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Flexibility in infrastructure projects: Practical insights into enablers and blockers of flexibility



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Colophon

Title: Flexibility in infrastructure projects: Practical insights into the enablers and blockers of flexibility

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Abstract

Large infrastructure projects are often characterized by budget and time overruns (Koppenjan et al., 2011). The increasing complexity of infrastructure projects and their environments has necessitated greater flexibility to adapt to changing circumstances and unexpected events (Leendertse et al., 2022 and Giezen et al., 2014). However, in practice, a tendency toward a control-oriented approach persists, where deviations from predefined project objectives are viewed as undesirable due to their associated time and cost implications (Koppenjan et al., 2011). Therefore, this study aimed to find the flexibility enablers and blockers in practice that can help or prevent a project organization to adapt well to the changing circumstances. Through asking interviewees about their responses towards unexpected events, insights into the flexibility enablers and blockers in practice have come to light. It was concluded that flexibility is enabled by the individuals working within the project organizations. Flexibility extends down to the personal level. Therefore, trust, stakeholder inclusion, and collaboration are highly important. Although the human aspect of flexibility is crucial, practical enhancements can also be made. A less diverse scope, not over-specifying the planning procedures, tender on quality, and allocating time for dialogue sessions were mentioned to improve the flexibility of a project organization.

Keywords: flexibility, control, large infrastructure projects, management approaches, adaptive capacity, complexity, uncertainty, environment.

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Chapter 1 Introduction

Even if you would prepare for the worst, humans are not able to predict and prepare for every event (Khosravi and Bin Mohammed, 2012). Due to our limited knowledge and experiences, humans are often caught off guard with unexpected events. Since infrastructure projects can be large and complex and are mostly context-specific, there is no routine response to these unexpected events. However, to deliver infrastructure projects within budget and time, a focus on project control, based on risk management has been developed (Koppenjan et al., 2011). To keep control over achieving a predefined result project standards are detailly set and strictly adhered to. Deviating from the set goals or predefined process is seen as undesirable, as changes will lead to the need for adjustments, costing time and money (Koppenjan et al., 2011). According to Leendertse et al. (2022), predefined goals or results which are strictly adhered to, are still a common management approach in infrastructure projects. However, the increasing complexity of the environment has led to the question of how to cope with changing circumstances.

Factors such as scarcity of space, and increased environmental awareness have complicated planning massively (Arts, 2007). In the past infrastructure projects were solely focused on improving the transportation networks. Now infrastructure projects strive to include sustainability goals (van Geet et al., 2019), meaning that environmental and societal values need to be treated equally as important as economic values (Kivilä, Martinsuo, and Vuorinen, 2017). This increase in project requirements leads to an increased complexity and uncertainty, making managing large infrastructure projects difficult (Erkul et al., 2016). Furthermore, infrastructure projects struggle with high uncertainty due to the long time span of the projects, where the world changes and unforeseeable disturbances happen (Westerveld and Hertogh, 2013). Since unplanned events cannot be anticipated on, in advance (Gerrits and Verweij, 2015), and consequently increased uncertainty, it is argued that more flexibility is needed in managing infrastructure projects (Westerveld and Hertogh, 2013; Edelenbos et al., 2007; Leendertse et al., 2022).

Flexibility means that a project organization is able to adapt to unplanned events (Szentés and Erikson, 2016). The organization is more likely to adjust the predefined goals to the new information and the new insights that have been obtained (Edelenbos et al. (2007). However, at the same time, control is needed, as endless flexibility leads to no direction (Aarts, 2007). A paradoxical perspective can be taken, meaning that instead of choosing one management style, both flexibility and control are needed. If changing decisions keep pushing the project in different directions, it will never be possible to finish the project. Therefore, it is argued that both flexibility and control, are needed to cope with unforeseen events and to keep having progress in the project (Westerveld and Hertogh, 2013).

Control comes for example from the fact that different demands need to be met. The client has for example the design standards the road needs to comply to, the authorities have environmental standards, and the public has nuisance standards. If all these demands and requirements are written down, then everything is specified leaving no room for any changes (Szentés and Eriksson, 2016). Flexibility on the other hand is needed to deal with a changing world and unexpected events. If the project is too controlled it will leave no room for innovation to deal with new incidents that have arisen over time (Szentés and Eriksson, 2016). So how to create this flexibility in infrastructure projects, without losing control?

In the end, dealing with unexpected events comes down to the final decision that is taken. Therefore, there is the decision-making process, which includes all the factors that are relevant to the final

decision (Sun and Bach, 2014). The decision-making process is of high importance since a decision in a project can make the difference between success and failure. Since the world is constantly developing and changing, a decision that fits the context is needed. If decision-makers hold on to the way things are usually done, it will lead to a narrow horizon, while innovation and new insights are a necessity to make improvements (Sun and Bach, 2014).

The decision-making process is highly complex since it is not linear. Stakeholder interaction, which forms the decision-making process, is highly dynamic. Project organizations have to deal with stakeholders who have unexpected actions (e.g. suddenly dropping out of the project), have to deal with governments who want to see a decision (even though the agreement might not be reached yet), or stakeholders taking the process to court because the project takes too long (van Buuren, 2006). Furthermore, the preferences of actors, for example the design of projects, are not static (Westerveld and Hertogh, 2013). During the project more and more information is gained and shared between the different stakeholders, this mutual learning leads to changing preferences and needs. Hence, the decision-making process of infrastructure projects is complex. This complexity leads to the need for flexibility in infrastructure projects (Westerveld and Hertogh, 2013).

Since the need for flexibility in infrastructure projects is highly acknowledged in literature, the question becomes how to achieve flexibility in practice. Sohi et al. (2020) have made a flexibility enabler framework for infrastructure projects. This research will expand on the flexibility framework of Sohi et al. (2020), and give an overview of flexibility blockers. Furthermore, this research aims to contribute to the existing literature by examining whether the flexibility enablers and blockers of theory align with practice. Are there any mismatches? This will be researched through interviewing the responses taken towards unexpected events. When is a more flexible approach taken, and when is a more control approach, and why? Through the case study of a large infrastructure project in the North of the Netherlands, the complexities and responses become clear.

In this study, there is chosen for the case of the Southern Ring Road in the North of the Netherlands since Rijkswaterstaat, the Dutch executive agency of the Ministry of Infrastructure and Water Management, has had a dominant focus on the control side of the paradox (AT Osborne, 2019). Due to the many appeal procedures of infrastructure projects in the past, Rijkswaterstaat has developed a management style focused on risk. The focus on keeping control has led to many procedures and guidelines to limit risks. However, due to the increased dynamic of the context of projects, there is awareness in the organization of Rijkswaterstaat of the developing need for flexibility in managing infrastructure projects (AT Osborne, 2019). But how to implement this flexibility in infrastructure projects? This question is of high societal relevance since large infrastructure projects heavily intervene with the environment. Construction work disturbs the environment, with for example redirects, traffic delays, and noise pollution. Since infrastructure projects are meant to last for decades, it is important that predefined goals, that have become irrelevant, due to the changing circumstances and new information, can be changed (Westerveld and Hertogh, 2013). Adapting to changing circumstances is crucial for the long-term sustainability of large infrastructure projects (Giezen et al., 2014). Therefore, it is important to create infrastructure projects that can cope with a developing world, where there is freedom for creativity and innovation, and at the same time enough control to give the project a clear direction.

This research will use the case of the deepening of the Southern Ring Road in the city of Groningen, located in the North of the Netherlands. The Southern Ring Road is a large infrastructure project facing budget- and time overruns. The project had to deal with a highly dynamic context due to the long time span. With the past tendency of Rijkswaterstaat to focus on control, the Southern Ring Road is a suitable case to study the barriers and enablers in practice of a flexible approach.

Problem Statement

Project organizations are persistently dealing with changing circumstances and unexpected events, which they cannot adapt to well, because in current project management, the detailed project design has been fixed, in the early phase of the project (AT Osborne, 2019). Therefore, the aim of this research is to find flexibility enablers that are in line with practice, to achieve a more effective approach in dealing with unplanned events for infrastructure projects. This has led to the following research question:

How do infrastructure project organisations respond to unexpected events taking into account the complexity of infrastructure projects and its environment? What do these responses learn us about barriers and enablers of flexibility?

Sub Questions:

1. What types of complexity play a role in infrastructure projects in theory?
2. What flexibility blockers and flexibility enablers are mentioned in theory?
3. What unplanned events do projects in practice have to cope with?
4. How do projects in practice respond (control or flexibility) to unplanned events? And how do these responses relate to literature (questions 1 and 2)?

First, an overview of the current theory on flexibility is given. In chapter 2.1 it is explained how complexity leads to uncertainty and surprises in infrastructure projects, and with which complexities infrastructure projects have to deal. Then in chapter 2.2 the tension between control and flexibility in infrastructure projects has been outlined through finding literature talking about flexibility. Chapter 2.3 goes in on achieving flexibility and ends with the flexibility enabler and flexibility blocker frameworks. Lastly the conceptual model is presented. In Chapter 3 the methodology is presented, given the reasons behind the chosen interviews and case study. Furthermore, the case of the Southern Ring Road in Groningen is presented. Chapter 4 presents the results of the interviews. And Chapter 5 discusses the results through comparing the flexibility enabler and blocker frameworks with the results of practice. Chapter 6 contains the conclusions and reflections.

Chapter 2 Theoretical Framework

2.1 Complexity

In the past (rational planning paradigm) it was believed that the environment could be controlled (de Roo, 2006a). The government knew what was best for their civilians and a top-down approach was “pushed” through society. However, in practice planners always face uncertainty. Even when a plan seems perfect, and everybody agrees, then still there might be a lack of action or even undesired outcomes, since the world is unpredictable (de Roo, 2006a). For insights and explanations of the complexity and uncertainty, system thinking, chaos theory, and complexity theory, are used.

System Thinking and Chaos theory

Since interventions in the environment do not take place as isolated events, it is impossible to get a full understanding of what is likely to happen when making them. Instead, actions take place within a stream of ongoing events, and might interact and intervene with these events. Furthermore, these actions are influenced by near-invisible patterns of unwritten social laws, rules, and processes (de Roo, 2006c). Therefore, the idea of system thinking can be used. System thinking considers to have entities that are connected to each other by their actions and reactions. And these entities are always interacting with each other and the environment leading to the existence of different systems. Thus, there are no isolated actors, they always exist within systems.

Chaos theory takes this even further by also including the development of systems in non-equilibrium situations, and by introducing the concept of time. In reality you do not have only stable entities since they also evolve over time, leading to non-linearity and a dynamic environment. Chaos theory argues that in an dynamic open system, the direct causal relationships are not clear anymore. Very small changes can have very diverse outcomes (de Roo, 2010,). Due to the fact that everything is connected to everything, you have systems interfering, which lead to the impossibility to predict the result of a certain action or intervention.

Chaos theory helps us understand reality since it takes into account the fact that you can have both stable predictable systems and dynamic unpredictable systems in the world. Furthermore, it accepts the interconnectedness of system and the fact that small changes can lead to significantly different outcomes. These principles are helpful in planning and interventions since different approaches can be tailored to different degrees of complexities. A stable predictable system can be categorized as simple, with clear predictable outcomes. A top-down management style, based on certainty, can be adopted to this closed off system. However, if you deal with highly complex systems, where it is impossible to predict the consequences of an intervention, it will lead to the need for a bottom up, communicative approach (De Roo, 2010). The causality becomes fuzzy. Since in highly complex systems, the problem itself might not even be clear you need to talk to all stakeholders, and use local information. (de Roo, 2010).

Complexity theory

Complexity theory takes into account the existence of both chaos and predictability. In every complex system there is a degree of structure, but not enough for a system to be entirely under control. Complexity theory challenges the assumption that if you dig deep enough into the circumstances of the problem that you will be able to uncover the direct causal relations. Nothing in the world is always stable (De Roo, 2006b). What was seen was that planning interventions based on the idea that we could predict the future due to direct causal relationships (rational planning paradigm), did not actually

lead to successful outcomes. One actor will not only influence the system, but also other actors. These relations influence each other, leading to a different influence on the system. The uncertainty faced by the fact that we are not able to find all the causes that play a role towards a certain outcome, results into unpredictable events. Therefore, it is important the uncertainty is accepted and absolutely not ignored (De Roo, 2006b).

Infrastructure projects have been treated as a closed off system, where outcomes of the intervention were predictable (Khosravi and Bin Mohammed, 2012). However, with unsuccessful infrastructure projects that have either not led to the expected improvements of mobility or have faced huge budget- and time overruns (Koppenjan et al., 2011), a different approach towards infrastructure projects has been called for. A simple problem, where there are not much unclarities (e.g. a traffic light) can indeed be solved with a top down approach. However, with infrastructure projects ambiguity comes into play. What is the best way to improve the mobility in a city when you do not yet know how the future will look like? What is the best for the environment? Instead of hierarchy and a top-down approach, the process needs to be opened to bring stakeholders with different perspectives together and get creative solutions.

2.1.1 Project Complexities

Busscher et al. (2022) have researched and categorized the different complexities Rijkswaterstaat projects face. They note that project complexities can be regarded as a combination of multiple different complexities.

Technical complexity

Technical complexity stems from technological uncertainty, the uniqueness of the project (are there already other examples), how diverse the tasks of the project are to reach the overall result, and how related those tasks are to each other. Furthermore time pressure, large amount of resources and people, and different interests add to the technical complexity (Busscher et al., 2022).

Organisational Complexity

Organisational complexity stems from the projects organisation and the stakeholders involved. Once a project organisation is large and has many hierarchical layers and different groups, you get a differentiated project organisation, increasing the complexity (Busscher et al., 2022).

Contextual Complexity

Contextual Complexity stems from the actors and their different interests. Political influences and different interest increase the complexity of projects. Furthermore, the context of the project, the laws and regulations, different cultures, different layers of government, and amount of support for the project increase the complexity (Busscher et al., 2022).

Institutional Complexity

Institutional complexity stems from the personal working methods of the project organisation. Since different actors have different working methods, and interests conflicts can arise more easily. Especially the difference between public and private actors is mentioned (Busscher et al., 2022).

2.1.2 Complexities of the decision-making process

Shi et al. (2020), have made an extensive framework on the complexities of the decision-making process that mega infrastructure projects face. Complexities of the decision-making process differ from

project complexities (Shi et al., 2020). Shi et al. (2020), have identified six forms of complexity affecting the decision-making process: Technical complexity, Social complexity, Time complexity, Organizational complexity, Financial Complexity, and Legal complexity (Table 1). All these different types of complexities are highly interrelated, and influence the decision-making. Awareness about these decision-making complexities is important, since it can help project organizations improve their decision-making process (Shi et al., 2020).

DIFFERENT TYPES OF COMPLEXITY	INFLUENCE ON THE DECISION-MAKING PROCESS (ACCORDING TO SHI ET AL., 2020)
TECHNICAL	Uncertainties about geology and innovation Extreme weather conditions Different technical standards
LEGAL	Laws and regulation
ORGANIZATIONAL	Division of responsibilities and tasks (principal-agent relationship)
TIME	Long time frames with constantly changing/developing world Huge time pressures
SOCIAL	Different interests and preferences Large number of stakeholders Changing preferences of stakeholder Large impact on environment and local stakeholders
FINANCIAL	High financial requirements Different sources of financing

Table 1. Different types of complexity (Shi et al., 2020).

In this research, it was chosen to use the framework of Shi et al. (2020) since it is more extensive and comprises the types of complexity mentioned by Busscher et al. (2022) in their recent research. As mentioned above, different complexities play a role in infrastructure projects leading to the need for flexibility. But how to incorporate flexibility in managing infrastructure project? literature mentions a control and flexibility paradox, meaning that both control and flexibility are needed to come to a successful end. Flexibility is needed to deal with unexpected events, uncertainties due to the complexity of projects and control to be able to come to a result. First an overview of the different literature is given.

