefore be understood as an analytical tool to indicate relative importance rather than a precise measurement. The outcome shows that three factors are in the high-risk segment displayed in red (F8 "communication", F1 "client-generated" and F17 "controversial

change orders”), and an additional three are in the medium-high segment marked with orange (F2 ”documentation”, F9 ”coordination” and F10 ”inexperienced project manager”). These six factors are therefore prioritised and will act as the main focus for the mitigation strategies discussed in Section 8.3.

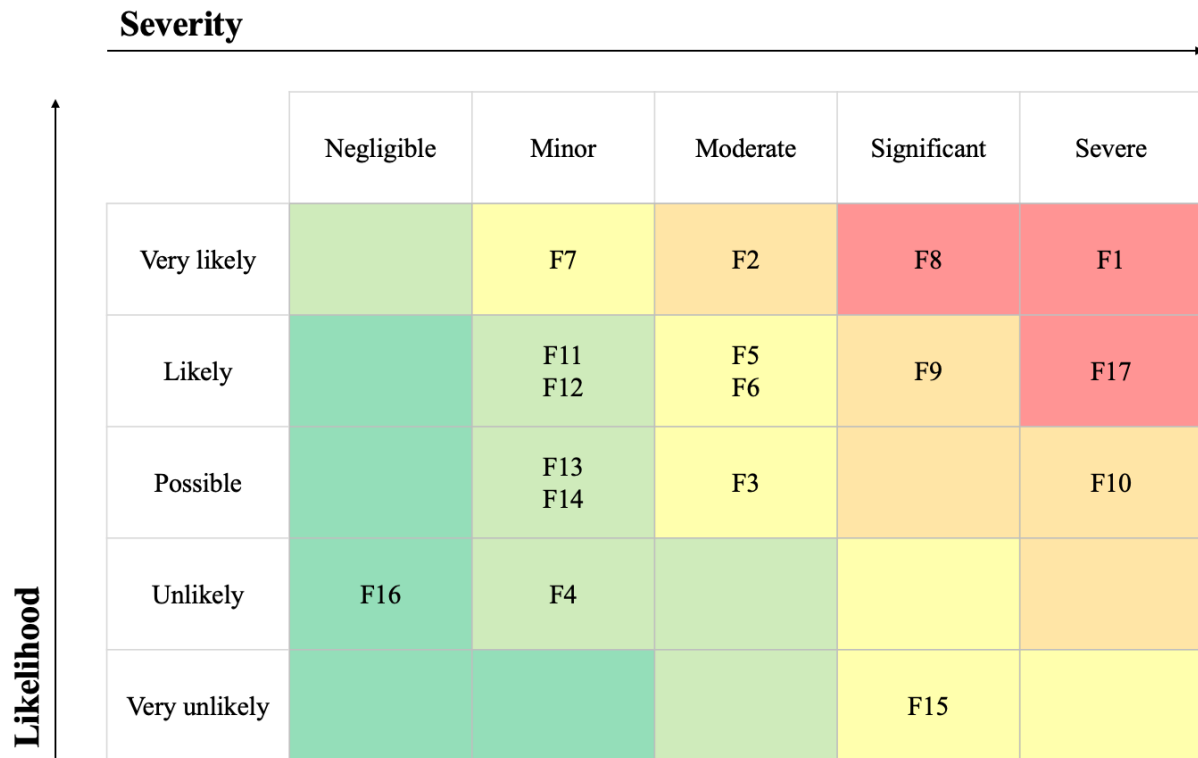


Figure 8.1. Risk assessment matrix with all factors from Table 5.1 plotted by likelihood and severity.

The selection of these six factors is guided by the fundamental principle emphasised by Pennetti et al. (2025), where they state that not all risks can or should be addressed at the same time. Risk management requires selective allocation of attention and resources to the critical risks, rather than attempting to eliminate all sources of uncertainty.

Among these risk factors, client-generated changes (F1) stand out as both very likely to occur and associated with severe consequences. The interview results consistently describe this as the most frequent cause for change orders, often driven by evolving client needs or late decision-making. While the severity of individual client changes can vary, their tendency to directly trigger drastic effects like rework and delays motivates their placement in the highest severity column, even if some specific changes are less severe and would belong in a column further to the left. It is also important to note how client-initiated changes often are connected to other causes, rather than being a unique

factor. It is common that these types of changes arise because of a lack of communication or unclear documentation. However, the findings from the interview show that client-initiated changes are one of the most common factors, requiring similar mitigation methods. They therefore form a category of their own in this study.

Further, the interview results indicate that there are two types of client-generated changes depending on where the change originates. Some originate from the client changing their mind, and this type is difficult to foresee and prevent since it might not be identifiable until the client brings it up. Other changes originate from more information coming up later in the project, when uncertainty has been reduced. These come with a better possibility of prevention through asking the right questions and working with clarifying as much as possible in early project stages. This indicates the complex nature of this category of change orders and that it might not be possible to be strictly addressed through either prevention or mitigation alone.

Controversial change orders (F17) are also associated with severe consequences, especially in terms of relationships and trust between stakeholders. While not as frequent as client-initiated changes, they are described by several interviewees as a recurring issue that creates conflicts, increases administrative burden, and complicates collaboration. In some cases, these two types of changes can even overlap, further amplifying their impact.

Having an inexperienced project manager (F10) is identified as a factor that can lead to severe consequences when critical aspects are missed, misinterpreted or poorly managed. This factor is considered less frequent due to the organisational practices that provide support and make sure that sufficient learning and experience are gathered before taking full responsibility. There is also some uncertainty in this placement, as the definition of inexperienced varies and its effects can overlap with other factors such as communication and coordination. Still, its potential impact on both project execution and stakeholder relationships places it in the high-risk category.

Documentation-related issues (F2), such as faulty, insufficient, or ambiguous documentation, are very likely to occur and cause change orders. On the other hand, the consequences of them are usually moderate. They tend to generate incremental adjustments rather than major disruptions, although their effects can escalate if misunderstandings arise late in projects when a large proportion of work would need to be redone. Their position in the medium-high segment therefore reflects a high occurrence and typically moderate impact. Given that most documentation is provided by the client, this factor

is highly overlapping with client-generated changes (F1), further highlighting that causes by clients are common and need a large managerial focus to reduce the occurrence of change orders.

Lack of communication (F8) and coordination (F9) are closely related but represent different aspects of information flow. Communication represents the exchange of information, while coordination represents the alignment of activities, and when information is available. The interview results show that communication failures are more common than coordination failures, which instead often lead to more complex consequences due to tasks being dependent on each other. Their placement in the matrix reflects this, although they often reinforce each other in reality. This is further reinforced by the description by Pennetti et al. (2025), who see risks in construction projects as being interdependent by nature and rarely isolated. Failures in areas such as communication or coordination can propagate across multiple project activities.

Using the distinction from Padala et al. (2020) between requirement-related changes and errors, the six factors can be classified based on their preventability. Client-initiated changes, documentation and controversial change orders are factors primarily driven by the client and, therefore, difficult for the contractor to prevent. These can be understood as requirement-related changes, and the focus here needs to be on working proactively and mitigating their negative effects. Client-generated changes also have an aspect of preventability, though, when the changes originate from not having asked the right questions in early project stages, which can be seen as errors and therefore are able to be prevented. Parts of controversial change orders could also be seen as preventable, looking from the perspective of how the company itself uses or handles them.