2.2 Overview of literature on flexibility and control in infrastructure projects

Extensive literature exists on the topic of the need for a project organisation to be able to adapt to uncertain events. However, different names have been given to the concepts control and flexibility. There has been made distinctions between control versus flexibility (Szentés and Eriksson 2016 and Koppenjan et al., 2011), control versus interaction (Westerveld and Hertogh, 2013) project versus process management (Edelenbos et al., 2007), internal versus external (Verweij, 2014), flexing versus

hedging (Leendertse et al., 2022), proactive versus reactive management (Eriksson et al., 2019), Lean versus Agile management (Sohi et al., 2016), and adaptive capacity (Giezen et al., 2014 and de Groot et al., 2020). Therefore, first, an overview has been given in the infrastructure projects literature about the flexibility of infrastructure projects.

First, Szentes and Eriksson (2016) and Koppenjan et al. (2011) argue that it is not either control or flexibility, but both are needed in infrastructure projects. It is important that project goals and requirements are not too rigid, as flexibility is needed to be able to adapt to the changing circumstances. However, at the same time, control is needed, as endless flexibility leads to no direction. If changing decisions keep pushing the project in different directions, it will never be possible to finish a project (Szentes and Eriksson, 2016). To achieve a high-quality project within budget and time, there needs to be control around these parameters of the project. However, the complexity and uncertainty of projects need flexibility (Koppenjan et al., 2011). Therefore, both are needed, but there is tension. Szentes and Eriksson (2016), show the tension that aiming for both control and flexibility gives (Figure 1). For example, there is the tension between flexibility in the design, and the statutory planning processes and rules and regulations. Or the tension between flexibility in the design and implementation, and minimizing disturbances for the environment. These tensions show why it is not self-evident that flexibility is created in infrastructure projects.

Organizational interface	Tensions between control and flexibility
Authorities–project	Regulations concerning HS and environment versus flexibility in design and production Statutory planning processes versus flexibility in design Review process by the STA's technical expert branch versus flexibility in design Public Procurement Act versus flexibility in organizing processes
Public–project	Noise reduction and minimizing of disturbances versus flexibility in design and production Demands for continuous traffic flow versus flexibility in production Protests and appeals of plans versus flexibility in production Efforts to address the public versus more focus on production
Megaproject management–client project manager	Harmonizing technology in megaproject versus flexibility in design Optimizing megaproject schedule versus flexibility in production planning Optimizing megaproject schedule versus flexibility in resource utilization Harmonizing megaproject contract management versus flexibility to negotiate
Contractor company–contractor project manager	Controlling governance forum or manager versus flexibility in decision making Contradictory decisions by different governance forums versus flexibility in decision making
Client–contractor	Contract specificities versus flexibility in design and production Fines for missing intermediate milestones versus flexibility in production planning Monitoring and spot checking versus trust and self-control Formal notification and protocol versus trust and informal communication

Figure 1 The paradoxical tensions between control and flexibility (Szentes and Eriksson, 2016)

Second, Edelenbos et al. (2007), differentiate between 'project management' and 'process management'. Project management focuses on the control and the manageability of the project. It assumes that the environment is more or less stable, therefore all the project requirements and goals need to be executed and disruptions are averted. The parameters of the project are thus fixed. The projects can be divided in different steps, which can be structurally finished. This design, convinces the stakeholders that the plan should be implemented (Edelenbos et al., 2007). On the other hand, there is the 'process management' style, which is based on the assumption of the dynamic and complex interests of the different stakeholders. Transparency is key, as the information from different stakeholders leads to continuous solving of problems (Edelenbos et al., 2007). In their research, Edelenbos et al. (2007) have concluded that projects managers do not use only one management style. Instead, strategies fitting both management styles, such as transparency, and consensus (process management), or decisiveness, and goal realization (project management), are used interchangeably.

Third, Westerveld and Hertogh (2013) make the difference between control versus interaction. Control means holding on to the existing project goals and having little attention for developments in the surrounding environment. Interaction on the other hand has a strong focus on involving stakeholders. Stakeholders need to be included in the project since it gives support for the decided project goals. While a focus on control deals well with detail complexity (E.g. The difficulty of producing the final product, the actions needed for the production, and the amount of stakeholders involved), a focus on interaction deals well with dynamic complexity (E.g. Small changes can have large, unpredictable consequences, and preferences of stakeholders are dynamic). Having a control approach in a highly dynamic environment often backlashes since unsatisfied stakeholders, can become a strong oppositional force leading to changes during the process of the project and stagnating the development of the project (Westerveld and Hertogh, 2013).

Fourth, Verweij (2014) have made the same conclusion as the research of Westerveld and Hertogh (2013), by making the distinction between internally-oriented management, and externally-oriented management. If unexpected events in infrastructure projects are internally managed, the event is kept within the organisation and a solution is chosen without input of the environment. If unexpected events are externally managed, the relevant stakeholders are involved, to together come up with a solution. The result of the research was that externally managed unexpected events led to a higher satisfaction. Instead of having strict control, flexibility is needed to opening the process, and including stakeholders. Then you know there is support for a decision or project (Verweij, 2014).

Fifth, Leendertse et al. (2022), differentiate between flexing versus hedging. Hedging means that the project organization holds on to the predefined output it has set, and the environment is seen as a threat which must be controlled. Flexing means that projects are able to move along with their environment, and have an open and interactive approach with the environment (Leendertse et al., 2022). Since, infrastructure project still have the focus on a hedging approach they ask the question if the project environment can actually be controlled. An increase in human awareness about their environment, and citizens initiatives, and participation, force project organizations to work together with the environment (Leendertse et al., 2022). And although, an open process might feel like a loss of control, it not necessarily means that, it actually just means a different type of control. Moreover, a different type of balance between hedging and flexing is needed in different phases of the project. In the designing phase there is more room for flexibility since fewer agreements are made. While in the executing phase, many agreements and investments are made (Leendertse et al., 2022).

Sixth, Eriksson et al. (2019) focus on reactive problem solving versus proactive development. Infrastructure project organisations get to deal with reactive problem solving when unforeseen problems happen. For example, uncertainty in geology, can lead to the need for having a strong capacity to be able to cope with sudden changes. However, this focus on reactive problem solving, or 'firefighting' means less attention and time for proactive development. Proactive development is highly important since proactively working with co-creation and innovation leads to a more robust foundation and support for implementing new knowledge and technology. Once new knowledge is shared with each other project participants learn new things and trust is created. This leads to a greater capacity of the project organisation to deal with unexpected events and problems. The organisation is better prepared to use the new information to choose an alternative solution (Eriksson et al., 2019).

Seventh, Sohi et al. (2016) write about the combination of lean, and agile management. The basic principle behind lean management is achieving more with less, and this has worked well for the construction industry. However, since lean cannot cope well with changing contexts agile management has been thrown in. Agile management does not plan everything beforehand at once, but in steps with the most current information. By continuous feedback continuous learning is achieved. And instead of

achieving the value of the wishes of the beginning of the project, people are satisfied in the current situation (Sohi et al., 2016).

Eight, Giezen et al. (2014) and de Groot et al. (2020) talk about adaptive capacity. Giezen et al. (2014) argue that adaptive capacity is needed for the challenges and surprises large projects give due to their complexity. There is a focus on reducing complexity instead of accepting it. Giezen et al. (2014) found that planners and decision-makers are likely to have a preference for inertia (no adaptations), even though adaptations could improve projects. A simplification of the project is preferred which leads to excluding oppositional forces, or having a small scope. The need for adaptation needs to be acknowledged in order to prevent deadlocks, and to deal with new challenges and opportunities. Especially oppositional forces should be accepted (Giezen et al., 2014). Disagreeing with other parties can lead to creative outcomes and might even speed up processes since it prevents opposition later on in the project (Giezen et al., 2014).

Furthermore, de Groot et al., 2020 link adaptive capacity to collective learning. Adaptive capacity is defined as the ability to deal with changing circumstances. To achieve adaptive capacity there is looked into how collective learning works as proxy for adaptive capacity. Since collective learning can be viewed as a process of adjustments or adaptation, where shared knowledge and perspectives evolve over time, new agreements are made, and action is taken based on the mutual learning, learning leads to flexibility in a project (de Groot et al., 2020).

This overview of the literature about the need for flexibility and control in infrastructure projects show that there is an overall understanding and agreement in literature that flexibility cannot be ignored. In Table 2 an overview of the different names together with the lessons each article gives about flexibility are given.

ARTICLE	APPROACH		LESSONS
SENTZES AND ERIKSON; KOPPENJAN ET AL., 2011	Control	Flexibility	Both control and flexibility are needed, however the different management styles come with the tension between certainty (control) and flexibility.
EDELENBOS ET AL., 2007	Project management	Process management	Project managers already make use of a mix of the characterises of both management styles.
WESTERVELD AND HERTOOGH., 2013	Control	Interaction	Control works well for detail complexity, and interaction works well for dynamic complexity
VERWEIJ, 2014	Internal	External	The project implementation is dependent on stakeholders. External management, thus including stakeholders, leads to a higher satisfaction
LEENDERTSE ET AL., 2022	Hedging	Flexing	Find the right balance between hedging and flexing in every phase of the project. In the executing phase there is less room for flexibility.
ERIKSSON ET AL., 2019	Reactive	Proactive	Proactive development, with co-creation and innovation leads to improved reactive problem solving

SOHI ET AL., 2016	Lean	Agile	Combine Lean management, which works well in the construction industry but lacks dealing with changing circumstances with agile management what makes use of short feedback loops and continuous learning.
GIEZEN ET AL., 2014 DE GROOT ET AL., 2020		Adaptive capacity	Adaptive capacity is the ability to cope with changing environments. Bringing oppositional forces together can lead to creative solutions and faster processes. And new information and learning leads to better project outcomes.

Table 2. Overview of control versus flexibility literature.

2.3 Flexibility Enablers

The information provided in Table 2 highlights the extensive amount of literature that exists on management styles, and the tension between control and flexibility in infrastructure projects. But how to get flexibility in the projects? Building on the flexibility enabler framework of Sohi et al. (2020), I have searched for further flexibility enablers in literature, to be able to compare those with experience from practice. In Table 3, an overview of all the flexibility enablers with explanation how this increases flexibility in infrastructure projects has been given.

Multiple flexibility enablers become clear from literature. *Functional requirements* in the contract give flexibility (Eriksson et al., 2019; Koppenjan et al., 2011; Sohi et al., 2020). Functional requirements give design freedom to the contractor. Instead of prescribing detailed solutions which lead to lock ins, functional requirements give flexibility since it gives design freedom to the contractor (Eriksson et al., 2019). Furthermore the scope should be defined by a *broad task division* (Koppenjan et al. 2011), meaning that not everything is written down from detail to detail. Furthermore, Sohi et al., 2020) mention a *broad scope* as flexibility enabler, defining the scope in broad tasks instead of detailed working packages results in increased flexibility.

Stakeholder inclusion was also seen as a flexibility enabler (Verweij, 2014; Eriksson et al., 2019; Sohi et al., 2020; Groot et al., 2020). Including diverse actors gives different perspectives and access to external information (Groot et al., 2020). Furthermore, stakeholders need to be included since the contractor is dependent on the wishes of the stakeholders. There needs to be a flexible approach which is open to involve stakeholders (Verweij, 2014). Eriksson et al. (2019) mention that involving stakeholders early, means that the infrastructure project meet the changing requirements of the environment. On top of that, closely involving stakeholders and being transparent about the decisions that are being made help enhancing communication, which is extremely important for trust and flexibility in the organisation (Sohi et al., 2020).

A strong *collaboration* between actors is an important flexibility enabler. Collaboration is important for proactive management where flexibility is needed to have innovation (Eriksson et al., 2019). Furthermore a good collaboration gives flexibility to the contract (Demerial et al., 2016).

Related to collaboration is *trust*, which is seen as another important enabler of flexibility (De Groot et al., 2020; Leendertse et al., 2022; Sohi et al., 2020; Eriksson et al., 2019). Involving stakeholders creates trust between actors (Eriksson et al., 2019). Furthermore, organizing interaction and social relations creates trust and an open atmosphere (Leendertse et al., 2022). And less hierarchy and having self-steering teams instead of only a project manager creates trust (Sohi et al., 2020). De Groot et al. (2020), talk about the trust between the project organisation and the parent organisation. Since there is less interaction between the project organisation and the parent organisation, it is more difficult to gain trust. However, trust is important to admit mistakes and spread newly learned information (de Groot et al., 2020).

(Multilevel) integration is another important factor. Multilevel integration reduces the horizontal and vertical barriers that are there, and supports interaction and knowledge sharing (Groot et al., 2020). Cross-discipline meeting structures can help realizing multilevel integration (Leendertse et al., 2022). Furthermore, Sohi et al. (2020) mention that reducing the hierarchy in an organisation makes changes in a project easier, and Koppenjan et al. (2011) mention that horizontal cooperation arrangements facilitate fast decision making since decisions are supported by different parties. Furthermore, weak hierarchy can lead to more creative solutions (Giezen et al., 2014).

Project organisations should be aware that changes are inevitable, and should therefore *Acknowledge changes* (Demiral et al., 2016; and Leendertse et al., 2022). Changes should be viewed as opportunities (Leendertse et al., 2022).

Therefore, contingency planning is important (Sohi et al., 2020 and Leendertse et al., 2022). Alternative plans need to be made for if the main plan cannot be executed anymore or does not lead to the desired result (Sohi et al., 2020). Anticipation of contingencies is needed, this can be done through looking at different scenarios and have programs that allow for easy access to information (Leendertse et al., 2022).

Learning was mentioned as an important enabler of flexibility (De Groot et al., 2020; Leendertse et al., 2022; Khorsvi and Mohammed, 2012; Sohi et al., 2016). Learning is linked to flexibility since responding to challenges in projects leads to the building of new knowledge, relationships and practices (Leendertse et al., 2022). Since there are no routine measures for coping with unexpected events, you need to learn how to deal with these events (Khorsvi and Mohammed, 2012). Sohi et al. (2016) talk about continuous learning. Recurrent feedback leads to continuous learning, which then continuously add improvements to the project (Sohi et al., 2016). This can be linked to *Iterative planning* (Sohi et al., 2020) since the project plans and objectives are constantly reviewed and adjusted over time. Therefore, *short feedback loops* (Sohi et al., 2020) are ensured, through installing short term meetings to receive feedback to adjust plans. Furthermore, Groot et al. (2020) view learning as a proxy for flexibility since collective learning can be seen as a constant process of adaptation.

Building in *adaptive capacity* in the process is an important flexibility enabler. Once symptoms of deadlock are known it is important to have mechanisms installed which prevent these lock-ins and promote adaptability (Giezen et al., 2014).

Lastly *late locking*, making decisions at the latest possible moment (Sohi et al., 2020), and *standardised process and design*, that can be used in similar projects (Sohi et al., 2020), were mentioned as flexibility enablers.

Literature	Flexibility enablers	Explanation
Eriksson et al., 2019; Koppenjan et al., 2011 Sohi et al., 2020	Functional requirements	Avoiding locking in of technical solutions and gives design freedom
Verweij, 2014 Eriksson et al., 2019 Sohi et al., 2020 Groot et al., 2020	Stakeholder inclusion	Need for stakeholder inclusion since the contractor is dependent on stakeholders for the implementation of the project. Early stakeholder involvement gets solutions that meet changing requirements.
Eriksson et al., 2019 Demerial et al., 2016	Collaboration between actors	Collaboration is vital for proactive development.
De Groot et al., 2020 Leendertse et al., 2022 Sohi et al., 2020 Eriksson et al., 2019	Trust	Safe, informal, and democratic environment, where stakeholders can be transparent about information gives flexibility
De Groot et al., 2020; Koppenjan et al., 2011; Leendertse et al., 2022; Giezen et al., 2014	Multilevel integration	Reducing of barriers for collective learning and supports knowledge synthesis across vertical and horizontal scales
Demerial et al., 2016 Leendertse et al., 2022 Sohi et al., 2020	Acknowledge Changes	Changes need to be acknowledged and not ignored Understanding of the potential changes. Project organisations need to view changes as opportunities.
Sohi et al., 2020 Leendertse et al., 2022	Contingency planning	Alternative plans need to be made.
De Groot et al., 2020 Leendertse et al., 2022 Khorsvi and Mohammed, 2012 Sohi et al., 2016	Learning	Learning is a flexibility enabler, since you learn how to adapt to unforeseen circumstances and challenges.
Sohi et al., 2020	Iterative delivery	Split the project up in smaller projects, where the subprojects are delivered to the client when finished. However, the whole cannot be overlooked.
Giezen et al., 2014	Build in adaptive capacity in the process	Built in processes that prevent lock-in and facilitate adaptability.
Sohi et al., 2020	Short feedback loops	Short-term meetings (e.g. daily), will help getting good quality for the end product

		since it gives in between feedback
Sohi et al., 2020	Standardised process and design	Having simple standards for e.g. processes or the design, that can be used for other similar projects.
Sohi et al., 2020	Late locking	Decisions are strategically delayed till the latest possible moment.

Table 3. Flexibility Enablers ¹

2.4 Flexibility Blockers

Although the opposite of flexibility enablers can be characterized as flexibility blockers, three flexibility blockers have explicitly been mentioned in literature (Table 4).

Extensive time and cost pressure, have been mentioned as flexibility blockers by Eriksson et al. (2019). Under time pressure, people tend to perform tasks in their accustomed way. If there is money for innovation and time to experiment different design options, it leads to creative solutions (Eriksson et al., 2019)

Protectionists forces, can block flexibility, once there is not let go of requirements that satisfy invested stakeholders, even if it leads to suboptimal solutions (Giezen et al., 2014).

Lastly, *taboos*, cause possible deadlock (Giezen et al., 2014). If parties still disagree on a certain design solution, and this is left in the middle, while still working on other parts of the projects, it leads to standstill in the project.

Literature	Flexibility blockers	Explanation
Eriksson et al., 2019	Extensive time and cost pressure	Time pressure causes for the use of existing and proven technologies. Allocate money for innovation.
Giezen et al., 2014	Protectionist forces	Strong protection of vested interests without the willingness to search for a solution that adds most value to the whole.
Giezen et al., 2014	Taboos	Not discussing difficult issues, in order to make progress on other fields.

Table 4. Flexibility Blockers

¹ In the article of Sohi et al., 2020 more flexibility enablers have been mentioned. Since they were of a very small scale there was chosen to not include these in the list. These were the following: Short feedback loops, Management support, stable team rather than building a team per project, joint project office for project teams, self-steering of the complete project team, have flexible desks, shared interface management, seizing opportunities and coping with threats, visualized project planning and progress, self-assignment of individuals to tasks, team priority over individual priority, visualized project planning and process, continuous locking.

With the flexibility enablers of table 2 and the flexibility blockers of table 3, the frameworks can be used to research which flexibility enablers are in line with practice and which are not. This will be done in the discussion chapter. But first the conceptual model will be presented.

2.4 Conceptual Model

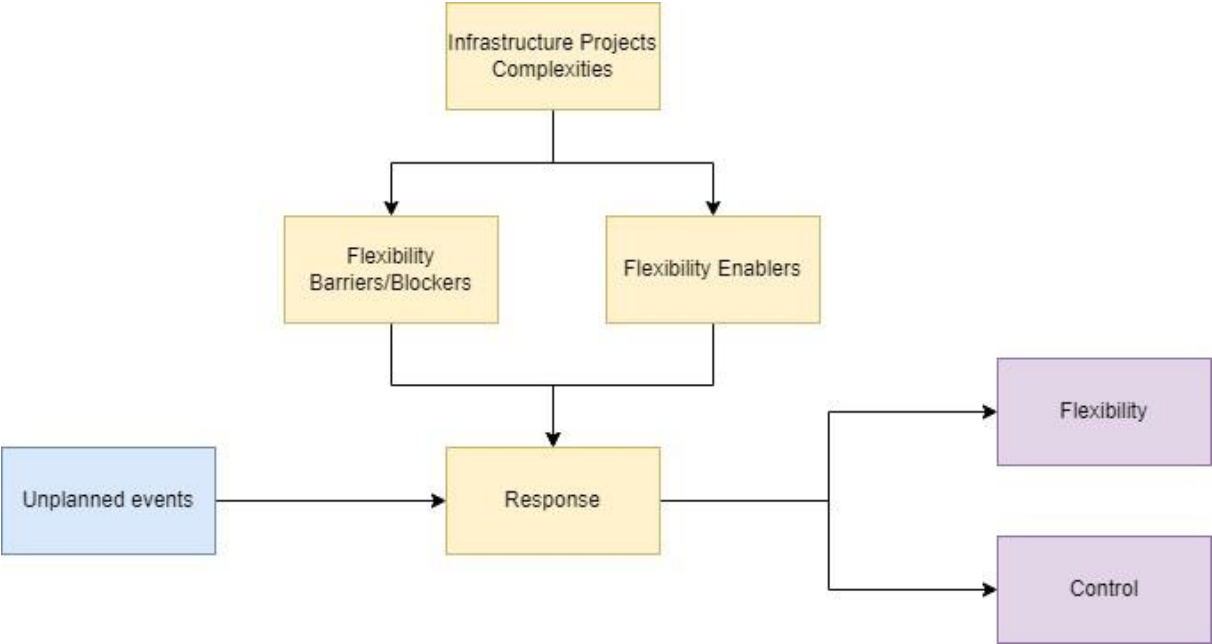


Figure 2. Conceptual Model

Chapter 2 started with the complexity theory and which types of complexity play a role in infrastructure projects. After the complexities the flexibility enablers and blockers were found in literature. In chapter 3 the case of the Southern Ring Road in Groningen will be explained, and in chapter 4 the results. How was responded towards unexpected events, what complexities played a role that make practice different, and which flexibility enablers and blockers were there. Then is looked if the response taken led to a flexibility or control response.

Chapter 3 Methodology

3.1 Research Design

To study the practice of handling of unexpected events in (complex) infrastructure projects a singular case study was conducted. This method was chosen since the organisation and management of infrastructure projects is mostly context-dependent. To be able to understand the complexity of the project in its environment, in-depth research is needed to grasp what is going on in a certain context (Flyvbjerg, 2006). Therefore, interviews have been conducted to collect experiences, and lessons that have been learned. The aim of this research is to find out how project practice responds to unexpected events, the effectiveness of the approach taken, and to find blockers or enablers for the most effective approach. Therefore, in the discussion, flexibility enablers and blocker in theory are compared to flexibility enablers and blockers in practice.

3.2. Case selection

The case selection was based on different criteria. First of all, the case needs to be an infrastructure project that faces huge complexity, due to the fact that complexity leads to the need to be flexible or adaptive. Therefore, there has been chosen for a mega infrastructure project since they are inherently complex. Complexity comes from the fact that a project is large, includes a lot of stakeholders, and has different objectives. Secondly, it needs to have a long lifespan, as uncertainties and unexpected events arise during longer timespans. Thirdly, the project needs to be ongoing, since the project organisation is still in the middle of facing unexpected events and coping with problems. In addition, respondents for interviews can be easily found since the project organisation still works together in one location. These criteria have led to the choice of the Southern Ring Road (Aanpak Ring Zuid) project in the city of Groningen as our case to study. This large infrastructure project is unique since it is about a highway through a city. With almost no space to build, a large scope, many different stakeholders and interests, many different goals, and a life span of the project larger than 10 years, the project fits exactly the requirements to study the subject of dealing with unexpected events and being flexible. Furthermore, the project organisation has its own location in the city of Groningen, which makes it easy to have access to personal, information, and data. The case description can be found in chapter 3.6

3.3 Data collection

First, there was chosen to make use of qualitative data instead of quantitative data. Since infrastructure projects are context dependent and the research aim is to analyse the responses to unexpected events, using quantitative data methods such as a survey does not fit the research strategy. Instead interviews are used to acquire data about the reasons behind choices. Interviews are important since it allows actors to tell their story and get insight in the different motives behind certain decisions. Stories put separate actions into a meaningful whole (de Roo, 2006c). Semi-structured interviews were used. During the interviews, interviewees were asked about their experiences with and perspectives on unexpected events. What were the reactions to the event, who were involved, and what was the final decision that was made. Were respondents satisfied by the final solution?

The interviews were conducting following the interview guide (Appendix 9.1). Interviewees were asked about their experiences while they worked in the project organisation. The timeframe of the experiences thus differs, and is in between the exploring phase and the building phase of the project. The eleven interviews have been conducted in May 2023. Seven people of the client have been interviewed, two of the contractor, two of the municipality, and one of the province. The interviews

have been recorded, transcribed, and then coded in Atlas.ti. This way the complexities the project organizations had to deal with become clear, and can be linked to a control or flexibility approach. Furthermore, enablers and blockers of a flexibility approach can be found.

3.4 Research Ethics

This research has multiple ethical considerations. The data collection contains personal stories that might involve information that is sensitive to the interviewee, therefore the interviews are handled carefully. The interviews have been recorded and transcribed. During the interview the interviewee was pointed at their rights that participating is voluntary, and quitting or deleting data was possible at any moment. The recordings and transcripts have only been used for the purpose of this study and have only been stored at the laptop of the researcher. Codes have been assigned to the interview quotes to be able to analyse the results structurally. Quotes have also been kept in their context.

However, as Drapeau (2002), mention research is always influenced by the subjectivity of the researcher. Researchers have their own experiences, biases, insecurities and pre-occupations which can lead to having a certain image of the interviewee (Drapeau, 2002). If researchers want to try to keep this image intact the researcher might over-emphasize certain data, while ignoring other parts of the data. This can lead to distorted conclusions (Drapeau, 2002). A third party can help analysing data more objectively (Drapeau, 2002). It is therefore important to acknowledge the subjectivity that influences the work of the researcher.

It is important to mention that this research was conducted with a background in the Environmental and Infrastructure Master. Furthermore, an internship at Rijkswaterstaat was followed. During the internship at Rijkswaterstaat a large part of the time (one or two days a week for five months) was spent at the office floor of the client. The contractor was also visited, and interviewed, but this difference should be taken into account. Although, the subjectivity is acknowledged, this background together with preoccupations and biases, could have influenced this research through the phrasing of the research questions, the way interview questions were asked, and the analysis of the results.

3.5 Data Analysis

The data was analysed using the program Atlas.ti. There has been made use of deductive coding. For every unexpected event that was mentioned in the transcription a code was created (Appendix 9.2). This has led to 14 codes of unexpected events. These unexpected events were further analysed by making network groups in Atlas.ti. In the networks groups on the left side all the quotes regarding the causes of the unexpected events were put. In the middle how was dealt with it, and on the right side the quotes about satisfaction. This gave a good overviewing for analysing all the aspects relevant to the unexpected event. An example is given in Appendix 9.3.

Next to the unexpected events, deductive codes have been made on different topics of the project that are relevant to this research (Appendix 9.2). Firstly the codes 'complexity', 'context-dependency' and 'uncertainty' were created, as they are important to understand the dynamics of the environment. Secondly, the codes 'changing laws and regulations', 'changes / becoming obsolete', 'learning / new insights' and 'innovation' have been created, to understand why the changes the project had to deal with happened. Thirdly, a code was created to analyse the different 'problems / causes', together with 'how they were dealt with', the 'tension between control and flexibility', and 'satisfaction'. Lastly, a separate code for the 'intuition of people' was made, and a separate code was created for when 'politics' influenced a decision.

3.6 Case description

The Southern ring road project consists of a variety of measures and components designed to enhance transportation, accessibility, and safety in the region. In figure 3, the scope of the project is shown. The twelve-kilometre-long road goes through the city and crosses city roads, train tracks, and waterways. The project is highly complex since it entails the (re)building of 35 viaducts, elevated roads, tunnels, new highway entrances, the renovation of the Euvelgunner bridge, and the redesign of neighbourhood streets together with a new park on top of the roof of deepened road. A couple of the most important improvements in the southern ring road can be found in figure 4.

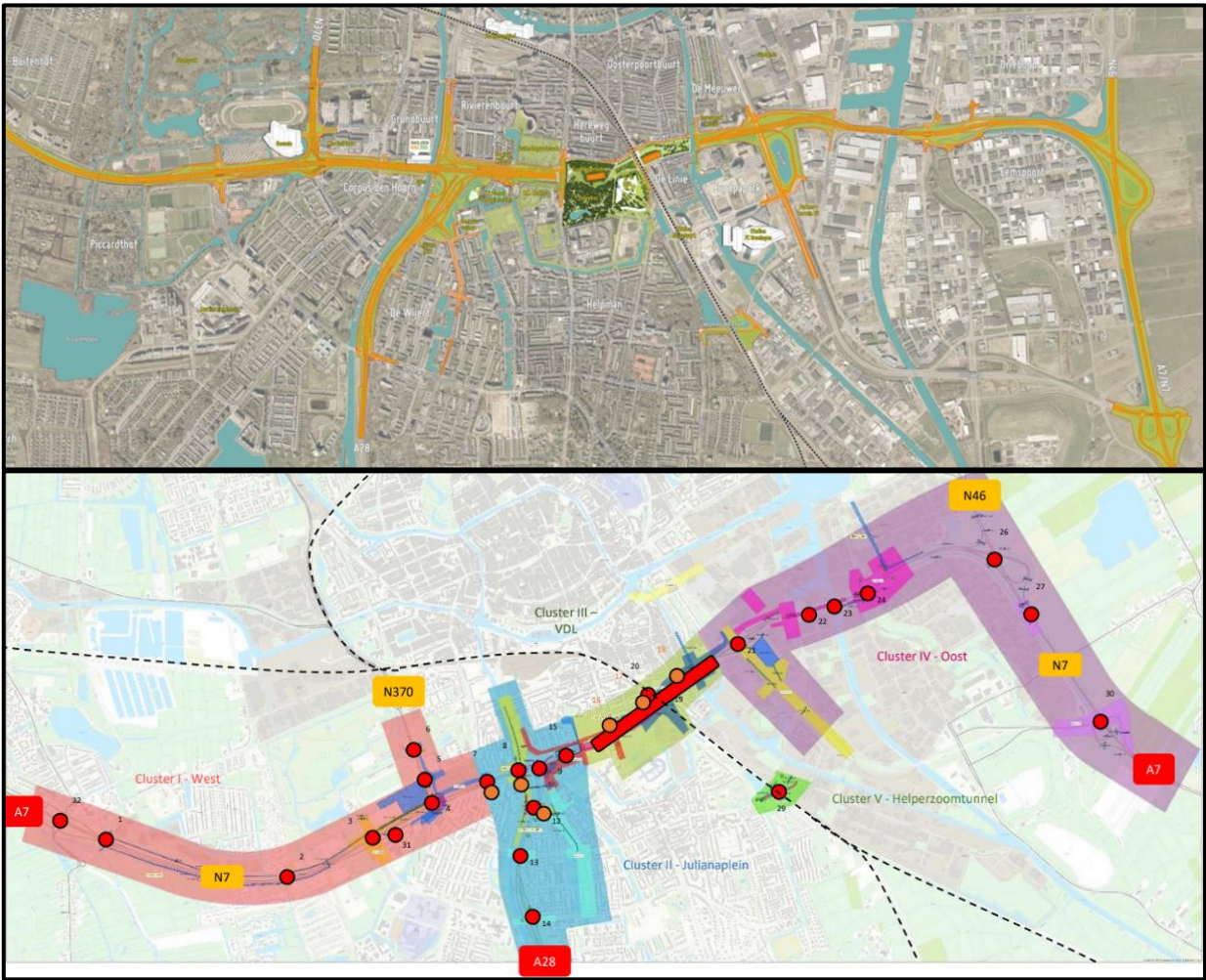


Figure 3: Scope of the project



- A Vrijheidsplein:** Traffic does not have to wait anymore at the roundabout since the roads will be build multi-level. Also an exit from the A7 to the Western Ring Road is build.
- B Julianaplein:** At the busiest crossing of the North, the traffic lights are being removed. Every of every direction will now get their own road. This entails building three layers of roads on top of each other.
- C Europaplein:** In between the Juliaplein and the Europaplein, the road will go underground at a depth of eight meters. On the road three roof planes will be placed which will be designed with greenery.
- D Euvelgunnerbrug:** The bridge is renovated and there will be an extra lane for traffic in the direction of the city. Together with other measures the companies located in the east are better accessible.