In contrast to the requirement-related changes, lack of communication, lack of coordination, and inexperienced project managers are more linked to internal processes and practices. This aligns with how Padala et al. (2020) describe errors, where improvements can reduce both the occurrence and impact of change orders. At the same time, their occurrence is influenced by factors such as project complexity and time pressure, indicating that they can be reduced but not entirely eliminated. From a risk management perspective, this distinction aligns with different types of risk response strategies. Preventable factors correspond to proactive responses aimed at reducing or eliminating underlying risk sources, while non-preventable factors require reactive responses focused on mitigating the impact of risk events (Pennetti et al., 2025).

This prioritisation highlights that the critical factors are not only the ones most probable to occur and cause severe consequences, but those that pose a high risk as well as a high degree of controllability. While requirement-driven changes must be managed, the greatest potential for improvement lies in addressing preventable causes and improving the processes around them. The results also indicate that project complexity and uncertainty play a key role in increasing the likelihood of both requirement changes and process-related errors. This is particularly clear in the early project stages, where requirements are not fully defined, making it essential to address these uncertainties to reduce their overall impact.

Based on this, the prioritisation can be summarised in two key perspectives. First, high-risk factors that are preventable should be targeted for reduction through proactive risk responses aimed at reducing or eliminating underlying risk sources. Second, high-risk factors that can or should not be prevented should be proactively managed to mitigate their negative effects on the project. These perspectives form the foundation for the strategies for mitigation and prevention discussed further in Section 8.3.

8.3 Strategies for reducing and managing change orders

In Section 8.2, the prioritisation of change order causes highlighted two key perspectives. First, that preventable high-risk factors should be reduced through improved processes and practices. Second, that high-risk factors that cannot be prevented must be actively managed to mitigate their effects. This section discusses operational strategies that address these two perspectives.

8.3.1 Reduction strategies for preventable factors

The following strategies primarily target preventable and process-related risk factors. The strategies revolve around improving early project clarity, communication and coordination, and the experience of project managers.

Improving early project clarity

The findings highlight the importance of asking the right questions early in the project to improve clarity and being able to prevent several change orders. This aligns with Winch (2010), who argues that project uncertainty is not only a lack of information, but rather that relevant knowledge is distributed across different stakeholders. Asking questions relates to the broad topic of communication, where Butt et al. (2016) stress that communication should be established early and

clearly to foster a collaborative culture leading to stakeholder involvement and enhancing innovative problem solving. Consequently, project management becomes a process of identifying which information is required, when it is needed, and from whom it should be obtained.

It becomes relevant here to bring up the distinction between different types of client-generated change orders. While some changes originate from the client genuinely changing their mind during the project, others arise because of relevant requirements, expectations, or constraints were not sufficiently identified during early project stages. In such situations, the issue is rather that the right questions had not been asked early enough to reduce uncertainty and clarify project requirements. That type of client-generated change orders can therefore be seen as preventable through more proactive communication, stakeholder involvement, and requirement clarification during the early phases of projects.

Another strategy to help identify what information is needed in projects is the use of checklists described in Section 6.5. By standardising what questions to ask, the organisation reduces its dependency on individual experience and reduces the risk of overlooking critical details in projects, which often leads to change orders. This reduces risk by lowering both the likelihood of change orders through improved clarity and their potential impact by identifying issues earlier. This reflects on the management principle of standardisation as a tool to reduce variation and risk in projects. The existing checklists are described as too broad and give no indication of the timing or deadline of each question, leaving a lot of responsibility to the project manager. Improvements on this, such as checklists for specific types of projects or digital tools to help with planning, would further improve this method for effective usage. The company is currently working on an extensive IT system that is planned to allow for the creation of individual checklists, including the time perspective on when each piece of information needs to be obtained. This part of the IT system is therefore highly supported by our findings and likely a valuable improvement.

In reality, it is not as easy as simply asking questions about all the details to have everything clarified. The findings point to a tension between being thorough and being perceived as difficult by the client. This highlights that asking the right questions is not only a technical activity but also a relational one. While thorough questioning enables the project team to reduce uncertainty and improve contractual clarity, as Winch (2010) describes, it may also risk negatively affecting the relationship with the client if perceived as excessive. With this in mind, some details might be beneficial to leave out of the contract in the sales phase, later determined by relational governance and trust. Even with

standardisation and the use of checklists, the balance depends on a personal and relational level, leaving the project manager to interpret each situation and decide the extent of questions to ask at each stage of the project.

Coordination and communication

One of the risk factors identified as preventable is lack of coordination. Here, early involvement of relevant stakeholders is highlighted as an important factor for improving coordination, since more details can be known at an earlier stage. This aligns with previous research indicating that many change orders originate from insufficient information and decisions made during early project stages (Ibbs, 1997). However, simply involving stakeholders early is not sufficient for significant improvements. The findings suggest that the primary value of early stakeholder involvement lies not in participation itself, but in enabling earlier alignment of expectations. By clarifying requirements, constraints, and interfaces between actors at an early stage, the likelihood of later rework and reinterpretation is reduced, thereby contributing to preventing change orders. This is particularly relevant in relation to tender documents and initial uncertainties, where incomplete specifications are a recurring source of change orders. Early involvement thus acts as a mechanism for improving the quality of initial information rather than simply increasing its quantity.

These findings resonate with Demirkesen and Ozorhon's (2017) description of integration management, where effective project management depends on aligning activities, stakeholders, and information throughout the project lifecycle. Coordination therefore concerns more than simply connecting technical activities. It also involves creating a coherent understanding of the project as a whole, where planning, execution, and decision-making are continuously aligned between actors. The findings suggest that when stakeholders primarily focus on their own responsibilities without understanding the interdependencies between activities, the risk of misunderstandings, rework, and fragmented decision-making increases. Establishing clear roles, responsibilities, and communication channels early in projects therefore becomes important for reducing coordination-related change orders. This responsibility falls partly on the project manager of the subcontractor, but mainly on the design build contractor who is the one responsible for hiring the different subcontractors on time, and are the main coordinators of the project as a whole.

The empirical findings further show that coordination is strongly dependent on both communication and the capabilities of the project manager. Effective coordination requires continuous information exchange between parties, structured planning, and active management of project interfaces. In this

context, the project manager, mainly on the client side, becomes a central coordinating actor responsible not only for distributing information, but also for structuring interactions between stakeholders and ensuring that the right actors are involved at the right time. This supports the description made by Winch (2010), with construction project management as requiring a combination of technical and soft skills. The role of the project manager therefore extends beyond administrative coordination toward actively interpreting, prioritising, and sequencing information flows between stakeholders. The findings also indicate that experience plays an important role in this process. Less experienced project managers may struggle to understand interdependencies between actors or identify which stakeholders need to be involved in specific decisions, thereby reducing the effectiveness of coordination efforts and increasing the risk of change orders.

At the same time, the findings reveal a coordination paradox related to early stakeholder involvement. While involving more actors early in projects improves information availability and alignment, it can simultaneously increase complexity in communication and decision-making. The empirical findings show that projects involving many actors often experience fragmented communication, slower decision processes, and unclear responsibility allocation if coordination structures are insufficient. This suggests that early involvement alone is not enough to improve project performance. Instead, it needs to be accompanied by clearly defined communication structures and responsibilities to avoid creating additional complexity.

Lack of communication was identified as another high-risk factor contributing to change orders, emphasising the importance of structured communication practices throughout projects. Here, the findings reveal a fundamental trade-off between communication efficiency and traceability. Oral communication is often preferred because of its speed, flexibility, and ability to reduce misunderstandings through direct interaction. However, oral communication also risks creating information loss over time if decisions and discussions are not documented properly. This becomes particularly problematic in projects involving many stakeholders or personnel changes, where undocumented decisions may later need to be revisited or reinterpreted. Structured communication routines therefore become increasingly important as project complexity increases. This supports Butt et al. (2016), who emphasise that effective communication structures and routines are important for reducing unmanaged changes and mitigating negative effects such as delays, rework, and cost increases. The findings particularly support their argument that communication established early in projects enables project actors to identify and address potential issues before they develop into larger disruptions.