Figure 4: Largest tasks of the project

3.6.1 From exploration to implementation of the project

The Southern Ring Road project in Groningen, in the North of the Netherlands, is a critical component of the region's road network (Plan van Aanpak Realisatiefase, 2014). Due to economic growth and population expansion, the existing road network had reached its maximum capacity, causing traffic delays, safety concerns, and impacting the city's quality of life. Already since 1992 the region has been under study to explore solutions for these accessibility problems (Plan van Aanpak Realisatiefase, 2014). Efforts to address these issues began in 2002 with the "Langeman measures" (Gemeente Groningen, 2011), and improvements to public transport and pricing policies. However, persistent bottlenecks led to the need for significant road infrastructure improvements, leading to the Southern Ring Road project (Projectteam Netwerkanalyse, 2006).

The exploration of the Southern Ring Road began in 2007, with three alternatives that were considered. With all an estimated cost of around 600 million euros, finance was needed. However, in the MIT program up to 2020 there was no money reserved for the Southern Ring Road, since its low priority compared to other infrastructure project in the Randstad (Ministerie Verkeer en Waterstaat et al., 2007). The project's significance increased after the Region Specific Package (RSP) was signed in 2008, providing compensation to the northern region of the Netherlands for missing out on the Zuiderzeelijn. This elevated the priority of the Southern Ring Road project, which had long been identified as a major bottleneck (Commissie van Onderzoek Kosten Overschreidingen, 2022) Several design options were explored, with the deepened road and tunnel being the most effective but costly solutions.

Despite financial challenges, the project proceeded and the preliminary design was accepted in 2011. The draft route decision and environmental impact assessment were completed by 2013 (Commissie van Onderzoek Kostenoverschrijdingen, 2022)

In 2014, the tender process was prepared, and the decision was made to award the project to a single contractor, Combinatie HerePoort (CHP). The basis agreement was signed in May 2016, with CHP undertaking the project for 388 million euros. However, collaboration between ARZ and CHP faced challenges, due to difficulties with staff recruitment and incomplete designs, leading to delays (Commissie van Onderzoek Kostenoverschrijdingen, 2022)

In November 2016, the alliance agreement was signed between ARZ and CHP, outlining responsibilities, risks, and tasks. The relationship continued to be strained, leading to further delays and disagreements. In 2017 the definitive design was not accepted, and in 2018 the requested summer road blockage by the contractor was not accepted, to the surprise of the contractor. Therefore, in September 2018, the Commission Hertogh was established to improve collaboration between the client and contractor. Their recommendations were used to create a "settlement agreement" for issues that still did not have an agreement, this was signed in January 2021 (Commissie van Onderzoek Kostenoverschrijdingen, 2022).

The project aims for completion of the main road network by September 2024 (Aanpak Ring Zuid, n.d.). Despite numerous challenges and setbacks, the overview in figure 5, highlights the progress of the projects and the difficulties that play a role in large infrastructure initiatives.



Figure 5. Progress of the project

3.6.2 Stakeholders

The project has a large number of stakeholders, with many different interests.

The Client

The client consists of three parties who together are named as Aanpak Ring Zuid (ARZ). *Rijkswaterstaat* who is in charge of all the highways in the Netherlands, and takes the lead in the project. The *province of Groningen*, who bears the financial risks. And the *municipality of Groningen* who takes care of the interests of the surroundings of the project.

The Contractor

The contractor consists of six parties who together form the *Combinatie Herepoort (CHP)*. There are two German companies in the combination and four Dutch companies.

External Stakeholders

Next to client and contractor there are many stakeholders in the surroundings of the city of Groningen. *Groningen Bereikbaar*, an organisation which gives up to date information about all the construction works in the city is an important one. Furthermore, companies are impacted by the construction works of the road and therefore have to be closely involved, which gives the stakeholders of *bedrijvenveriging west* and *bedrijvenveriging zuidoost*. Furthermore, public transport companies, the hospitals, universities, FC Groningen (soccer club), the cyclist association, activist groups, the bat working group, and the citizens of Groningen and workers in Groningen.

3.6.3 Project Context and Complexity

The Southern Ring road is a unique project since it is a highway project that runs through the city of Groningen. This means the involvement of three different government layers who all have a different background organisation and a different way of working and looking at the project. The project has multiple objectives, and many requirements coming from different stakeholders. Not only the accessibility and road safety needed to be improved by the project, also the liveability of the city. Furthermore, ecological standards have to be complied to. This has led to a large and technically complex project, including 35 viaducts and many other assignments. To pull off this immense construction work is a logistical challenge on its own. This all had to be realized while keeping the traffic on A7 highway running and keeping the city reachable and liveable. Keeping track of all the different road blockages, and communicating this well to all the stakeholders further complicates the challenge. Groningen is also special since it is located on the edge of an ice age ridge which makes the underground of the project very unpredictable.

3.6.4 Governance of the project

The project organisation of the Southern Ring Road works according to the IPM model of Rijkswaterstaat, which is a management tool that has the goal of an integral project organisation. This model consists of five different management roles. Project management, project control, contract management, technical management, and environment management. The five project managers are coordinated by the project director, which reports to the steering group. In the steering group there are representatives of the municipality, the province, and Rijkswaterstaat (Figure 6). Rijkswaterstaat acts as general manager of the project and apart from reporting to the steering committee, it also has to report to the Minister (Commissie van Onderzoek Kostenoverschrijdingen, 2022)

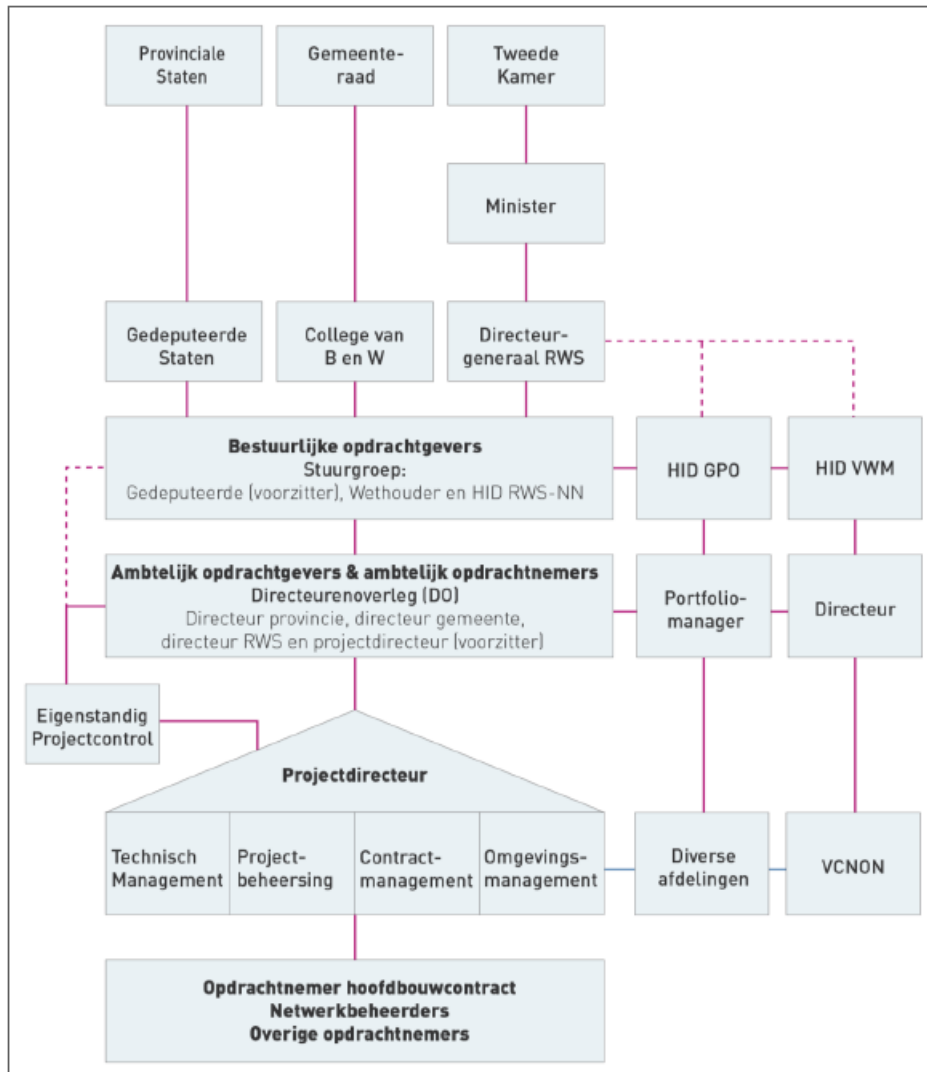


Figure 6 . Governance structure of the project (Commissie van Onderzoek Kostenoverschrijdingen, 2022)

Chapter 4 Results

During the eleven interviews conducted for this research, seven factors that influence complexity in projects became evident. The following factors played a role:

4.1 Factors leading to complexity

4.1.1 Complex environment and scarcity of space

The Southern Ring road project is located in the city of Groningen. Since the highway runs through the city, construction takes place in a dense environment with little space. The interviewees highlighted this struggle. Furthermore, the city of Groningen has to deal with quite some activist groups who are involved. The context is thus highly important.

“Things that worked really well on the Afsluitdijk project, did not work here and vice versa. If you cut one tree in Groningen the whole city is turning upside down. At the beginning, it makes you think just cut the tree and finish it.”

Additionally, the geology in Groningen further complicates the project. Since the city is located on the edge of a ridge that was formed in the landscape during the last ice age, the underground is highly varied even between two spatially close locations, which has led to unreliable measurement results. Usually, geological measurements taken on one exact location are representative of the subterranean composition in the surrounding area, but in Groningen this is not the case. This in turn resulted in many redesigns of the construction process.

4.1.2 Complex organisation

The ring road is part of the highway, the state has the authority over the road. However, since the road passes through the city Groningen, the municipality and province are closely involved. Since all three governmental bodies are used to working on different scales, all three work with different handbooks and have different interests, increasing the complexity of the project. Even though the contractor officially has to only deal with one client (RWS), in practice they felt as if they have to work with three. Especially the high demands of the municipality combined with the municipality's authority to grant permits, led to extra work and frustration.

“The many-headed monster of the municipality. There sit a lot of different puppets that all think that what they say is the truth. For example, we need to cut trees, then the guy of the trees says: ‘Yes, but you are not going to cut any trees here, are you out of your mind?’. Yes, that design is tested and accepted by the client, the tree has to go, otherwise it will be in the middle of the road”.

Furthermore, the contractor consists of a consortium of at the start six, and now five different companies. In this consortium there were two German parties and four smaller Dutch parties. Not only do the six different parties have to work together for the first time, there is also a cultural difference, a different way of working. Moreover, no party had experience working on such a large project. To get the whole project organized and running was quite the challenge.

“The idea was that the Dutch parties knew how it all worked here, because the Germans, in the Netherlands there is a different way of working. But the Dutch parties that were not a BAM, or Heijmans, the real large parties knew how to deal with Rijkswaterstaat. The Dutch parties were the four smallest, and they have to deal a little bit with that, but not on this scale. What we got was project managers that were used to doing projects in a village, so everybody needed to learn to do things in different ways. That was a whole challenge to pull off.”

Furthermore, the complexity of the project makes it difficult to have its organization run smoothly. For example, it is difficult to get the right information at the right place without any information loss.

“If you look at how much paper we have sent to the fourth floor, really trucks full.”

“For example, I write down that you cannot cause any dust or nuisance. Very logical. ... But how do I get that to the work planner who comes up with the implementation method, which causes dust, and then says, yes but I do need to build something”.

4.1.3 Large and diverse scope

Interviewees agreed on the fact that having one contractor for such a large and complex project is not ideal. The project’s scope is not only large, including a twelve kilometre long road, 35 viaducts, and a bridge, it is also diverse. It includes highways (the main road network), the underlying road network (neighbourhood streets), and a large park.

“I think with this project, it is so large and complex, looking back we should have never put it in one tender.”

The problem is that a contractor specialised in steel and concrete is put in charge of a ‘romantic’ park. Also the neighbourhood streets, for which the municipality has its own vision, are in the hands of the contractor, while these streets still adhere to decade-old requirements. Furthermore, all the greenery happens at the end of the project. Once the money is gone, there will be attempted to save money on these last features of the project such as the park, while for the municipality it is the showpiece of the project. This results in a rigid collaboration for finishing the final parts of the project.

In addition, investing in only one contractor for a large project forces the client to proceed with this contractor even if they would rather proceed with another one. Since, time, and money have already been invested in this contractor, a new contractor would cost too much, and would delay the project massively.

“Parties with whom you do not actually want to proceed further, you cannot say this is not going well, we quit, or this is not going well, we draw a strict line, because immediately you cut yourself in the fingers somewhere else in the project.”

However, putting different contractors at different parts of the projects would also have its disadvantages. To align road-closing with other contractors who work on a different part of the same road would be more difficult. Plus the fact that you have borders in the project where one contractor stops with working and the other contractor starts with working. This thus introduces planning complexities between contractors.

All interviewees concluded that the project was too large and that it would be better to break the project up into sub-parts, with maybe even different parties responsible for different parts of the project. Since just cutting the road in parts introduces new problems, it was mentioned to at least have different contractors for the different types of works within the project. So a division between the main road network with the viaducts, and the underlying road network with the greenery.

4.1.4 Tendered to take risks

In 2016, the project was put out for tender, a process where private contractors were invited to submit bids for the project. In the tender process, the contractors were forced to take risks since the project is established in a time of privatization. It was expected that market forces and competition would lead to efficiency, innovation, and cost-effectiveness.

“How we tender the project, makes that contractors are forced to take risks, or submitting plans very fast, and making promises that they cannot or only partly make come true.”

On the other hand, the private sector had the believe that they had the actual capacity to invent innovation solution, this has led to optimistic bids from the contractors. The tender process primarily emphasized selecting either the most cost-effective contractor or the one capable of delivering high-quality results. However, there was insufficient emphasis on evaluating how the selected contractor intended to implement their proposal.

“In the end the contractor that won was the cheapest, but with that, you tender someone who seems to be advantageous, but does not necessarily deliver the best quality.”

“We have tendered with demanding either extra quality, or a lower price, which puts a lot of pressure, and we have put high requirements for the mobility. With the knowledge we now have I would have lowered the requirements for the mobility significantly, and then replace that with a sort of robustness, so not only pretty words, but a well thought out plan with we are going to build it like this and thought about this.”

“And put requirements on the contractor, we have now four local parties and two Germans who have never worked together, we had our concerns with that but no foundation to not choose them.”

4.1.5 Financially unhealthy project

Due to the optimistic nature of the bidding process, the project faced financial instability when it encountered setbacks. Losses were incurred and in fact, one of the contractors within the consortium had to declare bankruptcy. The significance of finances in the project has been emphasized, as money provides possibilities and space for new ideas.

“Because if a project is financially healthy everything is possible, literally everything. The deeper a project gets into trouble, the more difficult it becomes”

4.1.6 Long time span of the project

The long time span of the project has led to new disruptions in the project. The project had to face a lot of expectancies that could not have known about ten years ago. A shortage in the availability of personal, the bat routes, the building of viaducts that took longer. Furthermore, the project had to face the Covid pandemic and the Oekraïn war that led to a scarcity of building materials.

4.1.7 Working relationship

The contractor-client relationship has been underscored as crucial. A strong partnership can navigate any situation, even if the contract presents contradictions or inaccuracies. However, the relationship between client and contractor has been described as challenging.

“Well, I find it still very arduous. Because still there is sometimes fallen back to the contract. Then there is somewhere a lost requirement. While I think these requirements are from 2014, 2013. That is 10 years ago. We are not able to predict the weather in fourteen days, so what do you know now.”

Multiple reasons have been given for this rough relationship between contractor and client.

Certain distance between client and contractor

First of all, during the dialogue sessions of the tender it was felt that the contractor and client could not be completely open with each other. The contractor does not want to evoke the image that they do not understand the whole project. At the same time the client cannot be completely open because it may not show any preference for the designs of the contractors. This resulted in a certain distance between client and contractor. Secondly, following the tendering process, the contractor promptly initiated the design phase due to the significant time constraints, aiming to complete the final design within a year. As a result, there was a lack of active engagement in discussions regarding the design requirements.

The contractor about just after the procurement:

"I think that we missed the boat there partly, I think we should have, for example the first two to three months with each other explicitly seek to establish the dialogue. You write down that you want four bedrooms, but do you really want that, or is it not way smarter to make three bedrooms. With other words, where may the design deviate from the requirement and which requirement is almost the law."

Additionally, an interviewee of the municipality highlighted that there was no established process in place for post-procurement activities. It is essential to foster a dialogue that goes beyond the frames of the contract, allowing both parties to explore how they can mutually support each other. In the absence of predefined processes for post-procurement interactions, differing expectations can arise, causing disruption within the organizations involved.

"And once you have a winner, you have to first start the dialogue. Okay we are married now, client and contractor, and what do we think actually of that. Because the contractor has read the whole contract, well interesting project, but some things we do not quite get. We can do that way easier or prettier. And that phase has been there, then we decided to start the chances procedure. And that has brought a lot I think. But for a part of the organisation it was a relief, let's sit with each other around the table and what can we, how can we help each other way more than just following the contract. But for a part of the organisation, it was very stressful. Yes because they say, what are we going to do now? We just have a tender, we know. And that is also a phase of which I think you should think about that better beforehand. How much space do you give each other after the procurement to look each other deep in the eye. What is difficult and what is easy, and where do we see risks and where do we see chances."

As a result of the absence of immediate dialogue following the procurement and the continued lack of communication throughout the entire design process, the relationship between the contractor and the client deteriorated significantly.

“What now happened was that we worked really hard on the design, with all ifs and buts, and in the end, we handed it in in September 2017. Then it stays quiet for two months because in those two months it gets reviewed. And in November there is the decision. We do not accept the DO (definitive design). Well panic. Big disappointment of course.”

Holden on strictly to requirements

The contractor and client have different interests. For the client it is important that they comply with the wishes of the stakeholders. However, when these preferences are translated into project requirements, it can limit the project's flexibility in an effort to avoid disappointing any stakeholder.

“And that is also what you see in this project. Is this not way smarter, more convenient, better, that that manoeuvre room is not there, that then fairly strictly is holden back to the requirements. It is not in the requirements so it is not possible, period. But that means that if your answer is constantly it is not possible it is in the requirements. Then the counterparty will also take at a certain moment that attitude. Why do I need to do that, it is not in the requirements. So that game..”

The project made use of a design and construct contract with functional requirements. Since the lack of dialogue has been missed about which requirements are “the law” and which requirements can be deviated from, you get difficult situations where the contractor offers a different solution which the client does not want. Quote from the client:

“But also for example, with the deepened road we have a leak requirement, so how much ground water may leak into the construction. We have written that down functionally. But we thus do not say we want this solution, no we say the solution needs to deliver this. Thus then the contractor does not come with a concrete container, but with a natural polder, and then we say, yes but we do not want that. Then you get really difficult discussions again.”

This disagreement in design solutions together with the lack of communication at the beginning of the design process results in the fact that the contractor is saying, but if it is not in the requirements I am not going to do it. Quote of the contractor:

“You did not write it down, thus we are not going to do it. But you understand that you need to do that, yes, of course I get that we need to do that, but it is not in there, thus I will not do it. And that hardens the relationship over time.”

Factors important to maintain a good relationship

One key aspect in fostering a positive relationship between the contractor and the client, mentioned in the interviews, was developing an understanding of each other's interests. From the contractor it was mentioned that the client has to deal with stakeholders interests, and also does not have endless money.

“Only having understanding for the client that they do not have an endless wallet. And also that they need to explain their stakeholders, I have interpreted your requirement like this and it is incorporated like this. Especially when a stakeholder is very strictly in their requirements it is very difficult for the client to let go of that requirement.”

An example shows that for the unexpected events of *Operation Julianaplein*, the client needed a lot of information since a heavy road-blockage of thirteen weeks was the only solution to go from the existing road to the temporary road. However, if the different party's interests are not clear, this results in a situation where extra questions are seen as distrustful.

“But that will come later on, it will work out, it is going well. Yes but we have told you now that we do it in thirteen weeks, do you not trust us. While we need to include the environment, directors, in the process. If you want to deal well with that, then you need the understanding of each other, that for the decision-making, directors, some things you need to have already detailed”. “And what you see is that understanding for each other about which interests you have, or what is important is important at what moment, that that differs sometimes, and if you cannot put yourself in each other shoes then it hinders sometimes to deal with that sort changes.”

Furthermore, reasonableness, fairness, and transparency have been mentioned as important. A good working relationship requires insight into what is reasonable for other parties. Transparency would help to have an open conversation about the crux of the issue. Once the reason for a certain decision is known, whether based on money, resources, or people, it becomes easier to find a mutual solution.

People work

Flexibility within a project is heavily influenced by the individuals involved and extends down to the personal level. How flexible are you in your attitude, and how flexible is the person you are dealing with? This interaction between persons on the individual level is highly significant. Since, everybody is different, some people prefer to maintain strict adherence to guidelines, while others lean towards a more flexible approach. An example of how approaches of people differ is when the client decided to not give a green light for the summer road blockage in 2017. Quote from the client:

“In the weeks before, the two months before, you had two camps throughout the whole project bureau. That were, I call it the precise and the flexible. Thus the one group said we need to draw a strict line. We are moving along way too much, and CHP needs to know the rules. And others said, yes but then we do not have a project, or we have such a large delay.”

And it is also about learning to work each other at a personal level.

“At the beginning it also went pretty bad. But that is also, you need to learn to find each other, at the beginning everybody was very strictly in the game”.

All these factors highlight the complexity and the multitude of influences that affect the execution of a project.

4.2 Unexpected events

When unforeseen events occurred, adjustments had to be made to the project. There are several reasons for changes in the Southern Ring project, which can be categorized as follows.

4.2.1 Changing Law and regulations

The long time span of the project meant the project organization had to deal with changing laws and regulations. Examples mentioned during interviews included heightened standards for construction safety zones, necessitating larger restricted areas around construction sites. Additionally, requirements for earthquake resilience were strengthened, and more stringent laws concerning fire resistance were enacted over the course of the project.

4.2.2 Requirements becoming obsolete

In some cases, requirements that were in the contract became obsolete. Examples mentioned were white bitumen, which was standardly used by the municipality for red asphalt. However, due to environmental considerations it is no longer in use. A system for acquiring information about the sewer became outdated. And lastly, the fact that the contract only required simple traffic lights, while the whole city of Groningen had already transitioned to smart traffic lights.

4.2.3 New insights

One example, is that in the contract it was stated to work at night, when there is less traffic. However, since the project runs through the city it was acknowledged that that would produce too much noise and light nuisance.

4.2.4 Requirements not possible to make

The contract initially included standstill detection cameras with the assumption that the technology would be available by the time the project entered the execution phase. However, when the expected technology was not yet available as needed, it necessitated a modification or change to the contract's specifications.

Now that we understand the reasons for changes, it's essential to analyse the responses to unexpected events. Interviewees have mentioned various unexpected events, ranging from minor to major. In Table 5, we have compiled an overview of these unexpected events from the interviews for further analysis.

Unexpected event	Problem	How was dealt with it	Satisfaction	Quotes
Operatie Julianaplein	Instead of needing two weekend to go from the old road to the temporary road 13 weekends were needed	There became insight in the fact that it was not possible anymore to keep the contract requirements. Acceptance for the situation lead to everybody working together and coming up with a new plan	Satisfaction was high, there was worked together to pull off the thirteen week road blockage	“The point is you grow at it. At the moment you hear it is not possible in two weekends you get first very angry and moody. But then, that is often the situation, you get used to it. There is a sort of acceptance for the new situation.”
Munting Brug	Due to safety reasons the Muntingbrug, a bridge for cyclists could not be opened yet. But this meant that there were not enough cycling connection open anymore.	Since the client did not get a cycling path and could not stop the work as they would cut themselves in the fingers, the client gave the contractor an instruction to put traffic lights at the road to have enough space for a cycling path.	Satisfaction was low, if the client was updated about the situation earlier there would have been a better option possible , just a cycling path next to the road.	“With the Muntingbrug we were like we are holding on to the requirements of the contract. And than 5 before 12, we were at the point of we you cannot work further. But exactly this moment was chosen because of the public transport. So we had to go along, and chose to in the end only have a lane for the public transport. But this gave a lot of nuisance. It was a moment of oeeee for me.”
Helperzoom tunnel	When the Helperzoom tunnel was at the point of being shoved into the ground under the railway the tunnel started moving, due to the unexpected quality of the underground.	Extra research was done by the contractor to be able to shove the tunnel in. The cost discussion had to be seperated from the work since the parties could not agree on that.	Partly satisfied. Yes because contractor dealt with it in a great way and it was clearly communicated to the environment that it was not known when the tunnel could be shoved into the ground. No, the contractor felt that the client should have given more information about the unexpected underground in Groningen (grillage grond). No, the client felt that there were discussions	-

			about the cost in an accusing way.	
Papiermolen Tunnel	The cyclist tunnel needed to be demolished since the road would not fit under it otherwise. However, the contractor found a way to build a new tunnel back.	At first there was a division in people who liked the idea of the new tunnel and the people who did not want to change it. In the end the papiermolentunnel was build. This was still possible since it was in 2017, and they were barely building outside.	High. Everyone was happy that the tunnel could be made possible.	“We have always said it is not possible, what is our story to say it is suddenly possible” “If I would have said the Papiermolentunnel is not in the project scope, I am not going to do anything, people would have gotten to know about it, that the neighbourhood there would be happy with it, and then you would have maybe slowed down that process and then you would have had that change maybe two years later, and then the party is really getting started.”
Standstill detection camera's	The camera's in the contract, could not be made since the technique was still not there.	There was a whole contractual discussion because there was asked for something that is not possible, the client wanted something else, however the contractor did not want that. In the end the client paid extra and was still responsible for the risk and the contractor needed to work together with a party that they did not have a good relation with.	Nobody is satisfied. Because both parties did not get what they wanted.	“In the end they (CHP) had to accept that we only want to open a road that has installed this specific standstill detection system. We (ARZ) have to accept that we need to pay so much money that it hurts.”
Summer road-blockage got a no	Since construction work during the night would have given to much nuisance, the contractor prepared a summer road blockage. However, last minute they got to hear that it was not safe enough to go on.	CHP had to wait a year to prepare the summer road closing for the next year. However, this event hardened the relationship.	The contractor saw the decision of the client as a huge setback, with a lack of communication the decision came as a surprise. Client is behind the final decision, since the plans did give certainty for a safe road closing.	
Rammstein concert	Due to the concert the construction work on the A28 had to start two hours later. One week before there was the news that it would be three hours later.	It was decided to just proceed with the work. But if the contractor did not finish in time the contract fines would not be imposed.	It is swallow or choke . Since there was trust between the managers of the contractor and client, the situation was dealt with well. The contractor would do his best and trust the client of not getting a fine.	“If you would follow the line of the contract only, this was not possible, but if you talk about reasonableness and fairness. What is still fair, what can I ask from the contractor. Am I being realistic as a client.”

Oekraï'n war	Due to the war CHP had more difficulties with getting materials. The prices increased massively.	From the client there was the reasonableness to see in that these price increases were so unexpected that the contractor had to be compensated. However, within the clients there was the discussion who had to pay. The province was listed for the 'normal' risks of the project. But this was so unexpected that the three public parties had to get to the table again. In the end it was decided that Rijkswaterstaat had to pay.	The province was satisfied that Rijkswaterstaat paid in the end. But this was related to the history of the province (unjustly as they felt) having to pay in the past. It included a lot of politics since governments need each other in a lot of situations.	-
Corona	Due to covid everybody had to work at home. For difficult discussions with a lot of emotion the interaction was missed, since non-verbal communication was not really possible anymore. Furthermore, where before information could be checked easily by walking to someone's desk or hearing things at the coffee machine.	Everybody had to find their way for working well in this situation. For example, for some meetings rules were put up. This did help.	Everyone just had to deal with the same situation.	-

Table 5. Unexpected events in the Southern Ring Road Project

4.3 Analysing the response to unexpected events

From analysing the unexpected events that were mentioned in the interviews the following things became clear.

4.3.1 There was moved along when:

1. Not realistic to hold on to an old requirement / reasonableness

With the unexpected event, such as Operation Julianplein, there has been acceptance for the situation. New information has led to the insight that there is nothing else possible. Once everyone has accepted this new situation, a collective shift in attitude occurs towards collaboratively addressing the problem. Although it may require considerable effort to overcome the challenges, the outcome leads to satisfaction.

“We needed a large road blockage that contractually was not possible for the tender. We have fixed that, but that is also the flexibility of the client. CHP had optimistically tendered. But also this change (new viaducts instead of renovation), meant that maintaining the requirement was not realistic anymore.”

2. New information that cannot be ignored

Once it became known that the cyclist tunnel could be build back, a highly desired feature for the community, could be reconstructed, a decision was made to openly share this information. The tunnel was constructed because of the strong desire from the local community, supported by the municipality's funding. It would not have made sense to keep this information within the project organisation, as it had a high likelihood of reaching the community later in the project timeline, potentially causing issues when it might have been too late to address effectively.

3. Experience, you feel you have to

Sometimes when you are in a situation where no party is willing to compromise, you feel that it is not going to get any better and signing and moving on is just the best way to deal with a certain situation. Satisfaction is low, but often for both parties.

“Most times it is just stick to the plan and I try to slap everything off me. At a certain point you see certain things, than you feel, here we cannot do anything else, we have to move along. That is always a sort of, call it craftsmanship, or experience.”

4.3.2 Moving along is facilitated by:

1. Nature of People and Trust

Flexibility within a project primarily arises from the individuals involved. While there are often strict rules and contractual obligations in place, what becomes evident is that when contractors and clients empathize and consider each other's perspectives, they become more willing to depart from these rules. However, some people like to draw outside the lines, while others are very uncomfortable with that. Once you work together with someone that is flexible and you yourself are too, it was felt that then possibilities are endless. To be able to be flexible you need to be able to put yourself in the position of the other. Furthermore, reasonableness and fairness have been mentioned as important. In addition, you need to know how the other person works. Then you know what you can expect in a certain situation and how to deal with it.