The findings also indicate that communication and coordination, while closely related, should not be viewed as identical concepts. Communication may exist without resulting in coordination, for example when information is exchanged between stakeholders without creating alignment in responsibilities, decisions, or project activities. Coordination, however, inherently depends on communication, since aligning activities and managing interdependencies requires continuous information exchange between actors. In this sense, communication can be understood as a necessary but not sufficient condition for coordination. This further highlights why the quality, structure, and interpretation of communication become important in preventing change orders, rather than merely the extent of communication taking place.

Senaratne and Sexton (2009) further highlight that communication in construction projects extends beyond formal reporting systems and documentation. Instead, coordination and problem-solving often rely heavily on interactive and informal communication through meetings, discussions, and collaborative interpretation of project issues. This is reflected in the empirical findings, where recurring meetings were described as important mechanisms for coordinating activities and maintaining alignment between stakeholders. At the same time, respondents also emphasised that there is still improvement potential regarding the consistency and structure of these interactions. Senaratne and Sexton (2009) also emphasise the value of visualisation techniques such as sketches, diagrams, and examples from previous projects as tools for expressing ideas and reducing misunderstandings. Similar practices were identified in the case company through the use of visual coordination tools such as Kanban systems. However, the findings suggest that visualisation and structured coordination tools could potentially be used more extensively to improve alignment and shared understanding between project actors.

The findings further point out that communication effectiveness cannot solely be explained by formal routines and structures. Informal interactions between stakeholders were described as important for creating trust, solving problems quickly, and facilitating knowledge sharing during uncertain project situations. However, creating conditions where such informal communication occurs is more difficult to manage directly, since it is strongly dependent on the relationships between stakeholders and the collaborative environment within projects. In this context, the importance of long-term relationships becomes evident. Errasti et al. (2007) distinguish between short-term transactional relationships and long-term relationships, arguing that long-term relationships enable stronger collaboration, learning, and process integration between actors. The empirical findings support this perspective by indicating

that continuity and familiarity between stakeholders facilitate smoother communication and coordination, particularly in situations characterised by uncertainty or changing project conditions.

At the same time, it is important to think about both the contractual and relational governance in projects, as described by Winch (2010). While relational aspects such as trust and familiarity facilitate informal communication and collaborative problem-solving, formal contractual structures remain necessary for defining responsibilities, ensuring traceability, and clarifying expectations between stakeholders. Effective coordination and communication therefore require a balance between formal structures and relational collaboration. Relying solely on informal relationships risks creating ambiguity and lack of accountability, while relying solely on contractual structures may limit flexibility and collaborative problem-solving during uncertain project situations.

Butt et al. (2016) also present how communication effectiveness is not only dependent on established routines, but also on the capabilities of actors involved. Communication therefore becomes both a structural and an individual capability issue. The empirical findings indicate that personal traits, communication skills, and relationship-building abilities of project managers significantly influence how effectively coordination and communication function in practice. This was particularly evident in relation to project managers on the client side, where communication quality and personal relationships were described as strongly affecting project collaboration and the management of change orders. Similar dynamics can reasonably be assumed to apply to project managers on the contractor side as well. Consequently, improving communication in construction projects is not only about implementing better routines and systems, but also about developing the interpersonal and communicative capabilities required to manage complex stakeholder interactions effectively.

Project manager experience

Empirical findings show strong dependence on the personal experience of project managers, especially regarding identifying and managing change orders. This supports Winch's (2010) view of projects as temporary organisations, where knowledge is often embedded in individuals rather than in organisational systems and rarely captured by the firm. As a result, less experienced project managers face challenges in recognising when a change order should be initiated, leading to inconsistencies in practice. This highlights a structural vulnerability, where organisational performance becomes dependent on individual competence rather than established processes.