"It is human work, we can both draw a strict line if we think that that is necessary, but we also try both to be reasonable and to put oneself in the others positions. Because if he calls me with such a story I think if I were in your shoes I would also be disappointed. How can I help him? And he also does that the other way around. And not everyone works like that. You are walking a little bit outside of your own responsibility, also outside of your safe frames of the contract, and not everybody likes that. If you do not have that naturally, but you are by nature someone who says contract is contract, then it is not going to work out. And for me flexibility is, maybe it is the wrong term, but a bit in colouring outside the lines."

2. Finances:

A financial healthy project, and contractor is really important. Once the contractor is making financial losses, it will take any opportunity to cut back costs. As one interviewee said, it are basically the finance people who are deciding what happens.

4.3.3 There was not moved along when:

1. Little changes are being underestimated

What becomes evident is that, after a decade, especially the municipality often has numerous new desires and preferences due to evolving circumstances. However, it was revealed through interviews that these seemingly minor changes, like extending a bus stops by a few meters, are frequently underestimated and can cause significant disruptions in the project's workflow for the contractor. Quote of the client:

“And just go, no disruptions, I do not even pick up the phone, especially the municipality does it. They think, those bus stops can be a bit longer or one meter to the left or one meter to the right. And that is also from the perspective of how much effort is it really to put it one meter to the left. But in the end we have a whole design here, the drawings are signed off, you need to the re-engineering, that needs to go through a whole process, it is a whole disruption that people underestimate. So most of the time I am just stick to the plan and finish.”

Once the contractor is in a phase of building outside, you get into a phase where changes are almost impossible. It was mentioned that had the design of the underlying road network been less detailed initially, it would have allowed for greater flexibility in the project's later stages. Additionally, there was a suggestion to exclude the underlying road network from the project's scope.

2. Claims of other contractors

The client cannot accept a completely different plan, since the fact that other contractors will be looking if there is being build what they signed in for.

“If you change a lot, you can get into problems with other contractors who also signed up for the tender, who say, but the way he does it now I could have done that too, then you get claims from other contractors.”

3. Contract

From the interviews it became clear that the contract is very fixed. Clear frames are needed to be able to set the rules of the game. Flexibility is in practice than searched outside of the contract.

“Flexibility is often not in contracts, since you want to have a fixed contract as client, to have a clear framework. Then you know the contractor moves inside these frames, and he cannot go out of that, but in practice, flexibility is often searched for outside these frames. And that does not fit within the contract. And I thus only think you can do that if you know how from each other how the other person works.”

4. Planning Procedures (Tracébesluit)

First of all, in the planning procedure flexibility is often lost since we want to write things down strictly to prevent any objections. Legal certainty is very important during the design phase, however later on the strict requirements can cause problems.

“But what we also do often is writing things down stricter than we have to. It is not possible due to the law. Sometimes the law offers more space, to do things. There are a couple of reasons why that does not happen. On the one hand it has to do with people wanting to give people legal certainty. If you just had a whole participation process and people said, noise barriers are okay, but never higher than three meters, than I write that down. Then the people will make no objection. At that moment, I am very happy because if have prevented any object, but by writing it down very strict, later I will run into it. The want to offer legal certainty, with the best intentions for the plan development. And also with the plan development you work more on offering legal certainty, please the environment, and please the directors”.

Furthermore, the planning procedures make that it takes years before a large change can be accepted.

“Once you start building there is no manoeuvre room for big changes. You change the scope, so you have to redo all the planning procedures, and the will take multiple years.”

5. The phase of the project

Once construction actually begins, there is considerably less flexibility for making changes. Significant investments have already been made, designers may no longer be involved, and any alterations typically come at a substantial cost.

“The moment that you start a project, I am going to think about do I have a project, a project exploration, than you have a lot more room to think about everything. In the plan development already less, but relatively a lot. And the moment we are building. If I now think I want it differently, people are working outside, so the impact is huge if I want something differently.”

6. Hierarchy

Lastly, sometimes the municipality did not move along, while Rijkswaterstaat did. Since, the client involves different layers of government, with their own interests, they have their own wants and needs. Therefore, if the municipality does not agree with a certain plan, it can withhold the permit for the contractor. This disrupts the project process for the contractor. Quote of contractor:

“Sometimes, hierarchy can also work against us, with the municipality stating, I have nothing to do with what Rijkswaterstaat thinks.”

Chapter 5 Discussion

This aim of this study is to investigate effective responses of infrastructure project organisations to deal with unexpected events. It is argued that increased flexibility is needed in managing infrastructure projects to be able to cope with unexpected events (Westerveld and Hertogh, 2013; Edelenbos et al., 2007; Leendertse et al., 2022). Therefore, flexibility enablers and blockers in theory are compared to practice. This chapter is structured by answering the two parts of the research question. To answer the first part of the research question: *How do infrastructure projects respond to unexpected events taking into account the complexity of infrastructure projects and its environment?*, we first looked into the type of complexities in infrastructure projects using the framework of Shi et al. (2020). See section 5.1.

5.1 Types of complexities in infrastructure projects

The extensive framework of Sohi et al. (2020), explained in chapter 2.1, showed that infrastructure projects face technical, legal, organizational, time, social, and financial complexity. All types of complexities are mentioned in the interviews. The results (Table 6), give more insight in how the complexities that play a role in infrastructure projects, such as changing laws and regulations (legal), long time span with changing circumstances (time), or diverging interests (social), cause for inevitable changes in infrastructure projects. Interestingly the organisational and social complexity was mostly emphasized in the interviews.

DIFFERENT TYPES OF COMPLEXITY ACCORDING TO SHI ET AL., 2020	COMPLEXITIES MENTIONED IN PRACTICE (CASE SOUTHERN RING ROAD)
TECHNICAL	Difficult technical project <ul style="list-style-type: none"> - Rough soil in Groningen - Large and diverse scope, the project including roads, viaducts, a bridge, a park, and underlying road network.
LEGAL	Laws and Regulation: <ul style="list-style-type: none"> - The Planning Procedures were written down with too much detail (loss of flexibility). And it takes years to put through a large change. Changes in Laws and Regulations: <ul style="list-style-type: none"> - Building Safety Zones became larger - Fire safety standard increased
ORGANIZATIONAL	Complex organisation <ul style="list-style-type: none"> - Large organisation makes getting the right information at the right place difficult. - Three public parties - Six contractors of which two are German and four are Dutch. - Contractor had no experience with working with Rijkswaterstaat in such a large project. - Investing in one contractor for the whole scope of the project means you cannot easily stop the collaboration since

	<p>huge investments are already made in all parts of the project.</p> <ul style="list-style-type: none"> - Tendered to take risks and have cheap price instead of tendered on the focus of a robust plan. - Certain distance between contractor and client during procurement.
TIME	<p>Huge time pressure:</p> <ul style="list-style-type: none"> - Design time of a year - Starting the design immediately without having clear conversations about the requirements (Which requirement is the law and which requirements offer room for changes?) <p>Long time frame of the project:</p> <ul style="list-style-type: none"> - Contract requirements from 2013 - Had to face COVID, Oekrain War.
SOCIAL	<p>Large number of stakeholders:</p> <ul style="list-style-type: none"> - Three public parties who all have a different way of working Rijkswaterstaat, Province, Municipality, - Contractor of six parties of whom two are German. So working together with different cultures. - Citizens, GroningenBereikbaar, activist groups, public transport, companies which are impacted due to the worsened mobility during the building phase. <p>Different interests and preferences (roughly):</p> <ul style="list-style-type: none"> - Client wants money - Municipality looks at lowest scale and wants the road to fit into the environment, - Province looks at regional scale an wants high quality of the viaducts - Rijkswaterstaat looks at national scales and wants the highways to have improved mobility - Public parties want high quality solutions, contractor wants cheapest solution that suffice the functional requirement <p>Changing preferences:</p> <ul style="list-style-type: none"> - Contractor puts down functional requirements, but knows exactly what is wants to build <p>Large impact on environment and local stakeholders:</p> <ul style="list-style-type: none"> - The dense environment, Scarcity of space means large impact on the environment and local stakeholders since
FINANCIAL	<p>Financially unhealthy project:</p> <ul style="list-style-type: none"> - Optimistic bidding - RWS led the project, however the province was covering the risks

Table 6. Types of complexities the Southern Ring Road project faced

The Southern Ring Road project started with a traditional project management style, where the project was designed to minimize changes. Deviations from the pre-defined project goals, were seen as undesirable for the project, which has already been mentioned by Koppenjan et al. (2011). However, with over five hundred changes in the project, a delay of three years, and cost-overruns of hundreds of millions, the traditional management style approach with a focus on control can be called ineffective/inapplicable. Changes are indeed inevitable (Hertogh and Westerveld, 2013 and, Gerrits and Verweij, 2015).

Since, unexpected events ask for an increased flexibility (Westerveld and Hertogh, 2013; Koppenjan et al., 2011; Leendertse et al., 2022), the flexibility blockers and enablers have been noted in chapter 2.3. But how do the responses towards unexpected events in practice relate to the flexibility enablers and blockers in theory? To get a better understanding of how flexibility is enabled or blocked we compare theory and practice in the next sections.

5.2 Practice compared to theory

To be able to answer the second part of the research question, *What do these responses learn us about barriers and enablers of flexibility?*, first the flexibility blockers in practice will be discussed. These will be linked to the flexibility blockers found in the literature. The blockers will then be linked to solutions in the form of flexibility enabler found in the literature. Afterwards, the flexibility enabler found in practice will be discussed. Lastly, unlinked blockers and enablers will be discussed. An overview is given in figure 7.

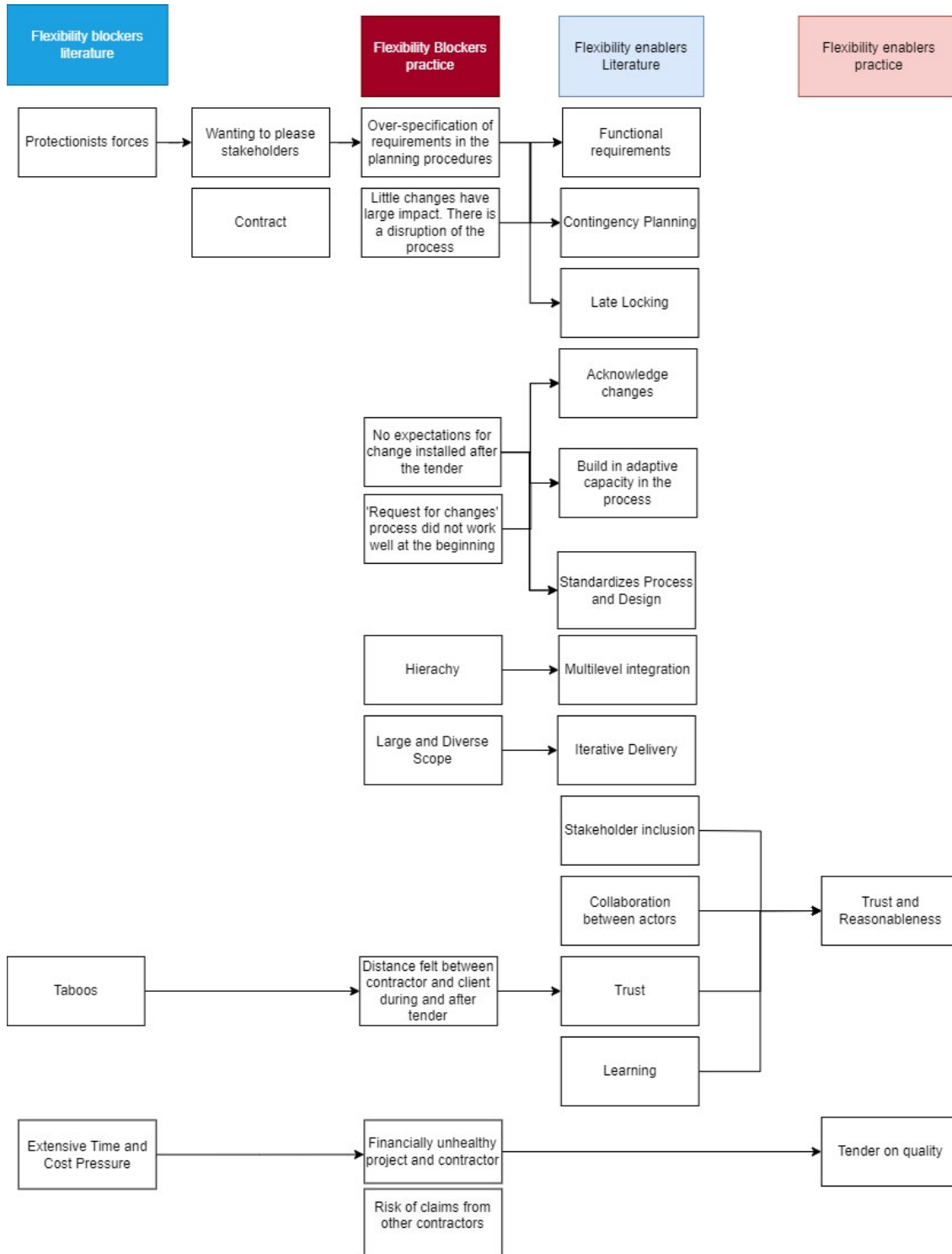


Figure 7. Overview of Practice linked to Literature

5.2.1 Flexibility Blockers found in practice compared to theory

Over-specification of requirements in the planning procedure.

A flexibility blocker found in theory was *protectionist forces* of Giezen et al. (2014), who mention that strong protection of stakeholder interests, without the willingness to compromise, will lead to sub-optimal solutions. This was also found in practice, where *wanting to please stakeholders* was mentioned in the interviews. Furthermore, it became clear that pleasing stakeholders contributed to an over-specified planning procedure, since every requirement of every stakeholder was put in there to satisfy them. Therefore, protectionist forces can be linked to an overspecification of the requirements in the planning procedure (Figure 7).

This over-specification of requirements lead to a lack of room for adjustments. One such example in the planning procedure of the Southern Ring Road project is found the underlying road network, which was designed in great detail, to the point that every traffic light had been planned out. The flexibility blocker of *over-specification of requirements in the planning procedures* can be linked to functional requirements, contingency planning, and late locking (Figure 7).

Functional requirements

Flexibility could have been increased by emphasizing function over specific details. This is called *functional requirements*, a flexibility enabler of theory, which gives design freedom to the contractor. (Eriksson et al., 2019; Koppenjan et al., 2011; Sohi et al., 2020). From interviews it became clear that for construction the detailly planned underlying road network, often was a restriction to move along with changing circumstances and new wishes.

However, where on the one hand flexibility was missed, on the other hand it was felt that too much flexibility was given to the contractor in places where control was needed. Since the ring road runs through the city Groningen, and there was little space, the client sometimes wanted not the design that met the function the best, but instead a design which prioritized safety. This led to impossible discussions that worsened the relationship between client and contractor. In this case, functional requirements lead to flexibility where that was not wanted. Sometimes it is better to write things down in detail, if the design does not have space for flexibility, like in the case of safety.

Contingency planning

Developing alternative plans is essential in case the primary plan becomes unworkable or fails to yield the desired outcomes (Sohi et al., 2020). Anticipation on contingencies can be achieved by examining various scenarios and implementing systems that facilitate access to information (Leendertse et al., 2022).

While contingency planning was not explicitly mentioned in the interviews, the project did prepare design optimizations. Once it was known that enough money was available to implement the optimizations, it was a fast process, as the research needed for the planning procedures was already finished.

However, although contingency planning was used, it could have been optimised in other parts of the projects. For example, a viaduct in the project was kept the same size with the assumption that it could be renovated, since rebuilding would be too expensive. However, while working on the viaduct, the contractor came to the conclusion that the quality of the viaduct was worse than expected, leading to the need for rebuilding. Since the size of the viaduct was fixed in the planning procedures, and there was no contingency plan available, it was not possible to change the size.

Late Locking

Sohi et al. (2020) mentioned late locking as a flexibility enabler. Late locking means that decisions are strategically delayed up to the last possible moment, so that the full picture is present when finalizing designs (Sohi et al., 2020). In practice, it turned out that the over-specification of requirements on the planning procedure gave problems further down the line. By wanting to give certainty to the stakeholders, decisions were locked in the contract prematurely. This led to problems later, as changes in design could not be afforded. One such problem was that the contract already specified the bus stop length. However, throughout the duration of the project, longer buses were introduced in the public transport by the municipality of Groningen, making the designed bus stop length too short. If those decisions were made definitive later, and function over specifications had been prioritized in the planning procedure, it would have prevented this problem.

Small changes heavily disrupt the process of a project

In line with the previous paragraphs, another problem in practice that was found was that small changes have a large impact. Small changes are underestimated, therefore a control approach is needed. This can be linked to function requirements (Figure 7), since the example of the bus stops used for late locking, showed that in the end a simple change of making a bus stop a few meters longer could not be agreed to. Therefore, functional requirements would not have locked in the project early.

'No expectations for change installed after the tender', and 'Request for change' process did not work well at the beginning

Two more blockers were found in practice. Firstly there were no expectations for change installed after the tender. Although after the tender a chances program was started, there was no prescribed process to decide how much space to give the contractor to come up with smart, new design solutions. Furthermore, process for the requests of changes did not run well at the beginning of the project. Both these flexibility blockers of practice can be linked to the flexibility enablers acknowledgement of changes, building in adaptive capacity in the process, and standardize process of design (Figure 7).

Acknowledge changes

Since changes were not acknowledged well enough at the beginning of the process, processes were not installed or did not work well. Project organisations should be aware that changes are inevitable, and should therefore *acknowledge changes* (Demiral et al., 2016; and Leendertse et al., 2022). Project organisations need to view changes as opportunities (Leendertse et al., 2022). Acknowledgement of changes is thus the first step in creating effective processes for change.

Build in adaptive capacity in the process

Giezen et al. (2014) have mentioned that there should be built in adaptive capacity in the process of large projects to prevent deadlock and to keep being responsive to developments in the world. Once symptoms of deadlock are known it is important to have mechanisms installed which prevent lock-ins and promote adaptability (Giezen et al., 2014). In practice it was seen that the 'request for change' processes did not run smoothly at first. Once the 'requests for change' is not dealt with contractually, but the work outside is ongoing, it will become a constraint. If requests for changes are not finalized for a long period, the discussion will have to be started again, and nobody knows anymore what the exact arguments or agreements were for the request. This thus disrupts the process and can lead to deadlocks, since parties have to agree in the end if what is build is good enough for the handover of the product from contractor to client. Therefore, having a change process installed increases the adaptive capacity of an organization.

Standardised process and design

Having simple standards for processes or the design that can be used for other similar projects was mentioned as flexibility enabler (Sohi et al., 2020). Since the 'request for change' processes did not run well at the beginning of the project, the new processes, developed during the project, should be standardized for similar projects. Every time lessons are learned on improving these processes they should be implemented in the regulations of the parent organisation and other projects. However, as de Groot et al. (2020) mention, projects are of temporary nature and therefore changes in the standardized processes of the parent organisation might not feel relevant. Large project organisations often develop their own processes and regulations. However, since large projects can become little islands, the lessons learned and processes developed might be lost and not or only partly transferred to the parent organisation (de Groot et al., 2020). Although project organizations exist of individuals who all have their own experiences, standardized process and learning from other projects have not been mentioned in the interviews. Once a project is finished, often there is no time for reflection, since the project organisation will invest itself in other projects (de Groot et al., 2020). Therefore, further research in information transfer between projects and parent organisation is a necessity.

Hierarchy

In practice, the contractor talked about the many-headed monster of the municipality being a blocker for the process of the project, since the contractor had difficulties with getting permits. Since the planning procedures give permission for the different permits, getting permits should not have been an issue. However, since the municipality did not care about the agreements made with Rijkswaterstaat, the contractor still had issues with permits. Therefore, it can be argued that horizontal integration is needed, as mentioned by Koppenjan et al. (2011), to improve the processes for permits. Although the client also found the municipality a party with high requirements, it did not mention permits as a blocker in the interviews, while this was emphasized in the interviews of the contractor.

In addition, the client talked about the problem of issues being kept within certain disciplines. For example for the clients' contract team, it is important that they know early-on about issues emerging, since they then still have tools (e.g. fines) to deal with the change. One interviewee mentioned that an extra meeting just for small talk between two disciplines was implemented, to see if there was any information that was necessary for other disciplines. This is in line with Leendertse et al. (2022), who mention implementing cross sectoral meeting structures to improve integration. One interviewee mentioned that certain problems could have been prevented, however since the client worked fragmented it did not oversee the consequences of, for example, a missing a cycling path. This can be linked to the flexibility enabler of multilevel integration of theory (Sohi et al., 2020; Koppenjan et al., 2011; Leendertse et al., 2022).

Large and diverse scope

In practice, it was felt that the large and diverse scope of the project made the project too complex. The scope included diverse types of work. Highways, tunnels, viaducts, a bridge, neighbourhood streets and a park. Having only one contractor who needs to focus on all of these diverse tasks increases the complexity. Keeping oversight, and getting the right information to the right people becomes difficult.

Iterative delivery

The flexibility enabler of iterative delivery (Sohi et al., 2020), links well to the problem of having a too large scope. If the project is split up in subprojects that can be delivered separately to the client it decreases the complexity. An example mentioned in practice was first delivering the Julianaplein (the

largest bottleneck), to see how much it improves the traffic flow, and to determine if the rest of the project was still necessary. Another solution is to appoint different contractors for different subprojects. However, it should be mentioned that these solutions bring other problems forward, like at the edges of the subprojects, where the work of two contractors intervenes, as well as more complex financing.

Distance felt between contractor and client

Another flexibility blocker found in practice was that a certain distance was felt between the contractor and the client. After the tender, there was no predefined processes in place, in which the client and contractor felt that they could engage in an open and transparent discussion about risks and opportunities they saw. Furthermore, there was a huge time pressure to finishing the definitive design in one year. As a result, the design process started immediately, without having clear insight between which requirements should be fixed, and those that could be modified. This can be linked to *taboos*, which was mentioned as a flexibility blocker in literature. If taboos are not discussed, but work is still proceeding in other parts of the project, it can lead to lock-in (Giezen et al., 2014). If questions are not asked, because as contractor you do not want to invoke the image that you do not understand the project it leads to problems later on in the process. Furthermore, the client had its questions with certain design solutions of the contractor. Transparency and trust is needed, which are flexibility enablers found in practice and theory. This will be expand on in paragraph 5.2.2.

5.2.2 Flexibility enablers found in practice compared to literature

Trust and reasonableness.

Trust and reasonableness were mentioned as flexibility enablers in practice. This is in line with theory, since multiple flexibility enablers (stakeholder inclusion, good collaboration, trust and learning) of theory can be linked to trust and reasonableness (Figure 7).

Stakeholder inclusion

Stakeholder inclusion is mentioned in literature as important for flexibility (Verweij, 2014; Eriksson et al., 2019; Sohi et al., 2020; Groot et al., 2020). Stakeholder inclusion can be linked to the flexibility enabler trust since closely involving stakeholders and being transparent about the decisions that are being made help enhance communication (Sohi et al., 2020). Miscommunication or not including stakeholders can lead to dissatisfaction, while stakeholder support is needed to be able to implement projects (Verweij, 2014). In addition, including stakeholders should be seen as an opportunity since they give different perspectives and specific information to the project (de Groot et al., 2022).

Examples in practice showed, that once unexpected events happen, stakeholders were often included. For example, with Operation Julianaplein, the client was closely involved which led to a successful outcome. The client had time to accept the situation and came to the realization that the original plan of the contractor would not be possible anymore. Since the contractor involved the client in the problem, there was the capacity to inform and involve all the external stakeholders as well. Also, when contractor shared new information about the fact that the Papiermolen cyclist tunnel was possible, when the client always thought it to be impossible, it was chosen to share this information, instead of keeping it within the organisation. This is in line with Eriksson et al. (2019), since opposition later on in the project might have been prevented.

The opposite effect was also seen, where excluding stakeholders led to complications. The example of the missing cyclist connection at the Muntingbrug showed that including the client too late led to a sub-optimal solution. Furthermore, in sharing the design of the Zuiderpark, the project organisation

was hesitant. The citizens had been involved with their wishes for the park at the beginning of the project, however there was no involvement after that for six years. At the moment, the client and contractor are still in dispute about the final design. The many different additional requirements of different stakeholders, and a lack of money are the cause for endless discussions. Therefore, they do not want to present the design to the citizens yet, since it is not finished. This links well to social complexity since including oppositional forces might feel like a loss of control, while it can actually lead to creative solutions and prevents opposition later on in the project (Eriksson et al., 2019). If the citizens had been involved throughout the design process (instead of a gap of 6 years), presenting the plans would probably have been less of an issue.

Collaboration between actors and Trust

In practice, the relationship between client and contractor has been rough. It was mentioned that if both parties do not want to compromise, flexibility is lost. Furthermore, if you can trust the other party and know what you can expect of them, it is possible to be flexible and work outside the strict frame of the contract. This is also in accordance to Demirel et al. (2016), who argue that flexibility in the contract was especially found through social relationships. However, once trust is lost, people will fall back on the contract. This is in line with theory, where trust, a good relationship and good collaboration between client and contractor are mentioned as flexibility enablers (Eriksson et al., 2019; Demerial et al., 2016; De Groot et al., 2020; Leendertse et al., 2022; Sohi et al., 2020). Involving stakeholders (Eriksson et al., 2019), organizing interaction and social relations (Leendertse et al., 2022), less hierarchy and self-steering teams (Sohi et al., 2020), creates trusts between actors. Furthermore, the interviews showed that trust is needed to cope with unexpected events, when there are no standard procedures and you have to be creative together outside the standard frame.

In the Southern Ring Road case, a rusty relationship has led to dissatisfaction and consequently to the non-cooperation of parties, resulting in a contractual discussion of interpretation of the requirements. In practice, it proves difficult to keep other parties' interests in mind. Therefore, putting yourself in the others' position, reasonableness and fairness are mentioned as important to improve trust in a project organisation. Furthermore, it was emphasised that trust and being flexible is fundamentally a people-driven aspect.

Learning

Learning is mentioned as an important flexibility enabler in literature (Leendertse et al., 2022; Khorsvi and Mohammed, 2012; Sohi et al., 2016) or even a proxy for flexibility (de Groot., 2020). Once unexpected events occur, project actors need to find each other to learn how to deal with this situation (Leendertse et al., 2022), since there are no guidelines for unexpected events (Khorsvi and Mohammed, 2012) and to learn how to deal with unexpected potential future situations. In practice a lot of learning experiences have come forward. For example, learning how to collaborate with the other party. One interviewee mentioned that at the beginning both contractor and client were strictly adhering to the rules, the predefined frames. However, once you build a relationship, have a network, have learned what you can expect from the other, and there is trust, there is room to work outside the lines of, for example, the contract. Another interviewee of the client mentioned that just believing the contractor when they said a cycling connection would be open had led to an unsuccessful outcome. Instead, they learned to ask for some insight to confirm that it is really possible to keep the connection open. Furthermore, when there was an issue where both parties could not compromise, it was learned to "suck it up" and just sign a change. Lastly, it was learned that small changes would lead to huge costs. Therefore, changes were only an option if the actor in favour thought it was worth the money. Because

of the price, the necessity of such a change became visible. Through these examples, it becomes clear that project organizations and individuals learn during projects.

However, it should be taken into account that the lessons learned are not transferred when the project ends. De Groot et al. (2020) mention this problem of sharing learning processes and information between projects, where projects can function as islands that work on their own. This relates to the organizational complexity of getting the right information in the right place. In the project organisation, but also in the parent organisation.

5.2.3 Other Blockers and Enablers in practice and theory

Extensive time and cost pressure (Literature)

In literature, extensive time and cost pressure was mentioned as flexibility blocker (Eriksson et al., 2019). Extensive time and cost pressure lead to inflexibility, since it will push people to take less risk and repeat familiar practices. However, to have flexibility there needs to be money and time available to come up with creative solutions and innovation (Eriksson et al., 2019). This is in line with what was found in practice since the huge time pressure led to finalizing the design early on, while for an optimal project outcome there should have been time for dialogues in the first months.

Tender on quality (Practice)

Furthermore, the project faced cost overruns since it was tendered with the incentives to take risks. A flexibility enabler in practice was mentioned to tender on quality. Making a bid for a low amount will not lead to a well-thought-out project process. Instead, the tender should be focused on showing the capability of the contractor to run such a complex project process. Giezen et al. (2014), have mentioned that cost overruns might not be only due to optimistic bidding, but also due to the underestimation of the complexity of the environment. A tender on quality could therefore take into account the complexity of the environment in the design processes.

Financially unhealthy project and contractor (Practice)

The tender focused on money instead of quality, which meant large budget overruns for the project. What was seen in practice is that once the project is running out of money, the flexibility decreases. Changes disrupt the process and cost time and money, therefore budget overruns lead to the rejection of new changes.

Claims of other contractors (Practice)

Lastly, in practice, it was mentioned that *claims of other contractors* prevent projects to be able to make large changes once a contractor has been chosen. If the project implementation differs too much from the plan, other contractor can say: "but if this was the plan I could have done it too". Although it has been mentioned, it was not emphasized, neither was it found in literature.

Chapter 6 Conclusion

Large infrastructure projects are often characterized by their budget- and time overruns (Koppenjan et al., 2011). The increased complexity of the environment has led to the need for an increased flexibility in infrastructure to be able to cope with the changing environment and unexpected events (Leendertse et al., 2022 and Giezen et al., 2014). However, in practice often a control approach is still taken where deviations from the predefined project objectives is seen as undesirable since changes cost time and money (Koppenjan et al., 2011). Therefore, this study tried to answer the following research question:

How do infrastructure project organisations respond to unexpected events taking into account the complexity of infrastructure projects and its environment? What do these responses learn us about barriers and enablers of flexibility?

In practice, project organizations have to deal with different types of complexities (Shi et al., 2020). The overview in Table 6, shows that infrastructure project organizations have to deal with a lot of uncertainties, complexities, and ambiguities. The increased complexity has led to the need for increased flexibility in infrastructure projects to deal with changing circumstances, unexpected events and new information.