In this context, the distinction made by Pennetti et al. (2025) between management and leadership as complementary aspects of project management becomes highly relevant. The empirical findings suggest that experienced project managers contribute not only through managerial capabilities related to planning, control, and coordination, but also through leadership capabilities such as clear communication, empathy, adaptability, and handling uncertain situations. While less experienced project managers may relatively quickly develop the structural and administrative capabilities required to manage projects, the more relational and situational aspects of leadership appear to develop primarily through experience. Knowledge and experience therefore need to be shared both between projects and between project managers to increase performance, reduce variability between projects and reduce the vulnerability if project managers are replaced or leave the company.

Strategies discussed in the group interview for sharing knowledge are recurring meetings dedicated to discussing problems and experiences across projects. This aligns with the description by Senaratne and Sexton (2009) of how knowledge in construction projects is largely tacit and transferred through social interaction rather than formal systems. Such meetings create opportunities for less experienced project managers to learn from more experienced colleagues, while simultaneously increasing awareness of problems and lessons learned from other projects.

This also means that the risk is spread across the organisation and not allocated to single actors, which Winch (2010) describes as an important aspect in risk allocation. Further, regular meetings and cross-project discussions can serve as mechanisms for transferring tacit knowledge and gradually converting it into more explicit knowledge. However, these meetings also require additional time from already stressed and overworked project managers, particularly the more experienced ones. A trade-off therefore emerges between investing time in long-term organisational learning while still maintaining a manageable workload. Standardisations like clearer definitions of situations suitable for initiating change orders can further support this by reducing variability between projects.

8.3.2 Management strategies for non-preventable factors

This section primarily focuses on managing high-risk factors that cannot be fully prevented, particularly client-initiated, documentation and controversial change orders.

Managing client changes

Using the previously defined distinction between two main types of client-generated changes: changes based on new opinions, or changes caused by additional information, the first type is

particularly hard to anticipate and eliminate. For these situations, contract options are suggested as a strategy for managing uncertainty and moving changes to earlier point in time where effects are smaller. As argued by Winch (2010), projects are inherently uncertain, and governance mechanisms should therefore focus on accommodating change rather than preventing it. This category of causes can be seen as unknown unknowns, as described by Winch (2010), emphasising the need for flexibility and adaptability in the organisation. By defining contract options early in the project, the contractor enables flexibility while maintaining control over the extent of potential changes. This can reduce the impact of late changes as changes are anticipated and partially predefined, and as Ibbs (1997) stresses, late changes have larger negative effects than early changes. Options can be a strategy for moving late unforeseen changes to earlier predicted changes.

However, the findings also indicate potential drawbacks of the method. Offering too many options may increase administrative workload and introduce additional complexity, as each option may require separate adjustments. With large adjustments to contract options, the changes can end up being as disruptive and unexpected as a regular change order. Furthermore, it may encourage clients to reconsider decisions that would otherwise have remained fixed, potentially increasing the number of changes.

The fundamental trade-off between flexibility and efficiency becomes evident when discussing contract options, where increased adaptability may come at the cost of higher coordination and administrative effort. The same trade-off is evident in the broad area of managing change orders overall. The case company is strongly focused on reducing the occurrence of change orders, however, this comes with a risk of reducing flexibility towards clients. Flexibility towards clients is presented as a very important aspect for the two clients included in the interviews. One client also explained how eliminating change orders might lead to accounting for too much cost or becoming more difficult partners for collaboration, defeating one of the purposes of eliminating change orders.