Interviewees of the Southern Ring Road project organisation have been asked about unexpected events in the project that they had to deal with. With this information enablers and barriers of flexibility have become clear in practice. Comparing the results of the interviews to the extended flexibility enabler framework of Sohi et al. (2020) (Table 3), and the flexibility blockers framework (Table 4), the following lessons have been learned:

- It has been emphasized that flexibility arises from the individuals working within project organizations. While strict parameters, such as those defined in contracts, often prioritize control, project teams can enhance project flexibility by thinking creatively beyond these boundaries. Trust, collaboration, and involving stakeholders are thus critical factors in facilitating flexibility. The inclusion of stakeholders and transparent decision-making fosters trust and garners acceptance for project decisions (Sohi et al., 2020). However, when relations between stakeholders become strained and there is a lack of willingness to cooperate, the project may resort to rigid frameworks.
- Learning is another important flexibility enabler. Project actors have to learn how to work together, and learn how to deal with unexpected events. However, the things that have been learned should be shared between different projects, and between project and parent organisation (de Groot et al., 2020). For instance, the project commenced with an inefficient 'request for changes' system. If the project would have made use of standardized processes (another flexibility enabler of literature) that have worked well in other projects, projects can optimize the start of a project, through for example facilitating changes.
- Flexibility is also enabled by a financially healthy project and contractor, it was felt that once there is money anything is possible. However, it should be kept in mind that further along in the process of the projects, changes become more expensive due to the fact there is invested in the design, and resources. Especially small changes are underestimated since they heavily disrupt the process. Therefore, for those a control approach was taken to not have too much little disruption in the process.
- To achieve more flexibility for the end phases of a project, it was felt that the scope of the project under one contractor, should be less diverse. Changes in preferences of the

municipality would have been less of an issue if the design for the neighbourhood streets was not fixed in the contract of 10 years ago.

Practice showed some extra lessons to enable a good relation et p and trust between actors.

- The tender should be focused on having criteria that ensure quality and demonstrate the feasibility of the design. Then it is more likely to prevent optimistic bidding, and a financially healthy project is promoted.
- A design time of one year puts a high pressure on the contractor to immediately start designing. Sufficient time should be allocated for a meaningful dialogue on distinguishing mandatory requirements from areas where flexibility can be applied. Furthermore, it should be clear beforehand how much flexibility the contractor has to come up with innovative solutions.
- Functional requirements are not always wanted. Do not give the contractor design freedom in places where there is no space, or where safety needs to be guaranteed. In practice, this has led to impossible discussions, where the client found the design solution of the contractor not good enough, although it met the functional requirements.
- Efforts for horizontal integration between the three public parties might be beneficial. The contractor should have no issues receiving permits that have been approved by the planning procedures.
- The different interests of both client and contractor should be acknowledged by the other.

In conclusion, the responses towards unexpected events have showed that flexibility is primarily enabled by the individuals working within the project organization. Overall there is the intention to include stakeholders and to be transparent. However, if communication is lacking, and trust is not there anymore, and contractor and client come into conflict with each other, this flexibility is blocked. Additionally, apart from the human aspect of flexibility, practical enhancements can be made by have a less diverse project scope and through not over-specifying the planning procedures. Adaptive capacity can also be improved by focusing on quality in the tendering process and reserving time for transparent dialogue sessions in the first months after tender.

Chapter 7 Reflection

8.1 Limitations and further research

This study made a valuable contribution to the scientific debate, since it compared flexibility enablers and blockers of theory with practice. However, it is important to acknowledge the presence of certain limitations. This study made use of one case study. Although a case study provides in-depth information about the case, only having one case makes it hard to generalize (Flyvbjerg, 2006). To make the findings of this research more robust, further research is needed. If multiple cases have been researched, findings of different researches can also be compared. Furthermore, this study made use of eleven interviews. The opinion of every interviewee thus weigh a lot. A larger set of interviewees would make the findings of this case more robust.

Further research is suggested on the comparison between one large project in one scope, and a large project that has been divided into subprojects. Since the project organisation felt that the Southern Ring Road project was too complex since the large and diverse scope, future research could look into the potential decrease of complexity through the implementation of subprojects. This study also showed that the process of finding a qualified contractor should be different. More research on improving the process to tender on quality instead of price, should be looked into.

8.2 Personal reflection

Writing this master thesis was a challenging journey. Although I found the topic interesting, it has been a struggle to come to the final results. Writing my thesis has thought me a lot, especially since I was able to do an internship at the project organisation of the Southern Ring Road project. The internship provided valuable insight into how project organizations operate in practice. Furthermore, I had the opportunity to join in on several meetings (also with external stakeholders), a team day, an expert meeting for citizens, and many more. With these new experiences I feel more prepared to start working.

Chapter 8 Bibliography

Aanpak Ring Zuid (n.d.). *Home*. [online] Website Aanpakringzuid. Available at:
<https://www.aanpakringzuid.nl/>.

Arts, J. (2007). *Nieuwe Wegen? Planningsbenaderingen voor duurzame infrastructuur*. Groningen: Rijksuniversiteit Groningen, pp.1–59.

AT Osborne (2019). *Eindrapportage Adaptiviteit in het MIRT bij RWS*. Baarn: AT Osborne, pp.1–64.

Commissie van Onderzoek Kostenoverschrijdingen (2022). *Met de wijsheid van nu. Rapportage Commissie van Onderzoek Kostenoverschrijdingen Aanpak Ring Zuid*. [online] *Aanpak Ring Zuid*, Provincie Groningen, pp.1–110. Available at:
<https://www.aanpakringzuid.nl/actueel/nieuws/nieuwsberichten/2022/06/rapport-aanpak-ring-zuid-overhandigd-commissaris/> [Accessed 1 May 2023].

de Groot, B., Leendertse, W. and Arts, J. (2020). Learning across teams in project-oriented organisations: the role of programme management. *The Learning Organization*, 29(1), pp.33–45.
doi:<https://doi.org/10.1108/tlo-06-2020-0118>.

De Roo, G. (2010). Being or becoming? That is the question! Confronting complexity with contemporary planning theory. In: G. de Roo and E.A. Silva, eds., *A Planner's Encounter with Complexity*. Taylor and Francis Inc, pp.19–40.

de Roo, G. (2006a). Actor consulting: A model to handle fuzziness in planning. In: *Fuzzy Planning*. Aldershot: Ashgate Publishing, pp.123–144.

de Roo, G. (2006b). Shifts in planning practice and theory: From a functional towards a communicative rationale. In: *Fuzzy Planning*. Aldershot: Ashgate Publishing, pp.89–100.

de Roo, G. (2006c). Understanding fuzziness in planning. In: *Fuzzy Planning*. Aldershot: Ashgate Publishing, pp.109–122.

Drapeau, M. (2002). Subjectivity in research: Why not ? But.... *The Qualitative Report*, 7(3), pp.1–15.
doi:<https://doi.org/10.46743/2160-3715/2002.1972>.

Edelenbos, J., Klijn, E-H., Kort, M. and van Twist, M. (2007). Project- versus procesmanagement in PPS-projecten: welke stijl levert het meeste op? *Bestuurskunde*, 16(1), pp.66–79.

Eriksson, P.E., Larsson, J. and Szentes, H. (2019). Reactive Problem Solving and Proactive Development in Infrastructure Projects. *Current Trends in Civil & Structural Engineering*, 3(2), pp.1–3. doi:<https://doi.org/10.33552/ctcse.2019.03.000558>.

Erkul, M., Yitmen, I. and Çelik, T. (2016). Stakeholder Engagement in Mega Transport Infrastructure Projects. *Procedia Engineering*, 161, pp.704–710. doi:<https://doi.org/10.1016/j.proeng.2016.08.745>.

Flyvbjerg, B. (2006). Five misunderstandings about case-study research. *Qualitative Inquiry*, 12(2), pp.219–245. doi:<https://doi.org/10.1177/1077800405284363>.

Gemeente Groningen (2011). *Raadsvoorstel: Evaluatie doorstromingsmaatregelen zuidelijke ringweg (fase 1)*. [online] Available at: <https://gemeenteraad.groningen.nl/Documenten/Evaluatie-doorstromingsmaatregelen-Zuidelijke-Ringweg-fase-1-1.pdf> [Accessed 2 May 2023].

Giezen, M., Bertolini, L. and Salet, W. (2014). Adaptive Capacity Within a Mega Project: A Case Study on Planning and Decision-Making in the Face of Complexity. *European Planning Studies*, 23(5), pp.999–1018. doi:<https://doi.org/10.1080/09654313.2014.916254>.

Khosravi, A. and Bin Mohammed, M. Abdul Hakim (2012). Why unexpected events of construction projects occur despite using risk management? *Archives Des Sciences Journal*, 65(9), pp.57–75.

Kivilä, J., Martinsuo, M. and Vuorinen, L. (2017). Sustainable project management through project control in infrastructure projects. *International Journal of Project Management*, [online] 35(6), pp.1167–1183. doi:<https://doi.org/10.1016/j.ijproman.2017.02.009>.

Koppenjan, J., Veeneman, W., van der Voort, H., ten Heuvelhof, E. and Leijten, M. (2011). Competing management approaches in large engineering projects: The Dutch RandstadRail project. *International Journal of Project Management*, 29(6), pp.740–750. doi:<https://doi.org/10.1016/j.ijproman.2010.07.003>.

Leendertse, W., de Groot, B. and Busscher, T. (2022). Balancing Hedging and Flexing for Inclusive Project Management. In: M. Mircea and M. Nguyen, eds., *Project Management - New Trends and Applications*. Rijeka: IntechOpen, pp.1–15. doi:<https://doi.org/10.5772/intechopen.102972>.

Ministerie Verkeer en Waterstaat, Gemeente Groningen, Provincie Groningen and Regio Groningen-Assen (2007). *Verkenning Zuidelijke Ringweg Groningen 2e Fase*. [online] *Aanpak Ring Zuid*, pp.9–116. Available at: aanpakringzuid.nl/bibliotheek/plan-historie/ [Accessed 1 May 2023].

Plan van Aanpak Realisatiefase. (2014). [online] *Aanpak Ring Zuid*. Aanpak Ring Zuid. Available at: <https://www.aanpakringzuid.nl/bibliotheek/plandocumenten/> [Accessed 25 Apr. 2023].

Projectteam Netwerkanalyse (2006). *Netwerkanalyse Groningen-Assen 2030*. Regio Groningen-Assen, pp.8–92.

Sohi, A.J., Bosch-Rekvelde, M. and Hertogh, M. (2020). Four stages of making project management flexible: insight, importance, implementation and improvement. *Organization, Technology and Management in Construction: an International Journal*, 12(1), pp.2117–2136.
doi:<https://doi.org/10.2478/otmcj-2020-0008>.

Sohi, A.J., Hertogh, M., Bosch-Rekvelde, M. and Blom, R. (2016). Does Lean & Agile Project Management Help Coping with Project Complexity? *Procedia - Social and Behavioral Sciences*, 226, pp.252–259. doi:<https://doi.org/10.1016/j.sbspro.2016.06.186>.

Sun, L. and Bach, C. (2014). *Influencing Factors in the Decision and Management Sciences*. Breda: University of Applied Sciences.

Szentesi, H. and Eriksson, P.E. (2015). Paradoxical Organizational Tensions between Control and Flexibility When Managing Large Infrastructure Projects. *Journal of Construction Engineering and Management*, 142(4), pp.1–10. doi:[https://doi.org/10.1061/\(ASCE\)CO.1943-7862.0001081](https://doi.org/10.1061/(ASCE)CO.1943-7862.0001081).

van Buuren, M.W. (2006). *Competente besluitvorming. Het management van meervoudige kennis in ruimtelijke ontwikkelingsprocessen*. [PhD Thesis] pp.1–296. Available at: https://www.researchgate.net/publication/241861154_Competente_besluitvorming_het_management_van_meervoudige_kennis_in_ruimtelijke_ontwikkelingsprocessen [Accessed 5 May 2023].

van Geet, M.T., Lenferink, S., Arts, J. and Leendertse, W. (2019). Understanding the ongoing struggle for land use and transport integration: Institutional incongruence in the Dutch national planning process. *Transport Policy*, 73, pp.84–100. doi:<https://doi.org/10.1016/j.tranpol.2018.11.001>.

Verweij, S. (2014). Achieving satisfaction when implementing PPP transportation infrastructure projects: a qualitative comparative analysis of the A15 highway DBFM project. *International Journal of Project Management*, 33(1), pp.189–200. doi:<https://doi.org/10.1016/j.ijproman.2014.05.004>.

Verweij, S. and Gerrits, L.M. (2015). How Satisfaction Is Achieved in the Implementation Phase of Large Transportation Infrastructure Projects. *Public Works Management & Policy*, [online] 20(1), pp.5–28. doi:<https://doi.org/10.1177/1087724x13518743>.

Westerveld, F. and Hertogh , M. (2013). De veilige illusie van de beheersbaarheid . *M&O*, [online] pp.22–35. Available at: <https://docplayer.nl/538340-De-veilige-illusie-van-de-beheersbaarheid.html> [Accessed 14 Feb. 2023].

Chapter 9 Appendices

9.1 Interview Guide

Allereerst bedankt dat je wil deelnemen aan mijn onderzoek. Ben je op de hoogte van alle interview rechten? Mag ik dit onderzoek opnemen? Het onderzoek gaat over hoe infrastructuur projecten om kunnen gaan met onverwachtse gebeurtenissen en veranderende omstandigheden.

Persoonlijke informatie:

- Wie ben je en wat is je functie op het project van de Zuidelijke Ringweg in Groningen? Hoeveel jaar zit je al op dit project.

Hoofdvraag:

- **Kun je een onverwachtse gebeurtenis opnoemen, waar je mee te maken hebt gehad?** (Onverwachtse gebeurtenissen kunnen van alles zijn waardoor de situatie verandert:
 - Technologische veranderingen
 - Plotselinge veranderingen in voorkeur van de stakeholders met wie je samenwerkt
 - Tegenvallen op het gebied van bouwwerkzaamheden

Verdiepingsvragen:

- **Hoe heeft deze gebeurtenis de situatie veranderd?** (Idee is dat nieuwe informatie, of gebeurtenissen, de huidige situatie veranderen waardoor, dingen die voorheen logisch waren dit nu niet meer zijn)
- Hoe is hier mee omgegaan? Wat is er allemaal gedaan?
- Wie waren er betrokken in het proces? En wat waren de belangen? (prioriteiten)
- Hoe is de beslissing tot stand gekomen?
- Ben je tevreden met hoe het is gegaan?
- Hoe had je het liever gehad?
- Wat heb je ervan geleerd?

Eindvragen:

- Heb je nog andere op- of aanmerkingen, of dingen die je kwijt wil?

Heel erg bedankt voor je deelname.

9.2 Interview Codes



Figure 8. Codes created for analysing the interviews.

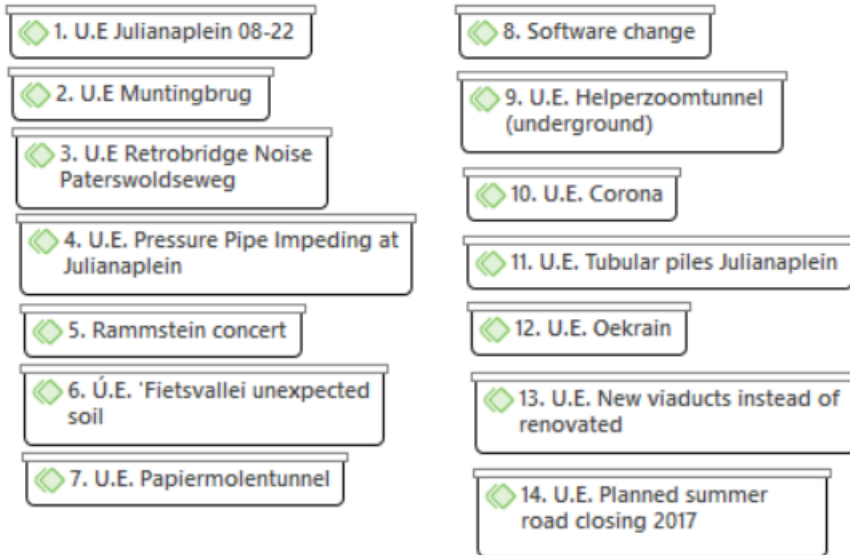


Figure 9. Coding of the unexpected events

9.3 Network group



Figure 10. Network group example