Unclear and incomplete tender documentation represents a non-preventable source of change orders, as deficiencies often originate from the client and are driven by time constraints or a “good enough” approach. The findings suggest that this management begins already in the sales phase, where systematic review of tender documents is essential to identify gaps and inconsistencies before they propagate into later phases, where they become more costly to handle. A key strategy is to explicitly state assumptions and deviations in the offer, thereby making interpretations transparent and aligning expectations with the client. This reduces the risk of misunderstandings and subsequent change

orders. In projects with higher levels of uncertainty, this need for clarity becomes even more critical, requiring structured communication and continuous dialogue to ensure shared understanding. Additionally, early involvement through collaborative contracting enables the contractor to actively clarify and refine the documentation before execution, reducing reliance on incomplete inputs. Findings also highlight that AI tools can be used as help to identify errors and ambiguities between documents, a strategy that would make the process of identifying ambiguities much more efficient, as well as putting less pressure on employees in the sales phase where time is often limited. After identifying errors, preventing change orders stemming from them can be seen as identical to the strategies suggested for the preventable causes in Section 8.3.1.

A high-risk factor seen as partly unpreventable, since it often relates to client behaviour and their requirements, is the controversial change orders. The heavy focus on this negative view of controversial change orders during the interview highlights the importance of the topic. Most apparent when talking about the topic is the significant effect it has on relations. Findings show several examples of heated discussions arising from change orders that are seen as dishonest, and a few examples of partnerships being ended based on this reason alone. It is evident that the long-term relationships established by Errasti et al. (2007) are very important in the construction business, both from the perspective of the client and the contractor. Long-term relationships are fostered through being honest and focusing on delivering a positive result, and hurt by focusing too much on the small economic wins. From this study, it is clear that both the client and the contractor form much more positive opinions of companies not initiating change orders for too small sums or using them as a way of earning extra money.

However, findings show that focusing fully on being “kind” and a reliable and collaborative partner might have negative cost consequences. It is important in this sense to realise that a relationship without conflict is not automatically a good partnership. Both parties need to gain positively from the partnership, and there needs to be a balance between being collaborative and being overly giving. This understanding is essential when managing these types of change orders and, in the long run, these types of clients.

Findings further suggest this factor is not only a cause of change orders, but a topic that affects the perspective on change orders overall in the case company. It becomes evident while talking to the interviewees that most employees in the case company have strong negative opinions towards change orders, despite the fact that change orders are a natural part of a construction project as well as an

opportunity for additional profitability. This view seems to stem from arguments and conflict caused in prior projects, and has led to what could be considered as an extensively negative view on the topic. Findings clearly highlight that there are “good” change orders and there are “controversial” change orders. Avoiding the use of controversial change orders, as well as looking for long-term partnerships with other actors that avoid these, is a good strategy to eliminate change orders and mitigate effects such as conflicts. This is a strategy that the case company already embraces. However, having an extensively negative view of the topic overall might risk causing unnecessary frustration, lower morale and avoidance of initiating change orders at all, negatively affecting the profitability of the company. This internal perspective of controversial change orders can be seen as preventable, since it is about how the company handles and views change orders and not how the client behaves. Given the similar attitude towards change orders provided by one of the clients, it can be reasonable to believe this risk is present in other companies as well.

8.4 Limitations

It has become evident during the research that cultural differences exist, particularly between Swedish construction and that of other countries such as American or English when it comes to contractual relationships. Swedish construction is characterised by informal communication where efficiency is often prioritised over the safety of establishing formal contracts before executing a change. The relationships are often more based on trust which introduces larger risks, but since this is the standard way of working, it seldom results in negative effects such as litigation. This suggests a limitation regarding the applicability of the research across other cultures. The research presents a good representation of the construction business in Sweden, but it might not be representative of the construction business in other countries.

Further, the case company chosen represents a small company with a heavier focus on efficiency and a broader use of IT systems than the average steel construction company. Only performing the research on one company of a unique kind has likely introduced biases which has affected the generalisability of the study. Applying the provided taxonomy in a different company would therefore likely require changes, additions and deletions to the categories used. The prioritisation of causes and strategies for prevention and managing change would also need adaptations to apply to a different company.

9

Conclusion

This study set out to identify and categorise the causes and effects of change orders in the steel construction industry, as well as to propose strategies for managing them. The results have led to the development of a taxonomy that differs from existing literature in both structure and level of detail. While previous taxonomies aim for comprehensiveness, our main contribution is an intentionally simplified taxonomy tailored to a practical context, making it more applicable for operational use. Five main themes of causes were identified: “client-related”, “project-related”, “project management”, “construction”, and “external factors”. Additionally, 17 factors or subcategories of causes were found. Among these, the identification of controversial change orders stands out as particularly noteworthy, as it is not explicitly recognised in previous taxonomies despite being highly salient in practice. Three themes of effects were identified: “time”, “cost” and “relational”, with 10 subcategories found. This finding also contributes to a more nuanced view of change orders, highlighting that not all change orders are inherently negative. Instead, a distinction must be made between desirable and undesirable change orders. Furthermore, the results emphasise that the effects of change orders are not limited to technical aspects such as time and cost, but also include significant relational impacts. The overlap between categories and the presence of interdependencies underline the complexity of change orders, suggesting that they rarely stem from a single isolated cause.

Given this complexity and the limited resources available in projects, it becomes essential to prioritise which causes of change orders to address. A risk management perspective was used to prioritise causes after probability of occurrence and severity of impact. Focus for managing change order should be put on causes with the highest risk level, identified as: “client-initiated changes”, “controversial change orders”, “documentation”, “communication”, “coordination” and “inexperienced project manager”. Following the logic of Padala et al. (2020), the findings indicate that some change orders are preventable and should be eliminated, whereas others are unavoidable and should instead be managed to reduce their negative effects. Results show that “inexperienced project manager”, “communication” and “coordination” are preventable, while “client-initiated changes”, “documentation”, and “controversial change orders” should be managed. This distinction

between elimination and mitigation provides a more structured approach to handling change orders and aligns with a risk-based perspective on project management.

Finally, the study highlights the importance of combining strategies aimed at both reducing the occurrence of change orders and mitigating their effects. Improving clarity in early project stages is identified as a key factor, particularly through structured communication and the ability to ask relevant questions at the right time. However, this must be balanced against practical constraints, as excessive information gathering may not be feasible or risk giving negative relational effects. Communication emerges as a central theme, closely linked to coordination, collaboration, and the quality of relationships between stakeholders. In this context, the role of the project manager is critical, requiring both technical understanding and strong interpersonal skills. Experience and knowledge sharing are also identified as important enablers for improving project outcomes and reducing risk of knowledge loss and negative effects caused by inexperience. Additionally, appropriate use of contractual options can provide flexibility in managing uncertainties, balancing efficiency with adaptability. Lastly, the findings underline the importance of maintaining honesty and fostering long-term relationships, as these contribute to trust and more effective collaboration over time. Together, these strategies provide a comprehensive approach to managing change orders in a complex and interdependent project environment.

Future research could build on this study by examining how our taxonomy of change order causes, which has an operational focus, could be applied to other types of construction actors. Since this study focuses on a steel subcontractor, it would be interesting to see if the same conclusions apply to design-build contractors or other subcontractors. Another aspect that could be further researched is the temporal dimension of change orders. Our taxonomy does not explicitly capture this dimension, such as when in the project lifecycle different causes are most likely to occur. Incorporating such a perspective could further enhance its practical usefulness by giving even clearer indications on how and when change orders occur. There is also a possibility for further exploration of aspects of project communication, as several causes of change orders identified in this study are connected to a lack of communication or misalignment between actors. Therefore, it would be interesting to look deeper into how communication routines and structures influence the management of change orders on a more detailed level. Lastly, future research could examine how digital tools and Artificial Intelligence can support the ability to prevent and manage change orders, since this is a subject that is only briefly mentioned in this study.

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